THE NEW [illegible]

PRACTICAL NAVIGATOR;

BEING AN

EPITOME OF NAVIGATION,

CONTAINING THE DIFFERENT METHODS OF WORKING THE

LUNAR OBSERVATIONS,

AND ALL

THE REQUISITE TABLES

USED WITH THE

NAUTICAL ALMANAC,

IN DETERMINING THE

LATITUDE AND LONGITUDE,

AND

KEEPING A COMPLETE RECKONING AT SEA:

ILLUSTRATED BY

PROPER [illegible] AND EXAMPLES;

THE WHOLE EXEMPLIFIED IN A

JOURNAL

KEPT FROM

ENGLAND TO THE ISLAND OF TENERIFFE:

ALSO,

The Substance of that EXAMINATION, every CANDIDATE for a COMMISSION in the ROYAL NAVY, and OFFICER in the HONOURABLE EAST INDIA COMPANY'S SERVICE, must pass through, previous to their being appointed: This, with the SEA TERMS, are particularly recommended to the ATTENTION of all YOUNG GENTLEMEN designed for, or belonging to the SEA.

So that THIS BOOK, and the NAUTICAL ALMANAC, will be found fully sufficient for the SEAMAN and TEACHER'S USE, and is rendered easy to any common Capacity.

THE TWELFTH EDITION,

CONSTRUCTED ON A NEW PLAN,

AND ILLUSTRATED WITH COPPER-PLATES.

By JOHN HAMILTON MOORE,

TEACHER OF NAVIGATION, HYDROGRAPHER AND CHART-SELLER TO HIS ROYAL HIGHNESS THE DUKE OF CLARENCE.

London:

PRINTED FOR AND SOLD BY B. LAW, IN STATIONERS' COURT;
G. G. AND J. ROBINSON, PATER-NOSTER ROW;
AND THE AUTHOR, ON TOWER HILL.

1796.

[*This Book is entered at Stationers' Hall.*]

National Oceanic and Atmospheric Administration

Rare Books from 1600-1800

ERRATA NOTICE

One or more conditions of the original document may affect the quality of the image, such as:

Discolored pages
Faded or light ink
Binding intrudes into the text

This has been a co-operative project between the NOAA Central Library, the Climate Database Modernization Program, National Climate Data Center (NCDC) and the NOAA 200th Celebration. To view the original document, please contact the NOAA Central Library in Silver Spring, MD at (301) 713-2607 x124 or at Library.Reference@noaa.gov

HOV Services
Imaging Contractor
12200 Kiln Court
Beltsville, MD 20704-1387
April 14, 2008

U. S. COAST AND GEODETIC SURVEY
LIBRARY
AUG 1940
43858

TO THE RIGHT HONORABLE

THE LORDS COMMISSIONERS OF THE ADMIRALTY

OF

GREAT BRITAIN.

AUG 1994

MY LORDS,

As your LORDSHIPS preside over the NAVY of the FIRST MARITIME POWER IN THE UNIVERSE, any Attempt tending to improve NAVIGATION will doubtless meet with your unfeigned Approbation and Encouragement. Depending upon your LORDSHIPS, as Lovers of every public-spirited Work, I have presumed, with the utmost Respect, to lay this SYSTEM OF PRACTICAL NAVIGATION under your Protection: and do assure your LORDSHIPS, that my Intention is more to serve the Public, than any private Emolument of,

MY LORDS,

Your LORDSHIPS'

Most obedient,

And humble Servant,

JOHN HAMILTON MOORE.

LONDON, *Jan.* 30, 1796.

PREFACE.

THE general design of this NEW PRACTICAL NAVIGATOR is to comprise every thing essential to form the Teacher, instruct the Pupil, and assist the Mariner, so as to render them proficients in the Nautical Art, both with respect to theory and practice.

By recurring to former treatises, the productions of others, as well as my own (of which Eleven Editions have passed through public favour) I presume that I have been enabled to make gradual improvements arising progressively, as my knowledge became extended through investigation, and my judgment matured by experience.

My grand object in this my New and last Treatise, has been to be concise yet comprehensive, explanatory in my Definitions, perspicuous in my Rules and Examples; and, in a word, most carefully attentive to every particular in theory and practice, that can further the grand design of the WORK, which is to facilitate the acquisition of an art that has been the object of my pursuits throughout life; and in which I have laboured with indefatigable assiduity.

To obtain this important purpose, I found it necessary to revise with the utmost care, circumspection, and caution, all the Treatises on Navigation now extant, to place them in a comparative view, and to discriminate their merits and defects, so as to adopt the former and reject the latter. Many of these works appeared too voluminous and elaborate, and the Tables necessary to the practical part of Navigation to be scattered throughout different books; hence, I conceived it might be both useful and acceptable, to bring these Tables into one point of view, by reducing them to a single volume, and numbering and arranging them in a more methodical manner than hitherto done, so that time would be saved in referring to them, and operations in the art greatly expedited thereby.

Upon a candid though circumspect review of the Tables in the NEW PRACTICAL NAVIGATOR, I presume they will be found not only more extensive but more correct than have ever before appeared in a work of this kind.

To

To assist the Learner in that very essential branch of Navigation, the keeping a complete Reckoning at Sea, I have subjoined to this work a compendium of oblique-angled Trigonometry, with its application in oblique and current Sailing, and also Surveys of Coasts and Harbours, and other particulars necessary to be known by every Practitioner in the art.

Such is the PLAN of the WORK now offered to the public, which I hope will obtain a decided preference, as it comprises, in a small compass, every useful Discovery and Improvement made by Theoretical as well as Professional Men, through a long series of study, observation and practice; and the whole laid down in a manner as concise, plain, and intelligible, as the nature of the subject can possibly admit.

Upon the whole, I may venture to affirm, that this BOOK, with the NAUTICAL ALMANAC, will be found in every respect adequate to the purpose both of the Teacher and Scholar, as well as fully adapted to the use and advantage of the industrious Mariner, as in the forming of it, I have occasionally considered myself as acting in those three several capacities, and in conformity to the same, have respectively adapted my remarks, observations, and instructions; keeping in view throughout the whole, uniformity of method and facility of operation. From pursuing this plan, the expence of purchasing several books will be obviated, loss of time and many inconveniencies will be prevented; and such advantages accrue to those immediately concerned in having recourse to it, as I trust will justify me in submitting it to the approbation of the public, and secure to me their sanction and encouragement, to merit which has been my highest ambition, and the ultimate view of my pursuits throughout life.

I am well aware that there are persons, who, to shew their own superior abilities in an obscure Club, will quibble and carp at some parts, and say, that they see nothing new, &c. To such Critics it may be answered, that a Triangle was a Triangle before the days of Euclid, and so it is now; but, if the arranging, digesting, simplifying, and rendering Navigation attainable to the most common capacity, with all the useful Tables contained in one Book, which was never done before, it certainly may be called New, or at least an Improvement. How far I have succeeded is left to the judicious Mariner to determine.

The Work may be more fully seen, by reading the following Contents.

CONTENTS.

CONTENTS.

	PAGE
GEOMETRICAL Definitions	1
Geometrical Problems	5
Projection of the Lines of Sines, Tangents, and Secants, on the Plane Scale	12
Description and Use of Gunter's Scale	14
On the Use of the Sector	17
The Use of the Logarithms	19
Multiplication by Logarithms	22
Division of Logarithms	22
To Extract the Root in Logarithms	23
The Application of Logarithms in measuring all Kinds of Packages taken on Board Ships	24
The common Way of finding a Ship's Tonnage at London	26
To find the Logarithms of Sines, Tangents, and Secants, belonging to any Number of Degrees and Minutes required	26
To find the Degrees, Minutes, and Seconds, corresponding to any given Logarithm	27
To find the Logarithm of the Sine or Co-sine, for Degrees, Minutes, and Seconds	27
To find the Arithmetical Complement of any Logarithm	28
Useful Propositions in Navigation	29
Trigonometry	31
Introduction to Navigation	42
Navigation	50
The Mariner's Compass	54
Plane Sailing	55
Traverse Sailing	65
Middle Latitude Sailing	77
Mercator's Sailing	91
Construction and Use of Mercator's Chart	118
Of Winds	124
Of Tides	130
Table for finding the Time of High Water at any Place	141
Tide Table	145
Of the Log-Line and Half-Minute Glass	146
Description and Use of Hadley's Quadrant	150
To work an Observation, or to find the Latitude of a Place by the Tables of the Sun and Star's Declination, or the Zenith Distance	155
The Variation of the Compass	158
To find the true Amplitude	159
To find the true Azimuth	161
The Method of Keeping a Ship's Reckoning at Sea	168

Rules for correcting the Dead Reckoning — — 175
Four separate Days' Work — — — 184
Journal of a Voyage from London to Madeira and Teneriffe 188
Abstract of the Journal — — — 205
The Method of finding the Latitude at Sea by two Altitudes 206
To find the Latitude by one Altitude of the Sun, when the Time is not more distant than one Hour from Noon — 217
To find the Latitude by the Meridian Altitude of the Moon 219
To find the Latitude by the Meridian Altitude of a Planet 221
Of the Parallax — — 221
To reduce the Sun's Declination from Greenwich, to any other Meridian — — 223
To find the apparent Time, and thereby regulate the Going of the Watch by equal Altitudes of the Sun — 225
To find the apparent Time by the Sun's Altitude — 226
To find the apparent Altitude of a fixed Star — 229
Another Method of finding the apparent Time — 232
How to know the Stars — — 234
The Method of finding the Longitude at Sea — 235
To take the Observations requisite for determining the Longitude 236
To measure the Distance between the Sun and Moon --- 237
To take the Distance between the Moon and Star — 237
To reduce the observed Distance of the Moon from the Sun or a Star to the true Distance — — 239
Having the apparent Altitudes of the Objects, and their apparent Distance, to find their true Distance — 241
Having the true Distance and Time to determine the Longitude 242
Six Examples worked for finding the Longitude --- 243
Rule to find the true Distance — 249
To find the Sun's true Altitude — — 252
To find the Altitude of the known or fixed Stars — 253
To find the true Altitude of the Moon's Centre — 254
To find the Longitude by Jupiter's Satellites — 255
To find the Longitude by the Eclipses of the Moon — 256
Oblique Trigonometry — — — 257
Oblique Sailing — — 260
Manner of Surveying Sea Coasts and Harbours — 265
To take a Draft Sailing along Shore — — 266
To Survey an Harbour by Observation on Shore — 269
To reduce a Chart — — 271
Of the Curvature of the Earth — — 273
Current Sailing — — 274
Explanation of the Rigging of a first-rate Ship --- 278
Explanation of the most useful Sea Terms — 279
Examination of a young Sea Officer — — 288
Remarks calculated to assist Commanders when coming into the British Channel — 307

THE TABLES ARE ARRANGED IN THE FOLLOWING ORDER.

	TABLE
Meridional Parts	I
Difference of Latitude and Departure for Points	II
Ditto for Degrees	III
Logarithms	IV
Artificial Sines, Tangents, and Secants	V
Finding the Latitude by two Altitudes of the Sun	VI
For computing the Altitude and Time when the Sun or Star is more than six Hours distant from the Meridian	VII
Natural Sines	VIII
Proportional Logarithms	IX
For computing the Effects of Parallax on the Moon's Distance from the Sun or fixed Stars	X
Turning Degrees and Minutes into Time, and the contrary	XI
The Refraction of the Heavenly Bodies in Altitude	XII
Dip of the Horizon	XIII
Sun's Parallax in Altitude	XIV
Augmentation of the Moon's Semidiameter	XV
Dip of the Sea	XVI
Sun's Declination	XVII
For reducing the Sun's Declination	XVIII
Sun's Right Ascension	XIX
Right Ascension and Declination of the fixed Stars	XX
Amplitudes	XXI
Sun, Moon, and Star's Rising and Setting	XXII
Distance of Terrestrial Objects	XXIII
Latitudes and Longitudes of Places	XXIV

CAUTION TO SEAMEN.

☞ The RAPID SALE my former Publications have had, has induced persons in *Scotland*, *Ireland*, and other *places*, to copy them, many of which have been distributed in different parts of the world, particularly in the *East Indies* and *America*;—in order to prevent such *spurious* and *erroneous* Editions being imposed on the Public in future, a striking likeness of the Author, drawn by MULLER, and engraved by BAKER, will be prefixed to each Book of this NEW WORK.

GEOMETRICAL DEFINITIONS.

GEOMETRY is the Science which treats of the Deſcription, Properties, and Relations of Magnitudes in general; of which there are three Kinds or Species, viz. a Line, which has only Length without either Breadth or Thickneſs; a Superficies, comprehended by Length and Breadth; and a Solid, which has Length, Breadth, and Thickneſs.

I.

A point conſidered mathematically, is incapable of being divided, and therefore hath no parts, or it is the ſmalleſt part of ſpace that can be aſſigned, and may be conceived ſo infinitely ſmall, as to be void of length, breadth, or thickneſs, being always denoted by a dot, as at A.

A

II.

A right line is the neareſt diſtance between two points which limits its length, without any ſuppoſed breadth, or thickneſs, as A C; it may be ſupppoſed to be the fluxion of a point.

A——————C

III.

A plane ſuperficies is that which lies evenly between its extreme points, reſembling a ſmooth table, or poliſhed glaſs; bounded by lines having length and breadth: but is conceived to have no depth or thickneſs, and may be conceived to be generated by the fluxion of a right line.

IV.

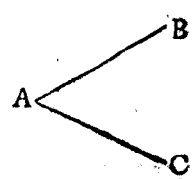
Parallel lines are ſuch as are equally diſtant in all their parts, which extended infinitely on the ſame plane would never meet, as the lines A B, B C.

A——————B

B——————C

V.

A plane angle is the inclination or meeting of two right lines in one point; the point where they meet is called the angular point, and the lines AB and AC are called ſides or legs; it is generally expreſſed by three letters, the middle one always denotes the angular point, as A, and the other two the legs or ſides that include it, as AB or AC.



A

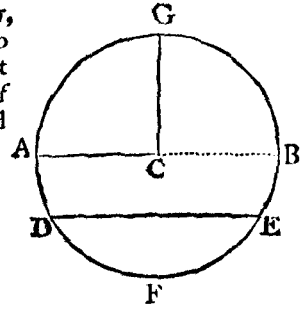
VI. A circle

VI.

A circle is a plane figure, bounded by an uniform curve line, it is ordinarily described by a right line, taken with a pair of compasses; *one point thereof being fixed, whilst the other is turned round to the* place where the motion first began; the fixed point is called the centre, and the line described by the other point is called the circumference.

VII.

The radius of a circle, or semidiameter, is a right line drawn from the centre to the circumference, as A C; or it is that line which is taken between the points of the compasses to describe the circle; and is half its diameter A B.



VIII.

An arch of a circle is any part or portion of the circumference, as D F E.

IX.

A chord of a circle is the subtence of an arch, or it is a right line joining the ends of an arch; it divides the circle into two unequal parts, called segments, and is a chord to them both, as D E is the chord of the arches D F E and D G E.

X.

A semicircle, or half a circle, is a figure contained under the diameter, as A G B or A F B.

XI.

A quadrant is half a semicircle, or one-fourth part of the whole circle, as the figure C A G.

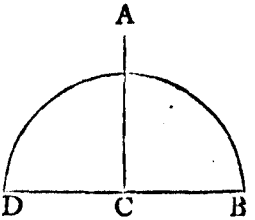
NOTE. All circles, whether great or small, are actually, or supposed to have their circumference divided into 360 equal parts, called degrees, and each degree into 60 equal parts, called minutes, and each minute into 60 equal parts, called seconds, and so on into thirds, fourths, &c.

All angles are measured by an arch of a circle, described round their angular points, with the chord of 60 degrees, taken from the line of chords on the plane scale, and are estimated greater or less according to the number of degrees contained betwixt their legs; and though legs be made longer or shorter, still the angle between them continues the same.

A right

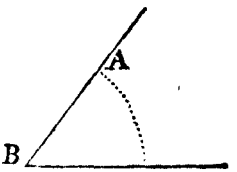
XII.

A right line is ſaid to be PERPENDICULAR to another line, when it falls upon it, ſo as to make the angles on each ſide of it equal, ſuch as the figure A B C D, where the angle ACD is equal to the angle ACB, each a quadrant, or right angle, containing 90 degrees.



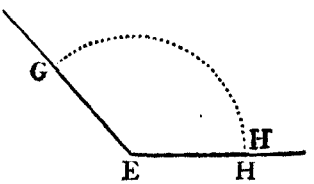
XIII.

An ACUTE ANGLE is leſs than a right angle, and is that which contains leſs than 90 degrees, as A B C.



XIV.

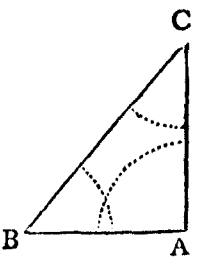
An OBTUSE ANGLE is greater than a right angle, and is that which contains more than 90 degrees, as the angle G E H.



The feweſt number of right lines that can include a ſpace are three, which form a figure called a triangle, or three-cornered figure, and conſiſts of ſix parts, viz. three ſides and three angles: it is diſtinguiſhed into three ſorts, viz. a right-angled triangle, an obtuſe-angled triangle, and an acute-angled triangle.

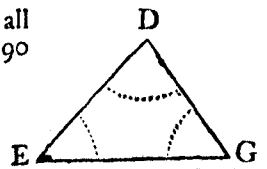
XV.

A RIGHT-ANGLED TRIANGLE has one of its angles right, or containing 90 degrees; the ſide oppoſite the right angle is called the hypothenuſe; and the other two ſides are called legs; that which ſtands upright, is called the perpendicular, and the other the baſe; thus B C is the hypothenuſe, A C the perpendicular, and A B the baſe: the angles oppoſite the two legs are both acute.



XVI.

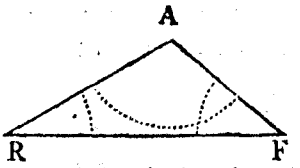
An ACUTE-ANGLED TRIANGLE has all its angles acute, or none of them equal to 90 degrees, as D E G.



XVII. An

XVII.

An OBTUSE-ANGLED TRIANGLE has one of its angles obtuse, or greater than 90 degrees, as R A F, the other two angles are acute, or less than 90 degrees, as in the triangle R A F.



NOTE. All triangles that are not right-angled, whether they are acute or obtuse, are in general terms called oblique-angled triangles, without any other distinction. The sum of the two acute angles of a right-angled triangle make 90°, the sum of all the angles of any triangle 180°. If from 180 you take the sum of the other two angles, the remaining angle will be found; but in a right-angled triangle, if from 90 you subtract the one angle, the other angle shall remain.

MARKS OR CHARACTERS.

+ Signifies *more*, or the Sign of Addition; it shews that whatever numbers or quantity follow this Sign must be added to those that go before it, thus 9+8, that is, 9 added to 8. Or, A+B implies that the quantities represented by A and B are added.

− Signifies *less*, and is used as the Sign of Subtraction, it denotes that the number following it must be subtracted from those going before it, as 7 − 5, or 5 subtracted from 7.

× The Sign of Multiplication, and shews that the numbers placed before and after are to be multiplied, thus 7 × 9, that is, 7 multiplied by 9, which makes 63, and 7 × 8 × 2 which makes 112.

÷ This Mark stands for Division, and signifies that the Number that stands before it is to be divided by the number following it, as 72÷12 shews that 72 is to be divided by 12. Or thus, $\frac{72}{12}$

= The Sign of Equality, it shews that the numbers or quantities placed before it are equal to those following it, thus, 8 × 12=96. Or 8 multiplied by 12 is equal to 96, and $\overline{7+2} \times 4=36$.

: :: : Proportion, and is read thus, 7 : 14 :: 10 : 20 that is, as 7 is to 14 so is 10 to 20. Or, A : B : : C : D that is, as A is to B so is C to D.

° Signifies Degrees, thus 45° shews the number 45 degrees.

′ Signifies Minutes, thus 24′ or minutes.

″ Signifies Seconds, thus 44″ or 44 seconds.

S. Stands for Sine.

Sec. Stands for Secant.

Tan. for Tangent.

Each of these last with Co. before them, signify the compliment, as Co-sine, Co-tangent, Co-secant.

< Signifies Angle.

<ᵈ Angled with an s at top, Angles <ˢ

△ Signifies Triangle, or △ˢ

Z Is frequently put to signify the sum of any two lines or numbers.

Y Signifies the difference.

GEOME-

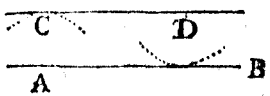
GEOMETRICAL PROBLEMS,

USEFUL IN *NAVIGATION.*

A PROBLEM *is a practical* PROPOSITION, *in which Something is proposed to be done or effected.*

PROBLEM I.

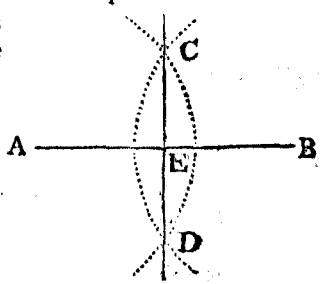
To draw a Right Line parallel to a given Right Line, to any given Distance, as at the Point D.



WITH a pair of compasses take the nearest distance between the point D and the given right line A B, with that distance set one foot of the compasses any where on the line AB, as at A, and draw the arch C, from the point D draw a line so as just to touch the arch C, and it is done, for the line C D will be parallel to the line A B, and at the distance of the point given D, as was required.

PROBLEM II.

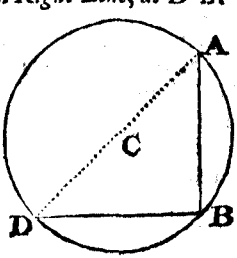
To bisect or divide a given Line into two equal Parts.



With any distance in your compasses greater than half the line A B, with one foot in B, describe an arch with the same distance, and one foot in A, describe an arch that will cut the former arch in C and D; through C and D draw a line, and that will cut A B in E; and the line A B will be divided at the point E into two equal parts.

PROBLEM III.

To erect a Perpendicular on the End of a given Right Line, as D B.

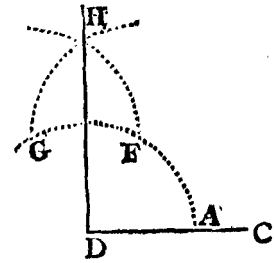


With any distance in your compasses, as from B to C, with one foot in C, describe the circle BDA, so that it may just touch the end of the given line, at B: from where the circle cuts the line, as at D, draw a line through the point C, to cut the circle in A, from A draw the line AB, which will be the perpendicular required.

Or thus,

With

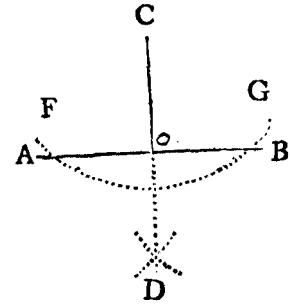
With any convenient diſtance in your compaſſes, as from D to A, with one foot in D, deſcribe the arch A F G, ſet off the ſame diſtance from A to F, and from F to G; upon F and G deſcribe two arches interſecting one another in H; draw a line from H to D, and it is done; for HD will be the perpendicular required.



PROBLEM IV.

From a given Point, as C, *to let fall a Perpendicular on a given Right Line* A B.

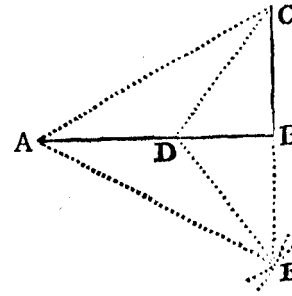
With one foot in C, deſcribe an arch to cut the given line A B in F and G, with one foot in G deſcribe an arch, and with the ſame diſtance, and one foot in F, deſcribe an arch to cut the former in D, from C to D draw a line, and it is done; for C D will be the perpendicular required.



PROBLEM V.

From a given Point to let fall a Perpendicular on a given Line, when the ſaid Perpendicular is to fall ſo near the End of the given Line that it cannot be done as above, as at the Edge of a Sheet of Paper, &c.

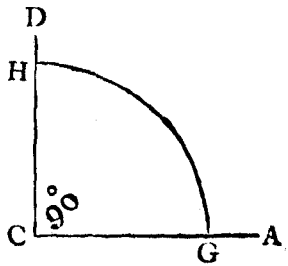
Let C be the point from which the perpendicular is to be let fall on the line A B, from any point in the line AB, as at A; with the diſtance A C, deſcribe an arch E, chuſe any other point in the line A B, as D, and with the diſtance DC deſcribe another arch interſecting the former in E, join C E, and it is done; for CB will be the perpendicular required.



PROBLEM VI.

To make Plane Angles, and first a Right Angle, containing 90 Degrees.

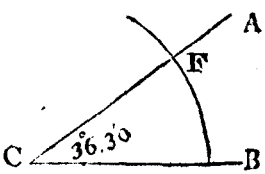
Draw the line C A on C, erect a perpendicular CD, and it is done; for the angle D C A is an angle of 90°. Or thus, On the point C, with the chord of 60°, describe an arch G H, and set off thereon from G to H, the distance of the chord of 90°, and from C through H draw C H D which will form the angle D C A, of 90° required.



PROBLEM VII.

To make an Acute Angle equal to any Number of Degrees. Suppose 36° 30′.

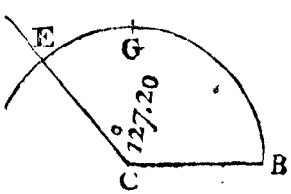
Draw the Line BC, with the chord of 60° or radius, in your compasses, and one foot on C, draw the arch FB, on which set off 36° 30′, or 36½, from B to F, through F and the center C, draw the right line A C, and it is done; for the angle ACB will be an angle of 36° 30′, as was required.



PROBLEM VIII.

To make an Obtuse Angle, that shall contain 127° 20′.

Draw CB, take the chord of 60° in your compasses, and with one foot on C, describe an arch; now as we can take off only 90°, set off 90° from B to G, and from G to E set off the excess above 90°, which is 37° 20′, or 37⅓; draw the line CE, and it is done; for the angle ECB will be an angle of 127° 20′.

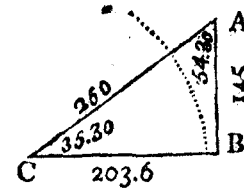


PROBLEM

PROBLEM IX.

The Angles and Hypothenuse of a Right-angled Triangle given, to find either of the Legs.

Given the hypothenuse 250 leagues, the angle opposite the base 54° 30′, consequently the other angle 35° 30′; the base and perpendicular are required.



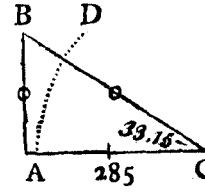
Draw the line C B, and at C make an angle equal to 35° 30′ by drawing the line C A, take 250 from any convenient scale of equal parts, and set it off from C to A, from A let fall the perpendicular A B, to cut the line C B, and it is done; for A B measured on the same scale, gives 145, and CB 203.6 leagues.

NOTE. The two acute angles of a right-angled triangle make 90 degrees.

PROBLEM X.

The Angles and one Leg of a Right-angled Triangle being given, to find the Hypothenuse and the other Leg.

The angle A C B 33° 15′, the leg A C 285 miles, to find the hypothenuse, and the other leg A B.

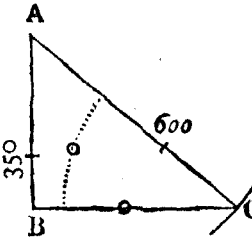


Draw the base A C, lay off on it 285 from your scale of equal parts, from A to C; on A erect the perpendicular AB, with the chord of 60° sweep the arch A D, and on it set off 33°¼, from your line of chords from A to D, through D and C, draw the right line B C, then B C will measure 341 nearly, and B A 187 nearly, on the same scale of equal parts that AC was taken from.

PROBLEM XI.

The Hypothenuse and one Leg given, to find the Angles and the other Leg.

The leg A B 350, the Hypothenuse 600 given, to find the angles, and leg BC.

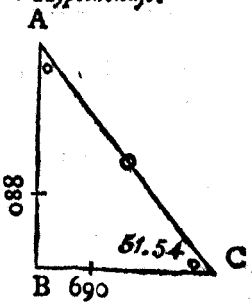


Draw the base C B, on B erect the perpendicular A B, on which set off 350 from B to A, on the point A with an opening of 600. Draw an arch to cut the line BC, in the point C draw AC, and it is done; for the angle ACB will measure 35° 41′ on the line of chords, and B C will measure 487 nearly, on the same scale of equal parts before used.

PROBLEM

PROBLEM XII.

The Legs given, to find the Angles and the Hypothenuse.



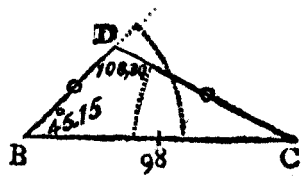
The leg AB 880 and BC 690 given, to find the angles A and C, and the hypothenuse AC.

Draw the base BC, on B erect the perpendicular AB, make BC equal to 690, and AB equal to 880; join AC, and it is done; for the angle C being measured as before, will be found as per figure, and the hypothenuse will measure 1118,2.

PROBLEM XIII.

Two Angles and one Side, of an Oblique-angled Triangle given, to find either of the other Legs.

The angle BDC 108° 30′, and CBD 45° 15′ and consequenly the angle BCD 26° 15′, and the leg BC 98 given, to find the sides CD and BD.

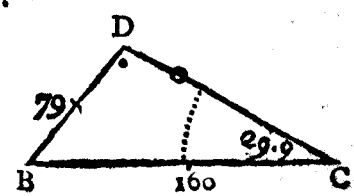


Draw the line BC, which make equal to 98, on the point B describe an angle of 45° 15′, then add 45° 15′ to 108° 30′, and the sum 153° 45′ taken from 180, the remainder is the angle DCB = 26° 15′; from the point C describe an arch with the chord of 60, and set off 26° 15′, and it is done; for the side DB will be 46 nearly, and DC 73,4, as was required.

PROBLEM XIV.

Two Sides and an Angle opposite to one of them given, to find the other Angle and the third Side.

The side BC 160, and BD 79, and the angle C 29° 9′ given to find the angle D, and the side CD.



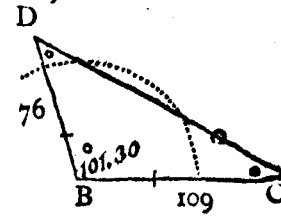
Draw the line BC equal to 160, on C make the angle DCB equal to 29° 9′, take 79 in your compasses, and with one foot on B, lay the other upon the line CD, draw the line BD, and it is done; for the angle D will be 99° 25′ the angle B 51° 26′, and the side DC 127 nearly.

PROBLEM XV.

Two Sides and their contained Angle given, to find either of the other Angles, and the third Side.

The side BC 109 BD 76 and angle CBD 101° 30′ given, to find the angles BDC or BCD and the side CD,

Draw the line BC, which make equal to 109; on B describe an arch on which set off from BC towards D 101° 30′ then, draw the line BD equal to 76, join DC, and it is done; for the angle BDC will be 47° 32′ the angle BCD 30° 58′, and the side DC will be 145, as was required

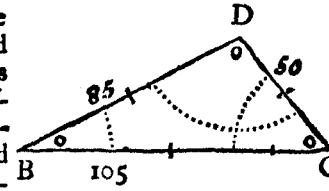


PROBLEM XVI.

Three Sides given, to find the Angles.

The sides BC 105, BD 85, and CD 50 miles given, to find the angles BDC, BCD, and CBD.

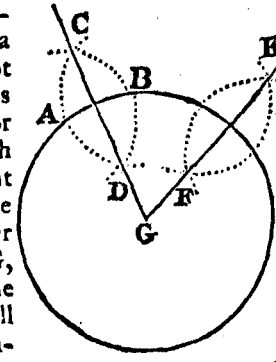
Draw the line BC equal to 105, take CD equal to 50 in your compasses, and with one foot in C, describe an arch as at D, then take BD 85 in your compasses, and with one foot in B, cut the former arch in D, join BD and DC, and it is done; for the angle B being measured, will be found 28° 4′, the angle C 53° 8′, which being added together, is 81° 12′, their sum subtracted from 180°, leaves angle D 98° 48′, as was required.



PROBLEM XVII.

To find the Centre to a given Circle.

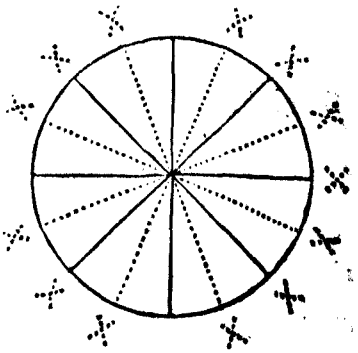
With any radius, and one foot in the circumference as at A, describe an arch of a circle, as CBD, then removing the foot from A to where it cuts the given circle, as at B, on B describe another arch, cutting or crossing the former, as C A D, and through the points of intersection draw the right line C D, which will give one right line passing through the centre; in like manner may another right line be drawn, as E F G, which shall cross the first right line at the center required, for any two diameters will always cut or cross one another in the central point.



PROBLEM

PROBLEM XVIII.

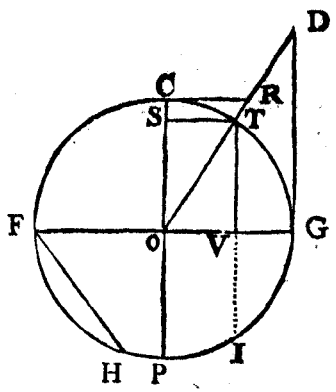
To divide a Circle into any Number of equal even Parts, as 4, 16, 32.



First draw the diameter through the center, which will divide it into two equal Parts, bisect the diameter with another right line perpendicular thereto, and the circle will be divided into four equal parts or quadrants; bisect each of these quadrants again by right lines drawn through the center and it will be divided into eight equal parts, and so may you continue on your bisections any number of times, that is, 8, 16, 32, &c. doubling the number of even parts.

This problem is useful in constructing the Mariner's Compass.

I. A chord or subtense of an arch, is a right line that divides the circle into two unequal parts, and is a chord to them both, as F H, T I.



II. A right sine of an arch, is a line drawn from the end or termination of an arch, perpendicular to the radius, or is half the chord of twice the arch so that T V is the sine of the arch, T G and of the arch T F, the sum of which arches together make 180°, or a semicircle.

III. The versed sine of an arch, is part of the diameter intercepted between the right sine and the arch as V G.

IV. The tangent of an arch is a line drawn perpendicular to the end of the radius, or diameter, just touching the arch, as D G.

V. The secant of an arch, is a right line drawn from the center through the circumference, meeting the end of the tangent line to the same arch, as O D is the secant of the arch T G, to which DG is tangent, also O R is the secant of the arch C T, to which C R is a tangent.

NOTE. Sines, Tangents, Secants, are said to be the measure of so many degrees as the arch contains parts of 360, so that radius being the sine of a quadrant, or a fourth part of the circumference, contains 90 degrees, thus the radius is always equal to the sine of 90°, as is also the tangent of 45° and the chord of 60°.

PROJECTION

OF THE LINES OF

SINES, TANGENTS, AND SECANTS,

ON THE PLANE SCALE.

1ſt. WITH the radius you intend for your ſcale, deſcribe a ſemicircle A D B C, and upon the center C raiſe the perpendicular C D, (which will divide the ſemicircle into two quadrants, AD, BD) continue CD directly to S, and upon B raiſe the perpendicular B T, then draw the right lines B D and A D.

2dly. Divide the quadrant B D into 9 equal parts, then will each of theſe be 10 degrees. Again you may ſubdivide each of theſe parts into ſingle degrees; and theſe again, if your radius admits it into minutes, or ſome aliquot parts of a degree greater than minutes.

3dly. Set one foot of the compaſſes in B and transfer each of the diviſions in the quadrant BD to the right line BD, then is B D a line of chords.

4thly. From the points 10, 20, 30, &c. in the quadrant BD, draw right lines parallel to C D, till they cut the radius C B, then is the line CB divided into a line of ſines, which muſt be numbered from C towards B.

5thly. If the ſame line of right ſines be numbered from B towards C, it will become a line of verſed ſines, which may be continued to 180°, if the ſame diviſions be transferred on the ſame line on the other ſide of the center C.

6thly. From the center C, through the ſeveral diviſions in the quadrant B D, draw right lines till they cut the tangent B T, ſo will the line B T become a line of tangents.

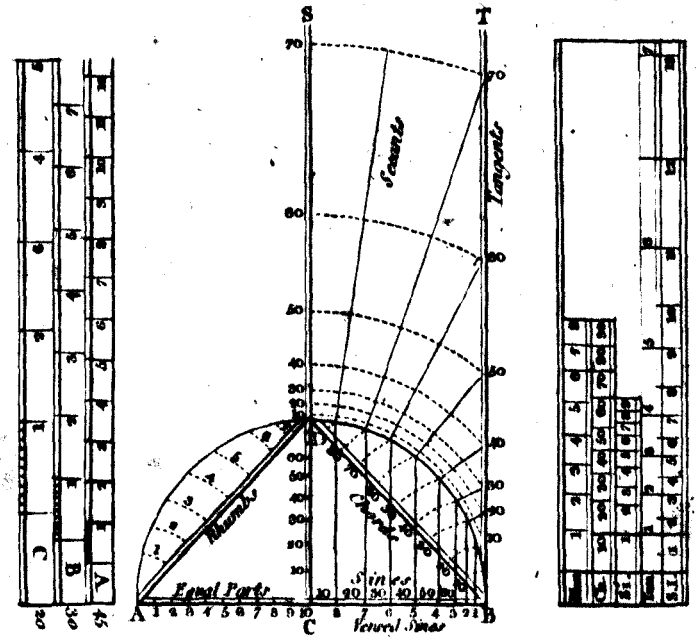
7thly. Setting one foot of the compaſſes in C, extend the other to the ſeveral diviſions 10, 20, 30, &c. in the tangent line B T, and transfer theſe extents ſeverally into the right line C S, then will the line CS be a line of ſecants.

8thly. Right lines drawn from A to the ſeveral diviſions 10, 20, 30, &c. in the quadrant B D, will divide the radius C D into a line of ſemi-tangents.

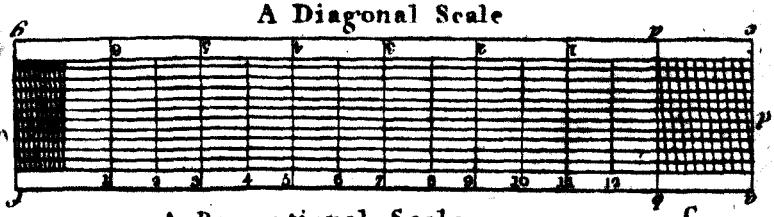
9thly. Divide the quadrant A D into eight equal parts, and from A transfer theſe diviſions ſeverally into the line A D, then is A D a line of rhumbs, each diviſion anſwering to 11° 15′ upon the line of chords.

The

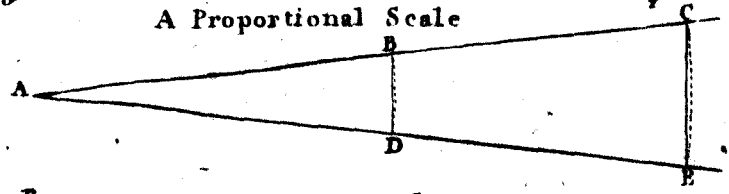
PROJECTION OF THE PLAIN SCALES, &c.

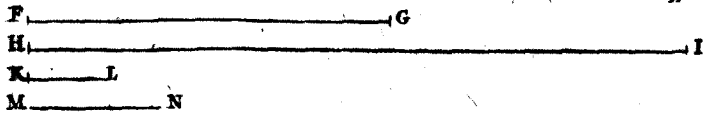


A Diagonal Scale



A Proportional Scale





The use of this line is for protracting and measuring of angles, according to the common division of the Mariner's compass. If the radius A C be divided into 100, or 1000, &c. equal parts, and the lengths of the several sines, tangents, and secants corresponding to the several arches of the quadrant be measured thereby, and this numbers be set down in a table, each in its proper column, you will by these means have a triangular canon of numbers, by which the several cases in Trigonometry may be solved, the right lines graduated as above, being placed severally upon a ruler, form the instrument called the Plane Scale: by which the lines and angles of all triangles may be measured. All right lines, as the sides of plane triangles, &c. when they are considered simply as such, without having any relation to a circle, are measured by scales of equal parts, one of which is subdivided equally into 10, and this serves as a common division to all the rest. In most scales an inch is taken for a common measure, to determine their largeness and number of parts: what an inch is divided into, is generally set at the end of the scale, as in the scales A, B, and C; the numbers 10, 20, 30, 45, shew that so many parts of the scales A, B, C, are contained in an inch. By any scale of equal parts, divided as above, any number less than 100 may be readily taken; but if the number should consist of three places of figures, the value of the third figure can only be guessed at; wherefore in these scales it is better to use such a scale as D, called a diagonal scale, by which any number of three figures may be exactly found.

Having prepared a ruler of convenient breadth for your scale, (which may be an inch more or less) First, near the edges thereof, draw two right lines, *af*, *cg*, parallel to each other; then divide one of these lines as *af*, into equal parts, according to the largeness you intend your scale; and through each of these divisions draw perpendicular right lines as far as the line c g; next divide the breadth into 10 equal parts, and through each of these divisions draw right lines parallel to the former af and cg; again divide the length a, b, c, d, each into 10 equal parts, and from the point to the first division in the line d q, draw a right line; then, parallel to that line, draw right lines through all the other divisions, and the scale is done.

Besides the lines already mentioned, there is another on the plane scale marked ML, which is joined to a line of chords; and shews how many miles easting or westing make a degree of longitude in every latitude; these several lines are generally put on one side of a ruler, two feet long; and on the other side are laid down a scale of the logarithms of the sines, tangents, and numbers, which is commonly called Gunter's Scale, and as it is of general use, it requires a particular description.

DESCRIPTION

DESCRIPTION AND USE

OF

GUNTER'S SCALE.

WHILE the reader is perusing the following, it is proper he should have a GUNTER'S SCALE before him.

Gunter's Scale hath set upon it these eight Lines following.

1st. Sine rhumbs marked (SR) is a line which contains the logarithms of the natural sine of every point and quarter point of the Mariner's Compass figured from the left hand towards the right, with 1, 2, 3, 4, 5, 6, 7, to 8, where is a brass pin, and where it can be done, into halves and quarters.

2d. Tangent rhumbs marked (TR) also corresponds to the logarithm of the tangent of every degree of the said compass, and is figured 1, 2, 3, 4, at the center, where there is a pin, and from thence towards the left hand with 5, 6, 7, it is also divided, where it can be done into halves and quarters.

3d. The Line of numbers marked (Num.) contains the logarithms of the numbers, and is figured thus; near the left hand it begins at 1, and towards the right hand is 2, 3, 4, 5, 6, 7, 8, 9; and then 1 is the middle, at which is a brass center pin, going still on 2, 3, 4, 5, 6, 7, 8, 9, and 10 at the end, where there is another center pin; (as this line is generally much used, it requires a larger description). The first one may be counted for 1, or 10, or 100, or 1000, and then the next 2 is accordingly 2, or 20, or 200, or 2000, &c. Again, the first 1 may be reckoned 1 tenth, or 1 hundredth, or 1 thousand part, &c. then the next is 2 tenth, or 2 hundredth, or 2 thousandth parts, &c. so that if the first 1 be esteemed 1, the middle one is then 10, and 2 to its right is 20, 3 is 30, 4 is 40, and 10 at the end is 100; again if the first 1 is 10, the next 2 is 20, 3 is 30, so on, making the middle 1 now 100, the next 2 is 200, 3 is 300, 4 is 400, and 10 at the end is now 1000. In like manner if the first 1 be esteemed 1 tenth part, the next 2 is 2 tenth parts, and the middle 1 is 1, and the next 2 is 2, and 10 at the end is now 10. Again, if the first 1 be counted 1 hundreth part, the next is 2 hundredth parts, the middle one is now 10 hundredth parts or one tenth parts, and the next 2 is two tenth parts, and 10 at the end is now but one whole number or integer.

As the figures are increased or diminished in their value, so in like manner must all the intermediate strokes or subdivisions be increased or diminished; that is, if the first 1 at the left hand be counted 1, then 2 (on the right hand of it) is 2, and each subdivision between them

them now is 1 tenth part, and so all the way to the middle 1, which now is 10, the next 2 is 20, now the longer strokes between 1 and 2 are to be counted from 1 thus 11, 12, (where is a brass pin, then 13, 14, 15, sometimes a longer stroke than the rest, then 16, 17, 18, 19, 20, at the figure 2; and all the shorter strokes between them longer are now each to be counted for $\frac{1}{10}$ parts from the middle 1 to the next 2, now 20, from whence the longer strokes between the figures are units, thus, 21, 22, 23, &c. to 3 which now is 30, and the shorter strokes each between them, now is the tenth part of an integer; from 3, each short stroke or division, is 1 tenth part of an unit. Again if 1 at the left hand be 10, the figures between it and the middle 1 are common tens; and the subdivisions between each figure are units; from the middle 1 to 10 at the end; each figure is so many hunderdths; and between these figures each longer division is 10; from the middle 1 to 2, each less division is 2 units; and from 2 to the end, each shorter division is 5 units. From this description it will be easy to find the divisions representing any given number thus: Suppose the point represented the number 12 was required? Take the division at the figure 1, in the middle for the first figure of 12; then for the second figure count 2 tenths, or longer strokes to the right hand, and this last is the point representing 12, where is the brass pin.

Again, Suppose the number 22 was required, the first figure being 2, I take the division to the figure 2, and for the 2d figure 2, count 2 tenths onwards, and that is the point representing 22.

Again, Suppose 1728 was required; for the first figure 1, I take the middle 1, for the second figure 7, count onwards as before, and that is 1700; then for the third 2 count 2 tenths from the last, and it represents 1720; lastly, for the 4th, figure 8, estimate 8 parts out of 10 of the next smaller division, or a little less than 10, this point, last found, represents 1728.

Required the Point, representing the number 435; from the 4 in the 2d interval count towards 5 on the right, three of the larger divisions, and one of the smaller, and that will be the division expressing 435, and the like of other numbers, which by a little practice is readily done.

All fractions found in this line must be decimals; and if they are not, they must be reduced into decimals, which is easily done by extending the compasses from the denominator to the numerator; that extent laid upon 1 in the middle will reach to the decimal required.

Example. Required the decimal fraction equal to $\frac{3}{4}$, extend from 4 to 3, that extent will reach from 1 on the middle to 75, towards the left hand; the like may be observed of any other vulgar fraction,

MULTIPLICATION is performed on this line, by extending from 1 to the multiplier; that extent will reach from the multiplicand to the product.

Suppose, for example, it was required to find the product of 16 multiplied by 4, extend from 1 to 4, that extent will reach from 16 to 64, the product required.

DIVISION being the reverse of Multiplication, therefore extend from the divisor to unity, that extent will reach from the dividend to the quotient.

Suppose 64 to be divided by 4, extend from 4 to 1, that extent will reach from 64 to 16, the quotient.

N. B. This extent in Division is to be taken backwards from the dividend to the quotient, but in Multiplication it is taken forward from the multiplicand to the product, they being contrary to one another.

PROPORTION, or the RULE OF THREE, being performed by Multiplication and Division, therefore extend from the first term to the second, that extent will reach from the third term to the fourth.

Example. If the diameter of a circle be 7 inches, and the circumference 22, what is the circumference of another circle the diameter of which is 14 inches?

Extend from 7 to 22, that extent will reach from 14 to 44, the same way.

In like manner may any other proportion of any denomination be worked, which makes this line of general use, particularly in measuring Superfices and Solids, which is done by extending from 1 to the breadth, that extent will reach from the length to the superficial content.

Example. Suppose a plank, or board 15 inches broad, and 27 feet long, the content of which is required.

Extend from 1 to 1 foot 3 inches; that extent will reach from 27 feet to 33,75 feet, the superficial content. Or extend from 12 inches to 15, &c.

The solid content of any bale, box, chest, &c, is found by extending from 1 to the breadth, that extent will reach from the depth to a fourth number, and the extent from 1 to that 4th number, will reach from the length to the solid content.

Example 1st. What is the content of a square pillar, whose length is 21 feet 9 inches, and breadth 1 foot threee inches?

The extent from 1 to 1,25, will reach from 1,25 to 1,56 the content of 1 foot in length; again, the extent from 1 to 1,56 will reach the length 21,75 to 33,98 or 34 the solid content in feet.

Example 2d. Suppose a square piece of timber, 1,25 feet broad, from, 56 deep, and 36 long, be given to find the content:

Extend from 1 to 1,25, that extent will reach from ,56 to ,7, then extend from 1 to ,7, that extent will reach from 36 to 25,2 the solid content. In like manner may the contents of any bales, &c. be found, which divided by 40 will give the tonnage.

3dly. The line of Sines marked (Sin.) begins at the left hand, and is figured thus: 1, 2, 3, 4, 5, &c. to 10; then 20, 30 40, &c. to 90, ending at the right hand, where a brass center pin, here, and in all lines under it, are called degrees.

4thly. The line of versed sines, marked (V.S.) begins at the right hand, against 90° on the sines, and from thence figured towards the left hand thus: 10, 20, 30, 40, &c. ending at the left hand—about 169°;

169° ; each of the ſubdiviſions, from 10 to 30, are 2 degrees, and from thence to 90, it is ſingle degrees, and from thence to the end, each degree is divided into 15 minutes.

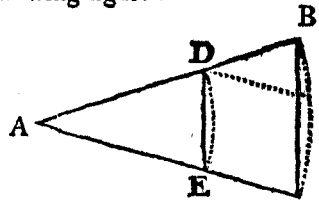
5thly. The line of tangents, marked (Tang.) begins at the left hand as do the ſines; from thence it is figured to the right hand, thus: 1, 2, 3, &c. to 10, and ſo on 20, 30, 40, and 45, at the right hand, where is a little braſs pin, juſt under and even with 90° in the ſines; from thence back again it is figured 50, 60, 70, 80, &c. to 89, ending at the left hand where it began at 1 degree. The ſubdiviſion of this line are the ſame as thoſe of the ſines.

6thly. The line of the meridional parts, marked (Mer.) begins at the right hand, and is numbered thus: 10, 20, 30, to the left hand, where it ends at 87 degrees. This line, with the line of equal parts, marked (EP) under it, are uſed together, and only in Mercator's ſailing. The uppermoſt line contains the degrees of the meridian, or latitude, in a Mercator's chart; and the lower is the equator, and contains the degrees of longitude.

ON THE USE OF THE SECTOR.

The Uſe of the Line of Lines, marked on the ſame Side of the Sector (LL.)

THE uſe of the ſector is taken from the property of two equilateral ſimilar triangles, thus in the following figure:

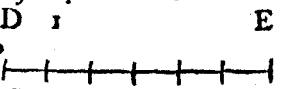


AB and AC are equal legs, or radii, of an iſoceles triangle, ſtanding on the baſe BC: Now, by the property of ſimilar <s, drawing DE parallel to BC, the two triangles ADE and ABC are ſimilar and proportional; or AD : DE : : AB : BC.
AB : BC : : AD : DE.

Now, ſuppoſing AB and AC to be divided each into 100 equal parts, and it is required to divide any opening of the legs as BC in the ſame ratio as AB, AC is divided into, it is inſtantly performed by taking laterally the diſtance DE in your compaſſes, and apply it from C to B, and the line BC will be divided in the ſame ratio as is the line AB or AC.

PROBLEM I.

To divide a given Line in any Number of Equal Parts.



Suppose DE is required to be divided into 6 equal parts?

OPERATION.—Take DE in your compasses, and open the legs of the sector, so that the opening of the compasses DE shall just fall on the line of lines on each leg of the sector, on 6.6; then take off 1.1 laterally, and set it from D to D 1, and D 1 will be the 1-sixth part of the given line DE.

To this problem may be referred the method of making a scale of a given length, to contain a given number of equal parts.

PROBLEM II.

Suppose the scale to the map of a survey is 6 inches long, and contains 140 poles, required to open the sector, so that a corresponding scale may be taken from the line of lines?

SOLUTION.—Make the transverse distance 7 and 7, or 70.70, *viz.* $\frac{140}{2}$ equal to 3 *inches*$=\frac{6}{2}$; and this possession of the lines will produce the given scale.

PROBLEM III.

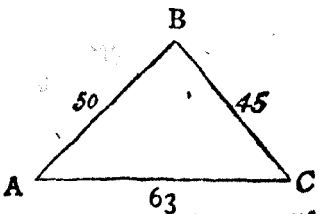
Let a scale of 4 inches to a degree in longitude be reduced to another scale of 3 inches to a degree of longitude?

SOLUTION.—Set off any distance on the 4-inch scale transversely to 40.40 or 4.4, on the line of lines; with this opening take off 3.3 or 30.30, and it is done; this lateral distance being the proportional part required.

PROBLEM IV.

One side of any triangle being given, of any length, to measure the other two sides on the same scale?

Let the triangle ABC be drawn. I would have the side AC measure 63. What are the measure of the other two sides, AB, BC?



SOLUTION.—Take AC in your compasses, and apply that distance transversely to 6.3 or 63; to this opening of the sector apply the distance AB in your compasses to the same number on both sides of the rule transversely; and where the two points fall will be the measure on the line of lines of the distance required; the distance AB will fall against 50.50, and BC against 45.45 on the lines LL on each side.

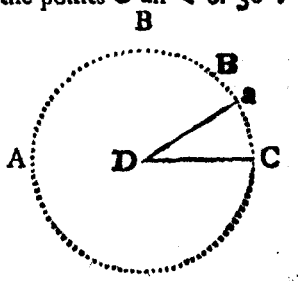
Use

Use of the Line of Chords on the Sector, marked (CC) *on each Side.*

The line of chords on the sector is laid down on both sides as far as 60°; each degree is divided in half or 30′; the use is only to lay down angles, or measure their arches to any given radius.

EXAMPLE I.

In the given circle ABC to lay off from the points C an < of 30°.



SOLUTION.—Take the radius DC in your compasses, and open the sector until 60.60 on both sides fall on each point; with this opening take off 30.30 on both sides transversely, and apply it from C on the arch towards B, as at a, and it is done; and the < a DC is an arch of 30° required.

In this manner, by setting 60.60 to radius on the chords, or 90.90 on the sines, or 45° 45° on the tangents, may the chord, sine, or tangent, of any angle, be found, set off, or known, to any given radius.

LOGARITHMS.

LOGARITHMS are a series of numbers, invented by Lord Napier, Baron of Marchinston, in Scotland, by which the work of multiplication may be performed by addition, and the operation of division may be done by subtraction; so that great time and trouble are saved thereby in the performance of all arithmetical operations; for if the logarithm of any two numbers be added together, the sum will be the logarithm of the product; and if from the logarithm of the dividend you subtract the logarithm of the devisor, the remainder will be the logarithm of the quotient. Again, if the logarithm of any number be divided by 2, the quotient will be the logarithm of the square root of that number; or if the logarithm of any number be divided by 3, the quotient will be the logarithm of the cube root of that number.

The most convenient series now made use of is the following:

0	1	2	3	4	5	&c. logarithms.
1	10	100	1000	10000	100000,	&c. logarithms.

By which you perceive the index of any logarithm always one less than the number of figures the integer contains.

To find the Logarithm of any Number containing less than 5 Figures.

EXAMPLES.

I would find the logarithm of 7?

Look in the table for the number of 7 in the side column, and against it is 0.84510. This number having but one figure in the index thereto is 0.

I would find the logarithm of 79?

Look in the table for the number of 79 in the side column, and against it is 1.89763; to which 1 is the index, because the number contains two figures.

I would find the logarithm of 763?

Against 763, in the first side column, is 2.88252; to which prefix the index 2, as the number contains 3 places of figures, 2.88252.

To find the Logarithm of 7634.

Find the logarithm of the three first figures in the side columns as before; and, casting your eye on the numbers on the top line of the table, look for the remaining figure 4, bring your eye to bear down that column, and eight against 763 is the logarithm 88275, to which prefix the index 3, as it contains four places of figures, thus: 3.88275 is the logarithm of 7634.

To find the logarithm of any whole Number to 5 places of Figures.

Suppose 76345?

Look out the logarithm of the three first figures 763 in the side column, and the next figure 4 in the top column as before, and against the angle of meeting is 88275, as before. Take the difference between this logarithm and the next greater; that is, the difference between 275 and 281, which is 6; then say, by the rule of three, if 10 gives 6, what will 5 give? that is its half or 3; which, added to the logarithm 88275, makes 88278; to which prefix the index 4, as it contains five places of figures; and that makes the logarithm of 76845 to be 4.88278.

Again, to find the Logarithm of any Number to 6 *places of Figures, as* 763458.

Find the logarithm of the 4 first places of figures as before 88275; as above, then say, if 100 gives 6 difference, what will 58 give? Answer 3; which added to 88275, makes 88278; to which prefix its index 5, makes the logarithm of 763458 to be 5.88278.

To

To find the Logarithm of any fixed Number, as 763.458.

Where the integer is 763, or has only three places of figures, the rule is: Find the logarithm to all the figures, the same as if they were whole numbers as before, to which prefix always the index of the integer, which in this number is 2; so that the log. of 763.458 is 2.88278, nearly the same as the above, only differing in its index.

To find the Number answering to any Logarithm to 4 Places of Figures.

Seek under the column 0, at top of the table, the next less logarithm; note the number against it, and carry your eye along that line until you find the nearest logarithm next less than the given one, and you will have the fourth figure at the top of the table, which affix to the three given ones in the first side column.

What is the number to the logarithm 3.77342?—I look in column 0, and find under it, against the number 593, the logarithm 7705; and, guiding my eye along that line I find the given logarithm 77342 under the column, with 5 at the top; so that the number is 5935.

The Number, if taken out by this precept, will be either the number required or the next less.

To find the Number answering any Logarithm to 5 Places of Figures nearly.

Find the next less logarithm to the given one; and take its difference betwixt it and the given one; also take the difference betwixt the next greater logarithm, and next less to the given one; then say, as the difference of the next greater and next less is to 10, so is the former difference to the correction sought;—as suppose you would find the number to the logarithm 4.59632?

4.59632			
4 59627	The nearest next log. I can find is	59627 = its num.	39470
	The next greater ditto is -	59638 =	39480
5	- - Difference.	11	10

Then say, 11 : 10 :: 5 : 5 nearly the correction; which I add to the number 3947, makes the number sought to be 39475, answering to the logarithm 4.59632.

NOTE.—Aliquot or even parts may be taken of the difference between the less and greater logarithms, where it can be done, thus: In this last 5 is nearly the half of 11, as 5 the number sought is of 10, the difference of the two numbers belonging to the greater and less logarithms, which will often save time and trouble.

MULTI-

MULTIPLICATION BY LOGARITHMS.

CASE I.

To find the Product of two whole or mixed Numbers.

Multiply	76	Log. =	1.88081	Multiply	76.4	Log. =	1.88309
by	54		1.73239	by	5.4		0.73239
Product	4104	=	3.61320	Product	412.5	=	2.61548

CASE II.

When both, or either, of the fractions are less than unity, as if

0.265	Log.	9.42325
0.031		8.49136
.008215	=	7.91461

Here the index of a fraction is 9, when the first decimal figure, as 2, stands in the first decimal place; but if it should stand in the second decimal place, as the 3 in .031, the index will be 8; if it stood in the third decimal place, as .0031, the index would be 7. Thus the number of cyphers, prefixed to any decimal, and the index of that decimal always together, make 9; so that if you take the number of cyphers prefixed to the decimal from, 9 remains its proper index. In the addition reject 10 in the sum of the indices; and the proper product, or value of the product, will be obtained: By reason, if 9 represent the index of a fraction, 10 will represent, in this case, the index of unity. Indeed the index of unity may be assumed either 0, 10, 100, &c. as you please; but generally for most uses, is not wanted to be more than 10, as in the sines, tangents, secants, &c. As 7 or 8 places of decimals are generally sufficient for all purposes, take these two more examples:

Multiply	3.72	Log. =	0.57054	Multiply	59.4	Log. =	1.77415
by	0.00064		6.80618	by	.000031'		5.49206
Product	.0023808		7.37672	Product	.0018414		7.26621

Here the remainder to 9 is 2 in the index; therefore prefix two cyphers to the number of the logarithm 37672 for the product required.

DIVISION BY LOGARITHMS.

CASE I.

To divide a whole or mixed Number by a less whole or mixed Number.

RULE.—From the logarithm of the dividend subtract the logarithm of the divisor, and the remainder is the logarithm of the quotient.

Divide 4104 by 54				Divide 420.4 by 5.4.			
4104	Its logarithm is		3.61321	410.4	Its logarithm is		2.61321
54	Its logarithm is		1.73239	5.4	Its logarithm is		0.73239
76	Quotient	=	1.88082	76.0	Quotient	=	1.88082

CASE

CASE II.

When both, or either, fractions are less than unity?

As divide .008215 by .031.

.008215	Its log. is	7.91461
.031	Its log. is	8.49136
.265	Product	9.42325

NOTE.—In the indices here I borrow 10 in the same manner as I flung it away in addition.

Divide 0023808 by 3.72.

.0023808.	Its log. is	7.37672
3.72	Its log. is	0.57054
.00064	Quotient	6.80618

NOTE.—If I had assumed the index of unity 100, then the index of the first number would have been 97 or 97.91461,
and .031 98.49136

99.42325

So that 99 is the index of the first decimal place under 100 in this case.

Divide 59.4 by 000031.

59.4	Its log. is	1.77415
.000031	Its log. is	5.49209
.0001915	Its quotient	6.28209

NOTE.—Whatever index you make represent unity, omit it in the sum of the indices, and borrow it in the subtraction of indices, the sum or remainder will be the true index required.

To EXTRACT the ROOTS in LOGARITHMS.

As the multiplying the logarithm of any number by the index of its power produces the logarithm of that power; so the division of any logarithm by its proposed index, the quotient will be the logarithm of the root required.

What is the square root of 324?

324	Its logarithm is	2)2.51054
18	Log. of the root is	1.25527

What is the cube root of 10648?

10648	Its log. is	3)4.02726
22	Log. of the root is	1.34242

To find any proposed root of any decimal fraction, you must first prepare the index for the division by the proposed power, thus: For the square you must add 10 to the index before you divide it; for the cube you must add 20 to its index before you divide it; and so on for the root of any power proposed.

EXAMPLE.—What is the square root of .001849?

.001849	Its log. is	7.26694
	Add	10.
		2) 17.26694
.043	The log. of the root is	= 8.63347

What is the cube root of .125?

.125	The log. is	9.09691
	Add.	20.
	Sum	3)29.09691
.5	Its root =	9.69897

The

The APPLICATION of LOGARITHMS in measuring Boards, Timber, Glass, Stone, and all kinds of Packages, usually taken on board Ships*.

Required the content of a board or plank $9\frac{1}{2}$ feet long and $1\frac{1}{4}$ foot broad?

Log. of $9\frac{1}{2}$ or 9. 5 is	0.97772
$1\frac{1}{4}$ or 1. 25 is	0.09691
11.88 nearly log. of cont.	1.07463

or 11 feet $10\frac{7}{8}$ inches nearly.

Required the content of a piece of glass 2. 9 feet long, and 1. 75 broad?

Log. of 2. 9	= 0.46240
1.75	= 0.24304
5.075	= 0.70544

The content is 5. 075 feet.

In like manner may any dimensions be squared, and the content be found.

If the solid content be required of any box, bale, &c. add the logarithms of the length, breadth, and depth together, the sum will be the log. of the solid content.

EXAMPLE.—What is the solid content of a box whose depth is 2. 7, breadth 2. 3 and length 4. 5 feet?

2. 7	Its log. is	0.43136
2. 3	Its log. is	0.36173
4. 5	Its log. is	0.65321

Sum equal the log. of the content 1.44630 = number 27. 95 or 28 feet nearly.

The diameter of a cask at the head and bung, and also its length being given, to find its content in beer and wine measure?

1st. Multiply the difference of the head and bung diameter by 0. 7, and add the product to the head diameter for a mean diameter.

RULE FOR WINE MEASURE.

Place down the log. of the mean diameter twice, the log. of the length, and under these two the constant log. 7.53148, the sum of these four logarithms will be the log. of the content, abating 10 in the sum of the indices.

RULE FOR BEER MEASURE.

Put this constant log. under the two former logs. always 7.44484 the sum of the four logs. will be the content for beer gallons, abating 10 in the index.

* The AUTHOR has lately published an improved GUNTER'S SCALE, on which the foot is divided into 10 equal parts, and these parts subdivided into 10 equal parts, for the purpose of taking dimensions and calculating by logarithms or decimal fractions.

EXAMPLE.—What is the content of a cask whose head diameter is is 20, the bung diameter 28, and length 40 inches?

	28	
	20	
	8	Difference.
	·7	
	5.6	Number to be added to
The head diameter	20.0	
	25.6	

FOR WINE.			FOR BEER.
Log. of mean diam. =	1.40824		1.40824
	1.40824		1.40824
Length 40 =	1.60206		1.60206
Constant log.	7.53148		7.44484
Log. of 89.13 gallons the content for wine.	1 95002	Ans. 73 gall. =	1.86338 of beer.

The way these two constant multiplying logarithms were found is thus:

1st. The area of a circle, whose diameter is unity, is 7854 decimal parts of the square thereof; so that if the square of the diameter of any circle be multiplied by ,7854, the product will be the area of the given circle: hence ,7854 is always a constant quantity whose logarithm is 9.89509.

2d. If the area of a circle be divided by 231, the number of cubic inches there are in a wine gallon, the quotient will be the number of gallons that circular area contains, at 1 inch deep: hence 231 is a constant divisor. Its logarithm is 2.36361, the arithmetical complement of which is 7.63639, which I add to the former constant logarithm 9. 89509
7. 63639

The sum 7. 53148, abating 10 in the indices, is the constant logarithm to be added, as per rule, for wine measure.

For beer measure the divisor is always 282, its logarithm is 2.45025, whose arithmetical complement is 7. 54975
Add 9. 89509

Sum 7.44484, the constant logarithm for beer measure, as per rule, omitting 10 in the index, or subtract 2.45025 from 9 89509
Take 2.45925

Remains 7.44484, the same as above.

The common Way of finding a Ship's Tonnage at London.

RULE.—Multiply the length of the keel by the breadth of the beam, and that product by half the breadth of the beam, and divide the last product by 94, and the quotient arising is the tonnage.

EXAMPLE.—Suppose a ship 72 feet by the keel, and 24 feet by the beam, what is the tonnage?

Length	72	-	-	log. is	1.85733
Breadth	24,	-	-	do.	1.38021
Half-breadth	12,	-	-	do.	1.07918
Arith. complement of log. of 94,				do.	8.02687
Tonnage 220.6		-	-	-	2.34359 Answer.

To find the Logarithm of the Sines, Tangents, and Secants, belonging to any Number of Degrees and Minutes required.

If the required degrees be less than 45, seek the degrees on the top, and the minutes in the left-hand column marked M, against which in the column signed at the top with the proposed name, stands the sine, tangent, and secant required; but when the degrees given are more than 45, seek the degrees at the bottom, and the minutes in the right-hand column marked M at the bottom, and the proposed name of the bottom. Here it may observed, that the degrees at the top and minutes at the left-hand column, added to the degrees at the bottom and minutes in the right-hand column, always make 90; hence, if a sine be looked for, the co-sine or complement will be found in the adjoining column, the same may be observed of tangents and secants.

EXAMPLE I.—Required the log. sine of 28° 37′?

Find 28 at the top of the page, and in the left-hand column marked M at the top, find 37; against which, in the column marked with the word Sine, stands 9 68029, the logarithm of the sine of 28° 37′ required. The same may be observed of tangents and secants.

EXAMPLE II.—Required the log. tangent of 67° 45′?

Find 67° at the bottom of the page, and 45′ at the right-hand column marked M at the bottom; against this in the column marked Tangent at the bottom, stands 10.38816, which is the logarithm required.

Having the sine, tangent, and secant, the co-sine, co-tangent, co-secant, are always found in the adjoining columns.

The logarithms to any number of degrees above 90°, is found by subtracting the given degrees from 180°, and taking the logarithm of the remainder; or if 90° be subtracted from the given sine, and the log. co-sine of the remainder be taken, it will give the same as above.

To find the Degrees, Minutes, and Seconds, corresponding to any given Logarithm.

If the degrees, minutes, and seconds, be wanted to a given logarithmic sine, or co-sine thus found, and the next greater and the next less than the given logarithm and the difference between the given logarithm and the next less if a sine, and the next greater if a co-sine; then say, as the difference between the next greater and next less is to 60″, so is the difference between the next less if a sine, and the next greater if a co-sine, to the number of seconds to be annexed to the degrees and minutes found before.

EXAMPLE I.—Find the degrees, minutes, and seconds, corresponding to log. sine 9.61405?

Next less log.	9.61382	Next less log.	9.61382
Next greater	9.61411	Given log.	9.61405
	29		23

Here the given log. is found standing between 24° 16′ and 24° 17′; then as 29 is to 60, so is 23 to 48, which annexed to 24° 16′, gives 24° 16′ 48″, answering to log. 9.61405.

EXAMPLE II.—Find the degrees, minutes, and seconds, corresponding to the log. co-sine 9.43297?

The nearest found between 74° 16′ and 74° 17′:

Next greater log.	9.43323	Next less log.	9.43323
Next less	9.43278	Given log.	9.43297
Diff.	45	Diff.	26

Now as 45 is to 60, so is 26 to 34″, which annexed to 74° 16′ gives 74° 16′ 34″, the degrees, minutes, and seconds required.

To find the Logarithm of the Sine or Co-sine, for Degrees, Minutes, and Seconds.

RULE.—Find the logarithm to the degrees and minutes as before; take the difference between the logarithm and the next greater in the sine; but if a co-sine, the next less; multiply this difference by the odd seconds, and divide the product by 60′; add the quotient to the right-hand of the log. of the degrees and minutes, if a sine, but subtract it if a co-sine, the sum or difference will be the logarithm, sine, or co-sine required.

EXAMPLE I.—Required the log. sine of 24° 16′ 48″?

Sine of	24° 16′	9.61382
Sine of	24° 17′	9.61411
	Diff.	29

Now 29 multiplied by 48 gives 1392; this divided by 60, the quotient is 23, which added to 9.61382, gives 9.61405, the log. of 24° 16′ 48″.

EXAMPLE II.—What is the log. co-sine of 74° 16′ 34″?

Log. co-sine of 74° 16′	9,43323
Log. co-sine of 74° 17′	9.43278
Diff.	47

Now 47 multiplied by 34 = 1598; this divided by 60, gives the quotient 26 nearly; and 26 subtracted from 9.43323, leaves 9.43297, the log. co-sine of 74° 16′ 34″.

If the given seconds be $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, or $\frac{1}{6}$, or any other even parts of a minute, the like parts may be taken off the difference of the logarithms, and added or subtracted as above, which may be frequently done by inspection.

To find the Arithmetical Complement of any Logarithm.

The complement Arithmetic of any logarithm, is what it wants of 10.00000 or 20.00000, and is used to avoid subtraction. For finding it this is the rule: Take the residue or remainder of the first figure to 9, and so of the rest, till you come to the last figure; of which take its remainder under 10, and it is done.

EXAMPLE I.—I would have the complement arithmetic of 9.62595?

For the first figure 9, write 0; for 6, 3; for 2, 7; for 5, 4; for 9, 0; and for the last figure 5 write 5; and so you have 0.37405 for the complement arithmetic sought.

EXAMPLE II.—The complement arithmetic of 20. 33133?

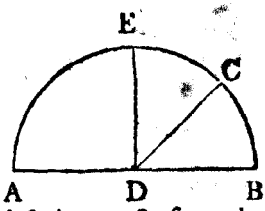
For 0 write 9, and so on as before directed, and then you will have 9.66867, which is the complement arithmetic of 20.33133. Or thus:

From	10.00000	From	20.00000
take	9.62595	take	10.33133
	0.37405		9.66867

It will be necessary for the reader to make himself well acquainted with the following propositions, as he will find them useful when he goes into Trigonometry, which are here rendered plain and easy to understood:

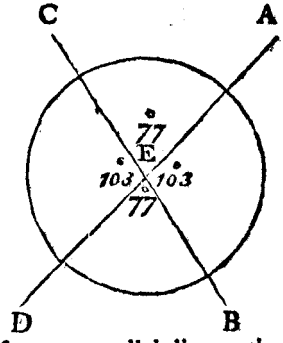
PROPOSITION I.—If a right line stands upon, or meets with another right line, and makes angles with it, the two angles taken together will be two right angles, or two angles equal to two right angles.

Let



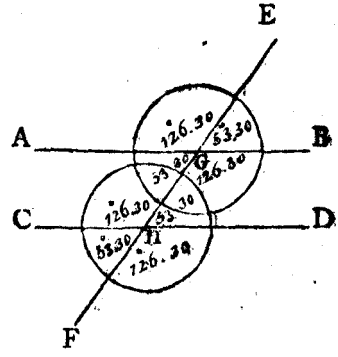
Let the line C D meet A B in D.; on D erect the perpendicular D E, with the chord of 60° in your compasses, and one in D describe the arch A E B, which will be a semicircle or 180°; of which A B is the diameter, and the angles A D E and BDE are quadrants, each 90°, because ED is perpendicular to AB: now the B D C is less than 90°, since the two angles together make neither more nor less than 180° or a semicircle; consequently any number of right lines standing upon the same side of the line AB, and coming from the same point D, the sum of all the angles formed by such right lines cannot exceed 180°. If the angle BDC be subtracted from 180°, the remainder will be the angle CDA; or if the angle ADE is given, the angle BDC is found in the same manner.

PROPOSITION II.—If two right lines cross each other, the angles which are opposite are equal one to the other.



Let the two lines A D and CB cross each other in the point E. With the chord of 60°, or any convenient radius, in your compasses, and one foot in E, describe a circle; then, by measuring the angles, it will be found that the angle A E B is equal to the angle C E D, and that the angle AEC is equal to the angle B E D; for the angle A E B added to the angle A E C makes a semicircle; and so does the angles B E D and D E C; and all the angles taken together make 360°.

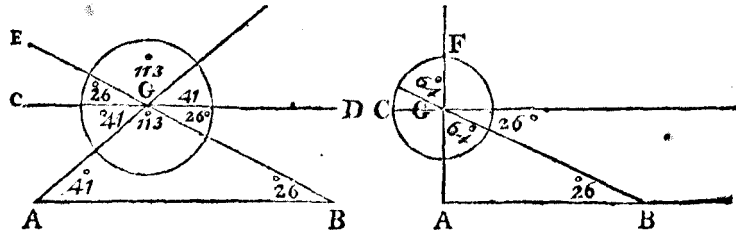
PROPOSITION III.—If a right line cross two parallel lines, the outward angles will be each equal to the inward and opposite ones.



Let the lines AB and CD be parallel lines, and E F the line that cuts them in the points G and H. With the chord of 60° in your compasses, and one foot on G and H, describe the arches BEA and DFC which will be each a semicircle: now, by measuring the angles BGE and AGE, they will be found equal to the angles DHF and FHC, and each equal to 180, by the first proposition. In like manner it may be proved, that the two outward angles are equal to the two inward and opposite ones.

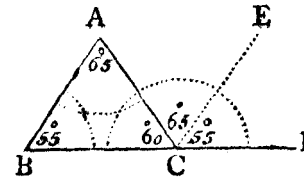
PRO-

PROPOSITON IV.—In every plane triangle, whether right or oblique, the three angles are equal to two right angles or 180°.



In the triangle AGB draw CD parallel to AB through the point G; on which point, with the chord of 60°, or any convenient radius, describe a circle on the point G; and with the same radius, on A and B, describe arches; now, by the last proposition, the angle AGB will be equal to the angles FGE, and the angle ABG will be equal to the angles CGE, and the angle BAG is equal to the angle DGF: now, since the opposite angles are equal, the angles DGF, FGE, and EGC, together, make a semicircle or 180°; therefore it is plain that the three angles of a plane triangle, whether right, acute, or obtuse, together, are equal to two right angles or 180°; hence it follows that, as the right angle BAG is 90°, the other two acute angles ABG and AGB taken together, can be no more than 90°; therefore, if one of the acute angles, in a right-angled triangle, be given, the other is found by subtracting the given angle from 90°. And in any oblique-angled triangle, if one of the angles be given, the sum of the other two is found by subtracting the given angle from 180°; and if two angles are given, the third is found by subtracting the sum of the two angles from 180°,

PROPOSITOIN V.—In every plane triangle, if one of its sides be produced, the outward angle will be equal to the two inward opposite angles.



Let ABC be the triangle, and CD the side produced, with the chord of 60°, or any other radius, describe arches on AB and C, draw CE parallel to AB; then, by the third proposition, the angle ACE must be equal to the angle BAC and the angle DCE equal to the angle CBA; therefore the outward angle DCA is equal to the two inward opposite angles ACB and BAC; which may be easily proved by measuring the angles by the line of chords on the plane scale.

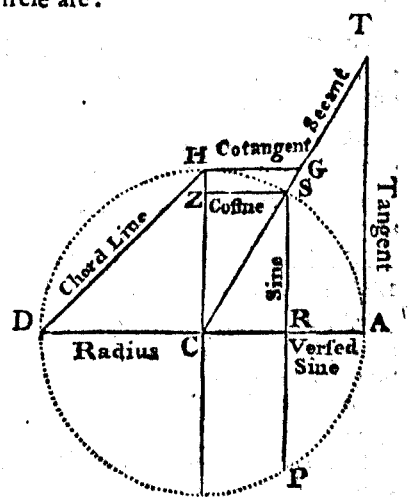
NOTE

NOTE.—I hope the learned mathematician will excuſe the method here taken of demonſtrating the above propoſitions in a mechanical manner, judging it beſt adapted to the capacity of thoſe for whoſe uſe this book is intended, not doubting but the teacher will, as I always do, demonſtrate them in a more geometrical manner to thoſe who are capable of receiving ſuch.

TRIGONOMETRY.

PLAIN Trigonometry is the art of meaſuring plane triangles, by comparing the ſides and angles together by known analogies; whereby three things being given, a fourth may be found, on condition that one of them be a ſide: but as angles are meaſured by the arch of a circle, deſcribed upon their angular points, and the proportions that theſe arches bear to right lines cannot be exactly found; therefore the writers of Trigonometry have applied right lines to theſe arches, that the proportion they bear to the ſides of a plane triangle may be found.

The right lines applied to a circle are:



1ſt. A CHORD, or the ſubtenſe of an arch, is a right line that divides the circle into two unequal parts, and is a chord to them both, as DH is the chord of the arches D H and D A H.

2d. A RIGHT SINE of an arch is, a right line drawn from one end or termination of an arch perpendicular to the radius, or it is half the chord of twice the arch; ſo that R S is the ſine of the arch A S, and S Z the coſine.

3d. A Verſed SINE is that part of the diameter contained between the right ſine, and the arch, as RA and R C D, and is the verſed ſine of S H D, or D E P its equal.

4th. A TANGENT of an arch, is a right line drawn perpendicular to one end of the diameter, juſt touching the arch, as A T is the tangent of the arch A S and H G the co-tangent.

5th. A SECANT

A SECANT of an arch is a right line drawn from the center through the circumference, and produced until it cuts the tangent, as C T.

NOTE. The ſine, tangent, and ſecant of the complement of an arch, is called the co-ſine, co-tangent, and co-ſecant of that arch.

The ſines, tangents, and ſecants of an arch, are ſaid to be the meaſure of ſo many degrees, as that arch contains parts of 360 degrees; ſo that the radius being the ſine of a quadrant, or a fourth part of a circle contains 90°, thus: The radius is always equal to the ſine of 90°, as is the chord of 60° and the tangent of 45°, all the three being each equal to the radius: and that the ſine, tangent, and ſecant of an arch is equal to the ſine, tangent, and ſecant of an arch, as much above 90 degrees as the former was deficient of 90; thus the ſine, tangent, or ſecant of 80° is = 100°, of 70° is 110°, of 60° is = 120°; of 40° is = 240°, &c. ſo that in taking out the logarithms of ſines, tangents, or ſecants, for any number of degrees above 90°, the given angle muſt be ſubtracted from 180°, and the logarithm of the remainder be taken; or ſubtract 90° from the given angle, and take the log. co-ſine, co-tangent, or co-ſecant of the remainder.

Notwithſtanding what has been ſaid in Geometry, it may not be improper here to obſerve that,

1ſt. The feweſt number of right lines that can include a ſpace are three; which is called a triangle, or three-cornered figure, and conſiſts of ſix parts, *viz.* three ſides and three angles.

2d. In every triangle the greateſt ſide is oppoſite the greateſt angle; conſequently, the greateſt angle is oppoſite the greateſt ſide.

3d. In every triangle equal ſides ſubtend or ſtand againſt equal angles.

4th. In every plane triangle the three angles together are equal 180°——See Prob. 3d, in Geometry.

5th. If in a triangle, one angle be right or obtuſe, the reſt are acute; and if one angle in a triangle be right, the other two taken together make one right angle, or 90°; wherefore if one of the acute angles, in a right-angled-triangle, be known, the other is found by ſubtracting the known angle from 90°.

6th. In every plane triangle, if one of the angles be given or known, the ſum of the other two is found by ſubtracting the given angle from 180°, and if two of the angles be known or given, the third is found by ſubtracting their ſum from 180°.

7th. The complement of an angle is what it wants of 90°.

8th. Thy

8th. The ſupplement of an angle is what it wants of 180°.

9th. All angles are meaſured by the arch of a circle, deſcribed about their angular points with the chord of 60°, and are ſaid to be greater or leſs, according to the number of degrees or parts to be contained between their legs; which legs may be ſuppoſed to be yards, miles, leagues, &c.; and are meaſured on a ſcale of equal parts.

10th. A circle deſcribed with a chord of 60°, the circumference will contain four right angles, or 360°, the quadrant 90°, and ſemicircle 180°.

11th. The angles of two triangles may be reſpectively equal, although their ſides may be unequal. Therefore, among the things given, in order to find the reſt, one of them muſt be a ſide.

In Trigonometry, the three parts given, in all triangles, muſt be either,

1ſt. Two ſides and angle oppoſite one of them.
2d. Two angles and a ſide oppoſite one of them.
3d. Two ſides and the included angle.
4th. Three ſides.

In either caſes, the other three things may be found by help of the table of logarithms, artificial ſines, tangents, and ſecants, by the following axioms; as well as by the foregoing conſtructions:

☞ It may not be improper here to obſerve, that the properties of a right-angled triangle, depend on the 47th propoſition of the firſt book of Euclid, where it is demonſtrated, that

In every right-angled triangle, the ſquare of the hypothenuſe or longeſt ſide, is equal to the ſum of the ſquares of the other two ſides or legs; conſequently having the ſquares of the baſe and perpendicular, the ſquare root of their ſum will be the length of the hypothenuſe.

And, if the ſquare of the baſe be ſubtracted from the ſquare of the hypothenuſe, the ſquare root of the remainder will be the length of the perpendicular;

And, if the ſquare of the perpendicular be ſubtracted from the ſquare of the hypothenuſe, the ſquare root of the remainder will be the length of the baſe; conſequently by having any two ſides of a right-angled triangle, the third ſide may be found.

Thus lines of the lengths 5, 4, 3, (or their doubles, trebles, &c.) will form a right-angled triangle.

Now the ſquare of 5 is 25, the ſquare of 4 is 16, and the ſquare of 3 is 9; then 16 and 9 is 25, its root is 5, the length of the hypothenuſe; and if 16 be ſubtracted from 25 the remainder is 9, its root is 3, the length of the perpendicular; again, if 9 be ſubtracted from 25, the remainder is 16, its root is 4, the length of the baſe; the ſame of any other numbers, which may be readily done by the logarithms, or by the extraction of the ſquare root.

The Solution of the several Cases in Plain Trigonometry depend upon four Propositions called Axioms, which the Learner should get perfectly by Heart.——We shall here give the first Axiom only, and the rest before we begin Oblique Sailing.

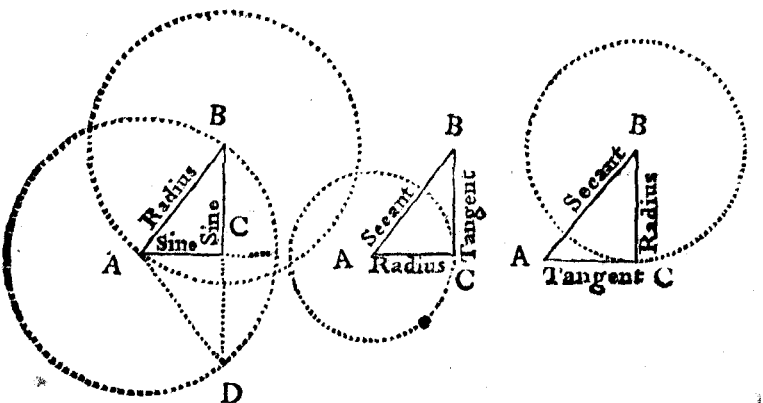
AXIOM I.

In any right-angled plane triangle,

If the hypothenuse be made the radius of a circle, the other two sides, or legs, will be the sines of their opposite angles; but

If either of the legs, including the right-angle, be made the radius of a circle, the other leg will be the tangent of its opposite angle, and the hypothenuse the secant of the same angle;

For let the three following triangles have their sides and angles equal:



It is plain, by comparing these with the first figure in Trigonmetry, that taking the hypothenuse A B as radius in your compasses, and on A and B describe circles, C B will be the sine of the angle B A C and C A will be the sine of the angle A B C, and B C will be the sine of half the arch B D, or the sine of half the angle B A D, being half the chord of twice the arch; but taking the base A C as a radius in your compasses, and with one foot in A describe a circle, it is plain that C B will be the tangent, and A B the secant of the same angle; but if C B, the perpendicular, be taken as the radius, and a circle be described on B, then will A C be the tangent of its opposite angle A B C, and the hypothenuse the secant of the same angle: for it should be remembered, that when any one of the legs becomes a tangent of its opposite angle, the hypothenuse always accompanying it, becomes the secant of the same angle.

Now, since, by making any of the sides of a right-angled triangle the radius of a circle, we can readily find the names or denominations of the other side, it comes next to be considered what parts or things are given, and what required, in order to state the question.

In

In this caſe we ſhall compare Trigonometry with the Rule of Three in common Arithmetic; where we are taught to conſider what name or denomination the anſwer is to be of, which names muſt always be made the ſecond term in ſtating the queſtion; if pounds are to be the fourth number, or anſwer, then pounds muſt be the ſecond term; if yards are to be the anſwer, then yards muſt be the ſecond term. As for example, if 60 yards coſt £120, what will 90 yards coſt? Then pounds being wanted, pounds muſt be the ſecond term.

If 60 yards coſt £120, what will 90 yards coſt?

```
        90
      ------
  60)1080(0
      ------
       180  Anſwer.
```

It is the ſame in Trigonometry; for if the fourth number, or anſwer, is to be an angle, an angle implied muſt be the ſecond term, and ſides the firſt and third terms: but when a ſide is required, it muſt be placed the ſecond term, and angles the firſt and third terms, in ſtating the queſtion; conſequently, in all queſtions in Trigonometry, if a ſide is required, you muſt begin with an angle or radius, which is always conſidered as a given angle, equal to 90°; but when an angle is required, then you muſt begin with a known ſide.

In the Rule of Three we multiply the ſecond and third terms together, and divide that product by the firſt term, and the quotient will be the fourth number ſought, and of the ſame denomination the ſecond term is of. Now; ſince the addition of logarithms anſwers the purpoſe of multiplication of whole numbers, and ſubtraction that of diviſion, add the logarithms of the ſecond and third terms together, and from their ſum ſubſtract the logarithm of the firſt term, the remainder will be the logarithm of the fourth term.

As log. — 60	——		1.77815
Is to log. of 120	——		2.07918
So is log. — 90	——		1.95424
		Add	4.03342
Firſt term ſub. 60		is	1.77815
To anſwer	180	=	2,25527

Here it is plain the logarithms give the ſame anſwer as that given by the Rule of Three.

In a right-angled triangle there are always two ſides, or the angles and one ſide given, to find the reſt.

To find a ſide, any ſide may be made radius; then ſay, as the name of the given ſide is to the given ſide, ſo is the name of the ſide

 required

required to the side required, which must be found among the logarithms.

To find an angle, one of the given sides must be made radius; then say, as the side made radius, is to radius, so is the other given side, to the sine, tangent, or secant, by it represented; which being looked for in the table of sines, tangents, and secants, where will be found the degrees and minutes corresponding to the angle required.

Solution of the Six Cases in Right-angled Trigonometry.

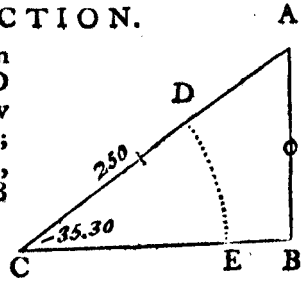
CASE I.

The Angle and Hypothenuse given, to find the Legs.

Given the Hypothenuse AC 250 Leag. and the Angle opposite to the Base CB = 54° 30′, to find the Base CB and Perpendicular AB.

By CONSTRUCTION.

Draw the base CB of any length, on C describe the arch DE, from E to D lay off 35° 30′, through C and D draw a line, which must be equal to 250; from A let fall the perpendicular AB, to cut CB in B, and it is done; for CB will be 203.5, and AB = 145.2.



By CALCULATION.

By making the Hypothenuse C A Radius, it will be,

To find the Base B C.		To find the Perpendicular A B.	
As radius	10.00000	As radius	10.00000
Is to the hypoth. CA 250	2.39794	Is to the hypoth. C A 250	2.39794
So is sine ang. A 54° 30′	9.91069	So is sine ang. C 35° 30′	9.76395
	12.30863		12.16189
	10.00000		10.00000
To the base B C 203,5	2.30863	To the per. AB 145,2	2.16189

By making the Base Radius, the Proportion by Axiom the first, will be,

To find the Base B C.		To find the Perpendicular AB.	
As sec. ang. C 35° 30′	10.08931	As sec. ang. C 35° 30′	10.08931
Is to hypo. A C = 250	2.39794	Is to hypoth. AC = 250	2.39794
So is radius	10.00000	So is tang. ang. C 35° 30′	9.85327
	12.39794		12.25121
	10.08931		10.08931
To the base B C = 203,5	2.30863	To the per. A B 145,2 =	2.16190

by

By making the Perpendicular Radius, by Axiom the first it will be

To find the Base B C.		To find the Perpendicular AB.	
As sec. ang. A 54° 30′	10.23605	As sec. ang. 54° 30′	10.23605
Is to hypoth. AC 250	2.39794	Is to hypoth. AC 250	2.39794
So is tang. an. A 54° 30′	10.14673	So is radius	10.00000
	12.54467		12.39794
	10.23605		10.23605
To the base BC = 203,5	2.30862	To the per. = AB 145,2	2.16189

NOTE. In the first stating, where the hypothenuse is made radius, the sum of the logarithms of the second and third terms are, 12.30863; from which it is easy to subtract the logarithm of the first term; for you may either cancel it, or leave it out; and then cast off the first figure towards the left hand, and it will leave the logarithm 2.30863, the same as if 10.00000 had been set down and subtracted from it: and indeed, the five cyphers may be always omitted in the radius, and only the index 10. set down.

It will greatly expedite the working the proportion by logarithms, if the two or all the statings be first made, and then the sines, tangents, or secants, may be taken out at one opening of the book; for if one angle of a right-angled triangle be given, the logarithm of its complement, or the other angle, whether sine, tangent, or secant, is found in the adjoining column, without being at the trouble of subtracting the given angle from 90°. If the given angle be less than 45 degrees, it is found at the top of the table, and the minutes in the left-hand column reckoned downwards, and its complement is found at the bottom, and the minutes on the right-hand column. On the contrary, if the given angle is found at the bottom, its complement, or the other angle, will be at the top of the table, and the minutes in the left-hand column, against which is the log. sine, tangent, or secant, corresponding to it.

By GUNTER's SCALE.

In all proportions wrought by Gunter's Scale, when the first and second terms are of the same kind, then the extent from the first term to the second, will reach from the third to the fourth;

Or when the first and third terms are of the same kind,

The extent from the first term to the third, will reach from the second to the fourth; that is, set one point of the compasses on the division expressing the first term, and extend the other point to the division expressing the second term, then, without altering the opening of the compasses, set one point on the division representing the third term, or second term, and the other point will fall on the division shewing the fourth term or answer.

Now in this last case, it will run thus:

Extend from radius, or 90° to 54° 30′ on the line of ſines, that extent will reach from 250, the hypothenuſe, to 203,5, the baſe, on the line of numbers; and the extent from radius, or ſine of 90° to 35° 30′ on the line of ſines, will reach from 250 to 145 on the line of numbers.

Obſerve the like in all that follows, except in thoſe proportions where the word ſecant is mentioned, which may be readily wrought by conſidering the hypothenuſe radius, as in the laſt caſe; there being no line of ſecants on Gunter's Scale.

NOTE. The radius, according to the nature of the proportion, may be any of theſe:

8 Points on the line of Rhumbs	90° On the Line of Sines.
4 Points on the line of Tan. Rhbs.	45° On the Line of Tangents.

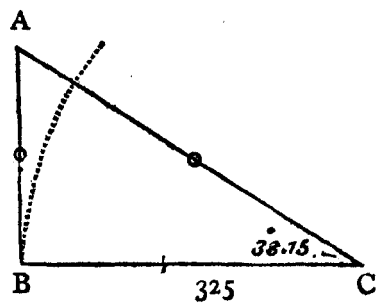
CASES II. and III.

The Angles and one Leg given, to find the Hypothenuſe and other Leg.

The Angle A C B 33° 15′, the Leg B C 325 Miles given, to fin the Hypothenuſe and the other Leg.

By CONSTRUCTION.

Draw the line BC, which make equal to 325 miles; on B erect the perpendicular B A; on C deſcribe an arch with the chord of 60°, and make the angle C = 33° 15′, through where that cuts the arch draw AC to cut A B in A, and it is done; for BA being meaſured on the ſame ſcale that B C was, will be 213,1 and A C 388,6 miles.



By making the Hypothenuſe A C Radius, it will be,

To find the Perpendicular A B		To find the Hypothenuſe A C	
As ſine ang. A 56° 45′	9.92235	As ſine ang. A. 56° 45′	9.92235
Is to the baſe B C 325	2.51188	Is to the baſe B C 325	2.51188
So is ſine ang. C 33° 15′	9.73901	So is radius 90°	10.00000
	12.25089		12.51188
	9.92235		9.92235
To the perpen. A B 213,1	2.32854	To the hypoth. AC 388,6	2.58953

By

By making the base B C Radius, it will be,

To find the Perpendicular A B.		To find the Hypothenuse A C.	
As radius 90°	10.00000	As radius 90°	10.00000
Is to the base BC 325	2.51188	Is to the base B C 325	2.51188
So is tang. ang. C 33° 15′	9.81666	So is sec. ang. C 33° 15′	10.07765
	12.32854		12.58953
	10.00000		10.00000
To the perpen. A B 213,1	2,32854	To the hypoth. A C 388,6	2.58953

By making the Perpendicular A B Radius, it will be,

To find the Perpendicular A B.		To find the Hypothenuse AC.	
As tang. ang. A 56° 45′	10.18334	As tang. ang. A 56° 45′	10.18334
Is to the base B C 325	2.51188	Is to the base B C 274	2.51188
So is radius 90°	10.00000	So is sec. ang. A 56° 45′	10.26699
	12.51188		12.77287
	10,18334		10.18334
To the perpen. AB 213,1	2.32854	To the hypoth. AC 388.6	2.58953

By GUNTER.

'Extend from 56 degrees 45 minutes to 33 degrees 15 minutes on the line of sines, that extent will reach from the base 325 to the perpendicular 213,1 on the line of numbers.'

2dly. 'Extend from 56 degrees 45 minutes to radius on the line of sines, that extent will reach from the base 325 to the hypothenuse 388,6 on the line of numbers.'

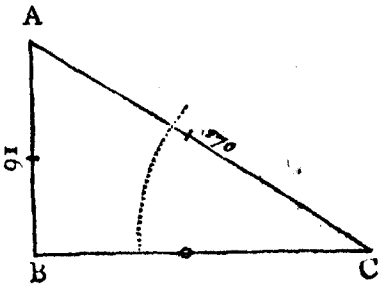
CASE IV. and V.

The Hypothenuse and one Leg given, to find the Angles and other Leg.

The leg A B 91, the Hypothenuse 170 given, to find the angle A C B, or B A C, and the leg B C.

By CONSTRUCTION.

Draw BC at pleasure, on B erect the perpendicular B A, which make equal to 91, take 170 in your compasses, and with one foot on A, lay the other on the line B C, and join A and C, and it is done: for the angle C will be 32° 22′, the angle A 57° 38′ and B C 143,6.



By

By making the Hypothenuſe Radius, it will be,

To find the angle C.		To find the baſe C B.	
As the hypothenuſe 170	2.23045	As Radius	10.00000
Is to the radius	10.00000	Is to the hypoth. 170	2.23045
So is the perpendicular 91	1.95904	So is ſine ang. A. 57° 38′	9.92667
	11.95904		12.15712
	2.23045		10.00000
To ſine angle C 32° 22′	9.72859	To the baſe 143,6	2.15712

By making the Perpendicular Radius, it will be,

To find the angle A.		To find the baſe B C.	
As the perpendicular 91	1.95904	As the radius	10.00000
Is to the radius	10.00000	Is to the perpend. 91	1.95904
So is the hypoth. 170	2.23045	So is tang. ang. 57° 38′	10.19805
	12.23045		12.15709
	1.95904		10.00000
To ſec. ang. A 57° 38′	10.27141	To the baſe 143,6	2.15709

By GUNTER.

'Extend from hypothenuſe 170 to the perpendicular 91 on the line of numbers; that extent will reach from radius to ſine angle C the complement A = 32 degrees 22 minutes on the line of ſines.'

2dly. 'Extend from radius to ſine angle A 57 degrees 38 minutes; that extent will reach from the hypothenuſe 170 to the baſe 143.6 on the line of numbers.'

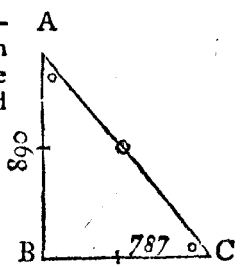
CASE VI.

The Legs given, to find the Angles and Hypothenuſe.

The legs A B 890, B C 787 given, to find the angle B A C, or A C B, and the hypothenuſe A C.

By CONSTRUCTION.

Make BC = 787, and on B erect the perpendicular B A, which make equal to 890; join A C, and it is done; for the angle C will be 48°31′; conſequently, the angle A 41°29′ and hypothenuſe 1188.



By

By making the Base Radius, it will be,

To find Angle C.		To find the Hypoth. A C.	
As the base 787	2.89597	As radius	10.00000
Is to radius	10.00000	Is to the base 787	2.89597
So is the perpend. 890	2.94939	So is sec. ang. C 48° 31′	10.17888
	12.94939		13.07485
	2.89597		10.00000
To tan. ang. C = 48° 31′	10.05342	To the hyp. AC. = 1188.	3.07485

By making the Perpendicular Radius, it will be,

To find Angle A.		To find the Hypoth. A C.	
As the perpend. 890	2.94939	As radius	10.00000
Is to radius	10.00000	Is to the perpend. 890	2.94939
So is the base BC = 787	2. 89597	So is sec. ang. A. 41° 29′	10.12543
	12.89597		13.07482
	2.94939		10.00000
To tan. ang. A 41° 29′	9.94658	To the hyp. AC = 1188	3.07482

By GUNTER.

'The extent from 787 to 890 on the line of numbers will reach from radius (or 45 degrees) to 41° 29′ on the line of tangents.

2dly. 'The extent from sine angle C 48 degrees 31 minutes to radius, or 90 degrees, will reach from the base 890 to the hypothenuse 1188, on the line of numbers.

Questions to exercise the Learner in Trigonometry.

Quest. 1. The hypothenuse 496 miles, and the angle opposite to the base 56° 15′ given, to find the base and perpendicular.

Ans. Base 412,4, and the perpendicular 275,6 miles.

Quest. 2. The perpendicular 275 leagues, and the angle opposite to the base 56° 15′ given, to find the hypothenuse and base.

Ans. The hypothenuse 495, and base 411,6 leagues.

Quest. 3. The base 33 yards, and the angle opposite to the perpendicular 53° 26′ given, to find the hypothenuse and perpendicular.

Ans. Hypothenuse 55,39′, and the perpendicular 44,49 yards.

Quest. 4. The hypothenuse 575, and perpendicular 50 miles given, to find the base.

Ans. Base 572,8 miles.

Quest. 5. The hypothenuse 59, and the base 33 miles given, to find the perpendicular.

Ans. Perpendicular 48,9 miles.

Quest. 6. The base 33, and perpendicular 52 leagues given, to find the hypothenuse.

Ans. Hypothenuse 61,59 leagues.

AN INTRODUCTION TO THE ART OF NAVIGATION.

BEFORE we begin Navigation, it may not be improper to give the Learner ſome idea of the Syſtem of the Univerſe, commonly called the Solar, or Copernican Syſtem, which is as follows:

The Sun, that immenſe and amazing globe of fire, the fountain of the heat and light of the whole ſyſtem, is placed near the common center of the orbits of ſeven opaque ſpherical bodies, which make their revolutions round it in leſs or more time, according to their ſeveral diſtances from it.

Mercury is neareſt to the Sun, and receives its light and heat from it, and revolves round it in an ellipſis in two months and twenty-eight days.

Venus is ſomewhat higher in the ſyſtem, and deſcribes its ellipſes round the Sun in ſeven months and fifteen days, and becomes our evening and morning ſtar by turns.

The Earth is next to Venus, and deſcribes an ellipſis round the Sun in 365¼ days, or one year, which being at a greater diſtance from the Sun than the former planets, and therefore receiving leſs of its light and heat, to make up the deficiency, the wiſe Author of nature has cauſed a ſecondary planet, called the Moon, to move round it in 27 days, 12 hours, and 44 minutes; it receives its light and heat from the Sun, and reflects it upon the Earth, which in ſome meaſure compenſates for the abſence of the Sun, during the winter ſeaſons, in the North and South.

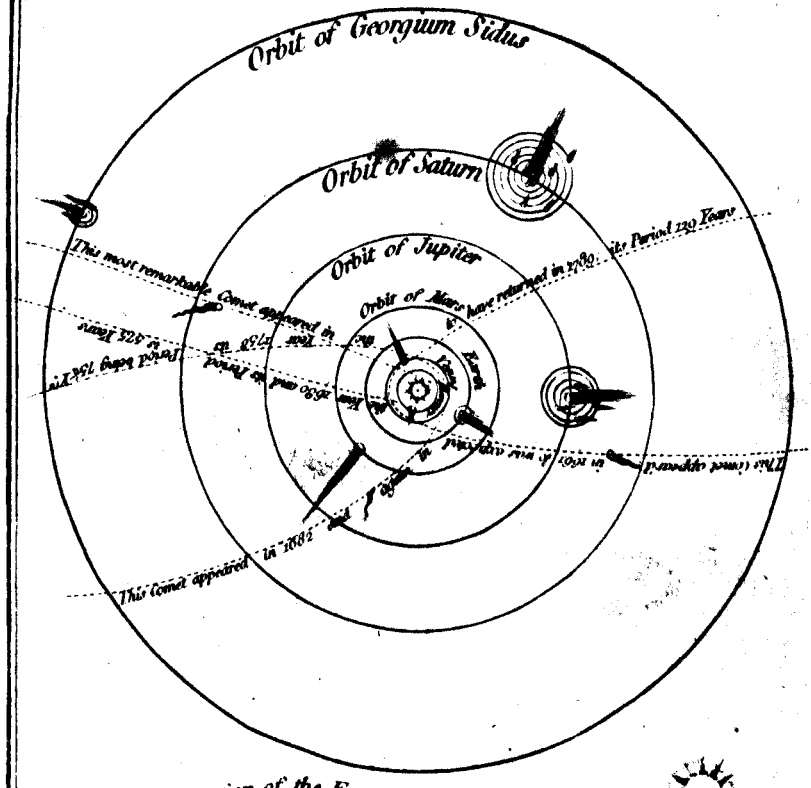
Mars is ſtill higher in the ſyſtem, and takes a larger circuit, revolving round the Sun in 1 year, 10 months, and 22 days.

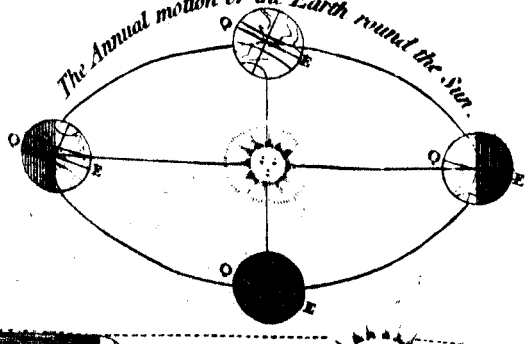
Jupiter is the largeſt of all the planets, and deſcribes a large ellipſis round the Sun in 11 years, 10 months, 27 days; there are four Satellites or Moons moving round it; they receive their light from the Sun and reflect it upon their primary planet, as the Moon does upon the Earth.

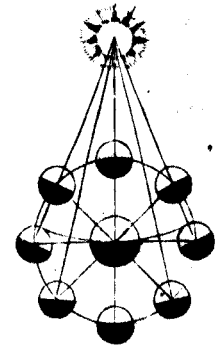
Saturn revolves round the Sun in 29½ years, has 5 Moons which move round him, and is alſo ſurrounded with a prodigious ring or atmoſphere.

The

THE SOLAR SYSTEM.







An Eclipse of the Moon.

An Eclipse of the Sun.

The Georgium Sidus is the moſt remote of all the planets, and is attended by two ſatellites:—the firſt or neareſt of which performs a ſynodical revolution in about eight days and three quarters.

The ſecond (which is about half as far again diſtant from its primary planet) is about thirteen days and a half in performing its ſynodical revolution.

The fixed ſtars, are ſupppoſed to be of the ſame matter with the Sun, and made for the ſame ends; each of them the center of its own proper ſyſtem, having planets moving round it as our Sun has.

Comets are a ſort of planets moving round the Sun, in ellipſis ſo very oblong, that their viſible parts ſeem to be in a manner parabolical, but have ſuch vaſt atmoſpheres about them, and tails derived from the ſame, eſpecially when they come near the Sun, as imply them deſigned for very different purpoſes from the other planets.

Having given a curſory view of the Syſtem of the Univerſe, we ſhall now conſider the Earth a little more particularly; a perfect knowledge of the figure and motion of which, with various real and imaginary lines upon it, is abſolutely neceſſary in the Art of Navigation.

The land and water of this Earth, or Planet, upon which we live, make a compoſition of a ſpherical form, or rather an oblate figure, called the Terraqueous Globe, which by turning round its axis every 24 hours, from Weſt to Eaſt, cauſe all the heavenly bodies to revolve apparently from Eaſt to Weſt in the ſame time, making the viciſſitudes of the day and night; and this Earth, together with its Moon by moving round the Sun in 1 year, or in 365 days 6 hours nearly, produce the ſeaſons of the year, viz. Winter, Summer, Autumn, and Spring.

The Earth is endued with a wonderful principle of gravitation, whereby all its parts are ſtrictly united together; and all bodies that are looſe upon it, cloſely adhere to its ſurface, tending directly to its centre. Hence it is, that ſhips are able to ſail with the ſame facility every where (void of impediments) upon the ſurface of the ſea, quite round the Terraqueous Globe, and that (as to ſenſe) there is no ſuch thing as an upper or lower part of the Earth; for let the inhabitant be in what part ſoever, he will there gravitate towards the Earth's centre, and imagine himſelf to be on the higheſt point of its ſurface; from whence he will obſerve the Heavens like a large vault over his head, and his Antipodes he will imagine to be directly under him, as they will alſo their's for the like reaſon.

According to this law of Gravity, if the Earth were at reſt (and not acted upon by any other power) and its parts looſe, or its ſurface all over covered with a deep fluid; it would naturally form itſelf into a true Sphere or Globe. But admitting the Earth

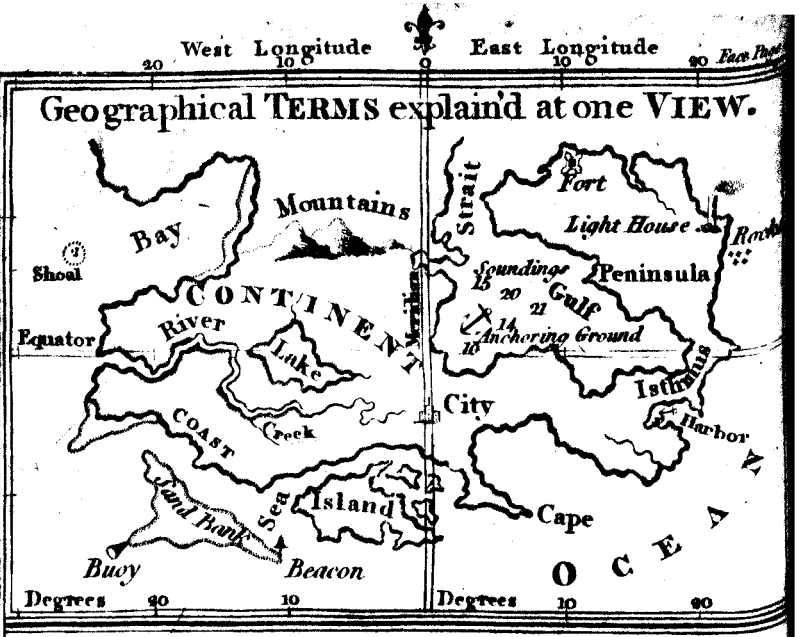
revolves about its own axis, with a rapid motion (from Weſt to Eaſt) in 24 hours, the gravity towards its centre will thereby be diſturbed, and all the parts endeavour to fly off from the axis of the motion; and this inclination is greateſt to that part of the ſurface, which is at the greateſt diſtance from the axis; and conſequently, the gravity towards the center is there the leaſt: whence it will follow, that thoſe parts which gravitate the leaſt, muſt yield or give way to thoſe that have a greater gravitation, to reſtore an equilibrium; and conſequently, here will be formed a Spheroid, whoſe greateſt diameter will be perpendicular to the axis of motion, (commonly called the Earth's axis) and the ſhorteſt diameter will be the axis itſelf.

It is demonſtrated by the writers of mechanics, that the times of the periodical vibrations of all pendulums of equal lengths, are in a certain proportion to the gravity by which they are acted upon; and it has alſo been demonſtrated, that gravity acts in a certain proportion to the diſtance from its centre. Hence, by the help of pendulums, we may find the proportion of gravity upon any part of the earth; and conſequently, the proportional diſtance of that part to the diſtance of any other part from the Earth's centre. Now, it has been found by experience, that the degree of gravitation upon the Earth's ſurface under the equinoctial, is to the ſame in any parallel of Latitude, in the ſame proportion (as near as obſervation could be made) that it would be, if the whole body of the Earth was compoſed of a fluid ſubſtance, and ſo formed itſelf into ſuch a figure as abovementioned. Hence we may infer, that the Earth is a Spheroid; and its greateſt diameter (which is under the Equinoctial) is computed to be to the leſſer diameter, (which is under the Poles, or the Earth's axis) as 289 to 288; and conſequently, the ſpace upon the Earth's ſurface, anſwering to a degree of a great circle where it is greateſt, (or under the Equinoctial) is to the ſpace anſwering to a degree near the Poles, (where it is leaſt) as 289 to 288; or as a 1000 to 996,5 nearly: but this difference is ſo ſmall, that in all aſtronomical and geographical caſes, the figure of the Earth may be eſteemed truly ſpherical, though the ſmall difference from it does ſenſibly effect the motions of pendulums.

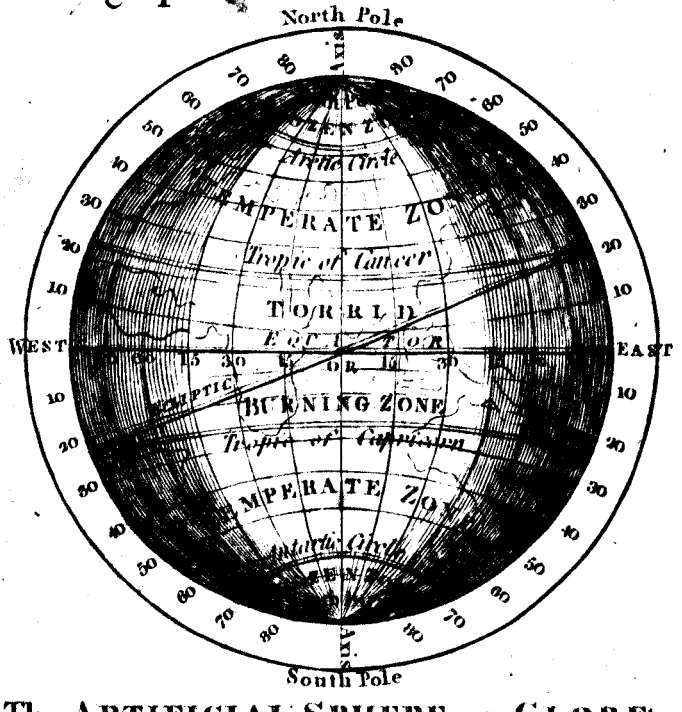
That the Earth is round or nearly ſo, will appear, not only from the circular ſhadow it has upon the Moon, when that body happens to be eclipſed by it, but alſo from the very appearance of the ſea, and the many obſervations made by perſons ſtanding upon the ſhore, and viewing a ſhip departing from the port: they firſt loſe ſight of the body of the veſſel, whilſt they can ſtill ſee the rigging and uppermoſt ſails; but as the ſhip recedes farther, they loſe ſight of theſe alſo, as if the whole were ſunk in the deep. Again, in a ſhip making towards land, the mariners firſt deſcry the tops of

ſteeples,

Geographical TERMS explain'd at one VIEW.



Geographical CIRCLES and ZONES.



The ARTIFICIAL SPHERE or GLOBE.

ſteeples, trees, &c. pointing above the water; next, they ſee the buildings themſelves; and laſtly the ſhore, which can only be the effects of the Earth's rotundity.

Its being a globe, is alſo confirmed by the many voyages which have been made round it, from Eaſt to Weſt: firſt by Magellan's ſhip in the years 1519, 1520, 1521, in 1124 days; by Sir Francis Drake, in the years 1577, 1578, 1579, 1580, in 1056 days; by the late Lord Anſon, in 4 years; and lately by the Captains Byron, Carteret, Cook, and Clark, accompanied with ſeveral able mathematicians and naturaliſts, whoſe obſervations and diſcoveries do honour to this nation, as well as greatly contribute to the improvement of Geography and Navigation: they have diſcovered many iſlands in the South Seas, which were formerly unknown to Europeans.

The little unevenneſſes of the Earth's ſurface, ariſing from the hills and vales, is no material objection to its being conſidered as round; ſince the higheſt hill or mountain bears not ſo great a proportion to the bulk of the Earth itſelf, as the little riſings upon the coat of an orange, bear to the bigneſs of that fruit.

In order to deſcribe the poſition of places, geographers have found it neceſſary to imagine certain circles drawn upon the ſurface of the Earth; to which they have given the names of Equator, Meridian, Horizon, Parallels of Latitude, &c.

I. The Axis is a ſtrait line, imagined to paſs through the centre of the Earth; the extreme points are the poles, on which the Earth is ſuppoſed to move, one called the Artic or North Pole, and the other, the Antartic, or South Pole.

II. The Equator is a great circle under the Equinoctial Line in the Heavens, compaſſing the Earth in the middle, between the two Poles, and divides it into two equal parts, called the Northern and Southern Hemiſpheres: from it the latitude of places is reckoned either North or South; and on it are counted the degrees of longitude from Eaſt to Weſt. This circle is called the Equator, becauſe when the Sun comes to it, which is twice a year, viz. about the 21ſt of March, at his entrance into Aries, and again into Libra about the 23d of September, then, making equal day and night throughout the world.

III. The Meridians are circles which paſs through the poles of the Earth, the Zenith, and Nadir, croſſing the Equator at right angles, and dividing the Earth into two equal parts, one Eaſt and the other Weſt; and is ſo called, becauſe when the Sun comes to the meridian of any place, it is then noon or mid-day. They are infinite in number, for all places from Eaſt to Weſt have their ſeveral meridians; of theſe one is called the firſt or chief Meridian, from which the longitude of places is reckoned; it is of ſpecial note and uſe, but variouſly placed by geographers; ſome placing it

at

at London, others at Paris, Teneriffe, &c. and is divided into twice 90 degrees, numbered from the Equator towards each Pole, ending in 90 degrees, and since the Earth turns once round its axis in 24 hours, every point upon its surface describing a circle of 360 degrees in that time; therefore, any place lying 15 degrees to the East of us, has the Sun upon its meridian one hour sooner; or it is twelve o'clock with the easternmost, when it is eleven with us; and any place 15 degrees to the westward of us, has the sun one hour after us.

IV. Latitude is the nearest distance of any place from the Equator; it is measured on an arch of the Meridian, intercepted between the place and the Equator, and therefore can never exceed 90 degrees. It takes its name according as the place is situated, either North or South of the Equator; therefore, all places that lie at the same distance from, and on the same side of the Equator, are said to be under the same parallel of Latitude. Whence it follows, that if a ship sails from a North Latitude directly North, or in a South Latitude directly South, she encreases her Latitude equal to the distance sailed; and if a ship sails in North Latitude southerly, or in South Latitude northerly, she decreases her Latitude, because she sails nearer the Equator, from whence the Latitude is counted upon the Meridian: but if a ship sails from a South Latitude into a northerly one, or from a North Latitude into a southerly one, from the difference of Latitude subtract the Latitude left, and the remainder will be the Latitude come to, and of a different name with the Latitude left.

Parallels of Latitude are circles parallel to the Equator.

The difference of Latitude is an arch of the meridian contained between the two Parallels of Latitude; or it is the least distance of the Parallels of Latitude of two places: shewing how far one of them is to the northward or southward of the other, and can never exceed 180 degrees.

V. The Longitude of any place on the earth is expressed by an arch of the equator, shewing the east or west distance of the meridian of that place, from some fixed meridian, where Longitude is reckoned to begin.

Difference of Longitude is an arch of the Equator, intercepted between the meridians of two places, shewing how far one of them is to the eastward or westward of the other.

Note. Here the Teacher will perhaps find it convenient to have a globe, or Map of the World before him, whereon he can point out the several Positions, Latitudes, Longitudes, &c. to the Pupil, as that will strengthen his memory, and give him a better idea than he can possibly have by only reading them over. The same may be observed in reading the use of Gunter's Scale and the Quadrant.

As Longitude begins at the meridian of ſome place, and is counted from thence both eaſtward and weſtward, till it meets at the ſame meridian on the oppoſite point, therefore the difference of Longitude can never exceed 180 degrees.

VI. The Horizon is that apparent circle which limits or bounds the view of a ſpectator on the ſea, or an extended plain; the eye of the ſpectator being always ſuppoſed the centre of his horizon. Every part of this circle is 90 degrees from the centre of it over our heads, which point is called the Zenith; and the point of the Heaven's oppoſite to it, or under our feet, is called the Nadir.

When the ſun or ſtars come above the eaſternmoſt part of the Horizon, they are ſaid to riſe; and when they deſcend the weſtern part they are ſaid to ſet.

When a ſhip is under the Equator, both the poles appear in the Horizon; and, in proportion as ſhe ſails towards either, or increaſes her latitude, that pole is ſeen proportionably above the Horizon, and the other diſappears as much: but when a ſhip is ſailing towards the Equator, or decreaſes her latitude, ſhe depreſſes the elevated pole; that is, its diſtance from the Horizon decreaſes: conſequently, the latitude of a place is always equal to the elevation of the pole above the Horizon.

This circle is repreſented by the Mariner's Compaſs, divided into 32 points or rhumbs, each $11^{\circ}\ 15'$.

The Tropics are two circles parallel to the Equator, and diſtant from it 23 degrees 29 minutes; that on the north-ſide of it is called the Tropic of Cancer, at which the Sun has its greateſt north declination; then, making to us, and all places in north latitude, the longeſt day and ſhorteſt night, which is about the 21ſt of June. The other on the ſouth ſide is called the Tropic of Capricorn, at which the Sun has its greateſt ſouth declination, making then our ſhorteſt day and longeſt night, which is about the 22d of December.

The Polar Circles are alſo parallel to the Equator, compaſſing the poles of the world at 23 degrees 29 minutes diſtance; that about the North Pole is called the Artic Circle, and the other is called the Antartic Circle.

Theſe Tropics and Polar Circles divide the globe of the earth into 5 parts, called Zones, of which 3 were accounted by the Ancients to be ſo intemperate as to be uninhabitable; the Zones are called Torrid, Frigid, and Temperate; that is, 1 Torrid or Burning Zone, 2 Temperate, and 2 Frigid or Frozen Zones.

The Torrid Zone is all that ſpace of the earth and ſea which lies between the Tropics of Cancer and Capricorn, and is 47 degrees broad: its inhabitants ſee the ſhadow of the ſun turn ſometimes towards one pole, and ſometimes towards the other.

The

The two Temperate Zones are thoſe ſpaces of the earth and ſea contained between each Tropic and the Polar Circles; the inhabitants of the North Temperate Zone have their ſhadows at noon fall north, and thoſe of the South Temperate Zone have their ſhadows at noon fall ſouth.

The two Frigid Zones are contained between each Polar Circle and its pole; thoſe who inhabit them have their ſhadow always running round them; according to the different motions of the ſun.

Climates are thoſe tracks of the earth bounded by imaginary lines running parallel to the Equator, and of ſuch a breadth from ſouth to north, that the length of the artificial day in one ſurpaſſes that in the other by half an hour.

The inhabitants of the earth are diſtinguiſhed by the ſeveral meridians and parallels under which they live, and are denominated either Periæci, or Antipodes.

The Periæci are thoſe people of the earth who live under the ſame parallels, but oppoſite meridians.

The Antiæci are thoſe people of the earth who live under the ſame meridians, but oppoſite parallels.

The Antipodes are ſituated directly oppoſite to each other, the feet of the one directly againſt the feet of the other, lying under oppoſite parallels and oppoſite meridians. It is midnight with one when it is noon day with the other; the longeſt day with the one is the ſhorteſt with the other; the length of the day with the one is equal to the other's night; and the ſeaſons are oppoſite; being ſummer with the one when it is winter with the other.

The Real Parts are earth and water, generally divided into four parts or quarters, called Europe, Aſia, Africa, and America; each of theſe, and conſequently the whole globe, is divided into continents, iſlands, ſeas, &c.

A Continent is a great quantity of land not divided by the ſea, wherein are ſeveral empires, kingdoms, and countries conjoined, as Europe, Aſia, and Africa, is one Continent, and America another.

An Iſland is a part of the earth that is environed or encompaſſed round by the ſea, as Great Britain and Ireland.

A Peninſula is a part of land almoſt ſurrounded with water, ſave one narrow neck of land which joins the ſame to the Continent.

An Iſthmus is a narrow neck of land joining the Peninſula to the Continent, by which the people may paſs from one to the other.

A Promontory is a high part of land, ſtretching itſelf into the ſea, the extremity of which is called a Cape or Headland.

A Mountain is a riſing part of dry land over-topping the adjacent country, and appearing firſt at a diſtance.

The Earth being encompaſſed with water, whoſe waſhings, in ſurrounding the dry land, cut and ſhape many winding bays, creeks,

and meandering inlets, and extending itſelf round them all, is but one continued ocean.

An Ocean, is a vaſt collection of ſalt water, ſeparating Continents from one another, and waſhing their borders or ſhores.

A Sea, is part of the Ocean, to which we muſt ſail through ſome Strait, as the Mediterranean and Baltic Seas.

A Strait, is a narrow part of the Ocean lying between two ſhores, and opening a way into ſome ſea, as the Straits of Gibraltar that lead into the Mediterranean Sea, and the Sound which leads into the Baltic Sea.

A Creek is a ſmall narrow part of the ſea or river, that goes up but a little way into the land.

A Bay is a great inlet of the land, as the Bay of Biſcay, and the Bay of Mexico; otherwiſe a Bay is a ſtation or road for ſhips to anchor in.

A River is a conſiderable ſtream of water iſſuing out of one or various ſprings, and continually gliding along in one or more channels, till it diſcharges itſelf into the Ocean: The leſſer ſtreams are called rivulets.

A Lake is that which continually retains and keeps water in it, as the lake Zair, in Africa, and Nicaragua, in America.

A Gulf is a part of the Ocean or Sea, contained between two ſhores, and is every where environed by land, except its entrance, where it communicates with other bays, ſeas, or oceans.

There are five oceans, namely, the Northern, the Atlantic, the Pacific, the Indian, and the Southern.

The Atlantic Ocean is uſually divided into two parts, one called the North Atlantic Ocean, and the other South Atlantic or Ethiopic Ocean.

The Northern Ocean ſtretches to the northward of Europe, Aſia, and America, towards the north pole.

The Atlantic Ocean lies between the Continents of Europe and Africa, on the eaſt, and America on the weſt.

That part of the North Atlantic Ocean lying between Europe and America, is frequently called the Weſtern Ocean.

The Pacific Ocean, or, as it is ſometimes called, the South Sea, is bounded by the weſtern and north-weſt ſhores of America, and by the eaſtern and north-eaſt ſhores of Aſia.

The Indian Ocean waſhes the ſhores of the Eaſtern Coaſts of Africa, and the ſouth of Aſia, and is bounded on the eaſt by the Indian Iſlands and the Southern Continent.

The Southern Ocean extends to the ſouthward of Africa and America towards the South Pole.

NAVIGATION.

THE great end and buſineſs of Navigation is to inſtruct the Mariner how to conduct a ſhip through the wide and pathleſs ocean, to the remoteſt parts of the world, the ſafeſt and ſhorteſt way, in paſſages navigable.

For the due and regular performance of which are requiſite— A perfect knowledge of the figure and motion of the earth, the various real and imaginary lines upon it, ſo as to be able to aſcertain the real diſtance and ſituation of places with reſpect to one another, with the uſe of the ſeveral inſtruments made uſe of in meaſuring the ſhip's way; ſuch as the log, half-minute glaſs, quadrant, to take the altitude of the ſun and ſtars; compaſs, to repreſent the ſenſible horizon; and azimuth compaſs, to take the azimuth or amplitude of the ſun, in order to know the variation of the magnetic needle; maps or charts of the ſeas and lands, together with the depth of water, the times and ſettings of the tides upon the coaſts he may have occaſion to approach near; a competent knowledge of currents; of the mould and trim of the ſhip, and the ſail ſhe bears, that ſo due allowance may be made for leeway: By help of theſe, and ſkill in the Navigator, he may know at all times the place the ſhip is in, which way he muſt ſteer, and how far, to gain his intended port.

Notwithſtanding what has been ſaid, it may not be improper here to obſerve, that,

As latitude is counted from the Equator upon an arch of the meridian, north and ſouth, the difference of latitude between two places, both north, or both ſouth, is found by ſubtracting the leſs latitude from the greater; but if one latitude be north and the other ſouth, the difference is found by adding both latitudes together.

Conſequently, if a ſhip in north latitude ſails northerly, or in ſouth latitude ſoutherly, ſhe increaſes her latitude; but in north latitude ſailing ſoutherly, or in ſouth latitude ſailing northerly ſhe decreaſes her latitude; becauſe ſhe ſails nearer to the Equator, from whence the latitude is reckoned.

Wherefore in north latitude ſailing northerly, or in ſouth latitude ſailing ſoutherly, the difference of latitude added to the latitude left, gives the latitude in.

In north latitude ſailing ſoutherly, or in ſouth latitude ſailing northerly, the difference of latitude ſubtracted from the latitude left, gives the latitude in.

When

When the latitude decreases, and the difference of latitude is greater than the latitude sailed from, subtract the latitude left from the difference, and the remainder will be the latitude in, and of a different name; for it is plain, in this case, that the ship has crossed the Equator.

As the longitude is counted from the first meridian east and west, until it comes to the opposite meridian, therefore it cannot exceed 180 degrees.

The difference of longitude between two places, being both east or west, is found by subtracting the less longitude from the greater; but if one be in east longitude and the other in west, their sum is the difference of longitude.

Therefore in east longitude sailing easterly, or in west longitude sailing westerly, the difference of longitude added to the longitude left, gives the longitude in.

In east longitude sailing westerly, or in west longitude sailing easterly, the difference of longitude subtracted from the longitude left, gives the longitude in.

When a ship sails east or west, until she passes the opposite meridian, or 180 degrees, she changes her longitude, or comes into a longitude of a different name.

What has been said, will be rendered familiar to the learner by the following examples:

EXAM. I. What is the difference of latitude between London in latitude 51° 32′ N. and Rome in latitude 41° 54′ N?

	°	′	
From London's lat.	51	32	N.
Subtract Rome's lat.	41	54	N.
Rem. the diff. of lat.	9	38	N.
	60		
Diff. in miles - -	578		

EXAM. II. A ship from latitude 29° 17′ S. sails southward until her difference of latitude be 374 miles, what latitude is she come to?

	°	′	
Latitude sailed from	29	17	S.
Diff. of lat. 374 ÷ 60 =	6	14	S.
Lat. in - - -	35	31	S.

EXAM. III. Required the difference of latitude between Cape Finisterre and Cape Rogue in South America?

Cape Finisterre's lat.	42	52	N.
Cape Rogue's lat.	5	0	S.
Diff. of lat.	47	52	
	60		
Diff. in miles	2872		

EXAM. IV. A ship from latitude 8° 25′ N. sails south 600 miles, what latitude is she in?

From diff. of lat. 600 miles, or - -	10	00	S.
Sub. lat. left - -	8	25	N.
Diff. lat. in	1	35	S.

In the laſt example it is plain, that as the difference of latitude is more than the latitude left, the ſhip muſt have croſſed the Equator, and conſequently come into ſouth latitude.

NOTE. When one of the places has no latitude, or is on the Equator, then the latitude of the other place is their difference of latitude.

EXAM. V. What is the difference of longitude between Cape Finiſterre and eaſt point of Barbadoes?

	°	′	
Cape's Finiſterre's long.	9	14	W.
Barbadoes' long.	59	37	W.
Diff. of long. —	50	23	W.
	60		
Diff. in miles —	3023		

EXAM. VII. What is the difference of longitude between Barcelona and Liſbon?

Barcelona's long.	2	18	E.
Liſbon's long.	9	7	W.
Diff. of Long. —	11	25	W.

EXAM. IX. What is the difference of longitude between the N. E. point of Japan and St. Chriſtopher's?

N. E. of Japan's long.	140	25	E.
St. Chriſtopher's long.	62	42	W.
Exceeds 180° 00′	203	07	
	360	00	
Diff. of long. —	156	53	W.

EXAM. VI. A ſhip from Cape Charles in Virginia ſails weſtward, till her difference of longitude be 400 miles, what longitude is ſhe in?

	°	′	
Cape Charles's long.	75	9	W.
Diff. of long. 400 miles =	6	40	W.
Long. in —	81	49	W.

EXAM. VIII. A ſhip from 15° 40 E. long. ſails weſtward till her diff. of long. be 27° 15′, what long. is ſhe in?

Long. left	15	40	E.
Diff. of long.	27	15	W.
Long. in —	11	35	W.

EXAM. X. A ſhip from longitude 160° 20′ W. ſails weſtward until ſhe differs her long. 41° 20′, what long. is ſhe in?

Long. left —	160	20	W.
Diff. of long. —	41	20	W.
	201	40	
	360	00	
Long. in —	158	20	E.

Here it is plain, that the ſhip has croſſed the oppoſite meridian, and therefore has come into a longitude of a different name.

In ſailing due north or ſouth, the ſhip changes her latitude only; and ſailing eaſt or weſt her longitude; but ſailing upon any other courſe, ſhe muſt change both latitude and longitude.

Eaſting or weſting in Plane Sailing is called departure or Meridian Diſtance.

The inſtrument uſed in meaſuring a ſhip's way at ſea, is the Log.

Ships at ſea are directed from one place to another by means of an inſtrument called the Mariner's Compaſs.

The Mariner's Compaſs is an artificial repreſentation of the horizon of every place, by the means of a circular piece of paper, called a card, divided like the horizon into degrees and points, which are called Rhumbs. Now the card being properly fixed to a piece of ſteel, called the Needle, that has been touched with a loadſtone (whoſe property is ſuch as to cauſe one end of the needle ſo touched to point towards the north, when turning freely on ſomething ſupporting it) all the points of the card will be directed towards the correſponding points of the horizon:

Hence it follows, that in every place the north point of the card ſhews the poſition of the meridian of that place, and ſome one rhumb or point of the card will coincide with, or be directed along the track that makes any given angle with the meridian; conſequently, by the help of the card or compaſs, a ſhip may be kept in any propoſed track or courſe.

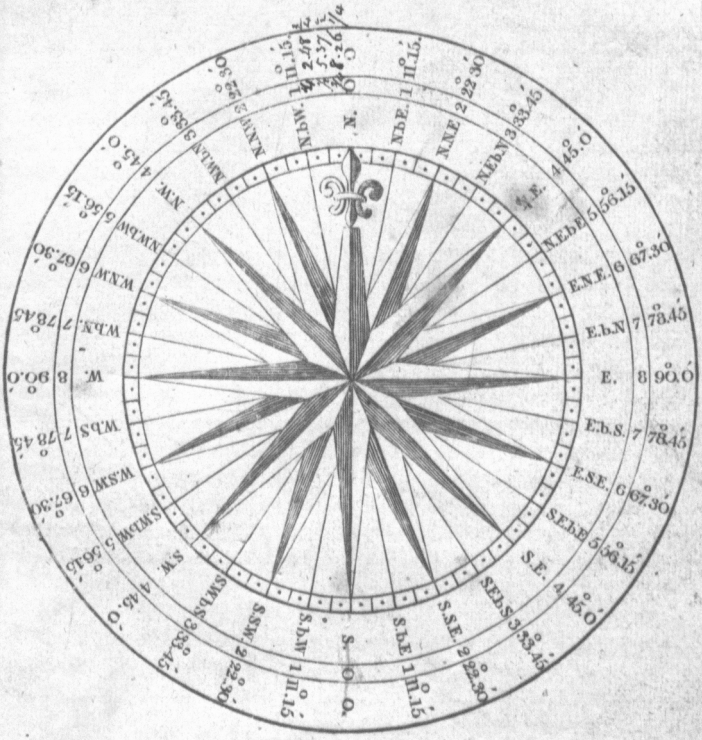
A Rhumb Line, or point, is a right line drawn from the centre of the compaſs to the horizon, and is named from that point of the horizon it falls in with.

The Courſe, is the angle which any rhumb line makes with the meridian, and is ſometimes reckoned in degrees, and ſometimes in points of the compaſs; ſo that if a ſhip ſails upon the ſecond rhumb, or N. N. E. the courſe is 22 degrees 30 minutes: and ſo for any other, as in the following table, which the learner ſhould be ſo well acquainted with, or the compaſs, as to be able readily to tell how many points any courſe or rhumb is diſtant from the meridian, or from the parallel.

A Table of the Angles which every Point of the Compass makes with the Meridian.

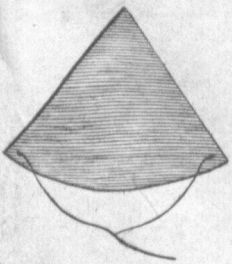
North.	South.	Points.	D. M.	North.	South.
		1/4	2. 49		
		1/2	5. 37		
		3/4	8. 26		
N. by E.	S. by E.	1	11. 15	N. by W.	S. by W.
		1 1/4	14. 4		
		1 1/2	16. 52		
		1 3/4	19. 41		
N. N. E.	S. S. E.	2	22. 30	N. N. W.	S. S. W.
		2 1/4	25. 19		
		2 1/2	28. 7		
		2 3/4	30. 56		
NE by N.	S.E. by S.	3	33. 45	N. W. by N.	S.W by S.
		3 1/4	36. 34		
		3 1/2	39. 22		
		3 3/4	42. 11		
N. E.	S. E.	4	45. 0	N. W.	S. W.
		4 1/4	47. 49		
		4 1/2	50. 37		
		4 3/4	53. 26		
NE by E.	S.E. by E.	5	56. 15	N. W. by W.	SW by W.
		5 1/4	59. 4		
		5 1/2	61. 52		
		5 3/4	64 42		
E. N. E.	E. S. E.	6	67. 30	W. N. W.	W. S. W.
		6 1/4	70. 19		
		6 1/2	73. 7		
		6 3/4	75. 56		
E. by N.	E. by S.	7	78. 45	W. by N.	W. by S.
		7 1/4	81. 34		
		7 1/2	84. 22		
		7 3/4	87. 11		
	East.	8	90. 0	West.	

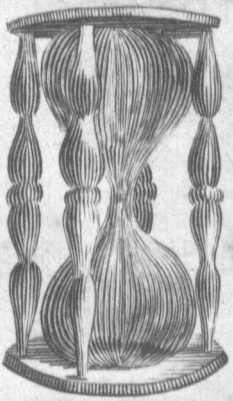
THE MARINERS COMPASS.



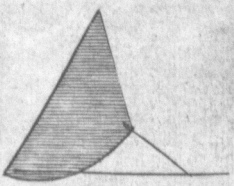
HALF MINUTE GLASS.

The Log





The Log
in the Act of heaving



NB. There are many kinds of Logs, but the above is the most Common.

PLANE SAILING.

PLANE SAILING is the art of navigating a ſhip upon principles deduced from the notion of the earth's being an extended Plane, and is no more than the application of Plane Trigonometry to the ſolution of the ſeveral variations, or caſes; where the hypothenuſe, or longeſt ſide, is always the rhumb that the ſhip ſails upon.

The Perpendicular is the difference of latitude counted on the meridian, and the baſe the departure: which is eaſting or weſting, counted from the meridian.

The Angle oppoſite the baſe is the courſe, or angle, that the ſhip makes with the meridian; and the angle oppoſite the perpendicular is the complement of the courſe, which being taken together, make always eight points or rhumbs, which is 90 degrees.

In conſtructing figures relating to a ſhip's courſe, let the upper part of the paper, or what the figure is drawn upon, always repreſent the north; the lower part will be the ſouth; the right hand eaſt; and the left weſt.

Draw the north and ſouth line to repreſent the meridian of the place the ſhip ſails from; then, if the ſhip's courſe is to the ſouthward, mark the upper end of the line for the place ſailed from; but if the courſe is northward, mark the lower end for that place.

When the courſe is eaſterly, deſcribe the arch, and lay off the courſe and departure on the right-hand ſide of the meridian; but when weſterly, on the left-hand ſide.

When the courſe is given in degrees, the degrees expreſſing it muſt be taken from the line of chords; but when in points, from the line of rhumbs; and is always to be laid off upon the arch, beginning at the meridian.

When the courſe is given in points, it may be ſet down with its correſponding logarithm in points in the calculation, as found in the firſt page of the logarithms, without reducing it into degrees, as it ſeems altogether unneceſſary.

In all caſes, wherever the complement courſe, or co-ſine, &c. is uſed, the degrees or points put down is the courſe itſelf; yet the logarithm belonging to the complement, or co-ſine, &c. of that courſe is taken.

CASE

CASE I.

Course and Distance sailed given, to find the Difference of Latitude and Departure from the Meridian.

A Ship from the Lizard, in latitude 49° 57′ N. sails S. W. by W. 488 miles.

Required the Latitude she is in, and her departure from the Meridian she sailed from?

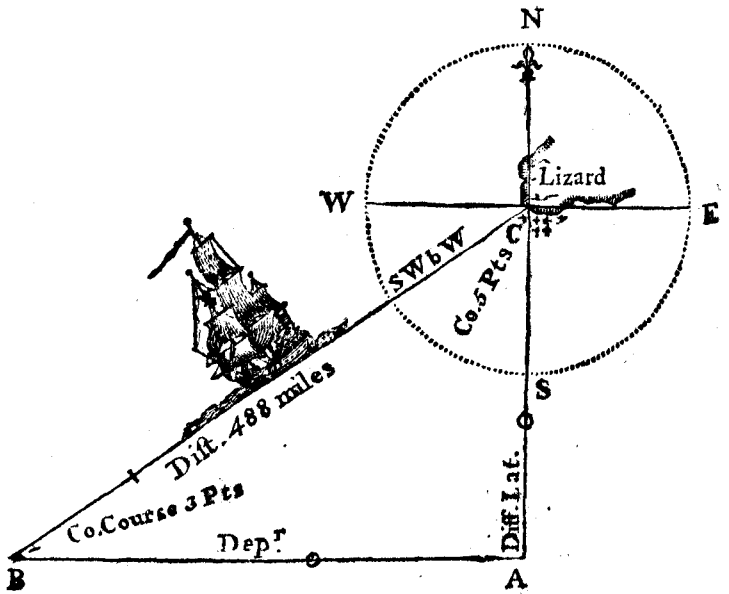
By CONSTRUCTION.

Draw the Line C A to represent the meridian of the Lizard, and C the Lizard Point.

With the chord of 60° in your compasses, and one foot in C, describe the compass N. W. S. E.

Take 5 points in your compasses from the line of rhumbs on the plane scale, and set it off on the arch from S. towards W. for the course; draw the line C B, which make equal to the distance 488; draw B A parallel to the E. and W. points W. E, to cut the Meridian in A.

Then will A C be the difference of latitude 271,1, and A B the departure 405,8.



By

By making the Diſtance Radius, it will be by AXIOM I.

The courſe 5 points = 56° 15′ To find the Departure.			The co-courſe 3 points 33° 45′ To find the Diff. of latitude.		
As radius	90′	10.00000	As radius	90′	10.00000
Is to the diſtance	488	2.68842	Is to the diſtance	488	2.68842
So is the ſine courſe 5 pts.		9.91985	So is co-ſine courſe 5 pts.		9.74474
		12.60827			12.43316
		10.00000			10.00000
To the departure	405,8	2. 60827	To the diff. of lat.	271.	2.43316

Now as the ſhip is in north latitude ſailing ſoutherly from the latitude left 49° 57′N.

Take the difference of latitude 271,1 = 4 31 S.

Gives the latitude in 45 26N.

And the departure from the Meridian is 405,8 miles.

By making the Departure Radius, it will be,

To find the Departure.			To find the Diff. of Latitude.		
As co-ſec. courſe 5 pts.		10.08015	As co-ſec. courſe 5 pts.		10.08015
Is to the diſt.	488	2.68842	Is to the diſt.	488	2.68842
So is radius 8 pts.	90	10.00000	So is co-tan. courſe 5 pts.		9.82489
		12.68842			12.51331
		10.08015			10.08015
To the departure	405,8	2.60827	To the diff. of lat.	271,1	2.43316

By making the difference of Latitude radius, it will be,

To find the Departure.			To find the Difference of Latitude.		
As ſec. courſe 5 pts.		10.25526	As ſec. courſe 5 pts.		10.25526
Is to the diſt.	488	2.68842	Is to the diſt.	488	2.68842
So is tang. courſe 5 pts.		10.17511	So is the radius 8 pts.	90°	10.00000
		12.86353			12.68842
		10.25526			10.25526
To the dep.	405,8	2.60827	To the diff. of lat.	271,1	2,43316

Here all the three ſides are made radius, to find the difference of latitude and departure; therefore, the Learner may make which ſide radius he pleaſes; but as for my part, I ſhall make the firſt, where the diſtance is made radius, whenever the courſe is given.

Though this method of working by logarithms is certain, yet the ſame may be wrought by Gunter's Scale and Compaſſes, much

more expeditiously, and exact enough in the practice of navigation.

NOTE.—When the course is given in points, make use of the lines marked sine rhumbs, and tangent rhumbs, on the upper side of the Scale; when in degrees, make use of the lines marked sine and tangent.

By GUNTER.

Now to perform the last case, extend from radius or 8 points to 5 points on the line marked S R; that extent will reach from the distance 488 to the departure 405,8 on the line of numbers.

2dly. 'Extend from radius or 8 points to 3 points (the complement of the course on the line S R; that extent will reach from the distance 488 to the difference of latitude 271 on the line of numbers.

Thus may all the operations be performed in the several cases of Navigation.

By this case is calculated the tables of latitude and departure for every degree, point and quarter-point of the Mariner's Compass, to the distance of 300 miles, which is of excellent use in working day's works at sea, and may be applied both to middle latitude and Mercator's Sailing, as shall be shewn hereafter; we shall only proceed now to the working of the last case by the Table of Diff. of Latitude and Departure.

By INSPECTION.

Find the given course at the top or bottom of the tables, either among the points or degrees, and in that page, and right against the distance taken in its column, stand the difference of latitude and departure in their columns.

Thus the course is S. W. by W. or 5 points, which is found at the bottom of the table of difference of latitude and departure for points: and as the distance 488 is too great to be found in the tables, divide it by 2, (or any other convenient number (and that gives 244, which look for in the distance column, and right against it stands 135,5 for the difference of latitude, and 202,8 for the departure, which being doubled (because divided by 2) gives 271, for the difference of latitude, and 405,6 for the departure, the same as before. Any of these methods will do, but the last is chiefly practised at sea.

NOTE.—All points above 4, are to be looked for at bottom of Table III. and all less at top, with minutes to right hand in those above 4, and minutes on left hand, in those less than 45° or 4 points.

CASE II.

Course and Difference of Latitude given, to find the Distance run, and Departure from the Meridian.

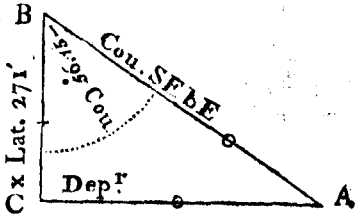
If a ship runs S. E. by E. from 1° 45′ north latitude, and then by observation is in 2° 46′ south latitude, what is her distance and departure?

Now,

Now, in this caſe, as the ſhip has croſſed the Equator, therefore the latitude 1° 45′ N. added to 2° 46′ S. is 4° 31′, which multiplied by 60 gives 271 miles for the difference of latitude.

Conſtructed the ſame as Problem VII. in Geometry.

Draw BC=271, and BA making an angle with BC=5 points, or 56° 15′: upon C erect the perpendicular CA to join BA in A and it is done; then will CA= 406, and AB=488.



By making the Diſtance A B Radius, it will be,

Courſe S. E. by E. 5 Pts. =56° 15′		Complement 3 Points = 33° 45	
To find the Departure.		To find the Diſtance.	
As co-ſine courſe 5 pts.	9.74474	As co-ſine courſe 5 pts.	9.74474
Is to the diff. of lat. 271	2.43297	Is to the diff. of lat. 271	2.43297
So is ſine courſe 5 points	9.91985	So is radius	10.00000
	12.35282		12.43297
	9.74474		9.74474
To the departure 405,6	2.60808	To the diſtance 487,8	2.68823

Hence the ſhip's diſtance run is 487,8 miles, and her departure from the meridian is 405,6 eaſterly.

By GUNTER.

'Extend from 3 to 5 points on the line marked S R, that extent will reach from the difference of latitude 271 to the departure 405,6 on the line of numbers.'

2dly. 'Extend from radius or 8 points to 3 points, that extent will reach from the difference of latitude 271 to the diſtance 488 on the line of numbers.'

By INSPECTION.

Find the courſe among the points or degrees, and the difference of latitude in its column, right againſt which ſtand the diſtance and departure in their columns.

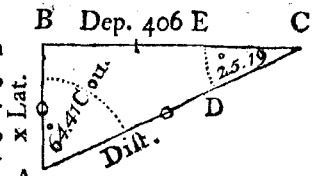
Now, as the difference of latitude 271 is too great to be found in the tables, I divide it by 2, and that gives 135 which I find over 5 points in the latitude column; againſt that ſtands 244, for the diſtance, and 202,5 for the departure, which multiplied by 2 gives the diſtance 488, and the departure 405.

CASE III.

Course and Departure from the Meridian given, to find the Distance and Difference of Latitude.

If a ship sails N. E. by E. $\frac{3}{4}$ E. from a port in 3° 15′ South latitude, until she depart from her first meridian 406 miles, I demand her distance, and what latitude she is in?

By CONSTRUCTION.



Draw the meridian A B, upon which erect the perpendicular B C, and set off thereon from B her departure 406 easterly from B to C, with the chord of 60°, on C describe and arch, and set off thereon the complement of the course, as D E, and through D and C draw the line CDA, cutting the meridian in the point A; then the distance AC, measured on the same scale before used, gives 449, and A B 192 the difference of latitude.

By making the Distance AC Radius, it will be,

The course $5\frac{3}{4}$ points = 64° 41′ To find the Diff. of Lat.		The compl. $2\frac{1}{4}$ points = 25° 19′ To find the Distance.		
As sine course $5\frac{3}{4}$ pts.	9.95616	As sine course $5\frac{3}{4}$ points		9.95616
Is to the departure 406	2.60853	Is to the departure 406		2.60853
So is co-sine course $5\frac{3}{4}$ pts.	9.63099	So is radius		10.00000
	12.23952			12.60853
	9.95616			9.95616
To the diff. of lat. 192	2.28336	To the distance	449,1	2.65237

From the latitude left	—	3° 15′ S.
Subtract the difference of latitude 192 miles, or		3 12 N.
The remainder being 3, shews the ship is in	—	0 03′ S.

By GUNTER.

'Extend from $5\frac{3}{4}$ points to $2\frac{1}{4}$ on the line marked S R, that extent will reach from the departure 406 to the difference of latitude 192 on the line of numbers.'

2dly. 'Extend from radius to $5\frac{3}{4}$ points, that extent will reach from the departure 406 to the distance 449 miles.'

By

By INSPECTION.

Find the course either among the points or degrees, and the departure in its column, right against which stands the distance and difference of latitude in their respective columns.

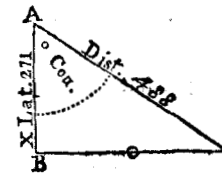
Thus, with the course 5¾ points, and half the departure, I find 202,5 for the distance, and 95,8 for the difference of latitude, which being doubled, gives the distance 405, and the difference of latitude 191,6, as before.

CASE IV.

Distance and Difference of Latitude given, to find the Course and Departure.

Suppose a ship sails 488 miles, between the south and the east, from a port in 2° 52′ south latitude, and then by observation is in 7° 23′ south latitude; what course has she steered, and what departure has she made?

From the latitude by observation 7° 23′ take 2° 52′ the latitude left, the remainder 4° 31′ multiply by 60 = 271 miles or minutes of difference of latitude.



Constructed as Problem VIII. in Geometry.

Draw the meridian A B = 271; upon B erect the perpendicular B C; take 488 in your compasses, and with one foot on A, lay the other on the line B C; join A and C; then will B C be the departure 406, and the angle B A C the course = 56° 10′, or 5 points nearly.

To find the Course.		To find the Departure.	
As the distance 488	2.68842	As radius - -	10.00000
Is to radius - -	10.00000	Is to the distance 488	2.68842
So is the diff. lat. 271	2.43297	So is sine course 56° 16′	9.91993
	12.43297		12.60835
	2.68842		10.00000
To co-sine cou. 56° 16′	9.74455	To the departure 405,8	2.60835

Hence the course is S. E. by E. and the departure 405,8.

By GUNTER.

'The extent, from the distance 488 to the difference of latitude 271, on the line of numbers, will reach from radius or 90° to 33° 44′ the co-course on the line of sines.

'And

'And the extent, from radius to 56° 16′ on the line of ſines, will reach from the diſtance 488 to the departure 405,8 on the line of numbers.'

By INSPECTION.

Seek in the tables till againſt the diſtance, taken in its column, be found the given difference of latitude in one of the following columns; and adjoining to it ſtands the departure; which, if leſs than the difference of latitude, the courſe is found at the top; but if greater, the courſe is found at the bottom.

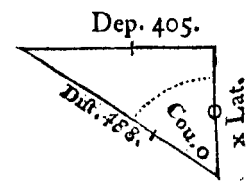
Now, with half the diſtance 244, and half the difference of latitude 135,5, look in the tables till they are found to agree in their reſpective columns, which they do nearly over 5 points, againſt them ſtands 202,8 for the departure, which being doubled, gives 405,6 nearly, as before.

CASE V.

Diſtance and Departure given, to find the Courſe and Difference of Latitude.

Admit a ſhip ſails 488 minutes between the north and weſt from the Iſland of Bermudas in lat 32° 25′ north, until her dep. is 405 miles; what courſe has ſhe ſteered, and what lat. is ſhe in?

NOTE. This caſe is conſtructed much the ſame as the laſt.



To find the Courſe.		To find the diff. of Lat.	
As the diſtance 488	2.68842	As radius - -	10.00000
Is to radius - -	10.00000	Is to the diſtance 488	2.68842
So is departure 405	2.60746	So is co-ſine co. 56° 6′	9.74644
	12.60746		12.43486
	2.68842		10.00000
To the ſine of cou. 56° 6′	9.91904	To the diff. of lat. 272,2	2.43486

Hence the Courſe is N. 56° 6′ W. or N. W. by W. nearly.

To the latitude ſailed from 32° 25′ add the difference of latitude 272, or 4° 32′, gives 36° 57′, the latitude the ſhip is in.

By

By GUNTER.

'Extend from the diſtance 488 to the departure 405 on the line of numbers, that extent will reach from radius to the courſe 56° 6′ on the line of ſines.'

2dly. 'Extend from radius to the complement of the courſe 33° 54′ on the line of ſines, that extent will reach from the diſtance 488 to the diff. of lat. 271 on the line of numbers.'

By INSPECTION.

Seek in the tables till againſt the diſtance, taken in its column, be found the given departure in one of the following columns; and adjoining to it ſtands the difference of latitude; which, if greater than the departure, the courſe is found at the top; but if leſs, the courſe is found at the bottom.

Now, with half the diſtance 244, and half the departure 203, I look in the tables, and find them to agree in their columns, nearly over 5 points, againſt which is latitude 135,5 which being doubled, is 271, the difference of latitude nearly, as before.

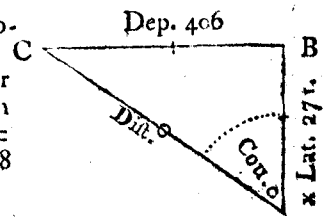
CASE VI.

Difference of Latitude and Departure given, to find the Courſe and Diſtance.

A ſhip ſails between the north and weſt till her difference of latitude is 271 miles, and her departure is 406 miles; I demand her courſe and diſtance?

Conſtructed as Problem IX. in Geometry.

Draw A B = 271, and perpendicular to it B C = 406; join C and A; then will the angle C A B be the courſe = 56° 17′, and A C the diſtance = 488 miles.



To find the Courſe.		To find the Diſtance.	
As the diff. of lat. 271	2.43297	As radius - -	10.00000
Is to radius	10.00000	Is to the diff. of lat. 271	2.43297
So is the departure 406	2.60853	So is ſec. of the courſe 56° 17′ - -	10.25564
	12.60853		12.68861
	2.43297		10.00000
To the tang. of the cou. 56° 17′ - -	10.17556	To the diſtance 488,2	2.68861

Hence her courſe is N. 56° 17′ W. or N. W. by W. and the diſtance ſailed is 488,2 miles.

By

By GUNTER.

'Extend from the difference of latitude 271 to the departure 406 on the line of numbers, that extent will reach from radius to 56° 17′ the course on the line of tangents.

2dly. 'For the distance we must consider it as radius (there being no line of secants on the scale), and extend from radius or 90° to the course 5 points on the line of sines, that extent will reach from the departure 406, to the distance 488 on the line of numbers.

By INSPECTION.

Seek in the tables till half the given difference of latitude 135,5 and departure 203 are found together in their respective columns; then right against them will be found the distance 244, in its column, and the course stand in degrees either at the top or bottom of the column where the difference of latitude and departure was found, which in this case is udner 56° 15′, or 5 points the course required.

The six foregoing Problems are common cases of Plane Sailing, which the learner ought to be well acquainted with; and for that end I here add six more for practice, whose answers may be found by the foregoing rules:

Question I. A ship in 2° 10′ south latitude, sails N. by E. 89 leagues; what latitude is she in, and what is her departure?

Answer. Latitude in 2° 12′ N. and departure 17. 36 leagues.

Question II. A ship sails S. S. W. from a port in 41° 30′ north latitude, and then by observation the said ship is in 36° 57′ north latitude; I demand the distance run and departure?

Answer. Distance run 98,5 leagues, departure 37,7 leagues.

Question III. A ship sails S. S. W. half W. from 2° 30′ south latitude, until her departure be 59 leagues; I demand her distance run and latitude in?

Answer. Distance run 125,2 leagues, latitude in 8° 1′ south.

Question IV. If a ship sails 360 miles south westward from 21° 59′ south latitude, until by observation she be in 24° 49′ south latitude, what is her course and departure?

Answer. The course is S. W. by W. ½ W. or S. 61° 47′ W. and her departure from the meridian is 317,3 miles.

Question V. Suppose a ship sails 354 miles north eastward from 2° 9′ south latitude, until her departure be 150 miles; what is her course and latitude in?

Answer. Her course is N. 25° 4′ E. or N. N. E. ¼ E. nearly, and she is in latitude 3° 11′ north.

Question

Question VI. Sailing between the north and the weſt, from a port in 1° 59′ ſouth latitude, and then arriving at another port in 4° 8′ north latitude, which is 209 miles to the weſtward of the firſt port; I demand the courſe and diſtance from the firſt port to the ſecond?

Anſwer. The courſe is N. 29° 40′ W. or N. N. W. $\frac{3}{4}$ W. nearly; and the diſtance of the ports is 422,3 miles, or 140,7 leagues.

TRAVERSE SAILING.

HAVING learned thoſe neceſſary Problems, concerning a Single Courſe, the next is a Compound Courſe, commonly called a Traverſe; in order to the right underſtanding of which, obſerve the following definitions:

A Traverſe is when a ſhip, meeting with contrary winds, ſails on ſeveral courſes.

When the wind is directly or partly againſt a ſhip's direct courſe to the place ſhe is bound to, ſhe reaches her port by a kind of Z like courſe; which is made by ſailing with the wind, firſt on one ſide of the ſhip, and then on the other ſide.

In a ſhip, when looking towards the ſtem or head;

Starboard ſignifies the right-hand ſide;

Larboard, the left-hand ſide;

Forwards or Afore, is towards the head or ſtem of the ſhip;

Aft or Abaft, is towards the hinder part or ſtern;

The Beam, ſignifies athwart or acroſs the middle of the ſhip.

When the ſhip ſails the ſame way the wind blows, ſhe is ſaid to ſail or run before the wind; and the wind is right aft, or right aſtern; and her courſe is then 16 points from the wind.

When a ſhip ſails with the wind blowing directly acroſs her, ſhe is ſaid to have the wind on the beam; and her courſe is 8 points from the wind.

When the wind blows obliquely acroſs the ſhip, the wind is ſaid to be abaft the beam, or afore the beam, according as her courſe is more or leſs than 8 points from the wind.

When a ſhip endeavours to ſail towards that part of the compaſs from whence the wind blows, ſhe is ſaid to ſail on a wind, or to ply to windward.

A veſſel ſailing as near as ſhe can to the point from whence the wind blows, is ſaid to be cloſe hauled. The generality of ſhips will lie within about 6 points of the wind, but ſloops and other veſſels will lie much nearer.

The Windward, or Weather-ſide, is that ſide of the ſhip on which the wind blows; and the other ſide is called the Leeward or Lee-ſide.

Tacks and ſheets are large ropes made faſt to the lower corners of the fore and main-ſails by which either of theſe corners are hauled fore and aft.

When a ſhip ſails on the wind, the windward tacks are always hauled forwards, and leeward, or lee-ſheets, aft.

The ſtarboard tacks are aboard when the ſtarboard ſide is to windward, and the larboard to leeward; and the larboard tacks are aboard when the larboard ſide is to windward, and the ſtarboard to leeward.

To know how near the wind a ſhip will lie, obſerve the courſe ſhe goes on each tack when ſhe is cloſe hauled, then half the number of points between the two courſes will ſhew how near the wind that ſhip will lie.

The moſt common caſes, in turning to the windward, may be conſtructed by the following precepts:

Having drawn the meridian, or north and ſouth, and parallel of latitude (or eaſt and weſt line) in a circle, repreſenting the horizon of the place, mark, in the circumference, the place of the wind; draw the rhumb, paſſing through the place bound to, and lay thereon the diſtance of that place from the centre.

On each ſide of the wind lay off in the circumference the points or degrees ſhewing how near the wind the ſhip can lie, and draw the rhumbs.

Now, the firſt courſe will be on one of thoſe rhumbs, according to the tack the ſhip leads with; draw a line through the place bound to, parallel to the other point, to meet with the firſt, and this will ſhew the courſe and diſtance on the other tack.

To reſolve a Traverſe, is to reduce and bring ſeveral courſes into one; the courſes are known by the compaſs, and the diſtance by the log, which in common voyages is hove once in two hours, but in ſhips of war, or in Eaſt-Indiamen, every hour.

In the ſteerage, or ſome convenient place in the ſhip, there is generally kept a table, called the log-board, divided into ſeven columns; in the firſt is written the hours of the day, in the ſecond the knots the ſhip runs during half a minute; each of theſe knots bear the ſame proportion to a ſea mile that half a minute does to an hour; conſequently, ſo many knots as the ſhip runs in half a minute, (the time allowed for trying the experiment) ſo many miles ſhe runs in an hour. In the third the fathoms, 10 of which ought to make a knot; in the fourth the courſes ſteered by

by the compaſs; in the fifth the winds; in the ſixth the leeway, or how far the ſhip is drove to the leeward of the courſe ſteered by the compaſs; in the ſeventh the tranſactions of the day, as in the following table. Every day at noon the contents are tranſcribed into the log-book, which is divided into columns, exactly like the log-board, and the ſeveral courſes being corrected by allowing for the leeway and variations, and the diſtance run upon each being ſet down in a traverſe table, ſhews what difference of latitude and departure the ſhip has made during the laſt 24 hours; and from thence is found the latitude and longitude the ſhip is in, &c. This operation is called doing a day's work.

THE LOG-BOARD.

H.	K.	F.	Courſes.	Winds.	Lee-way.	Tranſactions.
2	6		S. W. by S.	N.		
4	5	5				
6	5			N. W.		
8	5					Moderate gales & fair weather; at 8 A. M. ſaw a ſhip to the northward.
10	4	5	N. E.	N. N. W.		
12	4	5				
2	4	5				
4	4	5				
6	4	5				
8	5		S. W. by S.	W. N. W.		
10	4	5				No obſervation.
12	4					

Having placed the ſeveral courſes, and diſtances run upon each, begin with the firſt courſe S. W. by S. which is 3 points, and the diſtance run upon it being ſummed up, is 21,5 or an half, which being doubled (becauſe the log is hove every two hours) is 43. In like manner proceed with the other courſes, and then find the difference of latitude and departure for each courſe and diſtance.

When the courſe is to be ſouthward, the difference of latitude muſt be ſet in the column marked S, but if to the northward, in

in that marked N.; likewiſe when the courſe is to the eaſtward, the departure muſt be ſet in the column marked E.; but if to the weſtward, in that marked W. Thus the firſt courſe being S. W. by S. 3 points, the difference of latitude belonging to it is ſet under S. and the departure under W. as in the following table:

THE TRAVERSE TABLE.

COURSES.	DIST.	N.	S.	E.	W.
S. W. by S.	43		35, 8		23, 9
N. E.	45	31,8		31, 8	
S. W. by W.	27		22, 4		15, 0
		31, 8	58, 2		38, 9
			31, 8	31, 8	31, 8
		D. Lat. N.	26, 4	Dep. W.	7, 1

Here the weſtings being greater than the eaſtings, the difference ſhews how far the ſhip has got to the weſtward; and the ſouthings being greater than the northing ſhew how far ſhe has got to the ſouthward of the place ſhe ſet out from.

Now the difference of latitude 26,4 and departure 7,1 being looked for in the tables, will be found nearly ſtanding together under 15° and againſt diſtance 27. Hence the courſe made good upon the ſeveral courſes is S. 15° W. and the diſtance 27 miles.

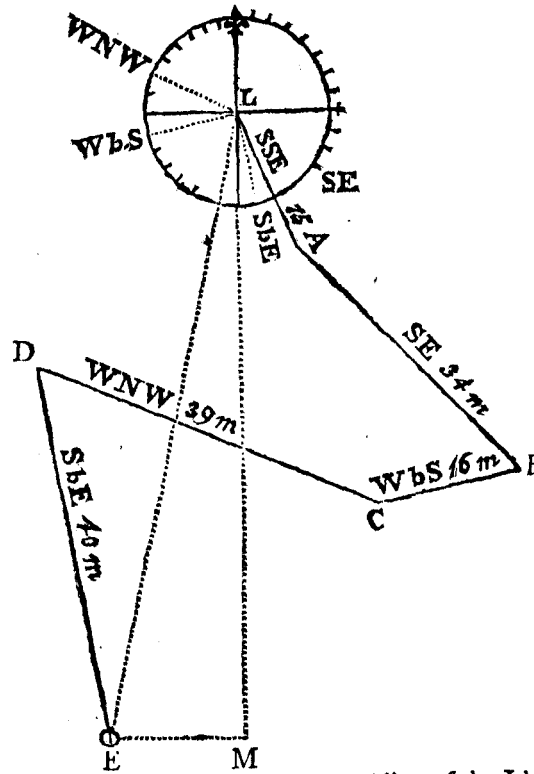
In heaving the log, one man holds the reel upon which the log-line is wound, and another holds the half-minute glaſs; an officer of the watch heaves the log over on the lee-quarter, and when he obſerves the ſtray-line is run off the reel (to denote which there is fixed a red rag) he cries *turn!* the glaſs-holder anſwers *done!* who, watching the glaſs, the moment it is run out, cries *ſtop!* the reel being immediately ſtopped, the knots, or knots and fathoms run off, ſhew the ſhip's rate of ſailing per hour, if the wind happens to have been conſtant.

EXAMPLE

EXAMPLE I.

Suppose a ship takes her departure from the Lizard in latitude 49° 57′ N. it bearing N. N. W. distance by estimation 5 leagues, sails S. E. 34, W. by S. 16, W. N. W. 39, and S. by E. 40 miles; required the latitude she is in, and her bearing and distance from the Lizard?

By CONSTRUCTION.



Draw the line L M to represent the meridian of the Lizard. and L the Lizard point; on L describe the compass; then set off the opposite point to the bearing of the Lizard, the S. S. E. line L A, which make equal to 15 miles; parallel to the S. E. line draw the line A B equal to 34 miles: again, from B parallel to W. by S. draw B C equal to 16 miles; next through C draw a line parallel to W. N. W. which make equal to 39 miles; from D draw D E, parallel to the S. by E. line, equal to 40 miles; then is E the place of the ship at the end of her several courses, E L the distance, L M the difference of latitude, E M her departure, and the angle E L M the course she has made good.

To

To find the same by CALCULATION.

For the first Course, S. S. E. 15 Miles.

To find the Diff. of Latitude.		For Departure.	
As radius 90°	10.00000	As radius 90°	10.00000
Is to distance 15	1.17609	Is to distance 15	1.17609
So is co-sine course 2 pts.	9.96562	So is sine course 2 pts.	9.58284
	11.14171		10.75893
	10.00000		10.00000
To diff. lat. 13,9	1.14171	To departure 5,7	0.75893

Second Course S. E. 34 Miles.

For Difference of Latitude.		For Departure.	
As radius 90°	10.00000	As radius 90°	10.00000
Is to co-sine course 45°	9.84948	Is to sine course 45°	9.84948
So is distance 34	1.53148	So is distance 34	1.53148
	11.38096		11.38096
	10.00000		10.00000
To diff. latitude 24	1.38096	To departure 24	1.38096

Third Course W. by S. 16 Miles.

For Difference of Latitude.		For Departure.	
As radius 90°	10.00000	As radius 90°	10.00000
Is to co-sine course 78° 45′	9.29024	Is to sine course 78° 45′	9.99157
So is distance 16	1.20412	So is distance 16	1.20412
	10.49436		11.19569
	10.00000		10.00000
To diff. latitude 3,1	0.49436	To departure 15,6	1.19569

Fourth Course W. N. W. 39 Miles.

For Difference of Latitude.		For Departure.	
As radius 90°	10.00000	As radius 90°	10.00000
Is to co-sine course 67° 30′	9.58284	Is to sine course 67° 30′	9.96562
So is distance 39	1.59106	So is distance 39	1.59106
	11.17390		11.55668
	10.00000		10.00000
To diff. latitude 14,9	1.17390	To departure 36	1.55668

Fifth Course S. by E. 40 Miles.

For Difference of Latitude.		For Departure.	
As radius 90°	10.00000	As radius 90°	10.00000
Is to co-sine cou. 11° 15′	9.99157	Is to sine cou. 11° 15′	9.29024
So is distance 40	1.60206	So is distance 40	1.60206
	11.59363		10.89230
	10.00000		10.00000
To diff. lat. 39,2	1.59363	To departure 7,8	0.89230

Though this method of finding the difference of latitude and departure by logarithms is certain, yet the same may be more readily found by the tables of difference of latitude and departure; that is, to find the difference of latitude and departure for each course and distance by inspection, and placing them down as in the following Traverse Table:

COURSES.	DIST.	DIFF. LAT.		DEPARTURE.	
		N.	S.	E.	W.
S. S. E.	15		13,9	5,7	
S. E.	34		24,0	24,0	
W. by S.	16		3,1		15,7
W. N. W.	39	14,9			36,0
S. by E.	40		39,2	7,8	
From sum	—	14,9	80,2	37,5	51,7
Take	—	—	11,9		37,5
Rests	—	—	65,3		14,2

Having placed them as above, add up all the westings, eastings, northings and southings, separately, and set down their respective sums at the bottom of each column; and as the westing is greater than the easting, subtract the easting therefrom, and the difference 14,2 shews that the ship's departure is so much west of her first meridian.

Again, the southing being greater than the northing, subtract the northing from it, and the remainder shews how far the ship is to the southward of her first place.

To

To find the direct Course or Bearing of the Lizard from the ship.

As the diff. lat. 65,3	1.81491
Is to radius 90°	10.00000
So is the departure 14,2	1.15229
	11.15229
	1.81491
To tang. cou. 12° 16′	9.33738

Which, because the difference of latitude is southerly, and the departure westerly, is S. 12° 16′ W. Whence the Lizard bears from the ship N. 12° 16′ E. or N. by E. 1° 1′ E.

To find the direct Distance.

As sine of cou. 12° 16′	9.32728
Is to the depart. 14,2	1.15229
So is radius 90°	10,00000
	11.15229
	9.32728
To the distance 66,84	1.82501

The course and distance may be found sufficiently near under 12 degrees in tables, where the distance is 67 miles.

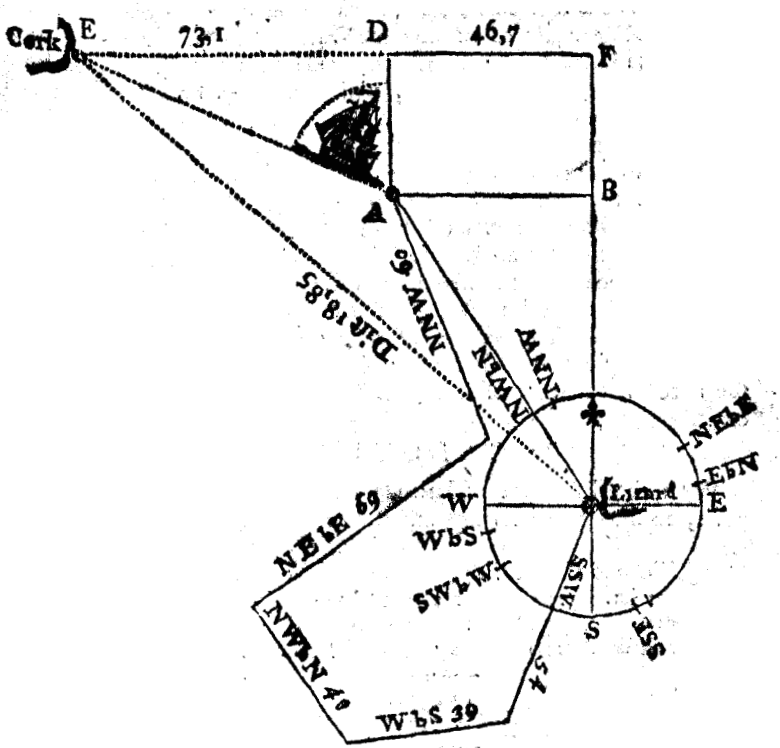
EXAMPLE II.

Suppose a ship from the Lizard 49° 57′ is bound to Cork in latitude 51° 41′ N. whose departure from the meridian of the Lizard is 120 miles west, but by reason of contrary winds is obliged to sail on the following courses, viz. S.S.W. 54 miles, W. by S. 39, N. W. by N. 40, N. E. by E. 69, and N. N. W. 60 miles; I demand the direct course, distance, difference of latitude and departure made good upon the several courses, with the latitude she is in, and what course she must afterwards steer, and how far to gain her intended port?

By

By PROJECTION.

Latitude of Cork	—	51° 41′
Latitude of Lizard	—	49 57
		1 44
Difference of latitude		104. Departure 120.



With the chord of 60° describe a circle, through which draw the meridian north and south, and, crossing that at right angles, draw the east and west points; the centre represents the Lizard; then set off two points from the south westerly; through which draw a line to the centre for the first course S. S. W.; upon that set off the first distance run 54 miles, which is the ship's place at the end of her first course.

Draw the W. by S. rhumb; and parallel to it a line, passing through the ship's last place; and upon it set off 39 for the second distance; draw the N. W. by N. rhumb; and parallel to it, as before, draw a line, passing through the ship's last place; upon it set off 40, and that will be the place of the ship at the end of her third course; then draw the N. E. by E. rhumb; and parallel to it a line, passing through the ship's last place; and upon it set off 69 for the fourth distance; then draw a N. N. W. rhumb; and parallel to it a line, as before, through the ship's last place; and upon it set off the last distance 60, which is the ship's place at the end of her several courses; from which draw a line parallel to the east and west line, until it cuts the meridian; for the whole departure, from this to the centre, being measured on the same scale, will give her difference of latitude made good upon the several courses; and a line drawn from the ship's last place to her first, will give the whole distance; and the angle which this line makes with the meridian, will be the ship's course made good.

Now, to find what course she must steer, and how far she must run, from the centre of the compass, or the Lizard point, set off the whole difference of latitude of the two ports, viz. 104, to F; through F draw an E. and W. line westerly, and set off thereon the whole departure 120 from F to E; then will E represent the situation of Cork; join A E, and draw A D parallel to the meridian; then will A E be the distance she has run to her intended port, the angle E A D is the course she must steer, E D is how far she is to the eastward of it, and A D is how far to the southward of it.

By CALCULATION.

With the difference of latitude and departure between the two ports, to find their bearings and distances.

To find the Bearing,			To find their Distances,		
As diff. of lat.	104	2.01703	As radius		10.00000
Is to radius	90°	10.00000	Is to diff. lat.	104	2.01703
So is whole dep.	120	2.07918	So is sec. course 49° 5′		10.18517
		12.07918			12.20081
		2.01703			10.00000
To tang. course 49° 5′		10.06215	To dist. asunder 158,8		2.20081

Whence the course between the Lizard and Cork is N. 49° 5′ W. or N. W. ¼ W. 1° 16′ westerly; distance 159 miles. Or with the difference of latitude and departure, the course will be found by inspection to be 49°, and distance 159 miles; and the several courses and distances being found, will stand as in the following

TRAVERSE TABLE.

COURSES.	DIST.	DIFF. LAT.		DEPARTURE.	
		N.	S.	E.	W.
S. S. W.	54	....	49.9	.....	20.7
W. by S.	39	....	7.6	.....	38.2
N. W. by N.	40	33 3	.....	.....	22.
N. E. by E.	69	38.8	.....	57.4	...
N. N. W.	60	55.4	.....	.....	23
From		127.0	57.5	57.4	104.1
Take		57.5	.....	.....	57.4
Remains		69.5	.....	.....	46.7

To find her direct Course and Distance made good.

To find the Course,

As diff. of lat.	69,5	1.84198
Is to radius	90°	10.00000
So is departure 46,7		1.66932
		11.66932
		1.84198
To tang. cou.	33° 54′	9.82734

To find the Distance,

As radius - -		10.00000
To diff. lat.	69,5	1.84198
So is sec. course 33° 54′		10.08092
		11.92290
		10.00000
To distance	83,73	1.92290

Or, with the proper difference of lat. 69,5, and the departure 46,7, look in the tables of difference of latitude and departure, the nearest numbers corresponding to these are 69,6 and 47 under 34° against distance 84.

To find the Bearing and Distance to the intended Port.

	° ′
Lizard's latitude,	49. 57 N.
Add diff. lat. - -	1. 9 N.
Ship's latitude in	51. 6 N.

In Angle A E D.

From whose diff. lat. ports	104
Subtract ship's northing	69. 5
Remains ship southw. of port	34. 5

From whole departure subtract ship's depart. 120—47=73 ED.

As diff. of lat.	34,5	1,53782
Is to radius	90°	10.00000
So is dep.	73	1.86332
		11.86332
		1.53782
To tang. cou.	64° 42′	10.32550

As radius 90 - -		10.00000
Is to diff. of lat. 34, 5		1.53782
So is sec. course 64° 42′		10.36921
		11.90703
		10.00000
To dist. 80,73		1.90703

Whence the course she must steer is N. 64° 42′ W. or N. W. by W. ¼ W. distance 81 miles.

Or, with the difference of latitude 34,5 and departure 73, look into the tables, the nearest numbers to these are 73,4, and 34,2 standing over 65 against distance 81.

All the preceding may be found by Gunter's Scale, but shall leave the working of them to exercise the Learner, who ought to be well acquainted with Traverse Sailing; and for that purpose it has been thought proper to subjoin the following, which is the most general and useful that well can be, and may be worked by any of the foregoing methods.

A ship being at sea in latitude 37° 10′ N. is bound to a port, which lies to the westward in latitude 33° 0′ N. the departure between the ship and the place is 180 miles; consequently, by Case VI. the course will be S. W. by S. 2 degrees westerly, and distance 308 miles, but the wind being variable, is obliged to ply upon these several courses, the distance run upon each, being obtained by the log; and the first she sails (with her larboard tacks on board) S. W. by W. 27 miles, W. S. W. half W. 30 miles, W. by S. 25 miles, W. by N. 18 miles.

(Starboard tacks on board wind shifting) S. S. E. 32 miles, S. S. E. three-quarters E. 27 miles, S. by E. 25 Miles, S. 31 miles, S. S. E. 39 miles.

Required the latitude the ship is in, and her departure from the meridian, upon what course she must steer if possible, and how far she must sail to gain her intended port?

The difference of latitude and departure being found by the preceding directions, will stand as in the following Table:

THE TRAVERSE TABLE.

COURSES.	DIST.	DIFF. OF LAT.		DEPARTURE.	
		N.	S.	E.	W.
S. W. by W	27		15, 0		22, 4
W. S. W ½ W	30		8, 7		28, 7
W. by S.	25		4, 9		24, 5
W. by N.	18	3,5			17, 7
S. S. E.	32		29, 6	12, 2	
S. S. E. ¾ E.	27		23, 2	13, 9	
S. by E.	25		24, 5	4, 9	
South.	31		31, 0		
S. S. E.	39		36, 0	14, 9	
		5,3	172, 9	45, 9	93, 3
			3, 5		45, 9
		Dist. Lat.	169,48	Depar.	47, 4 W.

The

The ship is in latitude 34° 21′ N. the departure is 47,4 W.
The course made good is S. 15° 38′ W. and distance 175,9.
The course to the intended port is S. 58° 35′ W. or S. W. by W. one-quarter west nearly, distance 155,4.

MIDDLE LATITUDE SAILING.

IN Plane Sailing the earth was considered as a plane, representing a bowling green, having the meridians parallel to each other, and consequently the degrees of longitude equal in all places; but this cannot be true, as the earth is a globe or sphere; for,

As the meridians are circles on the terraqueous globe, meeting in the poles, (as may be seen in the following figure) it is obvious, that any two of those circles must recede more at greater distances from the poles; and at equal distances from each pole, or at the equator, the distance between the meridians is greatest.

The true place of a ship at sea depends upon its distance from the equator, and some noted meridian; and since the meridional distance, that is, the distance between any two meridians, varies in every latitude, it is therefore convenient this distance should be reckoned in a fixed latitude; and where the degrees are of the same magnitude with those of the meridian, which can be no where but on the equator, where 60 geographical miles make a degree.

The circumference of all circles are in direct proportion to each other, as their radii: and since the earth turns once round its axis in 24 hours, every point upon its surface must describe circles parallel to the equator: hence it follows, that the circumference of any parallel of latitude in miles, is to the circumference of the equator, in miles, as the co-sine of that latitude is to radius; and, that the breadth of a degree, in any parallel or latitude, is to the breadth of a degree upon the equator, as the sine complement of that latitude is to radius.

By the last proportion was the following table calculated, which shews the breadth of a degree of longitude in every latitude: and may be made to answer for any degrees or minutes by taking proportional parts:

The following Table shews how many Miles answer to a Degree of Longitude at every Degree of Latitude.

D. L.	MILES.	D. L.	MILES.	D. L.	MILES.	D. L.	MILES	D. L.	MILES.
1	59 . 99	19	56 . 73	37	47 . 92	55	34 . 41	73	17 . 54
2	59 . 96	20	56 . 38	38	47 . 38	56	33 . 55	74	16 . 53
3	59 . 92	21	56 . 01	39	46 . 62	57	32 . 68	75	15 . 52
4	59 . 86	22	55 . 63	40	45 . 95	58	31 . 79	76	14 . 51
5	59 . 77	23	55 . 23	41	45 . 28	59	30 . 90	77	13 . 50
6	59 . 67	24	54 . 81	42	44 . 59	60	30 . 00	78	12 . 48
7	59 . 56	25	54 . 38	43	43 . 88	61	29 . 19	79	11 . 45
8	59 . 42	26	53 . 93	44	43 . 16	62	28 . 17	80	10 . 42
9	59 . 26	27	53 . 56	45	42 . 43	63	27 . 24	81	9 . 38
10	59 . 08	28	52 . 97	46	41 . 68	64	26 . 30	82	8 . 35
11	58 . 89	29	52 . 47	47	40 . 92	65	25 . 36	83	7 . 32
12	58 . 68	30	51 . 96	48	40 . 15	66	24 . 41	84	6 . 28
13	58 . 46	31	51 . 43	49	39 . 36	67	23 . 45	85	5 . 23
14	58 . 22	32	50 . 88	50	38 . 57	68	22 . 48	86	4 . 18
15	57 . 95	33	50 . 32	51	37 . 76	69	21 . 50	87	3 . 14
16	57 . 67	34	49 . 74	52	36 . 94	70	20 . 52	88	2 . 09
17	57 . 37	35	49 . 15	53	36 . 11	71	19 . 54	89	1 . 05
18	57 . 06	36	48 . 54	54	35 . 26	72	18 . 55		

Hence it follows, that

As radius, or sine 90°
Is to the diff. of long. in miles,
So is co sine of any paral. of lat.
To the dist. in miles between any
Two merid. in that paral. of lat.

AND,

As co-sine of any paral. of lat.
Is to the dist. run in miles in that lat.
So is the radius, or sine of 90°
To the diff. of long. in miles.

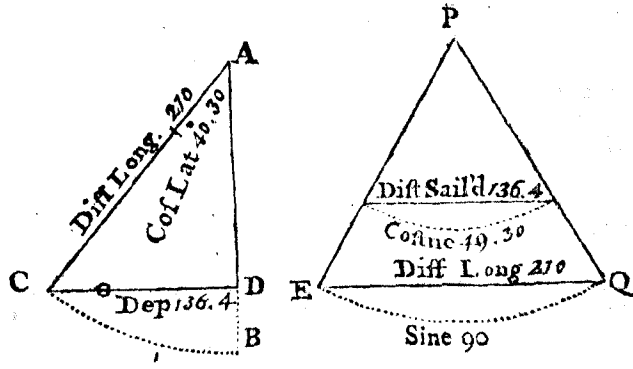
From what has been said, arises the solution of the following Problems:

PROBLEM I.

The Difference of Longitude between two Places both in one Parallel of Latitude being given, to find the Distance between them.

Suppose a ship in the latitude 49° 30′ N. or S. sails directly E. or W. until her difference of longitude be 3° 30′, and the distance sailed be required?

By



By PROJECTION.

With the ſine of 90° in your compaſſes taken from the Plane Scale, and with one foot in P. deſcribe the arch E Q. and upon it ſet off the difference of longitude 210 miles, and draw the lines P E and P Q to repreſent the two meridians; and then E Q repreſent the Equator, and P the Pole. Again, with the ſine com. of the latitude 49° 30′ *viz.* 40° 30′ in your compaſſes, taken from the line of ſines on the Plane Scale, and with one foot in P deſcribed an arch, and the diſtance between the points, where it cuts the two meridians, being meaſured upon the ſame ſcale of equal parts that the difference of longitude was, will be the departure 136,4 miles.

Or, thus:

Draw the meridian A B, and with the chord of 60 in your compaſſes deſcribe an arch, and upon it ſet off the complement of the latitude 40° 30′ (taken from the line of chords) and ſet it off upon the arch as a courſe in Plane Sailing, and draw the line A C as a diſtance, which make equal to the difference of longitude 210 miles; then will the departure C D be the diſtance 136,4 miles, as before: this laſt method is preferable to the former, as we are not confined to any particular ſcale.

Reverſe this Problem, and ſuppoſe the diſtance ſailed in any parallel of latitude given, to find the difference of longitude.

With the ſine com. of latitude in your compaſſes deſcribe an arch, upon which ſet off the departure 136,4 miles, and through the points where it cuts the arch draw the lines P E and P Q; then with the ſine of 90° in the compaſſes, and one foot in the former centre P, deſcribe an arch to cut P E and P Q; then E Q being meaſured upon the ſmall ſcale of equal parts that the departure was, will be the difference of longitude 210 miles.

By

By CALCULATION.

To find the Departure.

As radius — — —	90°	10,00000
Is to the difference of longitude	210	2,32222
So is co-ſine latitude —	49° 30′	9,81254
		12,13476
		10,00000
To the diſtance or departure	136,4	2,13476

By GUNTER.

'The extent from radius to ſine com. latitude 40° 30′ on the line of ſines, will reach from the difference of longitude 210 to the diſtance 136,4 on the line of numbers.'

By INSPECTION.

Find the ſine com. of the latitude among the degrees, and in the diſtance column the difference of longitude, oppoſite to which, in the column of departure, is the diſtance required; but as the co-latitude is 40° 30′, therefore,

For 40 degrees you will find —— ——	135
For 41 degrees you will find —— ——	137,7
The ſum is —— —— ——	272,7
Half is the diſtance required —— ——	136,3

This is done becauſe the table of difference of latitude and departure is calculated only for ſingle degrees.

By the reverſe of the laſt problem, having the diſtance run in any parallel to find the difference of longitude.

Suppoſe a ſhip in latitude 49° 30′ N. or S. ſails directly E. or W. 136,4 miles, and her difference of longitude be required?

As co-ſine of latitude —	49° 30′	9,81254
Is to the diſtance ——	136,4	2,13481
So is radius —— ——	——	10,00000
		12,13481
		9,81254
To the difference of longitude 210		2,32227

By

By INSPECTION.

Look for the complement of the latitude among the degrees as if it was a course, and the departure in its column; right against which stands the difference of longitude in the distance column. In the last Problem the ship is supposed to have sailed due east or west, in the same parallel of latitude, but in her course she generally crosses several meridians and parallels, and then arrives at a different latitude from that she left; and, as it is plain by the foregoing table, that the miles which make a degree in one parallel, will not be the same as those that make a degree in any other parallel, lying on the same side of the equator; therefore, add both latitudes together, and take half their sum for a mean or middle latitude; which may be conceived as if the ship had sailed in one latitude; with which the difference of longitude may be turned into departure, and departure into difference of longitude, in the same manner as has been already shewn, for it will be

As radius
Is to the difference of longitude,
So is the co-sine of the middle lat.
To the departure.

AND.

As the co-sine of the middle lat.
Is to the departure,
So is radius
To the difference of longitude.

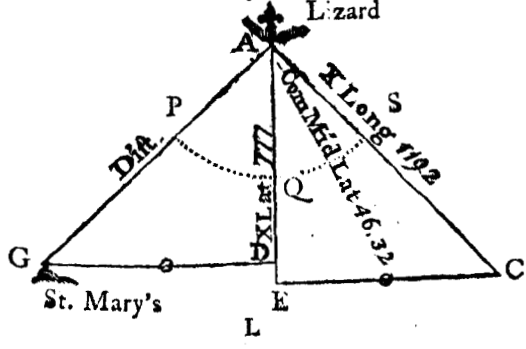
Having the difference of latitude and departure, the course and distance are found by Case the Sixth, in Plain Sailing.

CASE I.

Required the bearing and distance between the Lizard, in latitude 49° 57′ N. longitude 5° 14′ W. and the island of St. Mary, one of the Western islands, in latitude 37° N. and longitude 25° 6′ W.?

Lizard's lat.	49° 57′ N.		49° 57′	Long. 5° 14′ W.
St. Mary's lat.	37 00 N.		37 00	Long. 25 6 W.
	12 57	Sum 2)	86 57	19 52
	60			60
		Mid. lat.	43 28	
Diff. in miles	777		90 00	1192 diff. long.
		Co-mid. lat.	46 32	

The PROJECTION.



Draw

Draw the meridian AE, with the chord of 60 describe the arch PS, upon which set off 46° 32′, the complement of middle latitude, from Q to S; through S draw the line AC=1192, the difference of longitude; let fall the perpendicular CE, which will be the departure 865; upon AE set off AD 777, the difference of latitude; and upon D erect the perpendicular DG, and upon it set off the departure 865; join G and A, and it is done; for GA will be the distance 1168 miles, and the angle GAD the course S. 48° 4′ W.

The CALCULATION.

To find the Departure.

As radius 90	10.00000
Is to diff. of long. 1192	3.07628
So is co-sine mid. lat. 43° 28′	9.86080
	12.93708
	10.00000
To the departure 865,1	2.93708

To find the Course.

As diff. of lat. 777	2.89042
Is to radius 90	10.00000
So is departure 865,1	2.93708
	12.93708
	2.89042
To tang. of cou. 18° 4′	10.04666

To find the Distance.

As radius	10.00000
Is to diff. latitude 777	2.89042
So is sec. of cou. 48° 4′	10.17505
	13.06547
	10.00000
To the distance 1163	3.06547

NOTE. The course may be found without the departure, by Middle Latitude Sailing, thus:

As the diff. lat. 777	2.89042
Is to diff. long. 1192	3.07628
So is co-si. mid. lat. 43° 28′	9.86080
	12.93708
	2.89042
To tang. of cou. 48° 4′	10.04666

By GUNTER.

1st. 'The extent from 46° 32′, the complement of the middle latitude, to radius, on the line of sines, will reach from 1192 to 865 on the line of numbers.

2dly. 'The extent from radius or 90° to 41° 56′ the complement of the course on the line of sines, will reach from 777 to 1163 on the line of numbers.

3dly. 'The extent from 777 to 865,1 on the line of numbers, will reach from 45° to 48,4 on the line of tangents'.

By INSPECTION.

Look for the complement of middle latitude, as if it was a course in Plane Sailing, and difference of longitude in the distance column; opposite to which stands the departure in its column. Having the difference of latitude and departure, the course and distance are found as in Case VI. in Plane Sailing.

Thus, taking ¼ of the difference of longitude 1192=298, and as the complement of the middle latitude is 46° 32′, or nearly 46½

I 100

I look over 46 and 47, and against the distance stands 214,4 and 218 in the departure columns; which added together gives 432,4; half is 216,2; this multiplied by 4 gives 864,8, the departure.

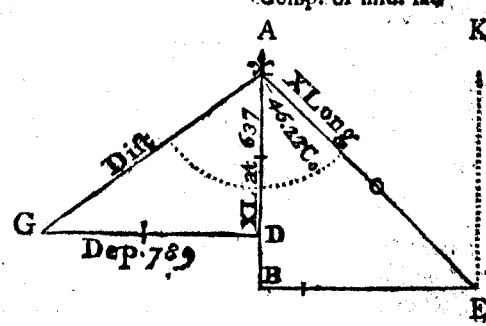
Again, taking $\frac{1}{4}$ the difference of latitude, and $\frac{1}{4}$ of the departure 194,2 and 216,2; the nearest number to these standing together are 216,2 and 194,7 over 48° and against the distance 29; this multiplied by 4 gives 1164 miles; hence the course is S. 48° W.; and distance 1164.

CASE II.

Both Latitudes and Departure from the Meridian given, to find the Course and Distance, and Difference of Longitude.

A ship in latitude 49° 57′ N. and longitude 5° 24′ W. sails south westerly, till her departure is 789 miles, and she be in latitude 39° 20′ N.; I demand the course, distance, and longitude she is in?

Latitude left	49°	37′ N.	Latitude left	49°	57′ N.
Latitude in	39	20 N.	Latitude in	39	20 N.
Diff. of latitude	10	37	Sum of latitude	89	17
	60		Middle latitude	44	38
In miles	637			90	00
			Comp. of mid. lat.	45	22



By CONSTRUCTION.

Draw the meridian AD, from A to D set off the difference of latitude 637 miles, and on D erect the perpendicular DG, which make equal to the departure 789 miles. Draw the line A G, and that will be the distance 1014 miles, and the angle D A G the course 51° 5′.

Again, draw E K parallel to A D, making the distance from A D equal to the departure D G 789, on A describe an arch; take the complement of the middle latitude 45° 22′ in your compasses from the line of chords, and set that off on the arch on the opposite side of the meridian AD, through where that cuts the arch draw the line A E to cut the line K E in E, from E let fall the perpendicular E B, and it is done; for A E will be the difference of longitude 1109 miles.

By CALCULATION.

To find the Course it will be,		To find the Distance it will be,	
As the diff. of lat. 637	2.80414	As the sine course 51° 5′	9.89101
Is to radius 90°	10.00000	Is to the departure 789	2.89708
So is departure 789	2.89708	So is radius 90°	10.00000
	12.89708		12.89708
	2.80414		9.89101
To tang. course 51° 5′	10.09294	To the distance 1014	3.00607

To find the Difference of Longitude it will be.

As co-sine middle latitude	—	44° 38′	9.85225
Is to departure	—	789	2.89708
So is radius	—	90	10.0000
			12.89708
			9.85225
To difference of longitude	—	1109	3.04483

Longitude the ship sailed from	—	—	5° 24′ W.
Diff. long. 1109 miles, or	—	—	18 29 W.
Longitude in	—	—	23 53 W.

By GUNTER.

1st. The extent from the difference of latitude 637 to the departure 789 on the line of numbers, will reach from radius, or 45° backward to 51° 5′ the course on the line of tangents.

2dly. The extent from 51° 5′ to radius or 90° on the line of sines, will reach from the departue 789, to the distance 1014 on the line of numbers.

3dly. The extent from the complement of middle latitude, 45° 22′ to radius or 90° on the line of sines, will reach from the departure 789, to the difference of longitude 1109 on the line numbers.

By INSPECTION.

Rule. With the difference of latitude and departure, find the course and distance, as in Case VI. in Plane Sailing.

2dly. Taking the complement of middle latitude as a course and the departure in its column, and the distance corresponding to these, will be the difference of longitude.

Thus, taking a tenth of the difference of latitude 637 and departure 789, that is, 63,7 and 78,9, the nearest numbers to these are 63,6 and 78,5 standing together over 51°, against the distance 101, which multiplied by 10 gives 1010; whence the course by inspection is S. 51° W. and the distance 1010.

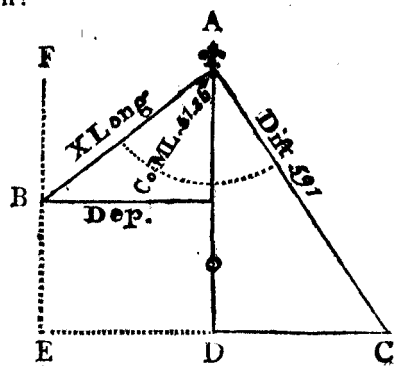
Taking

Taking 45° 22′ or 45° as a course, and a tenth of the departure 78,9 in its column, the nearest is 78,5, in the distance column stands 111, which multiplied by 10 gives 1110 for the difference of longitude nearly, as before.

CASE III.

One Latitude, Course and Distance given, to find the Difference of Latitude and Difference of Longitude.

A ship in latitude 42° 30′ N. and longitude 18° 31′ W. sails S. E. by S. 591 miles, or 197 leagues; I demand the latitude and longitude the ship is in?



By PROJECTION.

With the course and distance, find the difference of latitude and departure, as in Case I. in Plane Sailing, viz. Draw the meridian AD, and on A describe an arch with the chord of 60°, and upon it set off the course S. E. by S. or 3 points, through where that cuts the arch draw the line AC, making it equal to the distance 591, from C let fall the perpendicular CD; then will CD be the departure, and AD the difference of latitude 491 miles.

Draw the line E F parallel to A D, making the distance from it equal to the departure.

Take the complement of middle latitude 51° 36′ from the line of chords in your compasses, and set it off on the arch on the other side of the meridian A D, and through where that cuts the arch draw the line A B to cut the line E F in B, from B let fall the perpendicular E D, and it it is done; for A B will be the difference of longitude, 419 miles.

Latitude left	42° 30′ N.		Middle latitude	38 24	
Difference of latitude	8 11 S.		Com. middle latitude	51 36	
Latitude in	34 19 N.		Longitude left	18° 31′ W.	
Latitude left	42 30		Difference of longitude	6 59 E.	
Sum	76 49		Longitude in	11 32 W.	

From

From what has been ſaid, it will be eaſy to conſtruct any of the following caſes, as they are conſtructed the ſame as in Plane Sailing: only obſerving, that to find the difference of longitude you muſt take the complement of middle latitude as a courſe in Plane Sailing, with this courſe and the departure find the diſtance, and that will be the difference of longitude.

To find the ſame by CALCULATION.

To find the Difference of Lat.		To find the Departure.	
As radius 90°	10.00000	As radius 90°	10.00000
Is to the diſtance 591	2.77159	Is to the diſtance 591	2.77159
So is co-ſine cou. 3 pts.	9.91985	So is ſine courſe 3 pts.	9.74474
	12.69144		12.51633
	10.00000		10.00000
To the diff. of lat. 491,4	2.69144	To the departure 328,3	2.51633

To find the Difference of Longitude.

Without the Departure it will be,		With the Departure it will be.	
As co-ſi. mid. lat. 38° 24′	9.89415	As co-ſine mid. lat. 38° 24′	9.89415
Is to ſine courſe 3 pts.	9.74474	Is to departure 328,3	2.51627
So is diſtance 591	2.77159	So is radius 90°	10.00000
	12.51633		12.51627
	9.8.9415		9.89415
To diff. of long. 419	2.62218	To diff. of long. 419 = 6° 59′	2.62212
		Long. left	18° 31′ W.

Whence the ſhip is in lat. 34° 19′ N. and long. 11 32 W.

By GUNTER.

1ſt. 'The extent from radius or 8 points to the complement of the courſe, 5 points on the line marked S. R. will reach from the diſtance 591 to 491 the difference of latitude on the line of numbers.'

2dly. 'The extent from radius or 8 points to the courſe, 3 points on the line S. R. will reach from the diſtance 591 to the departure 328 on the line of numbers.'

3dly. 'The extent from the ſine complement middle latitude 51° 36′ to radius or 90° on the line of ſines, will reach from the departure 328 to the difference of longitude 419 on the line of numbers.'

By

By INSPECTION.

RULE.—With the course and distance find the difference of latitude and departure, as in Case I. in Plane Sailing.

2dly. Take the complement of middle latitude as a course and the departure in its column, and against it in the distance column stands the difference of longitude.

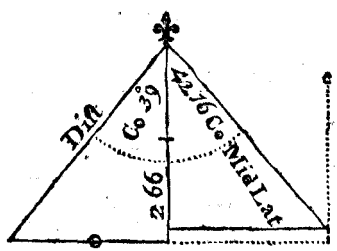
Thus, under the course 3 points, and against a tenth of the distance 591=59, stand 49,1 and 32,8; these multiplied by 10 give 491 for the difference of latitude, and 328 for the departure.

Now, taking the complement middle latitude 51° 36′ or 51° as a course, and a tenth of the departure 328=32,8 in its column, (the nearest is 32,6), against which stands 42 in the distance column; this multiplied by 10 gives 420 the difference of longitude nearly, as before.

If the foregoing directions be well understood, the learner will not find it difficult to work the following cases in Middle Latitude Sailing.

CASE IV.

Course and Difference of Latitude given, to find the Departure, Distance, and Difference of Longitude.



Suppose a ship sailing from the Lizard, makes when the variation, lee-way, &c. are allowed for, her course S. 39° W. or S. W. by S. half westerly, and then by observation is in latitude 45° 31′ N.; what is her distance run, and longitude in?

Latitude of the Lizard	49° 57 N.	——	49° 57′ N.
Latitude by observation	45 31 N.	——	45 31 N.
Difference of latitude	4 26	Sum of latitudes	95 28
	60	Middle lat.	47 44
In miles ——	266	Co-middle latitude	42 16

By CALCULATION.

To find the Departure it will be,

As the co-fine courſe 39°	9.89050
Is to the diff. of lat. 266	2.42488
So is fine courſe 39°	9.79887
	12.22375
	9.89050
To the departure 215,4	2.33325

To find the Diſtance it will be,

As the co-ſi. courſe 39°	9.89050
Is to diff. of lat. 266	2.42488
So is radius 90°	10.00000
	12.42488
	9.89050
To the diſtance 342,3	2.53438

To find the Diff. of Longitude.

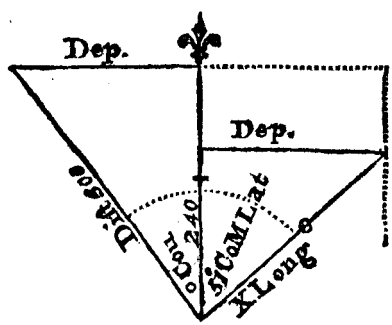
As co-ſi. of mid. lat 47° 44′	9.82775
Is to the departure 215,4	2.33325
So is radius 90°	10.00000
	12.33325
	9.82775
To the diff. of long. 320,3	2.50550

To find the Longitude in.

Lizard's longitude	5° 14′ W.
Diff. of lon. 320 miles or	5 20 W.
Longitude in	10 34 W.

CASE V.

Both Latitudes and Diſtance given, to find the Courſe and Difference of Longitude.



Suppoſe a ſhip runs 300 miles N. weſterly, from a port in 37° N. latitude, and longitude 10° 25′ W. until ſhe be in latitude 41° N.; what is her courſe and longitude in?

Latitude left	37° 00′ N.		37° 00 N.
Latitude in	41 00 N.		41 00 N.
Diff. of lat.	4 00	Sum of latitude	78 00
	60	Middle latitude	39 00
In miles	240	Co-middle lat.	51 00

By CALCULATION.

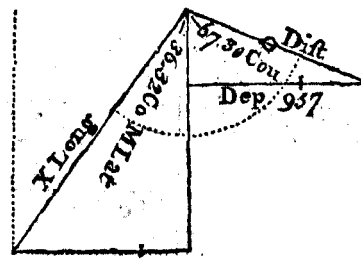
To find the Course it will be,		To find the Diff. of Long. it will be,	
As the distance 300	2.47712	As co-sine mid. lat. 39°	9.89050
Is to radius 90°	10.00000	Is to tang. course 36. 52	9.87501
So is diff. lat. 240	2.38021	So is diff. of lat. 240	2.38021
	12.38021		12.25522
	2.47712		9.89050
To the co-sine cou. 36° 52′	9.90309	To diff. of long. 231.6	2.36472

Longitude left	—	10° 25′ W.
Difference of longitude		3 52 W.
Longitude in	—	14 17 W.

CASE VI.

One Latitude, Course, and Departure given, to find the Distance, Difference of Latitude, and Difference of Longitude.

A ship sails E. S. E. from a certain port in latitude 50° 10′ S. and longitude 10° 16′ E. until her departure from the meridian be 957 miles; I demand her distance sailed, and the latitude and longitude she is in?



957

To find the Diff. of Lat. it will be,			
As sine course 6 pts.	9.96562		
Is to the departure 957	2.98091	Latitude left	50° 10′ S.
So is co-sine course 6 pts.	9.58184	Diff. of lat. 396, or	6 36 S.
	12.56375	Latitude in	56 46 S.
	9.96562		
To the diff. of lat. 396,4	2.59813		

To find the Diſtance it will be,

As ſine courſe 6 pts.	9.96562	Latitude left	50°	10′ S.
Is to the departure 957	2.98091	Latitude in	56	46 S.
So is radius	10.00000			
		Sum is	2)106	56
	12.98091			
	9.96562	Mid. lat.	53	28
To the diſtance 1036	3.01529	Co-mid. lat.	36	32

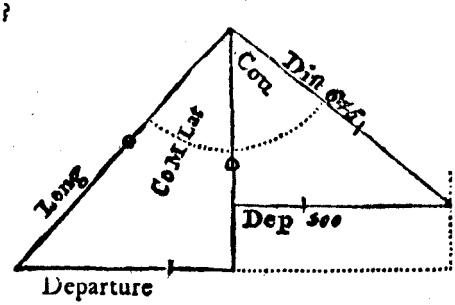
To find the Diff. of Long. it will be,

As co-ſi. mid. lat. 53° 28′	9.77473	Long. left is	10°	16′ E.
Is to the departure 957	2,98091	Diff. of long. 1608, or	26	48 E.
So is radius	10.00000	Long. in	37	4 E.
	12.98091			
	9.77472			
To the m. diff. of long. 1608	3.20618			

CASE VII.

One Latitude, Diſtance ſailed, and Departure from the Meridian given, to find the Courſe, Difference of Latitude, and Difference of Longitude.

A ſhip in latitude 49° 30′ N. and longitude 14° 40′ W. fails ſouth eaſtward 645 miles, until her departure from the meridian be 500 miles: I demand the courſe ſteered, and the latitude and longitude the ſhip is in?



To find the Courſe it will be,

As the diſtance 645	2.80956
Is to the radius	10.00000
So is the departure 500	2.69897
	12.69897
	2.80956
To ſine courſe 50° 50′	9.88941

To find the Diff. of Lat. it will be,

As radius	10.00000
Is to the diſtance 945	2.80956
So is co-ſine cou. 50° 50′	9.80043
	12.60999
	10.00000
To the diff. of lat. 407,3	2.60999

Lat.

Lat. left is	49° 39′ N.	Latitude left	49° 30′
Diff. lat. 407, or	6 47 S.	Latitude in	42 43
Latitude in	42 43 N.	Sum is	92 13
		Middle latitude	46 6
		Co-middle latitude	43 54

To find the Diff. of Long. it will be,

As co-fine mid. lat. 46° 6′	9.84098	Longitude left is	14° 40′ W.
Is to the departure 500	2.69897	Diff. of long. 721, or	12 1 E.
So is radius	10,00000	Longitude in	2 39 W.
	12.69897		
	9.84098		
To the diff. of long. 721.1	2.85799		

MERCATOR's SAILING.

PLANE SAILING, as has been before obſerved, ſuppoſes the earth and ſea to be in the form of a bowling green, on which the meridians are parallel, and the degrees of latitude and longitude equal in all places; but the earth and ſea compoſe a round body, or globe, on which the degrees of latitude are equal in all places, and the degrees of longitude decreaſe from the equator in proportion to the ſine complements of the latitudes.

Though the meridians all meet at the poles, and the parallels to the equator continually decreaſe, and that in proportion to the co-ſines of their latitudes; yet in old ſea-charts the meridians were drawn parallel to each other, and, conſequently, the parallels of latitude made equal to the equator, and ſo a degree of longitude on any parallel, as large as a degree on the equator: alſo, in theſe charts, the degrees of latitude were ſtill repreſented (as they are in themſelves) equal to each other, and to thoſe of the equator; by theſe means the degrees of longitude being increaſed beyond their juſt proportion, and the more ſo the nearer they approached the poles, the

degrees of latitude at the ſame time remaining the ſame; it is evident places muſt be very erroneouſly marked down upon thoſe charts, with reſpect to their latitude and longitude, and, conſequently, their bearings from one another muſt be very falſe.

To remedy this inconvenience, ſo as ſtill to keep the meridians parallel, it is plain we muſt protract or lengthen the degrees of latitude in the ſame proportion as thoſe of longitude are, that ſo the proportion in eaſting or weſting may be the ſame with that of northing or ſouthing; and, conſequently, the bearing of places from each other to be the ſame upon the chart as upon the globe itſelf

The difficulty in conſtructing a true ſea-chart conſiſts in finding a proper manner of applying the ſurface of a globe to a plane; which, Mr. WRIGHT, an Engliſhman, by an ingenious conception, happily accompliſhed.

He conceived the ſurface of this globe to ſwell like a bladder (while it is blowing up from the equator towards the poles,) proportionally in latitude as it does in longitude, until every part of its ſurface meet that of a concave cylinder impreſſed on it, whoſe diameter was equal to the globe's diameter. The equator being thus confined, the parts towards the poles muſt be extended, both in latitude and longitude, to fill up the cylinder, or figure, in the form of a rolling ſtone, and impreſs on its concave ſurface the lines drawn on the ſurface of the globe. This cylinder being cut on one of the meridians, from north to ſouth, and laid open, would repreſent a true ſea-chart, the parts of which bear the ſame proportion to one another as the correſponding parts of the globe do, and on which all the lines will be right lines; having every parallel of latitude on the globe increaſed till it is equal to the equator; and ſo the diſtance of the meridians in theſe parallels will become equal to their diſtance at the equators; conſequently, the meridians on the chart are expreſſed by parallel right lines.

Alſo the meridians being lengthened as the parallels are increaſed, every degree of latitude is lengthened in the ſame proportion as the degrees of longitude are increaſed; therefore, the diſtance of the parallels of latitude grow wider and wider as they approach the poles.

Mr. GERRARD MERCATOR, a Fleming, in 1556, publiſhed a ſimilar chart; but in what manner it was conſtructed he did not ſhow; neither were thoſe degrees in their true proportion; whence called Mercator's Charts.

Mr. WRIGHT, in 1599, publiſhed the Principles of the True Sea-Chart, and how to conſtruct it on the following principles; viz.

That the diſtance between any two meridians at the equator is in proportion to their diſtance in any parallel of latitude, as the radius is to the co-ſine of that latitude:

That any part of a parallel of latitude is to a like part of the meridian, as the radius is to the ſecant of that parallel:

And, that the diſtance of any parallel of latitude from the equator is equal to the ſum of the ſecants of all the arches between the equator and that parallel.

From theſe principles, Mr. WRIGHT ſet about forming a table, by the continual additions of ſecants, of all the parallels of latitude, beginning with one minute, which he made radius, and thereto adding the ſecond parallel of 2 minutes, and to the ſum of theſe two, the ſecant of 3 minutes, &c. The table thus formed, is that which is commonly called the Table of Meridional Parts (ſee Table I.) by means of which a true nautical chart may be conſtructed, called Mercator's Chart, and all the Caſes in WRIGHT's, commonly called Mercator's Sailing, conſtructed and calculated.

As this table contains the meridional parts for every degree and minute of the quadrant, from the equator to the poles, it will be eaſy to find the meridional parts correſponding to any parallel of latitude, as for example:

Required the meridional parts correſponding to the latitude 33° 45′?

Look in the top of the table for 33°, marked 33d, and in the right or left-hand columns, marked (M), under the degrees 33, and oppoſite the minutes 45 ſtands 2153, the meridional parts belonging 33° 45′.

When the given latitudes are both north or both ſouth, the meridional difference of latitude is found by ſubtracting the meridional parts of the leſſer latitude from thoſe of the greater.

Required the meridional difference of latitude between the Lizard, in latitude 49° 57′ N. and the Iſland of St. Mary's, in latitude 37° N?

The Lizard's latitude	49° 57′ N.	meridional parts	3470
St. Mary's latitude	37 00 N.	meridional parts	2393
		Meridional difference of latitude	1077

When the latitudes are one north, and the other ſouth, the meridional difference of latitude is found, by adding the meridional parts correſponding to both the latitudes together.

Required the meridional difference of latitude between Cape Verd, in latitude 14° 46′ N. and the Cape of Good Hope, in latitude 34° 29′ S.?

Cape Verd's latitude	14° 46′ N.	meridional parts	896
Cape of Good Hope's	34 29 S.	meridional parts	2207
		Meridional difference of latitude	3103

The ſeveral caſes in Mercator's Sailing are worked by geometry, trigonometry, Gunter's Scale, and the tables of difference of latitude and departure, exactly in the ſame manner as thoſe in Plane Sailing,

Sailing, by only considering the meridional difference of latitude, as if it was the proper difference of latitude, and the difference of longitude as the departure: for it is no more than enlarging the proper difference of latitude, so as to be equal to the meridional difference of latitude; then will the difference of longitude bear the same proportion to the departure, that the meridional difference of latitude does to the proper difference; for, in the following figure, (which is the first Case in Mercator's Sailing):

Let MT represent the meridional and M I the proper difference of latitude, TH the difference of longitude IO the departure, MO the distance, and the angle TMH, or IMO, the course; then will MI be in proportion to IO, as MT is to TH; and the contrary.

Wherefore, as the proper difference of latitude is to the departure, so is the meridional difference of latitude to the difference of longitude; and,

As the meridional difference of latitude is to the difference of longitude, so is the proper difference of latitude to the departure.

Since by lengthening or shortening the sides of a triangle does not alter the angles, the departure may be reduced into difference of longitude, and difference of longitude into departure.

In all the Cases (save the first) in Mercator's Sailing, the course, distance, difference of latitude and departure, are found in the same manner as those in Plane Sailing; and then the difference of longitude may be found by either of the following proportions, viz: (see the opposite figure.)

By making the enlarged Distance M H radius, it will be,		By making meridional Difference of Latitude M T radius, it will be,
As the co-sine of the course Is to the merid. diff. of latitude So is the sine of the course To the difference of longitude;	OR,	As radius Is to merid. difference of latitude So is the tangent of the course To the difference of longitude.

But in the First Case, it will be,

As the merid. diff. of latitude MT Is to radius So is the diff. of longitude T H To the tangent of the course;	AND	As radius Is to the proper diff. of lat. M I So is the secant of the course To the distance M O.

Or, when the course is found, you may say, As the co-sine of the course is to the proper difference of latitude, so is radius to the distance.

CASE I.

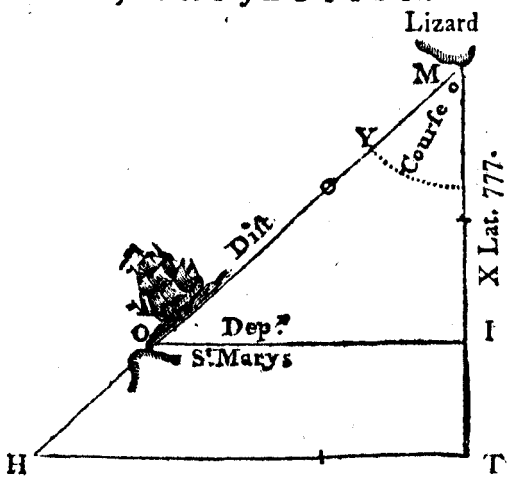
The Latitudes and Longitudes of two Places given, to find the direct Course and Distance between them.

Required the bearing and distance between the Lizard, in latitude 49° 57′, longitude 5° 14′ W. and the Island of St. Mary's, one of the Western Islands, in latitude 37° N. and long. 25° 6′ W.

Lizard's lat. 49° 57′ N. meridional parts 3470 long. 5° 14 W.
St. Mary's 37 0 N. meridional parts 2393 long. 25 6 W.

Diff. of lat. 12 57=777 Diff. 1077 Diff. 19 52=1192.

By PROJECTION.



X Longitude 1192.

Draw the meridian MT = 1077, the meridional difference of latitude, and M I = 777, the proper difference of latitude, perpendicular to M T; draw T H and I O, make T H 1192 miles, the difference of longitude, join H and M; then will the angle T M H be the course S. 47° 54′ W. and O M the distance 1159 miles.

By CALCULATION.

To find the Course, it will be,		To find the Distance, it will be,	
As mer. diff. of lat. 1077	3.03222	As radius 90°	10.00000
Is to radius 90°	10.00000	Is to prop. diff. lat. 777	2.89042
So is diff. of long. 1192	3.07628	So is sec. of course 47° 54′	10.17365
	13.07628		13.06407
	3.03222		10.00000
To tang. of cou. 47° 54′	10.04406	To the dist. 1159	3.06407

By

By GUNTER.

1ſt. 'Extend from the meridional difference of latitude 1077, to difference of longitude 1192, that extent will reach from radius, or 45°, to the courſe 47° 54′ on the line of tangents.

2d. 'Extend from radius, or 90°, to the complement of the courſe 42° 6′ on the line of ſines, that extent will reach from 777 to 1159 on the line of numbers.'

By INSPECTION.

1ſt. Look for the meridional difference of latitude and difference of longitude, until they are found ſtanding together in their reſpective columns (as if they were latitude and departure); and the courſe will be found among the degrees or points.

In the latitude column belonging to this courſe, find the proper difference of latitude, oppoſite to which ſtands the diſtance in its column.

2d. Now $\frac{1}{10}$ of the meridional difference of latitude and the $\frac{1}{10}$ difference of longitude are 107,7 and 119,2 the neareſt numbers in the tables are 107,7 and 119,6 ſtanding together over 48°.

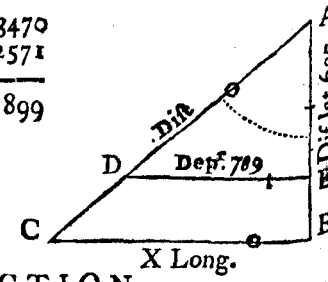
In the latitude column I look for $\frac{1}{10}$, the proper difference of latitude, which is 77,7, the neareſt is 77,6, againſt this ſtands 116 in the diſtance column, which multiplied by 10 gives 1160 nearly, the ſame as that found by calculation.

CASE II.

Both Latitudes and the Departure from the Meridian given, to find the Courſe, Diſtance, and Difference of Longitude.

A ſhip in lat. 49° 57′ N. and long. 5° 14′ W. ſails S. weſtward, until her depart. from the meridian be 789 miles, and then by obſervation is in the lat. 39° 20′ N. required her courſe ſteered, diſtance run, and longitude in?

Lat. left	49° 57′	Merid. parts	3470
Lat. in	39 20	Merid. parts	2571
Diff. of lat.	10 37 = 637 miles	Dif.	899



By PROJECTION.

With the proper difference of lat. and departure, project the ſame as in Caſe VI. in Plane Sailing; extend the meridian A E to B, and make A B equal to the meridional diff. of lat. and draw a line parallel to the departure D E; produce the diſtance A D to cut this parallel; and C B will be the difference of longitude. Hence the angle B A C will be the courſe, S. 50° 5′ W. D A the diſtance 1014, and B C the difference of longitude 1114 miles.

To

To find the same by CALCULATION.

As the p. diff. of lat. 637	2.80414	As radius 90°	10.00000
Is to radius 90°	10.00000	Is to diff. of lat. 637	2.80414
So is the departure 789	2.89708	So is sec. course 51° 5′	10.20191
	12.89708		13.00605
	2,80414		10.00000
To tang. course 51° 5′ =	10.09294	To the distance 1014	3.00605
As radius 90°	10.00303	Longitude left	5° 14′ W.
Is to mer. diff. lat. 899	2.95376	Diff. of long. 1114 =	18 34 W.
So is tang. course 51,5	10.09292	Longitude in	23 48 W.
	13.04668		
	10.00000		
To diff. of long. 1114	3.04668		

Her course is S. 51° 5′ W. and distance 1014 miles.

NOTE. The diff. of long. may be found by saying, As prop. diff. of lat. : dep. : : merid. diff. of lat. : diff. of long.

By GUNTER.

1st. 'The extent from diff. lat. 637, to dep. 789, on the line of numbers, will reach from radius, or 45°, to 51° 5′, the course on the line of tangents.'

2dly. 'The extent from radius to com. course 38° 55′, on the line of sines, will reach from diff. lat. 637, to 1014, the distance of the line of numbers.'

3dly. 'The extent from co-course 38° 55′ to sine course 51° 5′ on the line of sines, will reach from merid. diff. lat. 899, to 1114 the difference of longitude on the line of numbers.'

By INSPECTION.

The diff. of lat. and dep. being found together in their respective columns will give the course among the degrees or points, and the dist. in its column: in the lat. column belonging to the course, look for the meridional diff. of lat. and against it will stand the difference of long. in the departure column.

Now $\frac{1}{6}$ of diff. of latitude and of dep. are 106,1 and 131,5 the nearest numbers to these are 106,4 and 131,3, standing together over 51° the course, and against dist. 169; this multiplied by 6, gives 1014 the distance.

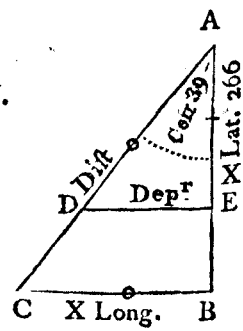
Again, over 51° look for $\frac{1}{10}$ of merid. diff. of lat. 89,9 in the lat. column, the nearest is 90, and against which stand 111,1 in the dep. column; this multiplied by 10 gives 1111 for the diff. of longitude.

CASE III.

Both Latitudes and Course given, to find the Distance and Difference of Longitude.

A ship from the Lizard makes her course S. 39° W. and then by observation is in latitude 45° 31′ N.; required her distance run, and longitude in?

Lat. of the Lizard	49° 57′ N.	Mer. parts	3470
Lat. by obser.	45 41 N.	Mer. parts	3074
Diff.	4 26 = 266 m.	diff.	396 M.



By CONSTRUCTION.

Draw a meridian AB, the upper end A will represent the ship's place in her first latitude.

Take the proper difference of latitude 266 in your compasses, and with one foot in A, the ship's place, lay the other upon the meridian; from A to E, take the merid. diff. of latitude 396 in your compasses, and with one foot in A, the ship's place, as before, lay the other upon the meridian at B; and upon these two points raise the perpendiculars D E and C B; a line drawn from the ship's place, making an angle with the meridian equal to 39° the ship's course, will cut the two perpendiculars at D and C; the first will be the departure, which terminates the distance A D 342, and the other will be the difference of longitude C B = 321 miles.

From what has been said, it is plain, that any case in Mercator's Sailing may be projected as a right angled triangle, by only considering the difference of longitude, or departure, as the base; the meridional, or proper difference of latitude, as the perpendicular, the hypothenuse cut by the departure, as distance; and the angle which that makes with the perpendicular, the course; for in all cases in Mercator's Sailing, the meridional difference of latitude bears the same proportion to the difference of longitude, that the proper difference of latitude does to the departure.

These instructions being well understood, will be sufficient to inform the learner how to construct any of the following cases:

By CALCULATION.

To find the Diſtance.		To find the Diff. of Longitude.	
As the co-ſine courſe 39°	9.89050	As the co-ſine courſe 39°	9.89050
Is to the diff. of lat. 266	2.42488	Is to mer. diff. of lat 396	2.59770
So is radius	10.00000	So is ſine courſe 39°	9.79887
	12.42488		12.39657
	9.89050		9.89050
To the diſtance 342,3	2.53438	To the diff. of long. 320,7	2.50607

Lizard's Longitude left 5° 14′ W.
Difference of long. 321; or 5 21 W.

Longitude in 10 35 W.

By GUNTER.

1ſt. 'The extent from co-ſine courſe 51°, to radius on the line of ſines, will reach from the proper difference of latitude 266, to the diſtance 342.3 on the line of numbers.'

2dly. 'The extent from co-ſine courſe 51°, to ſine courſe 39° on the line of ſines, will reach from the meridian difference of latitude 396, to the difference of longitude 321, on the line of numbers.'

By INSPECTION.

Under the courſe 39°, and againſt half the diff. of lat. 133, ſtands 171 in the diſtance column, which being doubled is 342, the diſtance; under the ſame degrees, and in the latitude column, look for half the meridian difference of latitude 198, againſt that, in the departure column, ſtands 160,5, doubled is 321, the difference of longitude nearly, as before.

CASE IV.

One Latitude, Courſe, and Diſtance given, to find the Difference of Latitude, and Difference of Longitude.

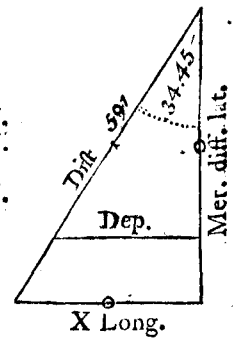
A ſhip in latitude 42° 30′ N, and longitude 18° 31′ W. ſails S. W. by S. 591 miles; I demand the latitude and longitude the ſhip is in?

To find the Difference of Latitude it will be,

As radius	10.00000	Lat. left	42° 30′	M. parts.	2822
Is to the distance 591	2.77159	Diff. lat. 491	8 11		2194
So is co-sine course 3 pts.	9.91985	Lat. in	34 19	M. diff. lat.	628
	12.69144				
	10.00000				
To the diff. of lat. 491,4	26.9144				

To find the Diff. of Long. it will be,

As co-si. course 3 pts.	9.91985	Lon. left	18°31′W.
Is to m. diff. of lat. 628	2.79796	Di.lo. 420 =	7 00W.
So is S. course 3 pts.	9.74474	Long. in	25 31W.
	12.54270		
	9.91985		
To diff. of long. 419,6	2.62285		



By GUNTER.

1st 'The extent from radius to 5 points, the com. of the course on the line marked S R, will reach from the distance 591, to the difference of latitude, 491,4 on the line of numbers.'

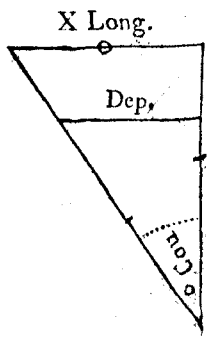
2dly. 'The extent from co-course 5 points, to the course 3 points on the line marked S R, will reach from the meridian difference of latitude 628 to the difference of longitude 419,6, on the line of numbers.'

By INSPECTION.

Under the course 3 points, and opposite a tenth of the distance 59. in the latitude column, stands 49,1, which multiplied by 10 is 491, the difference of latitude; then find ¼ of the meridian difference of latitude 157, in the latitude column, against which stands 105 in the departure column, which multiplied by 4, gives 420, the difference of longitude.

CASE V.

Both Latitudes and Distance given, to find the Course and Difference of Longitude.



If a ship runs 300 miles N. Westerly from a port in latitude 37° N. and longitude 10° 25′ W. until she be in latitude 41° N.; required the course steered and longitude in?

Latitue left	37 N.	Merid. parts	2393
Latitude in	41 N.	Merid. parts	2702
Diff.	4 = 240 M. diff.		309 M.

By CALCULATION.

To find the Course.		To find the Diff. of Longitude.	
As the distance 300	2.47712	As co-si. course 36° 52′	9.90311
Is to radius	10.00000	Is to mer. diff. of lat. 309	2.48996
So is pro. diff. of lat. 240	2.38021	So is sine course 36° 52′	9.77812
	12.38021		12.26808
	2.47712		9.90311
To the co-si. course 36° 52′	9.90309	To the diff. of long. 231.7	2.36497

Longitude left	10° 25′ W.
Diff. of long. 232, or	3 52 W.
Longitude in	14 17 W.

By GUNTER.

1st. 'The extent from the distance 300, to the proper difference of latitude 240, on the line of numbers, will reach from radius or 90°, to 53° 8′ the complement of the course, on the line of sines.'

2dly. 'The extent from co-course 53° 8′, to course 36° 52′, on the line of sines, will reach from the meridian difference of latitude 309, to the difference of longitude 231,7, on the line of numbers.'

By INSPECTION.

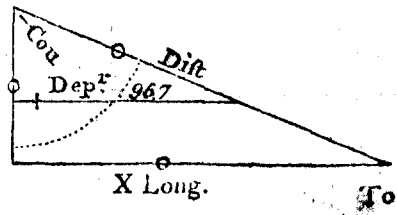
With the distance and difference of latitude find the course; then in the latitude column belonging to this course, find the meridian difference of latitude: against which, in the departure column, will stand the difference of longitude.

Thus, half the distance 150, and half the difference of latitude 120, will be found standing together in their columns, nearly under 37°, the course; and in the latitude column, find half the meridian difference of latitude 154,5 the nearest to it is 154,1; against which, in the departure column, stands 116,1, which doubled is 232,2, the difference of longitude nearly, as before.

CASE VI.

One Latitude, Course, and Departure given, to find the Distance, Difference of Latitude, and Difference of Longitude.

A ship sails E. S. E from a certain port in latitude 50° 10′ S. and longitude 10° 16′ E. until her departure from the meridian be 957 miles; I demand the distance sailed, and the latitude and longitude she is in?



To

To find the Diſtance it will be,		To find the Diff. of Lat. it will be,	
As the ſine courſe 6 pts.	9.96562	As ſine courſe 6 pts.	9.96562
Is to the departure 957	2.98091	Is to the departure 957	2.98091
So is radius	10.00000	So is co-ſi. courſe 6 pts.	9.58284
	12.98091		12.56375
	9.96562		9.96562
To the diſtance 1036	3.01529	To diff. of lat. 396=6° 36′	2.59813

To find the Diff. of Longitude,			
As co-ſine courſe 6 pts.	9.58284	Lat. left 50° 10′ S. mer. pts.	3490
Is to mer. diff. of lat. 667	2.82413	Lat. in 56 46 S. mer. pts.	4157
So is ſine courſe 6 pts.	9.96562	Merid. difference	667
	12.78975	Long. left	10° 15′ E.
	9.58284	Diff. of long. 1610 =	26 50 E.
To diff. of long. 1610	3.20691	Longitude in	37 6 E.

By GUNTER.

1ſt. 'The extent from 6 points to radius, on the line marked SR, will reach from the departure 957, to the diſtance 1036 on the line of numbers.'

2dly. 'The extent from 6 points to 2 points, on the line marked S R, will reach from the departure 957, to the difference of latitude 396, on the line of numbers.'

3dly. 'The extent from 2 points to 6 points, on the line marked S R, will reach from the meridian difference of latitude 667, to the difference of longitude 1610, on the line of numbers.'

By INSPECTION.

Over the courſe of 6 points, and againſt a fifth of the departure 191,4 ſtands 79,2 and 207, which multiplied by 5 gives 396, the difference of latitude, and 1035 for the diſtance.

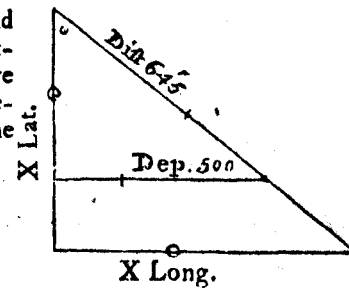
Then in the latitude column, find a tenth of the meridian difference of latitude 66,7, the neareſt to that is 66,6; againſt which, in the departure column, ſtands 160,8, which multiplied by 10 is 1608, the difference of longitude.

CASE

CASE VII.

One Latitude, Diſtance ſailed, and Departure from the Meridian given, to find the Courſe, Difference of Latitude, and Difference of Longitude.

A ſhip in latitude 49° 30′ N. and longitude 14° 40′ W. ſails S. eaſtward 645 miles, until her departure from the meridian be 500 miles. Required the courſe ſteered, and the latitude and longitude ſhe is in?



To find the Courſe it will be,

As the diſtance 645	2.80956
Is to radius 90°	10.00000
So is departure 500	2.69897
	12.69897
	2.80956
To ſine courſe 50° 50′	9.88941

To find the Diff. of Long. it will be,

As co ſine courſe 50° 50′	9.80043
Is to m. diff. of lat. 588	2.76938
So is ſine courſe 50° 50′	9.88948
	12.65886
	8.80043
To diff. of lon. 721,8 = 12° 2′	2.85843
Long left. 14 40	
Long. in 2 38 W.	

To find the Diff. of lat. it will be,

As ſine courſe 50° 50′	9.88948
Is to the departure 500	2.69897
So is co-ſi. courſe 50° 50′	9.80043
	12.49940
	9.88948
To diff. lat. 407,3 = 6° 47′	2.6099
Lat. left 49° 30′ N. M. pts.	3428
Lat. in 42 43 N. M. pts.	2840
Mer. diff. lat.	588
As pro. diff. of lat. 407,3	2.60992
Is to departure 500	2.69897
So is m. diff. of lat. 588	2.76938
	5.46835
	2.60992
To diff. of long. 721,8	2.85843

Hence the ſhip's courſe is S. 50° 50′ E. or S. E. ½ eaſt nearly, and ſhe is in the latitude of 42° 43′ N. and long. 2° 38′ W.

By GUNTER.

1ſt. 'The extent from the diſtance 645, to the departure 500 on the line of numbers, will reach from radius to 50° 50′, on the line of ſines.'

2dly.

2dly. 'That extent from 50° 50′ to 39° 10′, on the line of fines, will reach from the departure 500, to the difference of latitude 407, on the line of numbers.'

3dly. 'The extent from 39° 10′ to 50° 50′, on the line of fines, will reach from the meridian difference of latitude 588, to the difference of longitude 722, on the line of numbers.'

By INSPECTION.

Now a fifth of the diſtance and departure are 129 and 100, and are found together over 51°; and in the latitude column ſtands 81,2, which multiplied by 5 is 406, the difference of latitude.

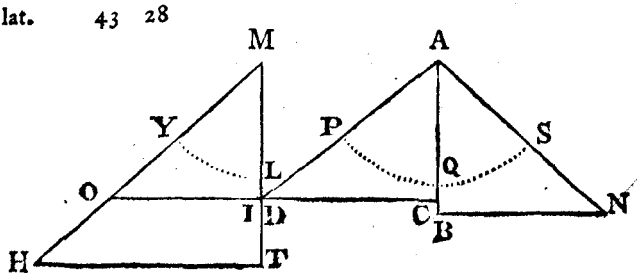
Then, in the latitude column, ſeek $\frac{1}{4}$ of the meridional difference of latitude 146, the nearſt is 146,6; againſt which, in the departure column, ſtands 181,1 which multiplied by 4 is 724,4 the difference of longitude.

Having in the preceding parts ſhewn how to work the moſt uſeful problems in Middle Latiude and Mercator's Sailing; ſhall now work the four following caſes both by Middle Latitude and Mercator's Sailing, in the manner I generally teach perſons who are of age, and youth of good abilities; eſpecially if they are limited to a ſhort time; and I believe they are all that can well happen at ſea.

The following four Caſes are worked by Middle Latitude and Mercator's Sailing.

Required the bearing and diſtance between the Lizard in latitude 49° 57′ N. longitude 5° 14′ W. and the Iſland of St. Mary's, one of the weſtern Iſlands, in latitude 37° N. and longitude 25° 6′ weſt?

Lizard's lat.	49° 57′	N. Merid. pts.	3470	Lon.	5° 14′	W.	
St. Mary's lat.	37	N. Merid. pts.	2393	Lon.	25 06	W.	
Diff. of lat.	12 57 = 777 miles.	Diff.	1077	Diff.	19 52 = 1192 miles.		
Sum lat.	2)86 57						
Mid. lat.	43 28						



By

By PROJECTION.

By Mercator's Sailing.

Draw the meridian MT = 1077 the meridian diff. of lat. and MI = 777 the proper diff. of lat. perpendicular to MT draw TH and IO. Make TH = 1192 miles, the difference of longitude. Join H and M, then will the angle THM be the course S. 47° 54′ W. and OM the distance 1159 miles.

By Middle Latitude Sailing.

Draw the meridian AB, with the chord of 60° describe the arch PS, upon which set off 46° 32′ the com. of middle latitude from Q to S; through S draw the line AN = 1192 miles, the difference of longitude. Let fall the perpendicular NB, which will be the departure 865. Upon AB set off AC 777 miles, the difference of latitude; and upon C erect the perpendicular CD, and upon it set off the departure 865.

Join D and A, and it is done; for DA will be the distance 1163 miles, and the angle CAD the course S. 48° 4′ W.

By CALCULATION.

By Middle Lat. Sailing.

As radius 90°	10.00000
Is to diff. of long. 1192	3.07628
So is co-si. m. lat. 43° 28′	9.86080
	12.93708
	10.00000
To the departure 865,1 =	2.93708
As diff. of lat. 777	2.89042
Is to radius 90°	10.00000
So is the departure 865,1	2.93708
	12.93708
	2.89042
To tang. of course 48° 4′	10.04666
As radius	10.00000
Is to the diff. of lat. 777	2.89042
So is sec. of course 48° 4′	10.00000
	13.06547
	10.17505
To the distance 1163	3.06547

By Mercator's Sailing.

As the m. diff. of lat. 1077	3.03222
Is to radius 90°	10.00000
So is the diff. of long. 1192	3.07628
	13.07628
	3.03222
Tang. of cou. 47° 44′	10.04406
As radius	10.00000
Is to the p. diff. of lat. 777	2.89042
So is sec. of cou. 47° 54′	10.17365
	13.06547
	10.00000
To the dist. in miles 1159	3.06407

NOTE. The course may be found by Mid. Lat. Sailing without the Departure; thus,

As diff. of lat. 777	2.89042
Is to diff. of long. 1192	3.07628
So is co-si. m. lat. 43° 28′	9.86080
	12.93708
	2.89042
To tang. course 48° 4′	10.04666

By GUNTER.

BY MIDDLE LATITUDE SAILING.

1ſt. 'Extend from radius or 90°, to 46° 32′ the comp. mid. lat. on the line of ſines, that extent will reach from the diff. of long. 1192, to the dep. 865, on the line of numbers.'

2dly. 'Extend from the diff. of lat. 777 to the dep. 865, on the line of numbers, that extent will reach from radius or 45°, to the courſe 48° 4′, on the line of tangents.'

3dly. 'Extend from the courſe 48° 4′, to radius or 90°, on the line of ſines, that extent will reach from the departure 865, to the diſtance 1163 miles, on the line of numbers.'

By MERCATOR.

1ſt. 'Extend from merid. diff. of lat. 1077, to diff. of longitude 1192 on the line of numbers, that extent will reach from radius or 45°, to the courſe 47° 54′, on the line of tangents.'

2dly. 'Extend from radius or 90°, to the comp. of 42° 6′ on the line of ſines, that extent will reach from the prop. diff. of lat. 777, to the diſt. 1159, on the line of numbers.'

By INSPECTION.

BY MIDDLE LATITUDE SAILING.

Look for the comp. of mid latitude, as if it was a courſe in Plane Sailing, and difference of longitude in the diſtance column, oppoſite to which will ſtand the departure in it's column. Having the difference of latitude and departure, the courſe and diſtance is found as in Caſe VI. in Plane Sailing.

Thus, taking $\frac{1}{4}$ of the difference of longitude 1192 = 298, and as the comp. of middle latitude is 46° 32′ or nearly 46 ½; I look over 46° and 47°, and againſt diſtance 298 ſtands 214,4 and 218 in the departure columns; which added together gives 432,4, half is 216,2, this multiplied by 4, becauſe the difference of longitude was divided by 4, gives 864,8, the departure: Again, taking $\frac{1}{4}$ of the difference of latitude, and $\frac{1}{4}$ of the departure 194,2 and 2162, the neareſt numbers to theſe ſtanding together, are 216,2 and 194,7, over 48° and againſt the diſtance 291; this multiplied by 4 gives the diſtance 1164 miles. Hence the courſe is S. 48° W. and diſtance 1164 miles.

By MERCATOR.

1ſt. Look for the meridian difference of latitude and difference of longitude, until they are found ſtanding in their reſpective columns, (as if they were latitude and departure) and the courſe will be found among the degrees or points, in the latitude column: belonging to this courſe, find the proper difference of latitude, oppoſite to which ſtands the diſtance in it's column.

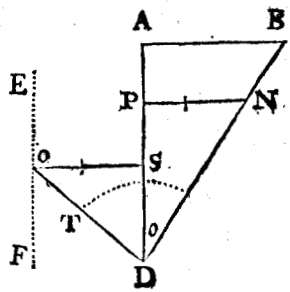
Now

Now $\frac{1}{10}$ of the meridian difference of latitude, and the $\frac{1}{10}$ of the difference of longitude are 107,7 and 119,2 the nearest numbers in the tables are 107,7 and 119,6 standing together over 48°, which is the course; over 48° in the latitude column, I look for the $\frac{1}{10}$ of the proper difference of latitude, which is 77,7 the nearest is 77,6, against this stands 116 in the distance column, which multiplied by 10 gives 1160 the distance nearly, as before.

The Difference of Latitude and Departure given, to find the Course, Distance, and Difference of Longitude, by Middle Latitude and Mercator's Sailing.

A ship from the latitude of 37° N. and longitude 48° 20′ W. sails between the north and east, until she be in latitude 51° 15′ N. and finds that she has made 564 miles of departure; what was her direct course, distance run, and longitude in?

Lat. left	37° 0′ N.	mer. parts	2393
Lat. in	51 15 N.	mer. parts	3593
	14 15 = 855	miles diff.	1200
Sum lat. $\frac{1}{2}$)	88 15		
Mid. lat.	44 7		90° ′
			44 7
Comp. mid. lat.			45 53



Draw the meridian DP, make it equal to 855 the difference of latitude; on P erect the perpendicular PN, and make it = 564 the departure; join D and N, then will the angle PDN be the course N. 33° 25′ W. and DN the distance 1025 miles.

At the distance of the departure 564, draw EF parallel to DP; with the chord of 60° describe the arch TS, and upon it set off the comp. of the middle latitude 45° 53′ from S to T, through T draw DO, to cut EF in O, then will OD be the difference of longitude 785,6 miles, by Middle Latitude Sailing.

Again, produce DP to A, and make DA = 1200 the merid. difference of latitude: draw AB parallel to PN, and produce DN until it cuts AB in B; then will AB be 791,7 miles; the difference of longitude by Mercator's Sailing.

By CALCULATION.

As the diff. of lat. 855	2.93197	As radius 90°	10.00000
Is to radius 90°	10.00000	Is to the diff. of lat. 855	2.93197
So is the departure 564	2.75128	So is sec. course 33° 25′	10.07848
	12.75128		13.01045
	2.93197		10.00000
To tang. of cou. 33° 25′	9.81931	To the distance 1024	3.01045

To find the Difference of Latitude,

By Middle Latitude Sailing.		By Mercator's Sailing.	
As co-si. mid. lat. 44° 7′	9.85608	As co-si. cou. 33° 25′	9.92152
Is to departure 564	2.75128	Is to mer. diff. lat. 1200	3.07918
So is radius 90°	10.00000	So is the sine cou. 33° 25′	9.74093
	12.75128		12.82011
	9.85608		9.92152
To diff. of long. 785.6 miles	2.89520	To diff. of long. 791,7 ms.	2.89859

6,0)78,6	6,0)79,2
Diff. 13. 6 E.	Diff. long. 13. 12 E.
Lon. left 48. 20 W.	Lon. left 48. 20 W.
Long. in 35. 14 W. by M. Lt. Sailing.	Long. in 35. 8 W. by Mer. Sail.

Her direct course is N. 33° 25′ E. or N. E. by N. nearly, and distance 1024 miles.

By GUNTER.

1st. 'Extend from 855 to 564 on the line of numbers, that extent will reach from radius or 45°, to 33° 25′ the course, on the line of tangents.'

2dly. 'Extend from radius or 90°, to the course 33° 25′ on the line of sines, that extent will reach from the departure 564, to the distance 1024, on the line of numbers.'

3dly. 'Extend from radius or 90°, to the complement of middle latitude 45° 53′ on the line of sines, that extent will reach from the departure 564, to 786 miles, the difference of longitude by Middle Latitude Sailing.'

4thly. 'Extend from the sine of the course 33° 25′ to the cosine of the course 56° 35′ on the line of sines, that extent will reach from the meridional differerence of latitude 1200 to 792 miles, the difference of longitude by Mercator.'

'Or, the extent from the difference of latitude 855, to the departure 564, will reach from the meridional difference of latitude 1200, to 792, on the line of numbers.'

By

By INSPECTION.

With the difference of latitude and departure, find the course and distance as in Case VI. in Plane Sailing. Take the complement of middle latitude as a course, and the departure in its column, the corresponding distance will be the difference of longitude, by Middle Latitude Sailing. And,

Having found the course, instead of the proper difference of latitude, find the meridional difference of latitude in the latitude column belonging to the course; the corresponding departure will be the difference of longitude, by Mercator's Sailing.

Now taking $\frac{1}{10}$ of the difference of latitude, $\frac{1}{10}$ of the departure, *viz.* 85,5 and 56,4, the nearest numbers standing together in the tables to these are, 85,5 and 55,5, under 33° against distance 102, and 85,4 and 57,6 under 34° against distance 103; now 33° added to 34° is 67, half is 33° 30′ the course; and 102 added to 103 gives 205, half is 102,5, which, multiplied by 10, gives 1025 the distance.

To find the Difference of Longitude.

Over the complement of middle latitude 46°, find $\frac{4}{5}$ of the departure, *viz.* 141 in its column, and against it stands 196 in the distance column, this multiplied by 4, gives 784 miles, the difference of longitude, by Middle Latitude Sailing.

Again, the course being 33° 25′ or nearly 33° $\frac{1}{2}$, look for $\frac{1}{10}$ of meridional difference of latitude = 120 in the latitude columns, under 33° and 34°, the nearest numbers to these are 110,9 and 120,2, the departures corresponding are 77,9 and 81,1, their sum is 159, half is 79,5, which multiplied by 10, gives 795 the difference of longitude, by Mercator's Sailing, nearly, as before.

From what has been said, it is easy to perceive that all the Cases (save the first) in Middle Latitude and Mercator's Sailing, are projected and worked in the same manner as in Plane Sailing, and to obtain the difference of longitude by Middle Latitude Sailing, the complement of the middle latitude is taken as a course in Plane Sailing, and with this course and the departure, the distance is found, which will be the difference of longitude by Middle Latitude Sailing. And having the course, take the meridional difference of latitude, as if it was the proper difference of latitude, the corresponding departure will be the difference of longitude by Mercator's Sailing.

The Course and Distance given, to find the Difference of Latitude, and Difference of Longitude.

A ship from Cape Clear, in latitude 51° 15′ N. and longitude 9° 50′ W. sails S. W. by S. until she has run 1022 miles, what latitude and longitude is she in?

As

As radius 90°	10.00000	As radius 90°	10.00000
Is to the distance 1022	3,00945	Is to the distance 1022	3.00945
So is sine course 3 pts.	9.74474	So is co-sine co. 3 pts.	9.91985
	12.75419		12.92930
	10.00000		10.00000
To the departure 567,8	2,75419	To the diff. of lat. 849,8	2.92930

Now 849,8 or 850 divided by 60, gives 14° 10′ S. and being subtracted from the latitude of Cape Clear, leaves 37° 5′ the latitude in: Hence the middle latitude is found to be 44° 10′, and meridional difference of latitude 1194. Whence,

To find the Difference of Longitude by Mid. Lat. Sailing.		To find the Difference of Longitude by Mercator's Sailing.	
As co-sine m. lat. 44° 10′	9.85571	As the co-si. course 3 pts.	9.91985
Is to the departure 567,8	2.75420	Is to mid. diff. of lat. 1194	3.07700
So is radius 90°	10.00000	So is sine course 3 pts.	9.74474
	12.75420		12.82174
	9.85571		9.91985
To the diff. of lon. 791,6	2.89849	To the diff. of lon. 797,8	2.90189
Cape Clear's long.	9° 50′ W.	Cape Clear's long.	9° 50′ W.
Diff. of long. 792	= 13 12 W.	Diff. of long. 798	= 13 18 W.
Long. in by mid. lat.	= 23 2 W.	Long. in, by Mercator	23 8 W.

The Course and Difference of Latitude given, to find the Distance and Difference of Longitude.

A ship in 37° N. and longitude 22° 56′ W. sails N. 22° 20′ E. for several days, and then by observation is found to be in the latitude 51° 15′ N.; required the distance run and longitude in?

Lat.	51° 15′	Merid. parts	3593
Lat.	37	Merid. parts	2393
Diff.	14 15 = 855 miles		1200 = merid. diff. of lat.
Sum	½)88 15 = 44,7 mid. lat.		

As co-sine course 22° 20′	9.96614	As co-sine cou. 22° 20′	9.96614
Is to diff. of lat. 855	2.93197	Is to diff. of lat. 855	2.93197
So is sine course 22° 20′	9.57978	So is radius 90°	10.00000
	12.51175		12.93197
	9.96614		9.96614
To the departure 351,3	2.54561	To the distance 924,3	2.96583

To

To find the Difference of Longitude,

By Mid. Lat. Sailing.			By Mercator's Sailing.		
As co-fine mid. lat.	44° 7′	9.85608	As co-fine course	22° 20′	9.96614
Is to the departure	351′	2.54531	Is to mid. diff. of lat.	1200	3.07918
So is radius 90°		10.00000	So is fine course	22° 20′	9.57978
		12.54531			12.65896
		9.85608			9.92614
To diff. l. 489 =	8° 9′ E.	2.68923	To diff. lon. 493 =	8° 13′	2.69282
Lon. left	22 56 W.		Long. left.	22 56	
Long. in	14 47 W. by m. lat.		Long. in	14 43 W. by Mer.	

These four cases are all that can well happen at sea; but as some young men are inattentive, and frequently looking in the book to see if their calculation is the same as that set down;

The Teacher perhaps may find it necessary to let such work the following questions by way of exercise:

Quest. 1st. Required the bearing and distance of Hang. Cliff in Shetland, in latitude 60° 9′ N, and long. 58′ W. and the North Cape of Lapland, in lat. 71° 10′ N. long. 26° 3′ E.?

Ans. { N. 44° 48′ E. dist. 938,5 miles, by Mercator's Sailing.
N. 45° 19′ E. dist. 940 miles, by Middle Lat. Sailing.

Quest. 2d. A ship in lat. 37° N. and longitude 48° 20′ W. sails between the N. and E. until she is in the latitude of 51° 18′ N. and finds she has made 564 miles of dep.; required her direct course, distance run, and longitude in?

Ans. { N. 33° 19′ E. dist. 1027 miles, long. in 35° 14′ W. by Middle Latitude Sailing.
N 33° 19′ E. dist. 1027 miles, long. in 35° 8′ by Mercator's Sailing.

Quest. 3d. A ship from the lat. of 50° 30′ N. sails S. S. W. 150 leagues; what lat. is she in, and how much has she differed her longitude?

Ans. { Lat. in 43° 34′ N. diff. of long. 253,3 miles, by Mercator's Sailing.
Lat. in 43° 34′ N. diff. of long. 252,6 miles, by Middle Latitude Sailing.

Quest. 4th. A ship from latitude 20° 40′ N. sails N. E. by E. until she be in the latitude of 27° 16′ N.; required her distance run, and difference of longitude?

Ans. { Distance run 712,8 miles, difference of longitude 648,1 miles, by Mercator.
Distance run 712,8 miles, difference of longitude 648,6 miles, by Middle Latitude.

Quest.

Quest. 5th. Suppose a ship from the latitude of 45° 40′ N. sails between the S. and E. 600 miles, and then her departure is computed to be 308 miles; required the course, latitude, and difference of longitude?

Ans. Course S. 30° 53′ E. latitude in 37° 5′ N. difference of longitude 411,5, by Mercator.
Course S. 30° 53′ E. latitude in 37° 5′ N. difference of longitude 410,4, by middle latitude.

Quest. 6th. A ship from the latitude 45° 30′ S. sails N. N. W. until her difference of longitude be 7° 40′; required the latitude she is in, and her distance sailed?

NOTE. This must be worked by Mercator's Sailing, thus:

As tang. course 22° 30′ : radius or 90° : : the difference of longitude to the mer. diff. of latitude 1110 miles. Now, from the meridian parts of latitude left 3073, take the meridian diff. of latitude 1110, the remainder 1963, is the meridian parts of the latitude come to 31° 4′ S. Having the course and proper difference of latitude, the rest is found by Case II. in Plane Sailing.

Ans. The ship is in latitude 31° 4′ S. distance 937,4 miles.

Quest. 7th. A ship in the latitude 51° 15′ N. and longitude 22° W. sails between S. and W. until she has made 564 miles of departure, and 786 miles of difference of longitude, required her course, distance, and latitude, and longitude in?

NOTE. This must be worked by Middle Latitude Sailing, as thus:

As diff. of long. 786 : radius : : the departure 564 : co-sine of middle latitude 44° 9′, + 44° 9′ = 88° 18′ the sum lat. and 88° 18′ — 51° 15′ = lat. in 37° 3′ N. Having the difference of latitude and departure, the course is found to be S. 33° 30′ W. and the distance 1021,7 miles.

It may now be supppsed that the Learner is capable of working any single course, either by Middle Latitude or Mercator's Sailing; we shall now proceed to Compound Courses, commonly called Traverse Sailing, which may be worked by Middle Latitude and Mercator's Sailing; either by projection, calculation, Gunter's scale, or inspection.

How to solve compound courses, or a traverse, has already been shewn in Plane Sailing; but it is necessary also to shew, how proper allowances for the longitude should be introduced into such accounts, which is easily done by any of the following methods:

1st. Complete the traverse table to each course and distance as in Plane Sailing, and find the whole difference of latitude, departure, and latitude in.

2dly. With the whole difference of latitude and departure, find the direct course and distance.

3dly. With the latitude left and latitude in, find the complement of the middle latitude; with which, and the departure, find the difference of longitude by Middle Latitude Sailing.

Or, with the course and meridional difference of latitude, find the difference of longitude by Mercator's Sailing.

These methods are generally used in working a day's-work at sea; but those that want a greater degree of accuracy, may work by the following methods, especially in high latitudes:

By the several differences of latitudes and departures, found in the tables of difference of latitude and departure, find the latitudes come to, middle latitudes, and complements of middle latitudes: with each complement of middle latitude and corresponding departure, find the difference of longitude to each course and distance, and set them down in the two additional columns marked difference of longitude, east and west, according to the departure used; add up the east and west columns, and their difference will be the whole difference of longitude, by Middle Latitude Sailing.

But if you work by Mercator's Sailing, find the meridional difference of latitude for each course and distance; with each course and meridional difference of latitude, find the difference of longitude; which set down as above directed, and the difference between the east and west columns will be the difference of longitude by Mercator's Sailing. By this method the ship's place may be found at the end of each course and distance run, and pricked off on a Mercator's chart.

EXAMPLE I.

Suppose a ship from the Land's End in latitude 50° 6′ N. and longitude 5° 55′ W. is bound to the island of St. Mary's in latitude 37° N. and longitude 25° 6′ W. but by reason of contrary winds is obliged to steer the following courses, viz. S. by W. 24 miles, W. S. W. 32, N. W. ½ W. 41, S. S. E. ¼ E. 49, E. N. E. ¾ E. 19, W. 21, N. E. ½ E. 36, S. 41, S. S. W. 92, and N. 36 miles; and it be required the latitude and longitude she is in, with the direct course and distance to her intended port?

With the several courses and distances, find their differences of latitude and departure, and set them down as in the following Traverse Table.

TRAVERSE TABLE.

COURSES.	DIST.	DIFF. OF LAT.		DEPARTURE.	
		N.	S.	E.	W.
S. by W.	24		23,5		4,7
W. S. W.	32		12,2		29,6
N. W. ½ W.	41				31,7
S. S. E. ¼ E.	49	26,0	44,3	21,0	
E. N. E. ¾ E.	19			18,4	
West.	21	4,6			21,0
N. E. ½ E.	36			27,8	
South.	41	22,8	41,0		
S. S. W.	92		85,0		35,2
North.	36	36,0			
		89,4	206,0	67,2	122,2
			89,4		67,2
		Dif. lat. S.	116,6	Depar.	55,0

It is plain by the Traverse Table, that the ship has made 116,6 miles of southing, and 55 miles of westing.

Now from latitude left		50°. 6′	Meridian parts	3484
Take diff. of lat. 117	=	1. 57		
Latitude in		48. 9 N.	Meridian parts	3305
Sum latitudes		2)98. 15		
Middle latitude		49. 7	Meridian difference	179

Whence to find the Difference of Longitude, it will be,

By Middle Latitude Sailing.		By Mercator's Sailing.	
As co-sine mid. lat. 49° 7′	9.81592	As p. diff. of lat. 116,6	2.06670
Is to the departure 55	1.74036	Is to the departure 55	1.74036
So is radius 90°	10.00000	So is mer. diff. lat. 179	2.25285
	11.74036		3.99321
	9.81592		2.06670
To diff. long. 84 = 1° 24′	1.92444	To diff. long. 84,4 = 1° 24′	1.92651
Long. left 5 55		Long. left 5 55	
Long. in 7 19 by m. lat.		Long. in 7. 19 by Mer.	

By

By INSPECTION.

Taking the complement of middle latitude 41° as a course, and the departure 55 in its column, the nearest is 55,1 against which stands 84 in the distance column, the difference of longitude by Middle Latitude Sailing. And,

With the proper difference of latitude and departure; the course found nearly 25° and distance 129 under the course; in the latitude column look for the meridian difference of latitude 179, the nearest is 180,4, against which stands 84,1 in the departure column, which is the difference of longitude by Mercator's Sailing.

To find the direct Course and Distance to St. Mary's.

Lat. of ship.	48° 9′ N.	Merid. pts.	3305	Lon. of ship	7° 19′	W.
Lat. St. Mary's	37 N.	Merid. pts.	2393	L. St. Mary's	25 6	W.
Diff.	11 9 = 669 ms.	Diff.	912	Diff. of long.	17 47 = 1067	
Sum lat.	2)85. 9					
Mid. lat.	42 34					

By Middle Latitude Sailing.

As the diff. of lat. 669	2.82543	As co-si. course 49° 35′	9.81180
Is to diff. of long. 1067	3.02816	Is to prop. diff. of lat. 669	2.82543
So is co-si. mid. lat. 42° 34′	9.86717	So is radius 90°	10.00000
	12.89533		12.82543
	2.82543		9.81180
To tang. course 49° 35′	10.06990	To the dist. 1032	3.01363

By Mercator's Sailing.

As merid. diff. of lat. 912	2.95999	As radius - -	10.00000
Is to radius 90°	10.00000	Is to p. diff. of lat. 669	2.82543
So is diff. of long. 1067	3.02816	So is secant course 49° 29′	10.18731
	13.02816		13.01274
	2.95999		10.00000
To tang. course 49° 29′	10.06817	To the distance 1030	3.01274

Hence the direct course from the ship to St. Mary's is S. 49° 35′ W. and distance 1032 miles, by Middle Latitude Sailing; and S. 49° 29′ W. and distance 1030 miles, by Mercator's Sailing. The same may be found

By INSPECTION.

Take $\frac{1}{4}$ of the diff. of 1067, viz. 267 nearly, and look for that in the dist. column over the complement middle 47° nearly, and in the departure column stands 195,3$\frac{1}{4}$ of the departure.

 Then

Then look for $\frac{2}{4}$ 167,2, and $\frac{1}{4}$ of departure 195,3, until they are found ſtanding together in their reſpective columns, the neareſt are found over 49° and 50°, viz. 195,5, 169,9, and 195,3 163,9; the diſtances correſponding to theſe are 259 and 255, their ſum is 514, half is 257, this multiplied by 4, gives 1028 miles. Hence the courſe is S. 49° 40′ W. diſt. 1028 miles, by Mid. Lat. Sailing.

Again, taking $\frac{1}{10}$ of the meridional difference, and $\frac{1}{10}$ of the diff. of longitude, viz. 91,2 and 106,7, the neareſt numbers to theſe are 106,4, 92,5, and 106,5; 89,4 ſtanding over 49° and 50° in the latitude columns, belonging to the above degrees; look for $\frac{1}{10}$ of the proper difference of latitude, viz. 66,9, the neareſt is 66,9 and 66,8, the diſtances to theſe are 102 and 104, their ſum is 206, half is 103, which being multiplied by 10, gives 1030 miles.

Hence the courſe is S. 49° 30′ W. and diſtance 1030 miles, by Mercator's Sailing, the ſame as by calculation.

Here, to have gone to geometrical ſtrictneſs, the difference of longitude ſhould have been found to every courſe and diſtance run, by Middle Latitude or Mercator's Sailing, which would have given the ſhip's true place at the end of each courſe and diſtance, but ſhall leave the doing of that to the Reader; and as all traverſes are worked in the manner ſhown above, which is ſufficiently exact for a ſhip's run in 24 hours, I ſhall therefore only add a few queſtions for the Learner's exerciſe.

Suppoſe a ſhip from the latitude 68° 38′ N. and longitude 8° 40′ E. is bound to the North Cape, in 71° 10′ N. and longitude 26° 3′ E. ſails as in the following table; required the latitude and longitude ſhe is in, and her direct courſe and diſtance to the Cape?

COURSES.	D.	N.	S.	E.	W.	LAT. IN		Diff. of Long. E.	Diff. of Long. W.
						68	38		
N. E. by N.	63	52,4		35,0		69	30	97,2	
N. E.	38	26,9		26,9		69	57	78,0	
N. N. E.	56	51,7		21,4		70	49	64,2	
North.	30	30,0				71	19		
N. W. by N.	25	20,8			13,9	71	40		44,1
N. N. W. ½ W.	36	31,8			17,0	72	12		55,0
N. by E.	40	39,2		7,8		72	51	26,0	
N. E. by E. ½ E.	72	33,9		63,5		73	25	219,4	
S. E.	50		35,3	35,3		72	50	120,6	
E. N. E.	65	24,9		60,0		73	15	207,9	
		311,5	35,3	249,9	30,9			813,3	99,1
		35,3		30,9				99,1	
Diff. of lat.		276,2	Dep.	219,0		Diff. lon.		714,2	E.

In working the above, the difference of longitude is found by the course and meridional difference between each parallel of latitude; or, it may be done by taking the complements of each middle latitude, and the departure for each course.

Now the lat. left was	68°	38′N.	Long		8° 40′E.
The diff. of lat. 276 ms. =	4	36. N.	Diff. of lon. 714 m. =		11 54 E.
Lat. in ——	73	14	Long. in ——		20 34 E.
Lat. of N. Cape	71	10	Long. of Cape		26 3 E.

The m. diff. lat. is 406 ms. 2° 4′ = 124 ms. Diff. of long. 5°. 29′ = 329 miles.

With the meridional difference of latitude 406, and difference of longitude 329, the course between the ship and the Cape is S. 39° 1′ E. distance 160 miles, by Mercator; and S. 39° 3′ E. distance 159,7, by Mid. Lat. Sailing.

By INSPECTION.

With $\frac{1}{3}$ of diff. of lat. 276 and $\frac{1}{3}$ of departure 219, viz. 92 and 73, the course made good is 38° 30′, and distance 354 miles.

And with $\frac{1}{10}$ of meridional difference of latitude 849, and the course 38° 30′, the difference of latitude is 676, by Mercator's Sailing.

And with the complement of middle latitude 19,2 and the departure 219, the difference of longitude is 675 nearly, by Middle Latitude Sailing; differing from that above 38 miles, by Mercator, and 39 miles by Middle Latitude Sailing.

But as ships never run such distances in 24 hours, the first method of finding the difference of longitude will be sufficiently exact for any day's run.

The bearing and distance to the North Cape may be either found by Middle Latitude or Mercator, by inspection, which will be nearly as above.

A ship from the Lizard, in latitude 49° 57′ N. and longitude 5° 14′ W. is bound to Funchal in Madeira, in latitude 32° 38′ N. and longitude 17° 5′ W. steers the following courses, S. S. W. 250 miles, W. 156, S. E. by S. 300, W. by N. 180, and S. 185 miles; required the latitude and longitude she is in, and her direct course and distance to the intended port?

By finding the difference of longitude for each course by calculation, the ship is in latitude 39° 27′ N. and longitude 11° 28′ W. by Mercator's Sailing; but by working by the whole difference of latitude and departure, the longitude will be 11° 23′ W.

The course from the ship to Funchal, is S 33° 15′ W. distance 489 miles, by Mercator's Sailing:

And S. 33° 19′ W. distance 489,4 miles, by Middle Latitude Sailing.

A ship

A ship from latitude 38° 14′ N. and longitude 25° 56′ W. runs the following courses and distances, viz. N. E. by N. ¼ E. 56 miles, N. N. W. 38, N. W. by W. 46, S. S. E. 30, S. by W. 20, and N. E. by N. 60 miles; required the direct course and distance made good, and the latitude and longitude she is in?

The course is N. 14 E. distance 108 miles, latitude in 39° 59′ N. longitude in 25° 22′ W.

Suppose a ship in latitude 67° 30′ and longitude 8° 46′ W. sails the following courses, N. E. 64 miles, N. N. E. 50, N. W. by N. 58, W. N. W. 72, W. 48, S. S. W. 38, S. by E. 45, and E. S. E. 40 miles; what latitude and longitude is she in?

By working by the whole difference of latitude and departure, the ship is in latitude 68° 43′ N. and longitude 11° 3′ W. But,

By finding the difference of longitude for each course and distance, she is in longitude 11° 37′ W. by Middle Latitude Sailing, and 11° 43′ W. by Mercator's Sailing.

Having gone through the necessary problems in Mercator's Sailing, we shall now proceed to shew how a true chart, commonly called Mercator's Chart, may be constructed either for the whole, or any part of the Terraqueous Globe.

When a Chart is to commence from the Equator, or if the Equator is to run through it.

Having provided a scale of convenient length, draw a line to represent the equator, and crossing that at right angles, another to represent the meridian of some known place, such as London, Paris, the Lizard, or any other place whose longitude is known; the upper end of which will represent the north, and the lower the south.

From the scale take 60 in your compasses, and with one foot upon the meridian, set off that distance on both of it upon the equator, if the chart is to contain east and west longitude; but, if it is only to contain east or west longitude, lay it off upon that side of the meridian the case requires: that is, if the longitude is to be westward, lay it off on the left-hand side of the meridian; but if easterly, the right-hand side.

Again, take 2 degrees or 120 miles in your compasses, and set it off from the meridian, in the same manner as before; or, with 60 miles in the compasses, turn over from the meridian, and that will point out the degrees of longitude, which may be divided into halves, quarters, or minutes, if required.

Having set off as many degrees of longitude as you intend the chart should contain, through the last draw a line (or lines) parallel to the meridian, which will be the bounds of the chart east and west.

Having divided the equator as above, proceed to set off upon the two extreme meridians from the equator, the meridional parts (as found in the table) belonging to each degree of latitude;

that is, take from the ſcale in your compaſſes the miles anſwering to one degree in the table, and, with one foot in the equator, ſet off that diſtance on each ſide of it upon the extreme meridians, if the chart is to contain north and ſouth latitude; but if only north or ſouth, upon one ſide of the equator.

Again, take the meridional parts anſwering to 2 degrees and 3 degrees, &c in your compaſſes, and ſet them off upon the meridian from the equator, as before.

In like manner proceed to ſet off as many degrees as you intend the chart ſhould contain; or, which will be the ſame thing, take the meridional difference of latitude between any two parallels, and ſet them off ſeverally from the leaſt latitude.

Lay a ruler on each of theſe diviſions, and draw lines parallel to the equator, and they will be the parallels of latitude; each of which will be enlarged towards the poles, in proportion as the degrees of longitude are.

Parallel to the meridian, draw lines through the points, expreſſing the degrees of longitude, to cut the parallels of latitude, which bound the chart north and ſouth.

The parallels of latitude may alſo be divided into halves, quarters, or minutes, by taking the meridional parts for degrees and minutes, and ſetting them off as before.

Draw double lines on the borders of the chart, and mark out the degrees of latitude and longitude; and, in ſome convenient place, draw the compaſs. In like manner may a chart be made that ſhall contain any number of degrees and minutes required. When the chart is not to commence from the equator, but is only to ſerve from a certain diſtance on the meridian, betweeen two parallels on the ſame ſide of the equator, then the meridians are to be drawn as before, and for the parallels of latitude you are to proceed thus;

From the meridional parts anſwering to each point of latitude in your chart, ſubtract the meridional parts anſwering to the leaſt latitude, and ſet off the difference ſeverally from the parallels of the leaſt latitude upon the two extreme meridians, and the lines joining theſe points of the meridian will repreſent the ſeveral parallels upon the chart.

Let it be required to draw a chart that ſhall ſerve from the latitude of 14 degrees north, to 52 degrees north, and that ſhall contain 1 degree eaſt, and 26 degrees of longitude weſt of the meridian of London.——See the chart.

Draw a line to repreſent the meridian of London, from which ſet off 60 miles towards the right hand, for one degree of longitude, and on the other ſide, towards the left hand, ſet off 26 degrees of weſt longitude, as before directed: through the two laſt points draw lines parallel to the meridian of London, and theſe will be the extreme meridians or eaſt and weſt bounds of your chart.

Having drawn the two meridians on the lower edge of the paper, draw a line perpendicular to the meridians, to repreſent the parallel of

of 14 degrees north; then, from the meridional parts anſwering to 15 degrees 910, ſubtract the meridional parts anſwering to 14 degrees 848, and take the difference 62 in your compaſſes, and ſet it off from the parallel on both the meridians from you, and that will repreſent the parallel of 15 degrees.

Again, take the meridional parts of 15 degrees 910, from the meridional parts of 16 degrees 973, and ſet off the difference 63, upon the meridians from the point repreſenting the parallel of 15 degrees, and that will repreſent the parallel of 16 degrees. In like manner proceed to ſet off the parallels upon the meridians.

Or, if the meridional parts of 14 degrees be ſubtracted from the meridional parts of every ſucceeding parallel, and the difference be ſet off from the parallel of 14 degrees upon the meridians, theſe points will repreſent the ſeveral enlarged parallels of latitude, the ſame as before; and, if it be required that the meridians ſhould be divided into degrees and meridians, the meridional parts for ſuch muſt be taken from the table, and ſet off as above.

Having ſet off as many parallels as you intend the chart ſhould contain, through each point draw parallels, or if you think drawing lines through every degree will croud your chart too much, you may divide the borders only into ſingle degrees, &c. and draw lines through every 5 degrees of latitude and longitude, as in the chart.

Take from the table of latitude and longitude of places, the latitude and longitude of each particular place contained within the bounds of the chart, and lay a ruler over its latitude, and another croſſing that over its longitude; the points where theſe croſs will repreſent the propoſed place upon the chart. In like manner may any place be readily marked. Hence, the particular points of a ſea-coaſt may be laid down as above, and lines properly drawn from point to point will form the out-lines of the ſea-coaſt, iſlands, &c. to which may be annexed, the depths of water, ſetting of currents, and whatever elſe may be thought convenient for the chart to contain.

This map or chart is not to be conſidered as a juſt or ſimilar repreſentation of the earth's ſurface, for in it the figures of iſlands and countries are diſtorted near the poles, For,

Suppoſe an iſland in the latitude 60° N. or S. where the breadth of a degree of longitude is juſt half as large as a degree upon the equator. Now, as the degrees of latitude are enlarged in proportion as the degrees of longitude are expanded towards the poles, it is plain, that every point of that iſland or country, being laid down in its proper latitude and longitude, will be repreſented twice as large as it really is.

Hence it follows, that as the degrees of latitude are every where increaſed like thoſe of longitude, it is plain the bearings between places will be the ſame on this chart as on the globe; and the proportions beween the latitude and longitude and nautical diſtances, will be the ſame upon this chart as upon the globe

And

And ſince the meridians in this projection are right-lines, it follows, that the rhumbs which form equal angles with the meridians will be ſtraight lines, which render this projection of the earth's ſurface much more eaſy and proper for the Mariner's uſe than any other.

Gunter's Scales have drawn upon them two lines, one marked N M, ſignifying the Nautical Meridian; and the other directly under it marked E P, ſignifying Equal Parts, or degrees of longitude, upon a Mercator's Chart.

Thoſe are equal parts, or degrees of longitude, to which the degrees of the nautical meridian are fitted, by increaſing them in their true proportion; hence the limits or bounds of a Mercator's Chart by theſe lines are eaſily made, by transferring the diviſions correſponding to the degrees to be uſed, from the ſcale to the paper the chart is to be drawn upon: but as the degrees drawn by theſe lines are too ſmall for the ſeaman's uſe, it is much better to uſe a ſcale of equal parts as before, and conſequently the degrees may be made of any propoſed length.

By the Latitude and Longitude in, to prick off the Ship on the Chart.

RULE. Lay the ruler acroſs the chart in the latitude your ſhip is in, then look upon the equator, or line marked with the degrees of longitude, for the longitude your ſhip is in by your reckoning, and ſetting one foot of your compaſſes in that longitude, take the neareſt diſtance to ſome north and ſouth line, and from where that line croſſes the edge of the ruler that lies in the given latitude; lay off that ſame diſtance along the edge of the ruler to the right-hand, if the longitude you are in was to the right-hand of the north and ſouth line, or to the left-hand, if it was to the left-hand; where this falls will be the place of the ſhip: but this will only do when the longitude marked on the chart, and your reckoning of longitude in, are both counted from the ſame meridian. Therefore, for a general rule, take the following, viz.

By the Latitude in and Longitude made, to prick off the Ship's Place.

RULE. Set one foot of your compaſſes in the place you take your departure from, and take the neareſt diſtance to ſome north or ſouth line, and from where that line falls upon the equator, or the line marked with the degrees of longitude, ſet off that diſtance the ſame way the place lies from it; that is, to the right-hand, if the place lies to the right-hand of the north and ſouth line, or to the left-hand if it lies to the weſt; and make a mark with a black lead pencil; this mark will ſerve to prick off by, till you come to take a new departure; and then rub it out, and make a new one as before.

Then lay a ruler acroſs the chart in the latitude you are in, and taking ſo many degrees in your compaſſes from the line of longitude, as your longitude made comes to, ſet them off from your black-lead mark along the edge of the ruler to the eaſtward; if the

 longitude

longitude made be eaſt, or to the weſtward if it be weſt; where this falls will be the longitude the ſhip is in by the chart; from which take the neareſt diſtance to ſome north and ſouth line, and from where that line, &c. as in the firſt caſe.

The ſhip's place on the chart being found, as before taught, it remains in the next to ſhew how to find the bearing and diſtance of any place from the ſhip; and firſt,

To find how any Place bears from the Ship.

RULE. Lay a ruler from the place of the ſhip to the place you would know the bearing of; then ſet one foot of your compaſſes in the centre of ſome compaſs near the ruler, and take the neareſt diſtance to the edge of the ruler; then run one foot of your compaſſes along by the edge of the ruler, and obſerving what point of the compaſs the other comes neareſt to, which will be the bearing required.

To find the Diſtance of any Place from the Ship.

CASE I.

If the place be in the ſame longitude that the ſhip is in; that is, if it bears due north or ſouth, then the difference of latitude between them turned into miles or leagues, will be the diſtance.

CASE II.

If the place be in the ſame latitude the ſhip is in; that is, if it bears due eaſt or due weſt, then take half the diſtance between the ſhip and the place in your compaſſes; and ſetting one foot on the line marked with the degrees of latitude, in the latitude the ſhip is in, ſee what latitudes the other foot will reach to, both above and below it; the difference between theſe two latitudes will be the diſtance required.

CASE III.

When they are neither in the ſame Latitude nor in the ſame Longitude with the Ship.

RULE. Take the difference of latitude between both places in your compaſſes from the equator, or graduated parallel; and laying a ruler over both places, put one foot on the ſhip's place, and ſlide your compaſſes along the edge of the ruler (holding both points parallel to the meridian) until the other cuts the parallel of latitude paſſing through the place, (or E. and W. line cut by the ruler) and then ſtay the compaſſes. Take the diſtance between where the point reſted by the edge of the ruler and the place (or where the ruler croſſed the aforeſaid eaſt and weſt line) in your compaſſes, and apply it to the equator, or graduated parallel, and that will give their diſtance in degrees, which may be turned into miles or leagues; and in the ſame manner as you find the bearing and diſtance

tance between the ſhip and any place, you may alſo find the bearing and diſtance of one place from another; or if the diſtance between the ſhip and place be taken in your compaſſes, and applied to the ſide of the chart, or graduated meridian, nearly in the parallels of the ſhip and place, will give the diſtance in degrees as before; and for this purpoſe there are generally marked on the ſides of charts ſcales of leagues, by which the diſtance between the places may be readily found.

Or the diſtance between two places upon a Mercator's Chart may be eaſily found, thus:

Take half the diſtance between any two places, and with one foot of the compaſſes in the middle parallel, extend both ways upon the graduated meridian; count the number of degrees between both points, which will be your diſtance, either in leagues or miles, according as the ſcale is divided; or take the diſtance in your compaſſes, and ſet one foot as much above the one place as the other point is below the other place, on the meridian, the number of degrees between the points of the compaſſes will be the diſtance.

EXAMPLE.

Required the Bearing and Diſtance between Cape St. Vincent *and* Teneriff?

Lay a ruler over both places, and take their difference of latitude 8° 30′, from the equator or graduated parallel, in your compaſſes; and ſlide one foot along the edge of the ruler from Teneriff, holding the other point in the direction of the line CB, until the other point juſt touches the eaſt and weſt line, (AB) paſſing through St. Vincent, as at B, from C where the foot of the compaſſes reſted, by the edge of the ruler, and St. Vincent being meaſured, and applied to the graduated parallel, gives 10 2-third degrees, or 640 miles the diſtance.

Again, take the neareſt diſtance between the centre of the compaſs in your compaſſes, and ſliding them along the edge of the ruler, as before directed, you will find the courſe to be S. W. by S. ¼ W. nearly.

Hence, the direct courſe between Cape St. Vincent and Teneriff is S. W. by S. ¼ W. diſtance 640 miles, or 213 one-third leagues; and the ſame with other places.

OF WINDS.

THE earth is endued with a wonderful principle of gravitation, whereby all its parts are ſtrictly united together; and all bodies that are looſe upon it cloſely adhere to its ſurface, tending directly towards its centre. Hence it is, that ſhips are able to ſail with the ſame facility every where (void of impediments) upon the ſurface of the ſea, quite round the terraqueous globe; and that (as to ſenſe) there is no ſuch thing as an upper or lower part of the earth; for let the inhabitant be in what part ſoever, he will there gravitate towards the earth's centre, and imagine himſelf to be on the higheſt point of its ſurface; from whence he will obſerve the heavens like a large vault over his head, and his antipodes he will imagine to be directly under him, as they will alſo theirs, for the like reaſon. According to this law of gravity, if the earth was at reſt, (and not acted upon by any other power) and its parts looſe, or its ſurface all over covered with a deep fluid, it would naturally form itſelf into a true ſphere, or globe.

Notwithſtanding this power of attraction, yet the ſun, whoſe rays upon the earth cauſe vapours or fumes to be continually riſing from it, which muſt partake of the quality of thoſe parts from whence they are evaporated; a collection of which form what we call our air or atmoſphere, ſurrounding the earth, and extending ſome miles above its ſurface, and is liable to be put in motion by various cauſes. Hence, air is a fine elaſtic fluid, and is found capable of being compreſſed, or condenſed by cold, and expanded or rareſied by heat.

Conſequently, an alteration of heat or cold happening in any part of the atmoſphere, the air in that part will be either condenſed or rareſied, and the neighbouring parts will thereby be put into motion, through the endeavour which the air by its elaſticity or ſpringineſs always makes to reſtore itſelf to its former ſtate, or come to an equilibrium.

Wind, is a ſtream or current of air which generally blows from one part of the horizon to its oppoſite.

The following obſervations have been made on it, particularly by Dr. Halley, which are not unworthy the ſeaman's notice.

Between 30 degrees north latitude, and 30 ſouth latitude, there is a coaſtant eaſt wind throughout the year, blowing on the

the Atlantic and Pacific oceans, and this is called the Trade Winds.

For as the ſun, in moving from eaſt to weſt, heats the air more immediately under him, and thereby expands it; the air to the eaſtward is conſtantly ruſhing towards the weſt to reſtore the equilibrium or natural ſtate of the atmoſphere, which occaſions a perpetual eaſt wind in thoſe limits.

The trade winds, near theſe northern limits, blow between the north and eaſt; and, near the ſouthern limits, they blow between the ſouth and eaſt.

For as the air is expanded by the heat of the ſun near the equator, therefore the air from the northward and ſouthward will both tend toward the equator to reſtore the equilibrium: now theſe motions from the north and ſouth, joined with the foregoing eaſterly motion, will produce the motions obſerved near thoſe limits, between the north and eaſt, and between the ſouth and weſt.

Theſe winds, if the whole ſurface of the globe were ſea, would undoubtedly blow quite round it, as they are found to do in the Atlantic and Ethiopic oceans; but ſeeing ſuch great continents interpoſe and break the continuity of the ocean; regard muſt be had to the nature of ſoils, and the poſition of high mountains, which are the principal cauſes of the variety of winds differing from the former general one.

In ſome parts of the Indian ocean there are periodical winds, which are called Monſoons; that is, ſuch as blow half the year one way, and the other half the contrary way.

For air that is cool and denſe will force the warm and rarefied air into a continual ſtream upwards, where it muſt ſpread itſelf to preſerve the equilibrium; ſo that the upper courſe or current of the air ſhall be contrary to the under current; for the upper air muſt move from thoſe parts where the greateſt heat is, and ſo by a kind of circulation the N. E. trade wind below will be attended with a S. W. above, and a S. E. below, with a N. W. above: And this is confirmed by the experience of ſeamen, who, as ſoon as they get out of the trade winds, immediately find a wind blowing from the oppoſite quarter.

In the Atlantic ocean, near the coaſts of Africa, at about 100 leagues from ſhore between the latitudes of 28° and 10° north, ſeamen conſtantly meet with a freſh gale of wind blowing from the N. E.

Thoſe bound to the Caribbee Iſlands acroſs the Atlantic find, as they approach the American ſide, that the ſaid N. E. wind becomes eaſterly, or ſeldom blows more than a point from the eaſt either to the northward or ſouthward.

Theſe trade winds on the American ſide are extended to 30°, 31°, or even to 32° of north latitude; which is about 4° farther than what they extend to on the African ſide; alſo to the ſouth-

ward of the equator, the trade winds extend 3 or 4 degrees farther towards the coaſt of Brazil on the American ſide, than they do near the Cape of Good Hope on the African ſide.

Between the latitudes of 4 degrees north and 4 ſouth, the wind always blows between the ſouth and eaſt: On the African ſide the winds are neareſt the ſouth, and on the American ſide neareſt the eaſt. In theſe ſeas Dr. Halley obſerved, that when the wind was eaſtward, the weather was gloomy, dark, and rainy, with hard gales of wind; but when the wind veered to the ſouthward, the weather generally became ſerene, with gentle breezes next to a calm.

Theſe winds are ſomewhat changed by the ſeaſons of the year; for when the ſun is far northward, the Brazil S. E. wind gets to the ſouth, and the N. E. wind to the eaſt; and when the ſun is far ſouth, the S. E. wind gets to the eaſt, and the N. E. wind on this ſide of the equator veers more to the north.

Along the coaſt of Guinea, from Sierra Leon to the iſland of St. Thomas, under the equator, which is above 500 leagues, the ſoutherly and S. W. winds blow perpetually; for the S. E. trade wind having paſſed the equator, and approaching the Guinea coaſt, within 80 or 100 leagues, inclines toward the ſhore, and becomes S. S. E. then ſouth, and by degrees, as it comes near the land, it veers about to S. S. W. and within the land it is S. W. and ſometimes W. S. W. This track is troubled with frequent calms, and violent ſudden guſts of wind, called Tornadoes, blowing from all points of the horizon.

The reaſon of the wind ſetting in weſt on the coaſt of Guinea is, in all probability, owing to the nature of the coaſt, which being greatly heated by the ſun, rarefies the air exceedingly, and conſequently the cool air, from off the ſea, will keep ruſhing in to reſtore the equilibrium.

Between the 4th and 10th degrees of north latitude, and between the longitude of Cape Verd and the eaſtermoſt of the Cape Verd Iſlands, there is a track of ſea which ſeems to be condemned to perpetual calms, attended with terrible thunder and lightnings, and ſuch frequent rains, that this part of the ſea is called The Rains. Ships in ſailing theſe 6 degrees have been ſometimes detained whole months, as is reported.

The cauſe of this ſeems to be, that the weſterly winds ſetting in on this coaſt, and meeting the general eaſterly winds in this track, balance each other, and ſo cauſe the calms and the vapours, carried thither by each wind meeting and condenſing, occaſion the almoſt conſtant rains.

The laſt three obſervations ſhew the reaſon of the two following, which mariners experience in ſailing from Europe to India, and in the Guinea trade. The difficulty which ſhips in going to the ſouthward, eſpecially in the months of July and Auguſt, find in

paſſing

passing between the coasts of Guinea and Brazil, notwithstanding the width of this sea is more than 500 leagues: This happens because the S. E. winds at that time of the year commonly extend some degrees beyond the ordinary limits of 4° N. latitude; and besides, coming so much southerly, as to be sometimes south, sometimes a point or two to the west; it then only remains to ply to windward. And if on the one side they steer W. S. W. they get a wind more and more easterly; but then there is danger of falling in with the Brazilian coast, or shoals; and if they steer E. S. E. they fall into the neighbourhood of the coast of Guinea, from whence they cannot depart without running easterly as far as the island of St. Thomas; and this is the constant practice of all the Guinea ships.

All ships departing from Guinea for Europe, their direct course is northward; but on this course they cannot go, because the coast bending nearly east and west, the land is to the northward; therefore as the winds on this coast are generally between the S. and W. S. W. they are obliged to steer S. S. E. or S. and with these courses they run off the shore; but in so doing they always find the wind more and more contrary, so that when near the shore they can lie south; at a great distance they can make no better than S. E. and afterwards E. S. E. with which courses they generally fetch the island of St. Thomas, and Cape Lopez, where, finding the winds to the eastward of the south, they sail westerly with it, till coming to the latitude of four degrees south, where they find the S. E. wind blowing perpetually.

On account of these general winds, all those that use the West-India trade, even those bound to Virginia, reckon it their best course to get as soon as they can to the southward, that so they may be certain of a fair and fresh gale to run before it to the westward; and for the same reason those homeward bound from America endeavour to gain the latitude of 30°, where they first find the wind begin to be variable, though the most ordinary winds in the North Atlantic ocean come between the south and west.

Between the southern lats. of 10° and 30° in the Indian ocean, the general trade-wind about S. E. by S. is found to blow all the year round in the same manner as in the like lats. in the Ethiopic Ocean, and during the six months, from May to December, these winds reach to within 2° of the equator; but during the other six months, from November to June, a N. W. wind blows in the track lying between the 3d and 10th degrees of southern lat. in the meridian of the north end of Madagascar; and between the 2d and 12th degrees of south lat. near the long. of Sumatra and Java.

In the track between Sumatra and the African coast, and from 3° of S. lat. quite northward to the Asiatic coast, including the Arabian sea and the gulph of Bengal, the monsoons blow from September to April on the N. E. and from March to October on the S. W.

S. W. In the former half year, the wind is more ſteady and gentle, and the weather clearer than in the latter ſix months: and the wind is more ſtrong and ſteady in the Arabian ſea than in the Gulf of Bengal.

Between the iſland of Madagaſcar and the coaſt of Africa, and thence northward as far as the equator, there is a track wherein, from April to October, there is a conſtant freſh S. S. W. wind, which, to the northward, changes into the W. S. W. wind blowing at that time in the Arabian ſea.

To the eaſtward of Sumatra and Malacca, on the north of the equator, and along the coaſts of Cambodia and China, quite through the Philippines as far as Japan, the monſoons blow northerly and ſoutherly; the northern ſetting in about October or November, and the ſouthern about May. Theſe winds are not quite ſo certain as thoſe in the Arabian ſea.

Between Sumatra and Java to the weſt, and New Guinea to the eaſt, the ſame northerly and ſoutherly winds are obſerved; but the firſt half year the monſoons incline to the N. W. and the latter to the S. E. Theſe winds begin a month or ſix weeks after thoſe in the Chineſe ſeas ſet in, and are quite as variable.

Theſe contrary winds do not ſhift from one point to its oppoſite all at once; in ſome places the time of the change is attended with calms, in others by variable winds; and it often happens on the ſhores of Coromandel and China, towards the end of the monſoon, that there are moſt violent ſtorms, greatly reſembling the hurricanes in the Weſt-Indies, wherein the wind is ſo vaſtly ſtrong, that hardly any thing can reſiſt its force.

All navigation in the Indian ocean muſt neceſſarily be regulated by theſe winds; for if mariners ſhould delay their voyages till the contrary monſoon begins, they muſt either ſail back, or go into harbour, and wait for the changing of the trade winds.

Vapours riſing from the ſea, and by the wind carried over low lands to the ridges of mountains, and compelled to mount up with the ſtream of the air to the tops, where the water preſently precipitates, gleeting down by the chinks and cliffs of the ſtones, and part of the water entering into the caverns of hills, and gathering into baſons, which being once filled begin to run over, and form ſubterraneous paſſages through the earth, breaking out in ſprings by the ſides of hills; ſeveral of thoſe meeting together form rivulets; ſeveral of theſe rivulets meeting together make a river. This, together with what is incorporated into vegetables, renders it impoſſible for all the water evaporated from the ſea to return to it again.

Hence the evaporations ariſing from the Mediterranean are ſuch, that notwithſtanding there are 9 capital rivers, which empty themſelves into it, beſides ſmaller ones, there is a conſtant current running through the Straits of Gibraltar from the Atlantic ocean, to make up the deficiency. R. Mead, M. D. and F. R. S. obſerves,

1. That

1. That ſome diſeaſes are properly the effects of the influence of the heavenly bodies. 2. That the moſt windy ſeaſons of the year are about the vernal and autumnal equinoxes. 3. All the changes we have enumerated in the atmoſphere do fall out at the ſame times when thoſe happen in the ocean, and, as both the waters of the ſea and the air of our earth or fluids, are ſubject in a great meaſure to the ſame laws of motion, ſo that natural effects of the ſame kind are owing to the ſame cauſes. 4. The alteration made by the ſun and moon in the atmoſphere muſt thereby have influence on the animal body. 5. The elaſticity of the air is of great moment, and it is reciprocally as the preſſure, ſo that the incumbent weight being diminiſhed by the attraction, the air underneath will be much expanded; theſe, and ſuch like cauſes, will make the tides in the air to be much greater than thoſe of the ocean; and there is no doubt to be made, but that the ſame infinite wiſe Being, who contrived the flux and reflux of the ſeas, to ſecure that vaſt collection of waters from ſtagnation and corruption, has ordered this ebb and flood of the air of our atmoſphere with the like good deſign; that is, to preſerve it ſweet, and a briſk temper of this fluid ſo neceſſary to life, by a continual circulation. 6. Two contrary winds blowing towards the ſame place, may accumulate the air there, ſo as to increaſe the height and the weight of the incumbent cylinder; in like manner the direction of two winds may be ſuch, as meeting at certain angles, may keep the gravity of the air in a middle ſtate; but if the wind blow different ways from the ſame place (which may be occaſioned by thunder and lightning) the height and weight of the air may be much decreaſed. 7. The changes in our atmoſphere at high water, new and full moon, the equinoxes, &c. muſt occaſion alterations in all animal bodies, for all living creatures require air of a determined gravity to perform reſpiration eaſily; for it is by its weight that this fluid inſinuates itſelf into the cavity of the breaſt and lungs: By a ſlow circulation the ſecretion of the ſpirits is diminiſhed; and, by the want of the force of elaſticity and gravity, the juices begin to ferment, change the union of their parts, break their canals, and diſeaſes follow.

Beſides the above cauſes, the atmoſphere may be put in motion by the elaſtic vapours forced from the bowels of the earth by ſubterraneous heats, and condenſed by whatever cauſes in the atmoſphere. A mixture of effluvia in different qualities in the air may, by rarefaction, fermentation, &c. produce winds and other effects like thoſe reſulting from the combination of ſome chymical liquors; and that ſuch things happen, we are aſſured from the nature of thunder, lightning, and meteors. From the eruption of volcanoes and earthquakes in diſtant places, wind may be propagated to remoter countries. The divided or united forces of the other planets and of the comets, may variouſly diſturb the influence of the ſun and moon, &c. We know that there happen violent

tempeſts in the upper regions of the air, when we below enjoy a calm, and how many ridges of mountains there are on our globe which interrupt and check the propagation of the winds, ſo that it is no wonder that the phænomena we have aſcribed to the action of the ſun and moon are not always conſtant and uniform, and that every effect does not hereupon follow: which, were there no other powers in nature able to alter the influence of, this might in a very regular and uniform manner be expected from it.

That the rarefied air aſcends is ſufficiently demonſtrated by the aeroſtatic globe, or air balloon, lately invented; this is a globe made of ſilk, or other light ſtuff, made air tight with gum; which being filled with inflammable or rarefied air, will, when let looſe, aſcend until it comes to that part of the atmoſphere that is nearly as light as the air within it, where it will continue ſome time.

Some of theſe globes have been made ſo large as to carry up men with them, as have frequently been ſeen in Britain, France, and other parts.

NOTE. The ſwiftneſs of wind in a great ſtorm is not more than 50 or 60 miles in an hour, and a common briſk gale is about 15 miles an hour.

TIDES.

A TIDE is that motion of the water in the ſeas and rivers, by which they regularly riſe and fall: the general cauſe of which was diſcovered by Sir ISAAC NEWTON, and is deduced from the following conſiderations:——Daily experience ſhews, that all bodies, when thrown upwards from the earth, fall down to its ſurface in perpendicular lines; and as lines perpendicular to the ſurface of any ſphere tend towards its centre, the lines, along which all heavy bodies fall, muſt be directed towards the earth's centre.

As bodies appear to fall by their weight, or gravity; the law, by which they deſcend, is called the law of gravitation: and as a magnet or loadſtone will draw ſmall portions of iron or ſteel, and as a piece of glaſs, amber, or ſealing-wax, when warmed by rubbing, will draw ſmall bits of paper and other light ſubſtances, the law, by which ſuch bodies fly to thoſe which draw them, is called the law of attraction. Hence it is not improper to ſay, that bodies, when

when falling by their gravity towards the earth, are *attracted* by the earth; and therefore, the words gravitation and attraction may, respecting the earth, be used indifferently, as by them is only meant that power, or law, by which all bodies tend towards its centre.

Sir ISAAC discovered, by a great number of observations, that this law of gravitation or attraction was universally diffused throughout the solar system; and that the regular motions, observed among the heavenly bodies, were governed by it; so that the earth and moon attract each other, and both of them are attracted by the sun. He also discovered, that the force of attraction, mutually exerted by these bodies, was lessened as the distance increased, in proportion to the squares of those distances; that is, the power of attraction, at double the distance, was four times less; at triple the distance, nine times less; at quadruple the distance, sixteen times less, and so on.

As the earth is attracted by the sun and moon, it follows, that all the parts of the earth will not gravitate towards its centre in the same manner as they would do, if those parts were not affected by such attractions. And it is evident, that were the earth entirely free from such actions of the sun and moon, the ocean, being on all sides equally inclined towards its centre by the force of gravity, would continue in a perfect stagnant state, without ever ebbing or flowing. But, as the case is otherwise, the water in the ocean must needs rise higher in those places where the sun and moon diminish its gravity, or where they have the greatest attraction.

As the force of gravity must be diminished most, in those parts of the earth to which the moon is nearest, or in the zenith, because her attraction will there be most powerful; therefore the waters, in such places, will rise higher, and it will in them be full sea or high-water. The parts of the earth directly under the moon, and also those in her nadir, *viz.* such places as are diametrically opposite to those where the moon is in the zenith, will have high-water at the same time. For either half of the earth would gravitate equally towards the other half, were they free from all external attraction. But, by the action of the moon, the gravitation of one half of the earth towards its centre is diminished, and that of the other increased. In the half-earth next the moon, the parts directly under her being most attracted, and consequently their gravitation towards the earth's centre most diminished, the waters in these parts must be higher than in any other part of this half-earth. And in the half-earth, farthest from the moon, the parts in the nadir being less attracted by her than those which are nearer, gravitate less towards the earth's centre, and consequently, the waters in those parts must be higher than they are in any other part of this half-earth.

Those parts of the earth where the moon appears in the horizon, or is 90 degrees distant from the zenith and nadir, will have their

loweſt waters: For as the waters in the zenith and nadir riſe at the ſame time, the adjacent waters will preſs towards thoſe places to reſtore the equilibrium; and, to ſupply the places of theſe, others will move the ſame way, and ſo on to 90° diſtant from the ſaid zenith and nadir; conſequently the waters, in thoſe places where the moon appears in the horizon, will have moſt liberty to deſcend towards the centre; and therefore they will, in ſuch places, be the loweſt. Hence it plainly follows, that the ocean, if it covered the ſurface of the earth, would put on a ſpheroidal, or egg-like figure; in which the longeſt diameter would paſs through the place where the moon is vertical; and the ſhorteſt where ſhe is in the horizon. And as the moon apparently ſhifts her poſition from eaſt to weſt in going round the earth every day, the long diameter of the ſpheroid, following that motion, would occaſion the two floods and ebbs in about every 25 hours, which is about the length of a lunar day, or the time ſpent between the moon's leaving the meridian of any place, and her coming to it again. Hence, the greater the moon's meridian altitude is at any place, the greater will thoſe tides be which happen when ſhe is above the horizon; and the greater her meridian depreſſion is, the greater will thoſe tides be which happen when ſhe is below the horizon. The ſummer day, and the winter night tides, have a tendency to be higheſt; becauſe the ſun's ſummer elevation, and his winter depreſſion are greateſt: this is more eſpecially to be obſerved when the moon has north declination in ſummer, and ſouth declination in winter.

The time of high water is not preciſely at the time of the moon's coming to the meridian, but about an hour after. For the moon continues to act with ſome force after ſhe has paſt the meridian, and by that means adds to the libratory, or waving motion, which ſhe put the water into whilſt ſhe was on the meridian; in the ſame manner as a ſmall force applied upwards to a ball, already raiſed to ſome height, will raiſe it ſtill higher. The tides are greater than ordinary twice every month: that is, about the times of new and full moon: they are called ſpring-tides. At theſe times the ſun and moon concur to draw in the ſame right line; and therefore the ſea muſt, under ſuch joint influence, be more elevated than at other times. During the time of their conjunction, or whilſt they are on the ſame ſide of the earth, they both conſpire to raiſe the water in the zenith, and conſequently in the nadir: and when the ſun and moon are in oppoſition, that is, when the earth is between them, whilſt one makes high-water in the zenith and nadir, the other does the ſame in the nadir and zenith. The tides are leſs than ordinary twice every month; that is, about the times of the firſt and laſt quarters of the moon; theſe are called neap-tides: becauſe in the quarters of the moon, the ſun raiſes the water were the moon depreſſes it, and depreſſes where the moon raiſes the water; ſo that the tides are then cauſed only by the difference of their actions. Hence it is

neceſſary

neceſſary to obſerve, that the ſpring-tides happen not exactly at the new and full moons, but generally three days after, when the attracting powers of the ſun and moon have conſpired for a conſiderable time. In like manner the neap-tides happen about three days after the quarters, when the moon's attraction has been leſſened by that of the ſun for ſeveral days together.

When the moon is in her *perigæum*, or neareſt approach to the earth, the tides riſe higher than they do, under the ſame circumſtances, at other times; for, according to the laws of gravitation, the moon muſt attract moſt, when ſhe is neareſt the earth. The ſpring-tides are greater about the time of the equinoxes, that is about the latter end of March and September, than at other times of the year; and the neap-tides are then leſs; becauſe the longer diameter of the ſpheroid, or the two oppoſite floods, being then in the earth's equator, will deſcribe a great circle of the earth; by the diurnal rotation of which thoſe floods will move ſwifter, deſcribing a great circle in the ſame time they uſed to deſcribe a leſs one, parallel to the equator; and conſequently the waters being thrown more forcibly againſt the ſhores, muſt cauſe them to riſe higher.

The following obſervations have been made on the riſe of the tides: namely, the morning-tides generally differ in their riſe from the evening-tides. The new and full moon ſpring-tides riſe to different heights. In winter the morning-tides are higheſt. In ſummer the evening-tides are higheſt. Thus it appears, that, after a period of about ſix months, the order of the higheſt tides are inverted; that is, the riſe of the morning and evening tides will change places, the winter morning high-tides becoming the ſame as the ſummer evening high-tides. Some of theſe effects ariſe from the different diſtances of the moon from the earth after a period of ſix months, when ſhe is in the ſame ſituation with reſpect to the ſun; for, if ſhe be in perigee at the time of the new moon, ſhe will, in about ſix months after, be in perigee about the time of full moon. Theſe particulars being well known, a pilot may chuſe that time which will prove moſt convenient for conducting a ſhip out of any port, where there is not a ſufficient depth of water on common ſpring-tides.

Small inland ſeas, ſuch as the Mediterranean and Baltic, are little ſubject to tides; becauſe the action of the ſun and moon is always nearly equal to the extremities of ſuch ſeas. The tides, in very high latitudes alſo, are very inconſiderable: for the ſun and moon acting towards the equator, and always raiſing the water towards the middle of the torrid zone, the neighbourhood of the poles muſt conſequently be deprived of the waters, and the ſea, within the frigid zones, muſt be low in compariſon to the other parts.

All the things hitherto explained would be exactly obtained, were the whole ſurface of the earth covered with ſea. But ſince there are a multitude

multitude of iſlands, beſides continents, lying in the way of the tide, which interrupt its courſe; therefore there ariſe, in many places near the ſhores, a great variety of other appearances, beſides the foregoing ones, which require particular ſolutions, in which the ſituations of the ſhores, ſtraits, ſhoals, winds, and other things, muſt neceſſarily be conſidered. For inſtance; as the ſea has no viſible paſſage between Europe and Africa, let them be ſuppoſed one continent, extending from 79° north, to 34° ſouth: the middle of thoſe two would be in latitude 19 degrees north, near Cape Blanco on the weſt coaſt of Africa. But it is impoſſible the flood-tide ſhould ſet to the weſtward, upon the weſtern coaſt of Africa, (for the general tide following the courſe of the moon, muſt ſet from eaſt to weſt) becauſe the continent for above 60°, both northward and ſouthward, bounds that ſea on the eaſt; and therefore if any regular tide proceed from the motion of the ſea from eaſt to weſt, ſhould reach this place, it muſt be either from the North of Europe ſouthward, or from the South of Africa northward.

This opinion is further corroborated, or rather fully confirmed, by common experience, which ſhews that the flood-tide ſets to the ſouthward along the weſt coaſt of Norway from the North Cape to the Naze, or entrance of the Baltic Sea, and ſo proceeds to the ſouthward along the eaſt Coaſt of Great Britain, and in its paſſage ſupplies all thoſe ports which lie in its way one after another. The coaſt of Scotland has the tide firſt, becauſe it comes from the northward to the ſouthward. On the full and change days, it is high-water at Aberdeen at 12 h. 45 m. but at Tinmouth Bar not till 3 h. Rolling thence to the ſouthward, it makes high-water at the Spurn a little after 5 h. at Yarmouth Roads a little after 8 h. at Harwich at 10 h. 30 m. at the Nore 12 h. and at London 2 h. 30 m. all in the ſame day. And although this may ſeem to contradict the hypotheſis of the natural motion of the tides being from eaſt to weſt, yet as no tide can come weſt from the main continent of Norway or Holland, it is evident that the tide we have been tracing, by its ſeveral ſtages from Scotland to London, is ſupplied by that tide, the original motion of which is from eaſt to weſt. As water always inclines to the level, it will in its paſſage fall to any other point of the compaſs, to fill up vacancies where it finds them; and yet not contradict, but rather confirm the hypotheſis.

While the flood-tide is thus gliding to the ſouthward along the eaſt coaſt of England, it alſo ſets to the ſouthward along the weſt coaſts of Scotland and Ireland; one branch of it falls back, north eaſt into St. George's Channel; and another runs between Uſhant and the Lizard, into the Britiſh Channel. Some may object that this courſe of the flood-tide, eaſt up the Channel, is quite contrary to the hypotheſis of the general motions of the tides being from eaſt to weſt; and conſequently of its being high-water where the moon is verticle, or any where elſe on the meridian. But it may be

be answered, that this particular direction of the tides does not contradict the general direction of the whole. A river with a western course may supply canals which wind north, south, or even east, and yet the river keep its natural course; and if the river ebbs and flows, the canals supplied by it would also do the same, although they did not keep exact time with the river; because it would be flood, and the water advanced to some height in the river, before it reached the farthest part of the canals; and the more remote the extremity of the canals are, the longer time it would require: it may also be added, that if it were high-water in the river just when the moon was on the meridian, she would be far past it before it could be high-water in the remotest part of those canals; and the flood would set according to the course of the canals that received it, and could not set west upon a canal of a different position. As St. George's Channel, the British Channel, &c. are no more in proportion to the vast ocean, than such canals would be to a large navigable river; it will evidently follow, that the flood-tide may, among those obstructions and confinements, set upon any other point of the compass, as well as west; and may make high-water at any other time, as well as when the moon is upon the meridian, without anywise contradicting the general theory of the tides.

Among pilots it is customary to reckon the time of high-water by the point of the compass the moon bears on at that time, allowing three quarters of an hour for each point. Thus, in places where it is high-water at noon, on the full and change days the tide is said to flow north and south, or 12 o'clock. In places where the moon bears 1, 2, 3, 4, or more points to the eastward or westward of the meridian, when it is high-water on such days, the tide is said to flow on such a point; so, if the moon bears south-east at high-water, it is said to flow south-east and north-west, or 9 o'clock; if she bears south-west, it flows south-west and north-east, or 3 o'clock; and in like manner for every other point of the moon's bearing.

From the observations of many persons, the times of high-water on the days of the new and full-moon on most of the coasts of Europe, and several other places, have been collected; and those are generally put in a table, against the names of their respective places, in an alphabetical order; hence it is called the tide-table.

The method generally prescribed for finding the time of high-water at any place, is contained in the following particulars:

To find the Leap-Year.

Divide the given year by 4, if nothing remains it is leap-year, but if 1, 2, or 3 remains, they shew that it is so many years after bissextile, or leap-year, as the remainder is: thus, in the year 1796 divided

divided by 4, gives 449, and the remainder is (0) shews it is leap-year.

To find the Golden Number for any Year.

RULE. Add one to the given year, and divide the sum by 19, the remainder will be the golden number.

EXAMPLE.

Required the Golden Number of 1796?

By adding one to that year, it gives 1797, this divided by 19, gives 94 for the quotient, and the remainder is 11, the golden number for 1796.

To find the Epact for any Year.

NOTE. The Epact is the moon's age at the beginning of the year, or rather the first of March. The Epact advances 11 every year, to 30, because the solar year is 11 days longer than the lunar year, and as the Epact increases, it shews the moon's age at the beginning of the year; it is here supposed, that at the end of 19 years, the sun and moon make all the variety of situations they possibly can with one another, and thence begin, and go over the same again. The golden number at the birth of Christ was 1, which is the reason that one is added to the given year, to find the golden number.

RULE. Divide the given year by 19, the remainder multiply by 11, and the product will be the Epact, if it does not exceed 29; but if it does, subtract 30 from it as often as you can, and the remainder will be the Epact, for it never exceeds 29.

EXAMPLE.

What is the Epact of the Year 1796?

1796 divided by 19, gives 94, and the remainder 10 multiplied by 11, gives 110; this divided by 30, gives 3, and the remainder is 20; which is the Epact for 1796.

To find the Moon's Age.

To the Epact, add the days of the month, and the Epact, or number for the month; the sum if it does not exceed 30 is her age; but if it does, subtract 30 from it as often as you can, and the remainder is her age.

NOTE. The Epact, or number for each month, is found thus: divide the number of days contained between the first of January and the first day of any month, by $29\frac{1}{2}$, the remainder will be the number for that month.

Required the Number or Epact for Sept. 1796?——*Ans.* 7,5.

The number of days contained between the first of January 1796, and first of Sept. are 244 days, divided by $29\frac{1}{2}$, gives 8 for the quotient, and 8 for the remainder, which is the number sought; and so for any other month.

EXAMPLE.

EXAMPLE.

Required the Moon's Age, April 29, 1796.

Day of the month	29
Epact for the month	20
Number for the month	3
	30)50(1
	30
	22 Moon's age.

Numbers for the Months are nearly as follows:

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
In com. years	0	2	0	2	2	4	4	6	7	8	10	10
In leap years	0	2	1	3	3	5	5	7	8	9	10	11

To find the Moon's Southing on any Day of her Age.

Since the sun returns to the meridian he has left in the space of 24 hours, and the moon in about 24 hours 49 minutes; therefore, if the moon leaves the meridian at the same time that the sun does, on any day, the next day she will come to the meridian 49 minutes after him, falling back, about 49 minutes every day; whence to find the time of the moon's southing, or coming to the meridian on any day, we have this easy RULE:

Multiply the day of her age by 49, and divide the product by 60, the quotient is the hours, and the remainder the minutes afternoon when she souths. Or, which is rather easier, and in many respects sufficiently exact for the mariner's purpose; multiply the moon's age by 4, and divide the product by 5, the quotient is the hours, and the remainder multiplied by 12, gives the minutes afternoon when she is upon the meridian; but if this time exceeds 12, subtract 12 hours from it, and the remainder is the time of her southing in the morning.

N. B. From the full moon to the change she comes to the meridian, or souths in the morning; but from the change to the full, in the afternoon.

EXAMPLE.

Required the Moon's Southing, August 25, 1796?

The epact is	20	Or thus,	22
Number for the month is	7		4
Day of the month	25		5)88
	30)52(1		
	30	Moon's southing	17 36
			12 00
Moon's age	22		5 36
	49		
	198		
	88		
	60)107, 8		
Moon's southing	17, 58 afternoon		
Subtract	12		
Moon's southing	5 58 in the morning.		

Hence it appears that the moon comes to the south at 58 minutes after 5 in the morning.

To find the Time of High Water on any Day of the Moon's Age at any Place.

From the observations of many persons, there have been collected the times when it is high water on the days of the new and full moon, on most of the sea coasts of Europe, and at several other places, and these times are commonly put in a table against the names of the places in an alphabetical order, for which reason, it is called the Tide Table: but in this treatise, the times of high water at full and change days, are set down after the latitude and longitude of each place, in the table of latitudes and longitudes of places.

RULE. To the time of the moon's southing on the given day, add the time of high water at the full and change at the given place, taken from the table; the sum is the hour past noon on the given day, when it is high water at that place; and if this hour exceeds 12, subtract 12 from it, and the remainder shews the time of high water in the morning; but if it exceeds 24, subtract 24 from it, and the remainder shews the time of high water in the afternoon.

EXAMPLE.

EXAMPLE I.

At what Time will it be High Water at London, August 25, 1796?

```
19)1796(94
   171
   ---
    86
    76
   ---
    10
    11
   ----
30)110(3
    90
   ----
```

The epact	20	
Num. of month	7	
Day of month	25	
	52	
Subtract	30	
Moon's age	22	
Multiply by	4	
	5)88(3	
	17=36	
Time at London	3	
Afternoon	20	36
Subtract	12	
Morning	8	36

So that it is high water 36 minutes after eight in the morning at London.

EXAMPLE II.

Required the Time of High Water at Dover, October 12, 1796?

```
19)1796(94
   171
   ---
    86
    76
   ---
    10
    11
   ----
30)110(3
    90
   ----
```

Epact	20	
Num. of month	9	
Day of month	12	
	41	
	30	
Moon's age	11	
	49	
	60)539(8	
	480	
	59	
Moon's southing	8	59
Time at Dover	10	30
Afternoon	19	29
Subtract	12	
Morning	7	29

Required the Time of High Water at the Start Point, Jan. 3, 1796?

EXAMPLE.

Fpact	20
Day of month	3
Num. of month	0
Moon's age	23
	4
	5 92
Moon's ſouthing	18 24
Time at Start	6
	24 24
	24
H. W. afternoon	00 24

Hence it appears that it is high water at the Start at 24 minutes in the afternoon.

Coming into a Port and find that it is High Water at a certain Hour, to know when it is High Water there on Full and Change Days?

RULE. Find the time of the moon's ſouthing on that day, and ſubtract from it the time of high water at the given place, if you can, and the remainder will be the time of high water on the full and change days of the moon; if you cannot, add 12 hours to it, and ſubtract the above time from the ſum; the remainder will be the time of high water at that port on the full and change days.

This is the method of finding the time of high water inſerted in common books of navigation, which, at times, will give the moon's age, whole days, and the time of ſouthing, and of high water, hours wide of the truth; and even if the moon's ſouthing be exactly found, yet the tides may differ leſs or more from the computed time; for the floods do not always happen at the ſame diſtance of time from each other, but at different diſtances, according to the times of the moon's age, and her aſpect with reſpect to the ſun; or as the waters are acted upon by the ſum or difference of the attractive forces of the ſun and moon, and alſo on account of winds and ſtorms, even when out of hearing, which greatly affected the tides, the real time of high water at any place will often differ from the computed times; therefore pilots, and all concerned, would do well to uſe the following method, which will in general give the time of high water within half an hour of the truth, when the tides are not greatly influenced by the wind.

A TABLE

A TABLE for the readily finding the Day of the Month the *New Moon* will fall on till the Year 1900, and consequently the *Moon*'s Age, for any Day, by knowing the Golden Number, according to the Method commonly used for finding the Moon's Age.—Add 1 to the given Year, and divide the Sum by 19, the Remainder will be the Golden Number, which being marked with a Pencil at the top of the Table, will shew the Golden Number during that Year.

Golden Num.	*Ja.*		*Feb.*		*Ma.*		*Ap.*		*May*		*Ju.*		*Jul.*		*Au.*		*Sep.*		*Oct.*		*No.*		*Dec.*	
	N	M	N	M	N	M	N	M	N	M	N	M	N	M	N	M	N	M	N	M	N	M	N	M
1	29		28		29		28		27		26		25		24		22		22		20		20	
2	18		17		19		17		17		16		15		13		12		11		10		9	
3	8		6		7		5		5		3		3		2		1.30		29		28		27	
4	26		25		27		25		25		23		22		20		19		8		[illegible]		17	
5	15		14		16		15		14		13		12		[illegible]		8		8		6		6	
6	4		3		5		3		3		1		1.30		29		27		27		25		[illegible]	
7	23		22		22		21		20		19		18		17		16		15		14		[illegible]	
8	12		10		12		10		10		8		8		6		5		4		3		3	
9	1		—		1		29		29		27		27		25		24		23		22		21	
10	20		18		20		19		18		17		16		15		13		13		11		11	
11	9		8		8		7		6		5		4		4		2		1		29		29	
12	27		26		27		26		25		24		23		22		20		20		18		18	
13	17		15		17		15		15		13		13		11		10		9		8		7	
14	6		4		6		5		4		3		2		1.30		29		28		27		26	
15	25		23		24		22		22		20		20		19		17		17		15		15	
16	13		12		13		12		11		10		9		8		6		6		4		4	
17	3		1		3		1		1.30		29		28		27		25		25		23		23	
18	22		20		22		20		20		18		18		16		15		14		13		12	
19	11		9		10		8		8		6		6		5		3		2		1		1.30	

Moon's Age.	Times Answ. High Water later each Day after the New & Full Moons.		
Day.	H	M	
1	0	44	Afternoon.
2	1	22	
3	1	56	
4	2	28	
5	3	2	
6	3	40	
7	4	24	
8	5	12	
9	6	[illegible]	
10	7	[illegible]	
11	8	[illegible]	
12	9	[illegible]	
13	10	15	
14	11	16	
15	12	12	
16	0	56	After Midnight.
17	1	24	
18	2	8	
19	2	46	
20	3	14	
21	3	52	
22	4	36	
23	5	22	
24	6	16	
25	7	18	
26	8	22	
27	9	26	
28	10	30	
29	11	32	
29½	12	12	

From the Change to the Full, the Moon comes to the Meridian in the Afternoon; and from the Full to the Change, she comes to the Meridian after Midnight.

The

The Use of the foregoing Table.

To find the moon's age on any given day, look in the first column (marked Golden Num.) for the golden number, and under the month, on the same line, stands the day of the new moon; then count the days which have completely passed since the last change, and they will be her age on the given day.

To find the Time of High Water.

Look for the moon's age in the table of times, and the hours and minutes opposite to which being added to the time of high water, on the change and full days, at any place, will, if it does not exceed 12 hours, give the time of high water there in the afternoon of the given day; but if it does exceed that number, take 12 from it, and the remainder will shew the time of high-water in the morning.

EXAMPLE I.

At what Time will it be High Water at London, April 29, 1796?

Opposite 11 the golden number, and under April, I find it was new moon the 7th day, and reckoning forward to April 29, gives 22 days for the moon's age.

Against 22, in the table of times, stand 4 hours 36 minutes, to which add 3 hours, the time of high water at London on the full and change days, and that gives 7 hours 36 minutes, the time of high water at London in the morning; differing one hour from that found in the first example by the common method.

EXAMPLE II.

Required the Time of High Water at Dover, October 12, 1796?

Opposite to 11 the golden number, and under October, I find it was new moon the 1st day; reckoning forward to October 12, I find the moon's age is 11 days; against 11 in the table of times stand 8 hours and 8 minutes. This added to 10 hours 30 minutes, the time of high water on full and change days at Dover, gives 18 hours 38 minutes; from which I take 12, and the remainder 6 hours 38 minutes is the time of high water in the morning at Dover on the given day, differing from that found in the second example by the common method, 41 minutes.

EXAMPLE III.

What Time will it be High Water at Torbay, July 10, 1796?

By the table it was new moon on the 4th day, and reckoning forward on the 10th, I find there are 5 days completely past. Against 5 in the table of times, stand 3 hours 2 minutes, which added to 6 hours, the time of high water at Torbay, on full and change days, gives 9 hours 2 minutes, the time of high water in the afternoon, on the above day; differing from that given by the former method, 58 minutes.

To find the Time of the Moon's rising.

If the moon is not yet come to the full, add the time of her ſouthing to the time of the ſun's riſing, and the ſum will be the time of the moon's riſing in the forenoon; but if the ſum exceeds 12, ſubtract 12, and take the remainder for the time of her riſing in the afternoon. But if the moon is paſt her full, then add the time of her ſouthing to the time of the ſun's ſetting, and the ſum will be the time of the moon's riſing in the afternoon. But if the ſum exceed 12, ſubtract 12, and take the remainder for the time of the moon's riſing in the morning.

NOTE. If the time of the ſun's riſing and ſetting is not known, it may be eaſily found, having the latitude of the place and the ſun's declination in the table, ſhewing the riſing and ſetting of the ſun, moon, or ſtars.——See Table XXII.

At London, Dec. 1, 1792, required the Time of the Moon's Riſing?

	H.	M.	
Riſing — — — —	2	00	
Sun riſes that day by the tables at —	8	02	
Sun ſets — — — —	3	58	
Moon ſouths that day at — —	2	24	
Moon riſes at — — —	6	22	afternoon.

To find the Time of the Moon's Setting.

Find the time of the ſun's riſing and ſetting by the tables as before, and if the moon is not yet come to the full, add the time of her ſouthing to the time of the ſun's ſetting, and the ſum will be the time of the moon's ſetting in the afternoon; but if the ſum exceeds 12, ſubtract 12, and take the remainder for the time of her ſetting in the morning.

And if the moon is paſt the full, add her ſouthing to the time of the ſun's riſing, and the ſum will be the time of the moon's ſetting in the morning; but if the ſum exceeds 12, ſubtract the 12, and take the remainder for the time of the moon's ſetting in the afternoon.

EXAMPLE

EXAMPLE.

At London, November 16, 1792, required the Time of the Moon's Setting.

	H.	M.	
Setting	12	00	
Sun rises Nov. 16th, by the tables, at	7	43	
Sun sets —— ——	4	17	
Moon souths Nov. 16th ——	1	36	
Moon sets Nov. 16th at ——	5	53	afternoon.

NOTE. The above method may differ half an hour from the time given by the almanacs.

In like manner may the time of high water be found at any other place. Whoever will compare these examples with the methods used in other books of this kind, will find a considerable difference, as they frequently give the moon's age several days, and of high water, hours wide of the truth; indeed, on account of the irregularities of the moon's motion, the times of her change may differ half a day from the truth; and the time of high water 30 minutes, but seldom more, if the sea is not greatly influenced by the wind.

The tides do not always answer to the same distance of the moon from the meridian at the same places, but are variously affected by the action of the sun, which bring them on sooner when the moon is in her first and third quarters; and keeps them back later when she is in her second and fourth quarters; because in the former case, the tides raised by the sun, alone, would be earlier than the tide raised by the moon; and in the latter case later, as may be seen in the table of the shifting of the tides.

As the Nautical Almanac is become now of general use in long voyages, the time of high water at any part of the world may be readily found, if the time making high water full and change be known; for in the sixth page of each month is given the time of the moon's passage over the meridian of Greenwich every day; this time may be reduced to the meridian of any other place, by allowing 1 hour for every 15 degrees of longitude. To this time add the time making high water there, on full and change days, which gives the time of high water nearly on that day, if the sum be less than 12 hours; but if above, subtract 12 hours, or 24 hours from it; observing, that the days in this Almanac begin 12 hours later than the common day.

A TABLE

A TABLE *of the Bearings of the* MOON *at the Time of High Water, nearly with the Times of those Bearings at the following Places:*

When the Moon bears as follows.		H.	
N. and	S.	12	Isle of Alderney, Gibraltar, Southampton, Beachy, Sheerness, a Sand called Kentish Knock, a Sand called the Swin, at the Mouth of the Thames.
N. by E.	S. by W.	$0\frac{3}{4}$	or 45 minutes past 12, Rochester, Flushing, Malden, Nore.
N. N. E.	S. S. W.	$1\frac{1}{2}$	or 30 minutes past 1, Bell Isle, Tinmouth, Gravesend, Holyhead.
N. E. by N.	S. W. by. W.	$2\frac{1}{4}$	or 15 minutes past 2, Berwick, Lisbon, St. Andrew's Coquet.
N. E.	S. W.	3	Whitby, London, Amsterdam, Bourdeaux, Bay of Biscay.
N. E. by E.	S. W. by W.	$3\frac{3}{4}$	Brest, Huntcliff, Isle of Bas, at the Maes, Scarborough.
E. N. E.	W. S. W.	$4\frac{1}{2}$	In Bresound, Ushant, Scilly, Cork, C. Clear.
E. by N.	W. by S.	$5\frac{1}{4}$	Humber Mouth, at the Spurn, Torbay, Start Point.
E.	W.	6	Hull, Wells, Weymouth, Plymouth, Ramhead, Torbay, Dartmouth.
E. by S.	W. by N.	$6\frac{3}{4}$	Bristol, Portland Road, Lynn, Foulness, Foy.
E. S. E.	W. N. W.	$7\frac{1}{2}$	Lizard, Land's End, Falmouth, Penryn, C. Barfleur.
S. E. by E.	N. W. by W.	$8\frac{1}{4}$	Eddiston, Yarmouth, Needles, Fly, Dublin, Isle of Ely.
S. E.	N. W.	9	Isle of Man, Isle of Wight, E. End, Caskets, Caen, St. Helen's.
S. E. by S.	N. W. by. N.	$9\frac{3}{4}$	North Foreland, Dungeness, Dunnose, Shoreham.
S. S. E.	N. N. W.	$10\frac{1}{2}$	Downs, Deal, Dover, S. Foreland.
S. by E.	N. by W.	$11\frac{1}{4}$	Margate, Harwich, Rose, Pool, Portsmouth, Spithead, Calais.
S.	N.	12	Dunkirk, Embden, R. Elbe, Coast of Flanders, Ostend.

NOTE. The current in the Downs generally runs $7\frac{1}{4}$ hours to the north; and $5\frac{1}{4}$ hours to the southward; at Dover the tide from the channel runs northward $7\frac{1}{4}$ hours; and from the north 5 h. 10 m. at the full and change of the moon. The tides set in the Downs N. N. E. and S. S. W. hourly. It is high water at London 46 minutes after two at full and change by the shore.

Pilots reckon 6 hours for a tide, then as $\frac{1}{2}$ a tide, is 3 hours, $\frac{1}{4}$ tide is $1\frac{1}{2}$ hour, and half-quarter tide is $\frac{3}{4}$ of an hour. So that if it flows tide, half tide, and quarter tide, it is high water at half an hour after 10 o'clock, which is the case in the Downs by the shore.

OF THE

LOG-LINE AND HALF-MINUTE GLASS,

AND HOW TO

CORRECT THE DISTANCE GIVEN BY THEM.

THE Log is a flat piece of wood like a flounder, or of the figure of a quarter of a circle, having its circular ſide loaded with lead ſufficient to make it ſwim upright in the water. To this log is faſtened a long line of about 150 fathoms, called the Log-line, which is divided into certain equal ſpaces, called Knots, each of which ought to bear the ſame proportion to a nautical mile (60 of which make a degree) that half a minute does to an hour, that being the time allowed for the experiment.

They are called Knots, becauſe at the end of each of them there is a piece of twine with knots in it, reeved between the ſtrands of the line; theſe pieces of twine ſhew how many knots run out in half a minute, and conſequently the ſhip's rate of ſailing per hour.

Mr. NORWOOD, and ſeveral other able mathematicians, have found that a degree of a great circle upon the earth contains about 367200 Engliſh feet, therefore a nautical mile being the $\frac{1}{60}$ part of 367200 feet, that is, 6120 feet, and ſince half a minute is $\frac{1}{120}$ part of an hour, the length of a knot on the log-line ought to be the $\frac{1}{120}$ part of 6120 feet, or 51 feet. But as for the moſt part, the ſhip's way is found, by experience, to be really more than that given by the log, and as it is ſafer to have the reckoning before the ſhip than after it, therefore 50 feet may be taken as the proper length of each knot, and theſe knots ſubdivided into ten fathoms, each of 5 feet, which is certainly the beſt adapted for practice, and will correſpond with all the tables and inſtruments uſed in navigation, as they are decimally divided, and conſequently, the ſhip's run determined with greater eaſe and certainty. But ſome experienced commanders find, that the allowing 50 feet to a knot generally makes a ſhip a-head of the reckoning; and to avoid danger moſtly divide the log-line into knots of 7 or 7½ fathoms of 6 feet each, to correſpond with a glaſs that runs 28 ſeconds. Others again divide the ſeconds the glaſs runs by 4, and take the quotient for the diſtance in fathoms between the knots; which of theſe methods are beſt, I leave to every captain's own experience to determine; but certain it is, that whatever length the knots are, the moſt convenient way is to divide them into tenths.

In hot or dry weather, the glaſs runs out faſter than in moiſt or rainy weather: therefore care ſhould be taken to try what number of ſeconds the glaſs runs.

The

The length of the log-line formerly uſed, was divided into knots of 42 feet, which way of dividing the ſame was founded on the ſuppoſition, that 60 miles, of about 5000 Engliſh feet, made a degree; whereas it is abundantly certain, that a degree contains about 73 ſuch miles. It was therefore to be wiſhed, that no lines ſo divided were in uſe, but very often cuſtom prevails over reaſon; and although mariners find by experience this length of the knots to be too ſhort, yet ſome of them, rather than quit the old way, uſe glaſſes for half minute ones that run but 24 or 25 ſeconds, which is but correcting one miſtake by another.

The knots commonly begin to be counted at the diſtance of 10, 12, or 15 fathoms from the log, according to the largeneſs of the ſhip, that ſo the log may be out of the ſhip's wake when it is thrown overboard before they begin to count, leſt the eddies ſhould ſuck the log after the ſhip; and for the more ready diſcovery of this point of commencement, there is commonly faſtened at it a piece of red rag; that part of the line between the red rag and the log is called the ſtray-line.

The log and log-line being duly prepared and hove overboard from the poop, or lee-quarter, and the line veered out (by the help of a reel which turns eaſy, and about which it is wound) as faſt as the log will carry it away, or rather as faſt as the ſhip ſails from it, will ſhew how faſt the ſhip has ſailed in the given time, or rate of ſailing per hour.

The experiment for finding the velocity of the ſhip is called heaving the log.

Care ſhould be taken to veer out the line as faſt as the log takes it, for if the log is left to turn the reel of itſelf, the log will come home and deceive you in the reckoning.

In king's ſhips, India ſhips, and ſome others, the log is hove every hour, but in coaſters, and thoſe uſing ſhort voyages, every two hours.

Here the ſhip is ſuppoſed to move with equal velocity between the times of trying the experiment. But if the gale has not been the ſame during the whole hour, or time between heaving the log, or if there have been more ſail ſet, or any handed, that ſo the ſhip has run more or leſs in any part of the hour than ſhe did at the time of the experiment; or if it ſhould fall little or more wind at that time, there muſt be allowance made for it according to the diſcretion of the artiſt: Sometimes too, when the ſhip is before the wind, and a great ſea ſetting after her, it will bring home the log; in ſuch caſes it is cuſtomary to allow one mile in ten, and leſs in proportion, if the ſea be not ſo great.

Care ſhould alſo be taken to meaſure the log-line pretty often, leſt it ſtretch and deceive you in the diſtance.

The like regard muſt be had, that the half minute glaſs be juſt 30 ſeconds, otherwiſe no account of the ſhip's way can be kept;

to prove which, if there be no ſtop-watch at hand, let a plummet, of any form or weight, be faſtened to a ſilk ſtring or thread, with a loop to hang on a ſmall pin or nail faſtened in any place, ſo that the plummet may ſwing freely; let it be 39[1] inches from the end of the loop to the middle of the plummet, and the plummet cauſed to ſwing; each of thoſe ſwings will be a true ſecond of time, always counting every time it paſſes the perpendicular let fall from the pin, and every time it paſſes from the perpendicular to the utmoſt ſwing will be half-a-ſecond.

How to correct the Diſtance given by the Log-Line and Half-Minute Glaſs.

The diſtance given by the log may be wrong on three accounts, *viz.* by an error in the glaſs, an errror in the log-line, or an error in both; for correcting of which take the following caſes:

CASE I.

When the log-line is truly divided, and the glaſs is faulty.

RULE. Say, as the ſeconds run by the glaſs are to 30 ſeconds, ſo is the diſtance given by the log to the true diſtance.

EXAMPLE I.

Suppoſe a ſhip runs at the rate of $7\frac{1}{2}$ knots in the time the glaſs runs out, but meaſuring the glaſs I find it runs 34 ſeconds; what is the true rate of ſailing?

As 34 : 30 : : 7,5 : 6,6 miles, the true diſtance ſailed in an hour.

EXAMPLE II.

Suppoſe a ſhip runs at the rate of $6\frac{1}{4}$ knots, but meaſuring the glaſs I find it runs only 25 ſeconds; required the true rate of ſailing?

As 25 : 30 :: 6,5 : 7,8 miles, the true diſtance ſailed in an hour.

CASE II.

When the glaſs is true and log-line faulty.

RULE. Say, as 50 feet is to the diſtance meaſured between knot and knot, ſo is the diſtance run by the log to the true diſtance.

EXAMPLE I.

Suppoſe a ſhip runs at the rate of $6\frac{1}{4}$ knots in half a minute, but meaſuring the ſpace between knot and knot, I find it to be 56 feet; required the true rate of ſailing?

As 50 : 56 : : 6,25 : 7 miles, the true diſtance ſailed in an hour.

EXAMPLE

EXAMPLE II.

Suppose a ship runs at the rate of $6\frac{1}{2}$ knots in half a minute, but measuring the space between knot and knot, I find it to be only 44 feet; required the true rate of sailing?

As 50 : 44 : : 6,5 : 5,72 miles, the true distance sailed in an hour.

CASE III.

When both the log-line and glass are faulty.

RULE. Multiply thrice the measured length of a knot by the distance run by the log, the product divided by 5 times the measured time of the glass, will give the true distance run.

EXAMPLE.

Suppose a ship runs 5 knots of a log-line of 45 feet to a knot, while a glass of 25 seconds is running out; what is the true rate of sailing?

The measured length of a knot — —	45
Multiplied by — — — —	3
Gives thrice the measured length of a knot	135
Which multiplied by the distance run per log	5
	675

And dividing the product by 5 times the time the glass runs, that is $5 \times 25 = 125$, the quotent is 5,4, the number of miles the ship runs per hour.

This rule is only a compound of the two former simple ones, which is contracted a little.

When the glass is faulty, the log-line may be divided as in the annexed table, shewing the length of the knots of the log-line of different glasses.

Seconds of Glass.	Length of Knots in Feet.
24	40,0
25	41,8
26	43,4
27	45,0
28	46,8
29	48,4
30	50,0
31	51,8
32	53,4
33	55,0
34	56,8
35	58,4
36	60,0

THE

THE DESCRIPTION AND USE OF HADLEY's OCTANT, COMMONLY CALLED HADLEY's QUADRANT.

THE inventor of this noble instrument is disputed; some say it was first invented by one GODFREY, in Philadelphia, and that Mr. HADLEY, then an officer in the royal navy, pirated it from him, and brought it to England, who being the first that made it public, it still bears his name. How far this is true, I cannot say, but certain it is, that two men in different parts of the world may hit upon one invention at the same time.

This instrument is now so much improved, that angles, whether vertical, horizontal, or any other position the objects happen to be in, may be taken to such a degree of exactness, that people unacquainted with the use of it would scarcely think it possible.

The principles of this admirable instrument have been so well demonstrated by other hands, that a repetition thereof here seems to me unnecessary; I shall therefore content myself with giving a short description of it, and its use in navigation.

The principal Parts of the Instrument are,

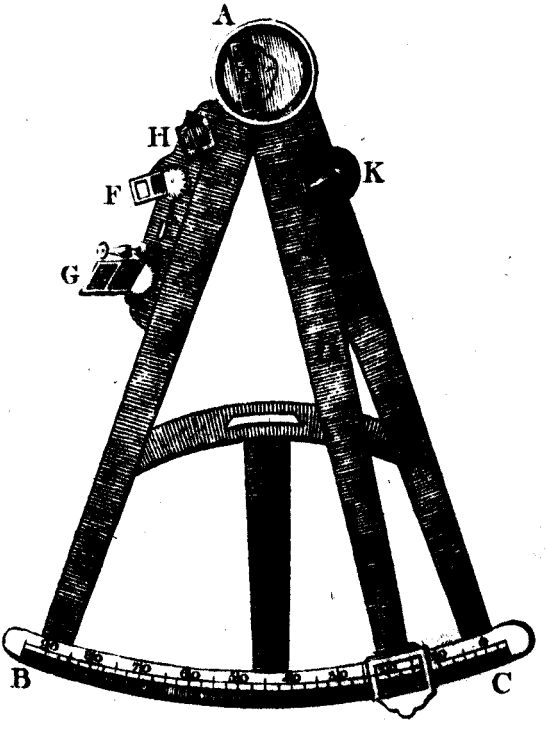
The Index D
The Index Glass E
The Horizon Glasses G and F
The Dark Glasses, or Screens H
The Sight Vanes K and G.

The graduated arch B C contains only 45 degrees, or is the 8th part of a circle, but it is to be esteemed as 90°, and so divided, because by the double reflection the angle is doubled.

The divisions run 0, 10, 20, &c. to 90 as in the figure, each degree is divided into 3 parts of 20 minutes each, which by the help of the vernier, or divisions on the index, is again subdivided into minutes of a degree, thus:

The index D is a flat bar moveable on the centre of the instrument; that part of the index that slides over the graduated arch, having the first and last divisions thereon corresponding to those on the arch, is called the Vernier or Nonius, and which divides every sub-division on the arch in minutes, thus, 7 divisions on the nonius being divided into 20 parts, it is evident the difference between the first division on the arch and on the nonius is $\frac{1}{20}$ of one of the sub-divisions on the arch, or 1 minute, because 7° there is divided into 21 parts, being one in 20 greater than on the arch. The difference

HADLEY's QUADRANT.



The principal Parts of this Instrument are

The Index D
The Index Glass E
The Horizon Glasses G *and* F
The dark Glasses or Screens H
The Sight Vanes K *and* G

ference of the two first divisions will be 2′, and the difference of the three first 3, and so on; hence it will arise, *that in whatever divisions on the vernier and arch cut one another the nearest, the vernier will indicate how many minutes above the next sub-division according as it is numbered to right or left thereof.* On the bottom of the index against the back of the arch is a *screw made to fix fast the index when required.*

The arch, as before observed, is divided into 90 degrees numbered 0, 10, 20, 30, &c. and each degree into 3 parts, each 20 minutes, and is to be read thus: 1d.—1d. 20m.—1d. 40m.—2d.—2d. 20m.—2d. 40m.—3d. &c. *observing to read to the division that the* 0, or diamond-like point, of the nonius last passed over; then the nonius will give the number of minutes more, to be added to the division last passed by the nonius. Thus, *suppose the* 0, or Δ of the nonius has passed over 15 degrees and two parts or 15d. 40m. and stands somewhere between 15d. 40m. and 6d. then observe what division or line on the nonius coincides with any division or line on the arch, that number on the nonius will be the minutes to be added to 15d. 40m. Suppose 15 on the nonius touches some division on the arch, then 15m. must be added to 15d. 40m. and the angle or altitude measured will be 15d. 55m.

The index glass E is a piece of glass truly ground, silvered on the back, and fixed in a brass frame, perpendicularly to the index; its use is to receive the rays proceeding from any object, and reflect them to the horizon glasses F and G; at the back of the brass frame of this glass are two screws, serving to adjust the frame perpendicularly to the index.

The horizon glasses F and G are smaller pieces of ground glass, one part of which is silvered and the other part open or unsilvered, in order to look at an object through it; these are set in frames and placed perpendicularly on the limb at G and F; their use is to receive the rays of any object reflected from the index glass, and again to reflect those rays to the eye through the holes of the sight vanes K and G.

To adjust the Quadrant.

First, The index glass must be perpendicular to the plane of the quadrant, which if not, you may thus discover; hold the plane of the quadrant in an horizontal position, with the index glass near the eye, look right down the quadrant in such a manner as to see the arch of the quadrant direct, *and at the same time reflected* by the index glass; then, if the arch seen direct together with its reflected image apppear to be in one line, the index glass is truly adjusted, if not it must be rectified by means of the screws placed at the back of the index glass; it is easy *to discover which way the inclination is by pressing the index glass* with your thumb while you observe the arch.

Secondly, The axis of the horizon glass must be parallel to the

axis

axis of the index glaſs, if not the error is eaſily diſcovered and rectified in the fore horizon glaſs when the index is adjuſted, thus: bring O on the nonius nearly to O on the graduated arch, and look directly through the ſight vane at the moon or any bright ſtar, ſo as to ſee the reflected image in the horizontal glaſs, and the object at the ſame time through the unſilvered part; then move the index backwards and forwards ſlowly, and obſerve if both images coincide or paſs behind one another, which if they do, the axis of both are parallel, which if not you ſhould nicely adjuſt by the two ſcrews placed on the top block of the horizon glaſs.

If a ſmall piece of coloured glaſs ſet in braſs be made to turn round to the ſight vane occaſionally to guard the eye, and the ſcrews turned back, the ſame correction may be made by uſing the ſun inſtead of the moon or ſtar.

To take the Altitude of the Sun by the Fore Obſervation.

The ſun's image at any time when not much obſcured by clouds may be ſeen as reflected from the unſilvered part of the horizon glaſs, by looking through the hole in the ſight vane; having put the ſcreens down to guard the eye, hold the inſtrument vertical, and turning towards the ſun, direct the ſight to that part of the horizon beneath the ſun, and moving the index you may bring down the red image of the ſun towards the horizon: if the ſun's image ſhould be faint you may turn back the ſcreens, and you cannot miſs it.

Having brought down the ſun's image near the horizon, ſwing the quadrant backwards and forwards, making your eye the centre of motion, and keep moving the index at the ſame time till the ſun's lower edge juſt touches the horizon, and you will have the apparent altitude of the ſun's lower limb upon the arch of the quadrant at that inſtant. But this altitude is greateſt at twelve o'clock, when the ſun is on the meridian, from which the latitude is determined; much time will be ſaved if you have a good watch well regulated to tell you within a minute or two when to begin your obſervation, but this apparent altitude requires the four following corrections:

Firſt, The index error, if any, to be added or ſubtracted.

Secondly, The dip of the horizon.

Thirdly, The ſun's ſemi-diameter and refraction.

Theſe four corrections are neceſſary to find the true altitude of the ſun's centre nearly, the correction of the ſun's parallax being ſo ſmall, that it may always be neglected in determining the latitude.

The back obſervation is managed the ſame as the fore obſervation, only your back muſt be turned towards the ſun, and the ſcreens ſhifted to the back horizon glaſs, remembering to ſubtract the ſun's ſemi-diameter (if the apparent lower limb be taken) and add the dip, ſubtracting the effect of refraction, and you will have the altitude of the ſun's centre.

5. The

The correction for the index error is thus: Turn down the ſmall knob of braſs, placed on the limb, to hinder the index from going off the arch, as it may be in the way. This correction may be accurately eſtimated by taking the diameter of the ſun, moon, or any object before and behind O on the arch; that is, bring the upper limb of the object to coincide with the lower, and note the angle, then take it on the extra arch, as it is called; that is, bring the lower limb to coincide with the upper, and note the angle, half the difference of theſe two angles will be the true correction of the index error.

E X A M P L E.

Suppoſe the ſun's diameter meaſures 36 on the arch and 28 in the extra arch. The difference is 8′, half which is the error to be ſubtracted, becauſe the diameter meaſures more on the arch, or gives the ſun's diameter too much, but had the extra arch given the greater angle, the error would have been additive.

To take the Altitude of the Moon.

The moon's altitude may be taken either by the fore or back obſervation exactly in the ſame manner as the ſun's altitude, only here you muſt bring the edge of the moon into contact with the horizon, which is round and well defined, whether that be the upper or under edge: the corrections to be applied to the obſerved altitude are as follow:

Firſt, The index error as before directed.

Secondly, The dip to be ſubtracted in the fore obſervation, and to be added in the back obſervation.

Thirdly, Semi-diameter to be found in the nautical ephemeris for every noon and midnight at Greenwich; if very great accuracy is required this ſemi-diameter muſt be corrected for the intermediate time: which being added to, or ſubtracted from, the obſerved altitude, will give the apparent altitude of her centre.

Fourthly, Parallax and refraction. The moon's horizontal parallax for every noon and midnight at Greenwich, is to be found in the nautical ephemeris. This muſt be corrected for the intermediate time; then take the proportional logarithm of the moon's horizontal parallax out of the nautical almanac, increaſe its index by 10, and ſubtract the log. co-ſine of the moon's apparent altitude from the ſun; the remainder will be the proportional logarithm of her parallax in altitude; from which take the moon's refraction, (table 5) and the remainder will be the correction of the moon's altitude; which being added to her apparent altitude, will give the true altitude of her centre.

To take the Altitude of a Star by the Fore Obſervation.

Set the index at O, and holding the plane of the quadrant vertical, direct the ſight to the ſtar, and at the ſame time look for the

reflected image of the ſtar in the ſilvered part of the horizon glaſs; move the index a little, which will ſeparate the reflected image from the direct image, the former will be eaſily diſtinguiſhed from the latter by its motion, when you ſtir the index; continue to advance the index, and at the ſame time follow the reflected image of the ſtar with your eye, directing the ſight lower and lower, and changing the poſition of the quadrant or octant, as the image of the ſtar deſcends, till you have brought it down to the horizon, the index will then ſhew the obſerved altitude of the ſtar. The corrections to be applied to the obſerved altitude of the ſtar are: Firſt, the Index Error; ſecondly, the Dip, theſe two give the apparent altitude; thirdly, the Refraction, which gives the true altitude; the fixed ſtars have neither ſemi-diameter nor parallax worth notice.

In taking the altitude of a ſtar, or the moon, by night, always get as near the water as poſſible; in eaſy weather a grating may be ſlung over the ſhip's ſide, and an obſerver ſit upon it to take the altitudes; the ſame may be done to take the altitude of the ſun in an hazy horizon; for the nearer the eye is to the ſurface of the water, the nearer the true horizon will be to the eye.

Advice to Seamen in the Choice of their Quadrants or Sextants.

The joints of the frame muſt be cloſe, without the leaſt opening or looſneſs, and the ivory on the arch and nonius inlaid and fixed, ſo as not to riſe at the ends, nor above the plane of the inſtrument; all the diviſions on the arch and nonius muſt be exceeding fine and ſtraight, ſo that when the index or nonius is ſet to any diviſion on the arch, the diviſions on the line that coincides may appear diſtinct, for only the firſt and laſt line on the nonius will coincide with the other lines upon the arch, if the quadrant is well divided; likewiſe try in different parts of the arch, if the nonius, or index plate, cuts regularly in order with thoſe on the arch, if they do not, the diviſions are bad, and the quadrant ought to be rejected.

Again, look into the great ſpeculum or index-glaſs ſlant-ways, holding it about ten or twelve inches from the eye, and obſerve the image of ſome diſtant object; if the image appears clear and diſtinct in every part of the glaſs, the ſpeculum is good; but if it appears notched, or drawn with ſmall lines, the glaſs is veiny, and muſt be rejected; if more images than one of the ſame object are ſeen, it ſhews that the two ſurfaces are not ground parallel; the other ſpeculum may be examined in the ſame manner.

Obſerve the ſun, or a candle, through the dark glaſſes ſeverally, holding the glaſs about eight or ten inches from the eye; if they are veiny the object will appear notched at the edges, but if clear and well defined, the glaſſes are good.

Moſt

Moſt people prefer black ebony, on account of its weight; but I have found by experience, that good mahogany takes the glue and ſtands the heat better.

Quadrants, like watches, may appear well to the eye, and yet be good for little; it is therefore much better to give two guineas and an half, or three guineas, for a good one, that will laſt a man for life, than purchaſe thoſe wretched inſtruments made up at a low price, which cannot be depended on.

Of the Dip and Refraction.

The rays of light in paſſing through the atmoſphere are bent out of their ſtraight courſe into a curve line; and hence it happens that all the heavenly bodies, except when they are in the zenith, appear higher than they ought to do, and ſo much the more the nearer they are to the horizon. This apparent elevation of the heavenly bodies above their true height is called the refraction of objects; and the quantity or effect of it, according to the different altitudes of objects, has been carefully obſerved by eminent aſtronomers, and muſt always be ſubtracted from the apparent altitude, but added to the apparent zenith diſtance of an object with whatever inſtrument the obſervation is made, in order to obtain its true altitude or zenith diſtance.

That the corrections of obſerved altitudes of objects, both on account of the dip of the horizon and the refraction of their light, may appear at one view, they are both exhibited together in the tables.

To work an Obſervation, or to find the Latitude of a Place, by the Tables, of the Sun or Star's Declination and the Zenith Diſtance.

The latitude of any place is its diſtance from the equator, either north or ſouth, counted in degrees, &c. upon an arch of the meridian, contained between the zenith, or that point directly over your head and the equator. It can never exceed 90 degrees, and is found by taking the altitude or height of the ſun or ſtar above the horizon of the ſea with a quadrant, when on the meridian or due north or ſouth of the place of obſervation.

This meridian altitude, corrected for dip of the horizon, and refraction, and 16 minutes the ſun's ſemi-diameter added thereto, gives the altitude of his centre, which being ſubtracted from 90°, gives the zenith diſtance or the number of degrees, &c. the centre of the object is from the point over your head; with which, and knowing how far the object is to the north or ſouth of the equator, which is called declination, the latitude is found by the meridian altitude of any celeſtial object, as follows:

Firſt, If the ſun or ſtar be ſouth when obſerved, call the zenith diſtance ſouth; but if north, call it north.

Then if the zenith diſtance and declination be of contrary names; that is, if the ſun or ſtar comes to the meridian in the north, and hath ſouth declination, or to the ſouth, and hath north declination, the zenith diſtance, added to the declination, gives the latitude of the place of obſervation; and of the ſame name the declination is of, whether north or ſouth.

Secondly, When the zenith diſtance and declination are of the ſame name: that is, when the ſun or ſtar comes to the meridian in the north, and hath north declination; or to the ſouth and hath ſouth declination, ſubtract the leſſer from the greater, and the remainder is the latitude; and to know whether it is north or ſouth, obſerve this general rule:

When the declination is greater than the zenith diſtance, the latitude is of the ſame name with declination; but if leſs, of a contrary name.

NOTE. Firſt, When the ſun or ſtar is on the equator, or hath no declination, the zenith diſtance is the latitude of the place, and of a contrary name to the zenith diſtance.

Secondly, When the ſun or ſtar is in the zenith, the declination is the latitude, and of the ſame name as the declination is of. For it is evident, that as they are equally diſtant from the equator, and on the ſame ſide of it; conſequently, if the declination be north, the latitude will be alſo north, and if ſouth, ſouth.

EXAMPLE I. and II.

Being at ſea May 27, 1796, the ſun's meridian alt. was found to be 57° 35′, and it was ſouth of me, what latitude was I in?

	90°	00′
Meridian altitude	57	35
Zenith diſtance =	32	25 S.
Sun's decli. in table for May 27, is	21	28 N.
Latitude in =	53	53 N.

Being at ſea 24th July, 1796, meridian altitude of the ſun was 27° 13′ being north of me, required the latitude in?

	90°	00′
Meridian altitude =	27	13 N.
Zenith diſtance =	62	47 N.
Sun's decli. in table for July 24	19	42 N.
Latitude in =	43	05 S.

EXAMPLE III.

Being at ſea January 14, 1796, the ſun's mer. altitude was found 72° 17′ ſouth, what was the latitude of the place of obſervation?

	90°	00′
Meridian altitude	72	17
Zenith diſtance =	17	43 S.
Sun's decli. Jan 14, is	21	18 S.
Latitude in =	3	35 S.

In this caſe, it is plain the obſerver was between the ſun and the equator.

EXAMPLE IV.

Being at ſea the 4th of May, 1796, I obſerved the bright ſtar Fomalhaut 27° 21′ above the horizon of the ſea, and it was ſouth of me, required the latitude in?

	90°	00′
Meridian altitude =	27	21
Zenith diſtance	62	39 S.
Fomalhaut's declination	30	42 S.
Latitude in =	31	57 N.

NOTE. The declination here is fitted to the year 1796.

The foregoing rules are for obſerving by the ſun or ſtars when they are at the greateſt altitudes, or upon the meridian above the pole, but as in ſome parts of the earth the ſun does not ſet for ſeveral days, and ſome ſtars never ſet, in that caſe they may be obſerved upon the meridian twice in 24 hours; that is, once at their greateſt height as before, and again when they are at the loweſt or upon the meridian below the pole, to work which obſervations, take the following

RULE. Add the complement of the declination to the meridian altitude, the ſum is the latitude of the ſame name with the declination.

EXAMPLE V.

At ſea I took the altitude of the north pole ſtar, when on the meridian below the pole, and found it 46° 21′; required the latitude?

Meridian altitude	46° 21′ N.
Compl. declination.	1 47 N.
The latitude in	= 48 8 N.

In the following examples the corrections for dip and refraction are introduced:

NOTE. As all the calculations are for 1796, thoſe that teach by this book will do well to furniſh themſelves in time with the above almanack.

EXAMPLE VI.

By a fore obſervation, the alt. of the ſun's lower limb was found by Hadley's Quadrant to be 40° 20′ S. when his declination was 9° 56′ N. the eye being 30 feet above the horizon; required the latitude of the place?

Obſ. alt. ſun's lower edge	40° 20′
Semi-diameter to be added	16
App. alt. ſun's centre	40 36
Dip of ho. to be ſubtracted	05
App. alt. corrected by dip	40 31
Refraction to be ſubtracted	01
True alt. of ſun's centre	40 30
Zenith diſtance	49 30 S.
Declination	9 56 N.
Latitude	59 26 N.

EXAMPLE VII.

Suppoſe the eye of an obſerver at 35 feet above the water ſhould with Hadley's Quadrant, by a fore obſervation, find the alt. of Sirius 53° 35′ S. when it paſſed the meridian, having before-hand ſet his watch, and found the time of Sirius's paſſage; required the latitude of the place of obſervation?

Obſ. alt. of Sirius	53° 35′ 0″
Dip of hor. to be ſubt.	05 39
App. alt. above hor.	53 29 21
Refraction to be ſubt.	42
True alt. of Sirius	53 28 39
True zenith diſtance	36 31 21 S.
Sirius's declination	16 26 47 S.
Latitude	20 04 34 N.

EXAM-

EXAMPLE VIII.

By a back observation with Hadley's Quadrant, the app. alt. of the sun's lower edge was 25° 12′ S. when his declination was 21° 14′ S. and the eye 40 feet above the horizon; in what latitude was the observation made?

Obs. alt. sun's lower edge	25° 12′ S.
Semi-diam. to be subtracted	16
App. alt. sun's centre	24 56
Dip of hor. to be added	06
App. alt. correct by the dip	25 02
Refraction to be subtracted	02
True alt. sun's centre	25 00
True zenith distance	65 00 S.
Declination	21 14 S.
Latitude	43 46 N.

EXAMPLE IX.

Suppose on the 12th June, 1796, an observer in an high northern lat. and 65° west of London, his eye being 28 feet high, observed the alt. of the sun's lower limb on the meridian below the pole to be 8° 15′ S. by a fore observation with Hadley's Quadrant; required the latitude?

The sun being observed below the pole, it must have been at 12 hours past noon at the place of observation, and that place being 65° W. of London = 4 hours 20′ later than at London, therefore it must have been 16h. 20′ past noon at London.

*June 12, 1796, the sun's declination 23° 13′ 46″ the daily variation is 3′ 12″: and as 24h. : 3′ 12″ : : 16h. 20′ : 2′ 11″, which added to 23° 13′ 46″ (because the declination is increasing) gives 23° 16′, the sun's declination at the time and place of observation nearly.

App. alt. sun's lower limb —	8° 15′ S.
Semi-diameter added —	16
App. alt. sun's centre —	8 31
Dip horizon subtracted —	05
Sun's alt. corrected by dip —	8 26
Refraction to be subtracted —	06
True alt. of sun's centre —	8 20 S.
Complement sun's declination —	66 44 N.
Latitude in — —	75 04 N.

OF THE VARIATION OF THE COMPASS.

THE variation of the compass is an arch of the horizon contained between the meridian of the place and the magnetic meridian, and is either east or west; or it is the number of degrees, &c. the needle's point stands from the true north or south points

* See Nautical Almanack for 1796.

of the horizon, reckoned to the eastward or westward, and is readily found either from the sun's amplitude or azimuth.

To find the true Amplitude.

The sun's true amplitude is an arch of the horizon, comprehanded between the true east or west points thereof, and the centre of the sun at its rising or setting; or it is the number of degrees, &c. the sun rises or sets to the northward or southward of the east or west points of the horizon.

The sun's magnetic amplitude is the number of degrees, &c. the centre is northward or southward of the east or west points of the compass at his rising or setting, and is found with an azimuth compass in the following manner:

Having placed the azimuth compass in a convenient part of the ship, look directly through the sight-vanes at the sun's centre; and when the sun's lower edge just touches the horizon, stop the card, by a stop which is placed on the compass for that purpose; then the quantity of degrees and minutes contained between the east or west, and the north and south points of the compass will be the magnetic amplitude.

The true amplitude is found either by inspection in the tables of the sun's amplitude, or by calculation, as follows:

RULE. As the sine complement of the latitude
Is to radius,
So is the sine of the sun or star's declination
To the sine of the true amplitude:

Which is always of the same name with the declination, whether north or south.

Or, to the secant of the latitude, (rejecting the index) add the log. sine of the sun's declination, the sum will be the log. sine of the true amplitude.

NOTE. The arithmetical complement of the co-sine of any arch is always equal to the secant of that arch, throwing away radius, or neglecting one, which stands the first figure in the secant's index; likewise the arithmetical complement of the sine of any arch, is the co-secant of that arch less radius, or the first figure of its index: Wherefore, the arithmetical complement of the sine or co-sine of any arch is found in the table of secants by inspection.

EXAMPLE I.

On the 20th of October, 1796, in latitude 51° 32′ N.; I demand the true amplitude?

As sine com. lat. 51° 32′	9.79383	Or thus:	
Is to radius	10.00000	Lat. 51° 32′ N. secant	0.20617
So is si. sun's dec 10° 43′ S.	9.26940	Decl. 10 40 S. log. sine	9.26940
To si. of true amp. 17° 24′	9.47557	True amp. 17° 24′ S. =	9.47557

EXAMPLE

EXAMPLE II.

In latitude 38° 25′ N. what is the ſun's true amplitude when the declination is 18° 59′ N.?

As ſine com. lat. 38° 25′	9.89405	Or thus:		
Is to radius	10.00000	Lat. 38° 22′ N. ſecant		0,10595
So is ſine ſun's decl. 18° 59′	9.51227	Decl. 18 59 N. log. ſine		9.51227
To ſun's true amp. 24° 32′	9.61822	Log. ſi. 24° 32′ true am. N.		9.61822

To find the true Amplitude by the Table of Amplitudes.

Look for the given declination at the top of the table, and the latitude in the firſt column on the left hand, in the common angle of meeting, will be the degrees and minutes of the amplitude required.

EXAMPLE I.

In latitude 40° N. when the declination was 17° N. required the ſun's true amplitude at riſing?

Under declination 17°, and right againſt the latitude 4°, ſtand 22° 26′ the true amplitude, and is to be counted from the eaſt towards the north, becauſe it is at the ſun's riſing, and the declination is north; that is, E. 22° 26′ N.

But when the latitude is given in degrees, and the declination in degrees and minutes, find the declin. at the top as before, and the neareſt degrees to the given latitude in the left-hand column, againſt which, and under the given declin. ſtands the true amplitude; or, if the minutes of the declination be near 30, or half a degree, find the amplitude for the given degrees of declination, and the amplitude for one degree above it, add theſe two amplitudes together, half their ſum will be the true amplitude, ſufficiently exact for practice at ſea.

EXAMPLE II.

Suppoſe I would know the ſun's true amplititude at his ſetting in latitude 57°, his declination being 11° 33′ S.

Find the ampl. as before for the Lat. 57°, and the declinations	11° 12	which will be	20° 22	29′ 15
		Their ſum	42	44
		Half the ſum	21	22 is

the true amplitude: that is, W. 21° 22′ S. becauſe at ſun ſetting, and the declination ſouth. In like manner, if the declination be in degrees, and the latitude in degrees and minutes, as in

EXAMPLE

EXAMPLE III.

Suppose it were required to find the sun's true amplitude at setting in latitude 49° 27′, when his declination was 21° N.

Now 27 minutes being nearly half a degree, therefore,

For lat.	49°	and declination 21°	33°	6′
	50	the amplitudes are	33	52
		Sum	66	58

Half the sum is 33 29, the true amplitude required; that is, W. 33° 29′ N. because the sun was setting, and the declination N.

When the latitude and declination are both given in degrees and minutes, take the nearest degrees to both, unless they are near 30 minutes, as observed before, and find the amplitude as in Example I.

EXAMPLE IV.

Suppose it were required to find the sun's true amplitude at setting, in latitude 49° 18′, his declination being 12° 41′ N.

Now as the latitude is nearest to 49°, and the declination nearest 20°, therefore against latitude 49° and under declination 20°, stands 31° 25′ N. the true amplitude; that is, W. 31° 25′ N. the declination being north, and at the sun's setting.

To find the true Azimuth.

The true azimuth is an arch of the horizon, contained between the meridian of the place and the azimuth circle, passing through the centre of the sun or star at the time of observation; or it is the true distance of the sun or star from the true north and south points of the compass.

The magnetic azimuth is an arch of the horizon contained between the magnetic meridian and the azimuth circle, passing through the centre of the sun or star when observed; or it is the apparent distance of the sun or star from the north or south points of the compass, either in the forenoon or in the afternoon, when they are 5°, 10°, 15°, &c. above the horizon; and the less the altitude is, the more exact you may perform the observation.

The magnetic azimuth is found by the compass in the following manner.

Place the compass in a convenient part of the ship; then move it so that the sights may be directed to the sun's centre; and the shadow of the string will fall directly on the line marked on the plane which join the sights; then the degree, &c. in the arch intercepted between the end of the index, and north point of the card, will give the magnetic azimuth required. If the sun does not shine strong enough to give a strong shadow,

look through one of the ſights, and move the compaſs till one of the ſtrings cuts the ſun's centre, and then the intercepted arch, as before, ſhews the ſun's azimuth, and the like of the ſtar's.

When there is a rough ſea, the obſervation is beſt made by two perſons, and if the card vibrates much, take the middle degree between the limits which the vibration reaches.

When the azimuth is obſerved, the altitude of the object muſt be obſerved at the ſame time.

Having the latitude of the place of obſervation, and the ſun or ſtar's declination with the altitude at the time of obſervation, the true azimuth is found as follows:

To find the true azimuth, obſerve theſe general rules:

R U L E.

Add the complement of the latitude,
the complement of the altitude,
and the ſun or ſtar's polar diſtance into one ſum:
From half this ſum, ſubtract the polar diſtance,
and note the half-ſum and the remainder.
Then add together
The arithmetical comp. of the log. co-ſine of the altitude,
The arithmetical comp. of the log. co-ſine of the latitude,
The log. ſine of the half-ſum,
And the log. ſine of the remainder into one ſum.

Half the ſum of theſe four logarithms, will give the log co-ſine of half the true azimuth, which being doubled, gives the true azimuth, reckoned from the north in north latitude, and from the ſouth in ſouth latitude.

Or thus:

Add together
The log. co-ſecant of the comp. latitude, } rejecting the indexes.
The log. co-ſecant of the comp. altitude, }
The log. ſine of the half-ſum,
And the log. ſine of the remainder, into one ſum;

Half the ſum of theſe four logarithms, will be the log. co-ſine of the half of the true azimuth.

N. B. The polar diſtance of the ſun or ſtar, is their diſtance from the neareſt, or elevated pole, and if the latitude of the place, and the declination of the ſun or ſtar, be both north, or both ſouth, then the complement of the declination is the polar diſtance; but if the latitude and declination one be north, and the other ſouth, the declination added to 90° gives the polar diſtance.

EXAMPLE.

EXAMPLE I.

In latitude 51° 32′ N. the sun's altitude was observed to be 39° 28′, his declination being then 16° 37′ N.; required the true azimuth?

	90°	00′		90°	00′		90° 00′
Latitude	51	32	N. Altitude	32	28	Declination	16 37
			Co-alt.	50	32	Polar dist.	73 23
Co-lat.	38	28	Ar. co-sine	0,20617			
Co-alt.	50	32	Ar. co-sine	0,11239			
Polar dist.	73	23					
Sum	162	23					
½ Sum	81	11′	Log. sine	9,99484			
Polar dist.	73	23					
Remainder	7	48	Log. sine	9,13263			
				19,44603			
			Log. co.-si. 58° 06′	9,72301			
			2				
True azimuth			116 12 from the north.				

EXAMPLE II. Worked by second method.

In latitude 42° 16′ N. the sun's altitude was observed to be 18° 40′, his declination being then 7° 38′ S.; required the true azimuth?

	90°	00′		90°	00′		90° 00′
Latitude	42	16	N. Altitude	18	40	Declination	7 38 S.
			Co-alt.	71	20		97 38
Co-lat.	47	44	Co-secant	0,13076			
Co alt.	71	20	Co-secant	0,02347			
Polar dist.	97	38					
Sum	216	42					
½ Sum	108	21	Log. sine	9,97733			
Polar dist.	97	38					
Remainder	10	43	Log. sine	9,26940			
			Sum	19,40096			
			½ Sum log. co-si. 59. 53 =	9,70048			
			2				
True azimuth			119 46	from the north.			

The following questions are set down for the Learner's Exercise:

Question I. Being at sea, in latitude 40° 38′ N. in the afternoon, the sun's altitude was observed to be 20° 46′, when his declination was 17° 10′ S; what was the sun's azimuth at that time?

Answer. 137° 50′ from the north.

Quest. II. What is the sun's true azimuth in lat. 26° 30′ N. in the forenoon, when his altitude is 24° 28′, and his declination 22° 40′ north?

Ans. 75° 44′ from the north point of the compass.

Quest. III. At the island of St. Helena, the sun's altitude was observed to be 30° 22′ in the forenoon, his declination being then 22° 58′ S.; required the azimuth at that time?

Ans. 72° 22′ from the south, or 107° 38′ from the north.

Quest. IV. What point of the compass does the star Aldebaran bear on, at the Cape of Good Hope, when its altitude is 22° 25′?

Ans. 130° 20′ from the south, or 49° 40′ from the north.

Having found the sun's true amplitude or azimuth by the preceding methods, &c. magnetic amplitude or azimuth by observation, it is evident, that when they agree there is no variation; but when they disagree, then, if the true and observed amplitudes be both of the same name, that is, both north or both south, their difference is the variation; but if the true and observed amplitudes be of different names, that is, one north and the other south, their sum is the variation. Again, if the true and observed azimuths be both on the east, or both on the west side of the meridian, their difference is the variation; but if the true and observed azimuths be one on the east and one on the west side of the meridian, their sum gives the variation; and to know whether the variation is easterly or westerly, observe this general

RULE.

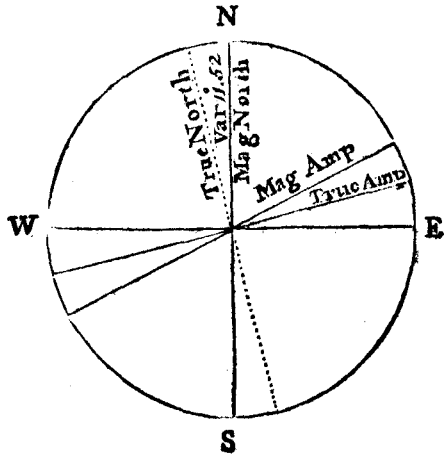
Let the observer's face be turned to the sun; then, if the true amplitude or azimuth be to the right hand of the magnetic, or observed, the variation is easterly; but if to the left hand, westerly.

EXAMPLE I.

Suppose the sun's magnetic amplitude at rising is found to be E. 26° 12′ N. but the true is found to be E. 14° 20′ N.; required the variation?

From the greater	E. 26°	12′	N.
Take the lesser	E. 14	20	N.
Remains the variation	11	52	E.

Which is eafterly, becaufe in this cafe the true amplitude is to the right of the obferved.



With the chord of 60 defcribe a circle to repreſent the compafs, through which draw the north, fouth, eaft and weft lines; take the amplitude at rifing, 26° 12′ from the line of chords, and fetting it from E. towards N. and likewife the true amplitude 14° 20′, and fet it from E. towards N, as before, the difference of thefe two angles, or between the true and magnetic amplitudes, viz. 11° 52′ is the variation. Now fuppofe yourfelf placed at the centre of the horizon, repreſented by the compafs, and looking towards the magnetic amplitude at the fun's rifing, it is plain that the true amplitude found by calculation is towards the right hand of the obferved, which fhews the variation is 11° 52′ E. and muft be allowed to the right hand in all courfes fteered, before they can be put in the Traverfe Table or bearings, taken by the compafs.

EXAMPLE II.

Suppofe the fun's true amplitude at fetting be W. 34° 26′ S. and his magnetic amplitude W. 23° 13′ S. required the variation, fince they are both of the fame name?

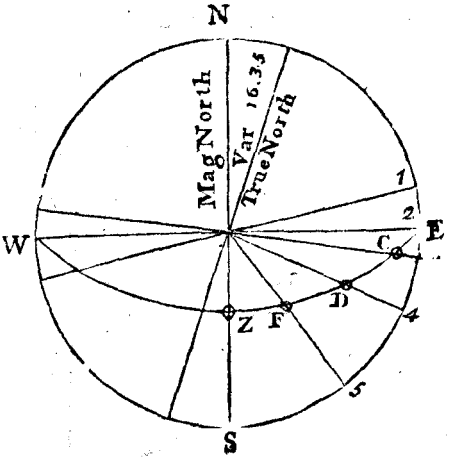
From the greater	— —	W. 34° 26′S.
Take the leffer	— —	W. 23 13S.
Remains the variation	— —	11 13W.

Which is wefterly, becaufe the true amplitude is to the left of the obferved in this cafe.

EXAMPLE III.

Suppose the true azimuth 84° 40′W.
The mag. az. 101 15 W.

* Variation 16 35



* Let N. E. S. and W. represent the horizon, C, D, F, an azimuth circle, passing through the sun's centre; now an observer, placed at the centre, will see the sun at rising in the line 1, but when he gets a greater altitude, and arrives at E, he will see the sun in the line ⊙ 2, and as the sun alters its altitude, will be seen in the lines ⊙ 3, ⊙ 4, ⊙ 5, at length will arrive at its meridian Z, S, and the figures 2, 3, 4, 5, will represent the magnetic azimuth; the difference between these and the true azimuth found by calculation is the variation.

EXAMPLE IV.

Suppose the sun's true amplitude at rising is E. 13° 24′ N. and his magnetic amplitude E. 12° 32′ S. required the variation, and which way?

Since the true amplitude and observed have different names

To the true amplitude E. 13° 24′N.
Add the magnetic amp. E. 12 32 S.

The sum is the variation 25 56W.

Which is westerly, because the true amplitude is to the left of the observed.

EXAMPLE V.

Suppose the sun's true azimuth in the forenoon is N. 86° 40′ easterly, but by the compass it is N. 73° 24′ easterly; required the variation and which way?

Since the true and observed azimuths are both on the same side of the meridian,

From the greater N. 86° 40′ E.
Take the lesser N. 73 24 E.

Remainder variation 13 16 E.

Which is easterly, because the true azimuth is to the right of the observed.

EXAMPLE

EXAMPLE VI.

Suppose the sun's true azimuth is N. 32° 28′ easterly, and his magnetic azimuth N. 8° 50′ west; required the variation, and which way?

Since they are on the different sides of the meridian,

To the true azimuth	N. 32°	28′	E.
Add the mag. azim.	N. 8	50	W.
Sum is the variation	41	18	E.

Which is easterly, because the true azimuth is to the right of the observed.

EXAMPLE VII.

Suppose the sun's true azimuth S. 17° 45′ E. and the magnetic azimuth S. 5° 48′ west, required the variation and which way?

Since they are on different sides of the meridian,

To the true azimuth	S. 17°	45′	E.
Add the observed az.	S. 5	48	W.
Sum is the variation	23	33	W.

Which is west, because the true azimuth is to the left of the observed.

The use of the variation is to correct the course steered by the compass; when the variation is east, it must be allowed to the right hand upon every course steered quite round the compass; but when the variation is west, to the left hand.

NOTE. The variation may be easily found by taking the sun's altitude in the morning, and observing what point of the compass he bears upon; and in the afternoon when the altitude is the same, the middle point will be the true meridian, the difference between which and the north or south points of the compass is the variation. If the altitudes are taken at 5, 6, or 7 o'clock in the morning, you will have the same altitude at 5, 6, or 7 o'clock in the evening, being equally distant from noon.

The variation of the compass was first observed at London, in the year 1580, to be 11° 15′ easterly; and in the year 1622, it was 6° 0′ E. still decreasing, and the needle approaching the true meridian, until it coincided with it in the year 1662, since that time the variation still continues at London to increase westerly, at the rate of about 11 or 12 minutes every year; and is at this time about 23° 30′ westerly, and in the English channel about 25° 33′ westerly; but how far it will go that way, time and observations will probably be the only means to discover.

The variation at Paris in the year 1640, was 3° E. but in the year 1681 it was 2° 21′ W. and is now about 22° 20′ westerly, still continuing to go westerly.

In short, from observations made in different parts of the world, it appears, that in different places the variation differs, both as to its quantity and denomination, it being east in one place, and west in another; the true cause and theory of which has not yet been discovered, and therefore in long voyages it is absolutely necessary that the mariner should find the variation of the compass by observation as often as possible.

One

One Magnus, a ſhepherd, firſt diſcovered the wonderful power of the loadſtone, that gives polarity to the needle, by its ſticking to the iron of his ſandals; whence the name of Magnet was given to the ſtone, or magnetic needle. GIO, of Naples, about 300 years ago, firſt diſcovered that a piece of iron rubbed on it, and then ſuſpended, had the property of pointing to the north and ſouth, and thence applied to Navigation. An author of ſome degree of popularity, who has drawn a variation chart, ſays, he has found out the theory of the variation of the magnetic needle, without favouring the world with the principles; if his genius has been able to penetrate into the bowels of the earth, to diſcover this wonderful phenomenon, it is more than Sir ISAAC NEWTON's or Dr. HALLEY's could do; however, his veracity may be well doubted, as Mr. WALES, who accompanied Captain Cook round the world, told me, that his theory did not reach thoſe iſlands which they diſcovered.

How to touch the Compaſs Needles.

Having two ſtrong magnetical bars, lay the compaſs needle as nearly north and ſouth as you can, with the intended north northwards, join the two magnets in a line, conſiderably above the needle, the north end of each being northward, and bring them down upon the needle, ſo that the place of junction may be over its centre; then draw them aſunder along each half of the needle, and continue their motion till they are eight inches clear of the needle's end; by a circular motion bring them again to the centre and join them as before; repeat this operation ſix or ſeven times, taking care not to put the magnets out of their parralleliſm, and the needle will be ſufficiently magnetical.

THE METHOD OF KEEPING A SHIP'S RECKONING OR JOURNAL AT SEA.

BY keeping a Ship's Reckoning or Journal, is meant keeping ſuch an account of the ſhip's way, that the mariner may be able at any time to aſcertain the latitude and longitude the ſhip is in; it therefore ſhould be the great concern of every perſon who takes upon them the navigating of ſhips to remote parts, to be expert therein, as the lives and fortunes of ſo many men are committed to their charge.

When a ſhip is bound from one place to another, which lies ſo far from her, that ſhe is obliged to go out of ſight of land for any conſiderable time, as from England to Jamaica; at the time of her leaving ſight of land, ſhe is ſaid to take her departure, and that part of the land ſhe then leaves, is ſaid to be the place ſhe takes her departure from; ſuch as the Land's-end, Lizard, &c. and at the time of taking ſuch departure, the captain or mate generally takes the bearing and diſtance of that land, (according to his judgment) and ſets it down on the log-board, or in the log-book againſt the time it was taken, thus, Land's-end N. N. E. diſt. 7 leagues, or Lizard N. by W. diſt. 5 leagues, &c.

In the ſame manner may the departure from any place be taken, as may be ſeen in the firſt day's log of the following journal, where the log-book is marked in columns for hours, knots, fathoms, courſes, winds, leeway, tranſactions; and under it the columns for courſes, diſtances, northings, or ſouthings, eaſtings, or weſtings, the latitude by dead reckoning, latitude by obſervation, meridian, diſtance, difference of longitude, longitude in, and in the laſt, bearing and diſtance of the land.

Notice muſt be taken, that in the column for courſe, you are always to ſet down the courſe you have made by your reckoning for that twenty-four hours; that is, from the noon of the day before to the noon of the day you work on, the ſea account being always kept from noon to noon.

Dead reckoning, is that account deduced from occurrences which are written on the log-board.

In the columns for diſtance you are to ſet down the diſtance made by your reckoning for that twenty-four hours.

In the columns of northing and ſouthing, you are to ſet down the difference of latitude made in that twenty-four hours, marking the column with north, if the difference of latitude be north; and ſouth, if ſouth.

In the column of eaſting or weſting you are to ſet down the departure made that 24 hours, marking the column with eaſt, if the departure be eaſt, and with weſt, if weſterly.

In the column marked latitude by D. R. you are to ſet down the latitude you reckon yourſelf in on that day; and in the column marked lat. by ob. you are to ſet down the latitude found by obſervation; alſo the difference of longitude made in the 24 hours in the column marked diff. long.; the longitude in, in the column marked long. in; and in the laſt, the bearing and diſtance from the land.

The variation, if any, muſt be allowed upon all courſes ſteered, and upon all bearings that are taken by the compaſs; that is, if it be eaſterly variation, it muſt be allowed the right-hand, if weſterly, to the left of the courſe or bearing. Suppoſing your-

ſelf placed in the centre of the compaſs, and looking directly forward to the point you are to allow the variation upon.

EXAMPLE.

Suppoſe I ſteer S. W. and there is one point weſterly variation, then my true courſe is S. W. by S; or ſuppoſe I ſet a point of land, and find it to bear by the compaſs E. S. E. and I know there is half a point eaſterly variation, then the true bearing is S. E. by E. ½ E.

Leeway muſt be allowed upon all courſes ſteered, which is the difference between the point which the ſhip endeavours to ſail upon, and the point ſhe really ſails upon, and is cauſed by the force of the wind or ſurge of the ſea, when ſhe is cloſe hauled or plying to windward, which makes her fall off and glide ſide-ways from the point of the compaſs ſhe capes at, and muſt be allowed to be on the right-hand of the courſe ſteered when the larboard tacks are on board, and to the left-hand when the ſtarboard tacks are on board. The allowances that are generally made are as follow:

1ſt. When a ſhip is cloſe hauled, if all her ſails be ſet, the water ſmooth, and a moderate gale of wind, ſhe is then ſuppoſed to make little or no leeway.

2dly. The ſhip being upon a wind, and the ſmall ſails in, allow *one point for leeway.*

3dly. The wind blowing hard, ſo as to cauſe one top-ſail to be taken in, allow two points for leeway.

4thly. When it blows ſo hard that both top-ſails are taken in, and the ſea runs high, allow then three points for leeway.

5thly. The fore-ſail being furled, and the ſhip tries under a main-ſail and mizen, allow four points for leeway; for ſhe then makes her way about four points before the beam, as the ſea phraſe is.

6thly. When the ſhip tries under the main-ſail only, ſhe then makes her way about three points before the beam, that is, allow *near five points leeway.*

7thly. If the ſhip tries under the mizen only, the way is about two points before the beam; that is, allow ſix points for her leeway.

8thly. When ſhe lies hull, that is, with all her ſails furled, her way is one point before the beam, and then ſeven points is her leeway.

9thly. When a ſhip is lying-to under a main-ſail, mizen, &c. then obſerve how ſhe comes up and falls off, and take the middle between the two points, and from that allow the leeway and variation.

NOTE. In all caſes, reſpect muſt be had to the ſmoothneſs of the water, or to the ſea's running high, the mould and trim of the ſhip, and then the allowances may be aſcertained with the greater certainty,

certainty, by ſetting the ſhip's wake by a compaſs placed on each rail of the ſhip's quarter, which is uſually ſet there for that purpoſe.

For it is well-known, that ſome ſhips, with the ſame quantity of ſail, and with the ſame gale, will make more or leſs leeway than others; and alſo the ſame ſhip when ſhe is out of her trim, or differently loaded, will make different leeways: for it is obſervable, that the more water a ſhip draws, the leſs leeway ſhe makes; becauſe ſhe then meets with a greater reſiſtance in ſplitting the water with her ſide, than otherwiſe ſhe would.

The leeway may be eaſily found by the azimuth compaſs, by turning the inſtrument about until you ſee the wake of the ſhip either over the ſights or parallel to them; then the point of the card, which is cut by the vertical line in the box, which is neareſt to you, is the true courſe; the difference between that and the courſe given by the compaſs in the binnacle, is the leeway required, which ought to be accordingly entered upon the log-board.

There is another way of finding the leeway, by fixing a compaſs cut in lead (or in other metal) on the poop, or ſome other convenient part of the ſhip's ſtern, with the meridian parallel to the ſhip's ſide, and in the centre a pin is fixed, to which is faſtened a ſmall line of a good length, with a piece of wood at the end of it, that it may be dragged after the ſhip. The point or degree cut by this line will ſhew the leeway; if it cuts the meridian, the ſhip makes no leeway; but if it does not, the difference between the meridian and where it cuts is the leeway.

By ſome of the above methods, the leeway (if there be any) ought to be carefully obſerved as often as may be judged neceſſary; and theſe obſervations ſhould be punctually ſet down by the officer of the reſpective watch; at leaſt, if no obſervation be made, he ought to ſet down the leeway according to his judgment once or twice in the watch, and by this means the courſe made good may be found to a much greater certainty and exactneſs than by the common method of allowing for leeway, when the day's account comes to be worked (which is generally once in 24 hours); for an obſervation muſt certainly be better than any gueſs. But if no obſervation be made, the perſon who is upon deck, and has the care of the watch, is better able to make proper allowances, while things are freſh in his memory, and while he is an eye-witneſs of the ſeveral accidents that happen; and certainly much more capable than another who was not upon the deck during the whole watch.

I have often admired to ſee how particularly every thing is ſtated upon the log-board, excepting the leeway: and yet that (which is one of the moſt material articles, ſince the courſe, according to the compaſs, muſt be corrected by it) only allowed for the next day according to every one's fancy, thereby, as it were, keeping as many different journals as there are artiſts (ſo called) on

board the ſhip, and yet not one regular journal properly kept amongſt them all, ſince one of the moſt material articles is only gueſſed at.

EXAMPLE I.

Suppoſe I ſteer N. E. by E. with my larboard tacks on board, and make one point leeway, then my courſe made good is E. N. E.

Leeway and variation, when they are both to be allowed one way, that is, both to the right hand, or both to the left, add them together, and allow their ſum the ſame way they were to be allowed.

But if they are to be allowed, one to the right-hand, and the other to the left, ſubtract the leſs from the greater, and allow the remainder the ſame way the greater was to be allowed.

EXAMPLE II.

Suppoſe I ſteer N. N. W. with by ſtarboard tacks on board, and make one point leeway, there being at the time half a point weſterly variation; I would know my true courſe?

Leeway to the left-hand	——	1	point.
Variation to ditto	——	$\frac{1}{2}$	point.
Their ſum to be allowed to the left-hand		1 $\frac{1}{2}$	

Whence the true courſe is N. W. by N. $\frac{1}{2}$ W.

EXAMPLE III.

Suppoſe I ſteer S. W. by W. with my larboard tacks on board, and make two points and a half leeway, and I have one point and a quarter weſterly variation; what is my true courſe?

Leeway to the right-hand	——	2 $\frac{1}{2}$	points.
Variation to the left-hand	——	1 $\frac{1}{4}$	point.
The rem. to be allowed to the right-hand		1 $\frac{1}{4}$	

Whence the true courſe W. S. W. $\frac{1}{4}$ weſterly.

EXAMPLE IV.

Suppoſe a ſhip lying-to under a main-ſail, with her ſtarboard tacks on board, comes up E. by S. and falls off to N. E. by E. there being one point weſterly variation, and ſhe makes 5 points leeway; what courſe does ſhe make good?

The middle between E. by S. and N. E. by E. is E. by N.; for which, allowing 6 points to the left-hand, the true courſe will be N. by E.

It is plain by the preceding examples, that if the leeway is made towards

towards the meridian, it is taken from the course steered; but when it is made from the meridian, it must add to the course steered, to find the true course. The same may be observed of the sum or difference of the leeway and variation, as may be seen by the following table, which is here set down to exercise the young Navigator in the foregoing rules.

THE TABLE.

Courses steered.	Winds.	Leeway	Variation.	Courses corrected.
N. W. ½ W.	N. N. E.	½	¾ W.	N. 5 ¾ W.
W.	N. N. W.	¾		S. 6 ½ W.
W. S. W.	S.	1		S. 6 ¼ W.
W.	S. S. W.	¾		W.
W. by N.	N. by W.	1		S. 7 W.
S. W.	W. N. W.	1½		S. 1 ¾ W.
S.	W. S. W.	¾	1¼ W.	S. S. E.
S. S. W.	W.	1		S ¼ E.
S. W.	N. W. by W.	½		S. S. W. ¾ W.
W.	S. S. W.	1¾		W. by N. ½ W.
W. by N.	N. by W.	1		W. S. W. ¾ W.
S.	E. S. E.	2		S. ¾ W.
E. by S.	S. ½ E.	¾		E. by N.
E. N. E.	N.	1¾		E. N. E. ½ E.
E.	N.	¾		E. by N. ⅙ E.
E.	S.	0		E. N. E. ¾ E.
S.	E. S. E.	½	1¾ W.	S. by E. ¼ E.
E. S. E.	N. E.	½		E. by S. ¼ E.
W. S. W.	S.	¾		S. W. by W.
W. by N.	S. W. by S.	1		W. ¼ N.
N. W.	W. S. W.	1		N. W. ¾ W.
S.	W. S. W.	1	0¾ E.	S. ¼ E.
N. by E.	N. W. by W.	¾	1	N. N. E. ¾ E.
N. W. by N.	W. by S.	1¼	1	N. ¾ W.
N. W. by W.	N. by E.	1½	1¼	N. W. by W. ¼ W.
W. by S.	N. W. by N.	1¾	2½	W. ½ S.

NOTE. In sailing in the channel, or along a coast in a tide or current, particular care must be taken to take its setting for a course, and its drift for a distance, which must be entered among the courses and distances in the table of that day's reckoning. And

And where the setting of the tide and drift are not known, you must attain the point it must set upon, both of the flood and ebb, from the chart of the coast you are sailing along, by the times of high water at different places on the coast, and by the principles of fluids acting against such rocks, shoals, sand banks, &c. By a strict regard to these, both the drift and setting of the tides may be pretty nearly ascertained and allowed for.

Currents, the way they set you, and the distance you suppose you are driven by them, is to be set in the traverse table for the day, as any other course and distance.

EXAMPLE V.

Suppose I try the current, and find it to set W. by N. per compass one mile per hour, the variation being one point easterly; then if I sail in that current 24 hours, I set down in the table as a course, W. N. W. distance 24 miles.

Heave of the sea is to be accounted for in the same manner as currents: as, suppose there is a great sea heaving towards the S. W. by my compass, there being half a point westerly variation, I then set down in my traverse table S. W. by S. half westerly, with so much distance as I judge the sea has heaved the ship.

At leaving the land, the opposite point of the bearing, with the variation allowed upon it, and the distance you judge yourself from it, must be set down in the traverse table as a course and distance.

EXAMPLE VI.

Suppose, having one and a quarter point westerly variation, the Start bearing by my compass N. N. E. distant four leagues; the opposite point to N. N. E. is S. S. W. which, with the variation, makes S. ¼ westerly, for the course to be set in the traverse table, distant 12 miles.

When you make the land your bearing, itself (with the variation allowed upon it, and the distance you judge yourself from it) is to be set down in the traverse table, as a course and distance. This needs no example.

The courses marked on the log-board are the courses steered by the compass. In order to obtain the true course, it is necessary to allow both for the variation of the compass, and for the leeway upon each coarse on the log-board, as has been shewn, before they are put into the traverse table.

Every day, at noon, the log-board is to be transcribed into the log-book, which is ruled exactly like the log-board.

Mariners reckon by the civil account of time used on shore, but they keep the reckoning for the ship's place, by beginning at noon,

noon, and counting from thence 24 hours to the next noon. From noon to midnight they mark with P. M. signifying after mid-day; and the second twelve hours with A. M. signifying after midnight; ending their day's work at the noon of the civil day. Hence, their ship's account is twelve hours earlier than their shore account of time. And as the sun's declination used for finally determining the ship's place at the end of the sea-day is calculated for the noon of the common day at London or Greenwich, therefore the declination for the noon of the civil day must be taken for determining the latitude, &c. at finishing their day's account. Thus, a day's work marked Tuesday, May 6th, began on Monday at noon, and ends on Tuesday noon, so that the sun's declination for the 6th of May is used for the noon of Tuesday, and fitted to the meridian of the ship, according as she is E. or W. of London.

There are various methods of keeping a sea journal, according to the sentiments of various persons, with regard to what deserves being recorded: some approve of a journal including the log-book, each day's work at some length, and such occurrences as seem of most importance; while others prefer a short abstract of this long journal, containing little more than the course run, the latitude and longitude in, and sometimes the bearing and distance of the intended port for each day.

In the following journal the long form is used as representing more fully each day's work, and the necessary corrections: and an abstract of this may be drawn out in the shortest form that seems consistent with distinctness. The Learner ought to be thoroughly acquainted with the long form, and when he does that, he may either continue it, or take the shortest form; or retrenching from the first, and adding to the second what particulars he thinks proper, and thereby make out a form adapted to his own particular taste.

RULES for correcting the DEAD RECKONING by an Observation.

NOTWITHSTANDING the rules already laid down for keeping a ship's way at sea, yet by reason of the several accidents that may attend a ship in one day's run, such as swelling seas, different rates of sailing between the times of heaving the log, want of care

care at the helm in letting the ſhip fall off, or come to, accidental currents, ſudden ſqualls, when no account can be kept, &c. the latitude by account and latitude by obſervation may very often differ, then it is neceſſary that proper corrections be made in the difference of longitude.

When you have made all proper allowances you can, ſuch as for leeway, variation, currents, &c. and ſtill find that your latitude by account will not agree with your latitude by obſervation, then you muſt correct as follows:

Firſt, Conſider whether you have made proper allowances for currents, heave of the ſea, if the courſe at the helm has been carefully attended to, if the log-line and half-minute glaſs be juſt, and the log properly hove, or any ſudden ſqualls, or proper allowances made for the leeway, &c. which of theſe you conjecture your error is in; make what allowances you think meet to your difference of latitude and departure by dead reckoning, and ſee if that will reform your latitude by account, ſo as to make it agree with your latitude by obſervation; if it does, you have gueſſed right (for you muſt always keep to the latitude by obſervation, it being the only thing to be depended on); but if it will not agree with the obſerved latitude, it is to be ſuppoſed that there are miſtakes in your conjecture, or ſome other cauſe which produces the error in the reckoning, and ſtands in need of being corrected. In this caſe, you are firſt to examine your log-line and half-minute glaſs, and if there be an error in them, allow for it, as in the following examples:

EXAMPLE I.

Yeſterday at noon, we were in latitude 48° 20′ N. and till this day at noon we have ſailed S. S. W. 48 miles, S. W. by S. 36 miles, N. E. 24 miles, and find by good obſervation that we are in latitude 47° 14′ N.

TRAVERSE TABLE.

COURSES.	DIST.	N.	S.	E.	W.
S. S. W.	48		44,4		18,4
S. W. by S.	36		29,9		
N. E.	24	17,0		17,0	20,0
		17,0	74,3		38,4
			17,0		17,0
			57,3		21,4

By

By the Traverse Table it appears, that by account the diff. of lat. is 57,3 S. and the departure 21,4 W.

Now the lat. left was	——	48° 20′ N.
Diff. of lat. by account	——	0 57 S.
Latitude in by account	——	47 23 N.

Differing 9 miles from the true latitude by observation.

Wherefore I examine the log-line and half-minute glass, and find that the former measures 52 feet between knot and knot, and that the latter runs only 27 seconds. Now, as the log line and half-minute glass are both faulty, I correct my difference of latitude and departure as in Case III. and find my correct difference of latitude 66,2 S. and my departure 24,7 W.

Now from latitude left	——	48° 20′ N.
Take diff. corrected for error in dist.		1 6 S.
Lat. in, corrected for error in dist.		47 14 N.

Agreeing exactly with my latitude by observation; I therefore conclude my reckoning sufficiently correct. Then, with the difference of latitude 66,2, and departure 24,7, together with yesterday's latitude, I find the difference of longitude either by Middle Latitude or Mercator's sailing.

In the last example 57,3 and 21,4, multiplied severally by 156, thrice the measured length of a knot, and divide the two products by 135, five times the measured time of the glass, will give the difference of latitude 66,2, and departure 24,7, which is the same thing as if every course had been corrected separately.

EXAMPLE. II.

Yesterday at noon, we were in lat. 36° 15′ N. and have sailed these 24 hours S. E. ½ E. 55 miles, N. E. by N. 20 miles, W. S. W. 70 miles, S by W. ½ W. 20 miles, and by observation this day at noon we are in lat. 34° 56′ N.

THE TRAVERSE TABLE.

COURSES.	DIST.	N.	S.	E.	W.
S. E. ½ E.	55		34.9	42.5	
N. E. by N.	20	16.6		11.1	
W. S. W.	70		26.8		64.7
S. by W. ½ W.	20		19.1		5.8
		16.6	80.8	53.6	70.5
			16.6		53.6
			64.2		16.9

By the Traverse Table it appears, that by account the diff. of lat. is 64.2 S. and the departure 16.9 W.

Latitude failed from ——	36° 15′ N.
Difference of latitude by account	1 4 S.
Latitude in by account ——	35 11 N.

Differing 15 miles from the latitude by obſervation.

I now examine the log-line and half-minute glaſs, and find them both right. Next I conſider whether there be any current, and I think I have reaſon to ſuſpect one; upon trial I find there is one ſetting S. S. W. ¾ W. at the rate of 7 fathoms an hour, and judge I have been in it theſe 24 hours. Then 7 fathoms (or tenths of a knot) per hour, in 24 hours, makes about 17 miles; and to the diſt. 17 miles, and courſe S. S. W. ¾ W. the diff. of lat. is 14,6 S. and departure 8,7 W.

	Diff. Lat.	Dep.		
Now by tra. table	64,2 S.	16,9 W.	Latitude failed from	36° 15′ N.
And by current	14,6 S.	8,7 W.	Diff. of lat. cor. for cur.	1 19 S.
Correct for cur.	78,8 S.	25,6 W.	Lat. in correct for cur.	34 56 N.

Which agreeing with my latitude by obſervation, I conclude that my reckoning is right; then having the latitude left, and latitude come to, the difference of longitude may be found either by Middle Latitude or Mercator's Sailing as before.

If, after all proper allowances are made for errors in diſtance, currents, &c. the latitude by account and obſerved latitude ſhould diſagree, then the reckoning muſt yet be further corrected; and to do which, the following are the common, and ſeem to be the moſt rational methods.

CASE

CASE I.

If the Course found by Dead Reckoning be less than three Points, thirty-three Degrees.

RULE. To the difference of latitude and departure by account find a course; to this course and the difference of latitude by observation, find the difference of longitude, either by Middle Latitude or Mercator's Sailing.

EXAMPLE.

Yesterday at noon, we were in lat. 39° 18′ N. by an observation, this noon we are in lat. 37° 48′ N. and our dead reckoning gives 107 miles of southing, and 64 of westing; required the true difference of longitude?

To the difference of latitude 107, and departure 64, I find the course 2 ¾ points; then with the meridional difference of latitude between the two observations 115, and the same course, I find the true difference of longitude 69 miles.

CASE II.

If the Course found by Dead Reckoning be more than three Points, or thirty-three Degrees, and less than five Points, or fifty-six Degrees.

RULE. With the diff. of lat. and dep. by account, find the distance; with this distance, and diff. of lat. by observation, find another departure. Take half the sum of this dep. and dep. by account, for the true dep. with which and the diff. of lat. by observation, find the diff. of longitude.

EXAMPLE.

Yesterday at noon, we were in lat. 52° 40′ N. and are this noon in lat. 54° 22′ N. having by account made 84 miles of northing and 76 miles of westing; required the true difference of longitude?

To the diff. of lat. 84, and dep. 76, the distance is 113 miles, and the course 42°.

To dist. 113, and diff. of lat. between the two observations 102, the dep. is 47,7; then 76 added to 47,7, is 123,7, half of which is 61,8, the true dep.

To dep. 61,8, and diff. of lat. by observation 102, the course is 31°, and with the course 31°, and the meridional diff. of lat. between the two observations 171, I find the diff. of long. is 103 miles.

CASE III.

If the Course by Dead Reckoning be more than five Points, or fifty-six Degrees.

RULE. With the diff. of lat. and departure by account find the distance; then with this dist. and diff. of lat. by observation find the diff. of long.

EXAMPLE.

Yesterday at noon we were in lat. 38° 52′ N. to-day at noon we are in lat. 40° 18′ N. and by account have made 68 miles northing, and 112 miles of westing; required the true diff. of longitude?

With the diff. of latitude 68, and departure 112, I find the distance 132 miles, and to distance 132, and difference of latitude by observation 86, the course is 49° 30′ nearly; with this course, and the meridional difference of latitude between the two observations 111, the difference of longitude is 130 miles.

The reason of the above rule is plain, if we consider, that when a ship sails near the meridian, it will require a sensible error in the course, to make any considerable error in the difference of latitude; which can hardly happen if proper care is taken at the helm; and therefore it is most likely that the error is in the distance run; but when the course is near the middle of the quadrant, or between 3 and 5 points from the meridian, it is then probable the error may be in both course and distance; and when the course is more than five points from the meridian, it is then most likely the error is in the course, as it will require a great error in the distance to make any considerable one in the difference of latitude.

NOTE. As the true place of a ship depends upon her latitude and longitude being truly ascertained, I have set these down only, the rest being of less consequence to the mariner.

To correct for several Days.

By help of the three preceding rules, the longitude may always be corrected for a single day, but if an observation has been wanted for one or more days, then mark the latitude and longitude at last observation, or if this be your first observation since leaving the land, mark the latitude and longitude of the land you left; this is the only latitude and longitude you can call certain; all the following part of the reckoning must undergo a correction, which is made as follows:

Take the northings, southings, eastings, and westings, that you have made since your last observation; or if this be your first observation, then for every day from your leaving the land, minding not to leave out the difference of latitude and departure of the day you correct on, and bring them into the traverse table, by which you will have the whole difference of latitude and departure by account

count ſince the laſt obſervation; and with that ſame difference of latitude and departure find the courſe by dead reckoning; then obſerve which of the foregoing caſes that courſe falls under, and correct by the rule for that caſe. But when an obſervation has been wanting for ſeveral days, then mark the latitude and longitude you were in at your laſt obſervation, of leaving the land as before, and then you may correct with a greater degree of certainty; eſpecially in high latitudes, by the following rules:

CASE I.

Reckoning from the laſt certain latitude and longitude.

When the courſe given by the meridional difference of latitude and difference of longitude by account, taken as difference of latitude and departure is leſs than three points, or 33 degrees.

RULE. To the meridian difference of latitude and difference of longitude by account (taken as difference of latitude and departure as ſhewn in the Mercator's ſailing,) find a courſe; with this courſe and the meridian difference of latitude by obſervation, find a correſponding departure, which will be the correct difference of longitude.

EXAMPLE I.

Having ſailed three days ago from latitude 49° 57′ N. and got no obſervation till this day at noon, and find I am in latitude 45° 23′ N. and by dead reckoning I am in 45° 12′ N. having differed my longitude 173 miles; required my difference of longitude?

		M. Parts.			M. Parts.
Lat. ſailed from	49° 57′ N.	3470	Lat. ſailed from	49° 57′	3470
Lat. by account	45 12 N.	3047	Lat. by obſer.	45 23	3063
Merid diff. of lat. by acc.		423	Mer. diff. of lat. by obſ.		407

To meridian difference of latitude by account 423, and difference of longitude by account 173, the courſe is 22° 15′. Then with the courſe 22° 15′, and meridional difference of latitude between the obſervations 407, I find the difference of longitude is 167 miles.

CASE II.

When the courſe given by the meridional difference of latitude and difference of longitude by account, (taken as before) is greater than 3 points, and leſs than 5 points.

RULE. To the meridian difference of latitude and difference of longitude by account, taken as difference of latitude and departure, find a diſtance; with this diſtance, and meridian difference of latitude by obſervation, find a correſponding departure; half the ſum of

of this departure, and the difference of longitude by account, is the correct difference of longitude.

EXAMPLE II.

Three days ago we were in latitude 45° 23′ N. and have since that time sailed between south and west, have by dead reckoning altered our latitude 94 miles, and our longitude 147 miles; but by an observation this day, we find we are in latitude 43° 34′; required the correct difference of longitude?

	M. Parts.		M. Parts.
Lat. sailed from 45° 23′ N.	3063	Lat. sailed from 45° 23′ N.	3063
Lat. by acc. 43 49 N.	2931	Lat. by obser. 43 34 N.	2910
Mer. diff. of lat. by account	132	Mer. diff. by observation	153

With the meridian difference of latitude by acc. 132, and difference of longitude by acc. 147, I find the distance 198, and course 48°. Then to distance 198, and meridian difference of latitude by observation 153, the dep. is 125; now 125 added to 147 is 272, and half this sum, viz. 136, is the correct diff. of longitude.

CASE III.

When the course given by the meridian difference of latitude and difference of longitude by account, (taken as before) is more than 5 points or 56 degrees.

RULE.—To the meridian difference of latitude and difference of longitude by account, taken as difference of latitude and departure, find a distance.

To this distance and meridian difference of latitude by observation, find a corresponding departure, this departure will be the correct difference of longitude.

EXAMPLE III.

Two days ago I was in latitude 43° 34′ N. and have since then made by account 50 miles by southing, and 256 miles difference of longitude west, but find by observation that I am in 42° 30′ N.; what is my true difference of longitude?

	M. Parts.		M. Parts.
Lat. sailed from 43° 34′ N.	2910	Lat. sailed from 43° 34′	2910
Lat. by account 42 44 N.	2841	Lat. by obser. 42 30	2822
Mer. diff. of lat. by account	69	Mer. diff. of lat. by obser.	88

Then to meridian difference of latitude by account 69, and diff. of longitude by account 256 (taken as difference of latitude and departure), the distance is 265, and course 75 degrees.

And to distance 265, and difference of latitude 88 (the meridian difference of latitude by observation), the departure is 250, which is the correct difference of longitude.

Here we have given at ſome length the different methods of correcting the dead reckoning by an obſervation, which are readily done by the table of difference of latitude and departure.

The ſhip's way is generally greater than the diſtance given by the log, and it is always ſafeſt to have the reckoning a-head of the ſhip, that the mariner may be looking out for land, and not make it before he is aware of it.

When a great ſea ſets after the ſhip, it is common to allow one mile over for every ten given by the log, for the heave of the ſea; but if the ſea be againſt or athwart her, her diſtance muſt be leſs than that given by the log.

The error in the ſhip's reckoning is frequently attributed to unknown currents; for by various cauſes yet undetermined, there are many counter motions of the water in the open ſeas, as well as thoſe obſerved near the ſhores, where the motions may be tolerably well accounted for. Some of the obſerved currents in the great ſeas may perhaps be owing to the tides following the moon, and to the libratory motion the waters may have thereby, and the unſettled ſetting and drift of theſe currents may poſſibly depend on the change in the moon's declination. However, it is well known from obſervations, that the trade-winds occaſion a conſiderable current within their limits, particularly within the Torrid Zone, where the motion is perpetually towards the weſt, at the rate of 8 or 10 miles a day, but at the extremities of the trade-winds, or near the latitudes of 30° N. or S. it is likely that the currents are compounded of the ſaid weſtern motion, and of one towards the equator; therefore all ſhips ſailing within theſe limits ſhould allow a courſe each day for this current.

Note. When the difference of latitude by account is leſs than the difference of latitude by obſervation, the ſhip is a-head of the reckoning, but if leſs, the reckoning is a-head of the ſhip.

When the mariner is dubious of his account of longitude, he generally runs into the latitude of the intended port, and then ſails E. or W. if there be ſea room, according as it is ſituated, and keeps a good look-out for the land.

The method I have choſen to introduce the young mariner into the moſt capital part of navigation is, by ſhewing him firſt how to work a few ſeparate day's works independent of each other, and then proceed to a continued journal from London to Madeira and Teneriffe, in which will be inſerted moſt of the occurrences that commonly happen at ſea, or in harbour.

I have ſeen many young navigators who have been taught the principles of navigation on ſhore, very deficient in keeping a journal at ſea; and therefore, muſt requeſt the Teacher not to omit putting the pupils over the following journal, which will render them ready at working a day's work at ſea, and confirm in their memory thoſe rules they have been over.

EXAMPLE

EXAMPLE I.

Yesterday at noon we were in the latitude of 46° 28′ N. and longitude 22° 18′ W. and have sailed till this day noon, as by the log-board, the tide having all the time set S. by E. 2½ miles per hour; required the ship's place and the direct course and distance made good?

LOG-BOARD.

H	K	F	Courses.	Winds.	L. Way
1	6	3	N. N. E.	W.	
2	6	4			
3	6	5			
4	6	4			
5	6	0			
6	6	1	E. N. E.	N. W.	
7	6	6			
8	5	8			
9	5	6			
10	5	4			
11	5	5			
12	5	3	E. by S.	N.	
1	5	9			
2	6	2			
3	6	0			
4	6	3			
5	6	4			
6	7	0	S. S. E.		
7	6	8			
8	7	3			
9	7	5			
10	7	1			
11	7	9			
12	7	3			

TRAVERSE TABLE.

Courses.	Dist.	N.	S.	E.	W.
N. N. E.	31	28.6		11.9	
E. N. E.	35	13.4		32.3	
E. by S.	36		7.0	35.3	
S. S. E.	51		47.1	19.5	
S. by E.	60		58.8	11.7	
		42.0	112.9	110.7	Dep.
			42.0		
		Diff. Lat.	70.9		

Lat. left	46° 28′ N.	M. Par. = 3156	
Diff. lat.	1 11 S.		
Lat. in	45 17 N.	M. Par. = 3054	
Sum. Lat.	91 45	Mer. D. Lat. = 102	
Mid. Lat.	45 52		
Co. M. Lat.	44 08		
Long. left	22 18 W.		
Diff. of lon.	2 39 E. or 2° 40′		
Long. in	19 39 W.		
Direct Course S. 57° 22′ E			
Distance 131 miles.			

The courses and winds on the log-board being examined, it appears that the ship goes large and has no lee-way; therefore the several courses from the log-board are entered in the Traverse Table without alteration.

Next the fathoms and knots belonging to each course are summed up, and the results are put in the column of distances in the Traverse Table: and to these courses and distances, the whole difference of latitude, departure, course and distance made good, are found as above.

Then having the latitude left, and the latitude come to; find the complement of the middle latitude, and with that, and the departure, find the course, &c. by middle latitude sailing.

Or with the course, and meridional difference of latitude, find the difference of longitude, by Mercator's Sailing.

NOTE. When the odd fathoms are above five, we allow one knot, but, if under five nothing is allowed.

EXAMPLE

EXAMPLE II.

June 29, 1795; being yesterday noon in latitude 25° 30′ S. and longitude 10° 15′ E. we have sailed till this day noon, as per log-board, in a current setting south $2\frac{1}{2}$ miles an hour, the variation $1\frac{1}{2}$ point west; required the ship's place?

LOG-BOARD.

H	K	F	Courses.	Winds.	L.Way
1	6	0	S. W.	W.N.W.	1
2	6	2			
3	6	4			
4	6	0			
5	5	3			
6	6	0	S. by W.	W. by S.	1
7	5	1			
8	5	4			
9	5	2			
10	5	3			
11	5	5			
12	5	2	S. S. W.	W.	1
1	5	2			
2	5	0			
3	4	6			
4	5	0			
5	5	1			
6	5	2	S. E. by S.	S.W. by S.	1
7	5	4			
8	5	4			
9	6	0			
10	6	0			
11	5	4			
12	5	5			

TRAVERSE TABLE.

Courses.	Dist.	N.	S.	E.	W.
S. by W. $\frac{1}{2}$ W.	30		28,7		8,7
S. by E. $\frac{1}{2}$ E.	32		30,6	9,3	
S. $\frac{1}{2}$ E.	30		29,9	2,9	
S. E. by E. $\frac{1}{2}$ E	39		18,4	34,4	
S. by E. $\frac{1}{2}$ E.	60		57,4	17,4	
	Diff. Lat.		165,0	64,0	8,7
				8,7	
				55,3	Dep.

Diff. lat.	2° 45′ S.	
Lat. left	25 30 S.	Mer. parts 1583
Lat. in	28 15 S.	Mer. parts 1768
Sum lat.	53 45	M. diff. lat. 185
Mid. lat.	26 52	
Co. m. lat.	63 08	
Long. left	10 15 E.	
Dif. Long.	1 02 E. or 1°. 01′ $\frac{1}{2}$ E.	
Long. in	11 17 E.	
Course is S. 18 30 E.		
Distance 174 miles.		

The courses and winds on the log-board being examined, it appears that the ship is close hauled on each tack, and one point lee-way being allowed, reduces the courses, and taking a course for the current S. these several courses being corrected by the variation $1\frac{1}{2}$ point west, give those in the traverse table, to which the whole difference of latitude and departure is to be found as above.

And hence the latitude and longitude in may be found, either by middle latitude or Mercator's sailing; for as the ship is near the Equator, the difference will be almost insensible.

NOTE. In the two following examples, the courses are corrected to the nearest degrees, as set down in the traverse table, and the odd minutes are rejected.

EXAMPLE III.

Yesterday at noon we were in latitude 33° 40′ N. longitude 16° 20′ west, the sun was observed to set 50° 18′ from the north point of the compass; we have sailed this day noon, as per log-board, in a current setting W. S. W. $1\frac{1}{2}$ mile per hour; required the ship's place, and her course and distance to the west end of the Island of Madeira?

Log-Board.

H	K	F	Courses.	Winds.	L. Way
1	6	2	S. by W.	W.	0
2	6	0			
3	6	3			
4	7	0			
5	7	2			
6	7	3			
7	7	2	S. W. by S.	W. by N.	1
8	7	2			
9	7	4			
10	7	6			
11	7	4			
12	8	1			
1	8	0			
2	8	5			
3	8	2			
4	7	5	S. W by W	N. W.	0
5	7	3			
6	6	6			
7	6	4			
8	6	0			
9	6	2			
10	6	1			
11	6	3			
12	6	1			

Traverse Table.

Courses.	Dist.	N.	S.	E.	W.
S. 01° E.	40		40,0	0,7	
S. 10 W.	70		68,9		12,2
S. 44 W.	58		41,7		40,3
S. 55 W.	36		20,6		29,5
	Diff. lat.		171,2	0,7	82,0
					0,7
				Dep.	81,3

Before the courses can be corrected to put into the Traverse Table, the variation of the compass must be found from the sun's true amplitude.

The declination is 22° 30′ N.

As cos. lat. 33° 40′ : rad. :: fin. 22° 30′ : sine 27° 22′.

So that the true amplitude = N. 62° 38′ W.
Mag. amplitude = N. 50 18 W.

Variation = 12 20 W.

The courses on the log-board being corrected by this variation and the lee-way, will give the courses fitted for the Traverse Table.

Lat. left -	33° 40′ N.	
Diff. last. -	2 51 S.	
Lat. in - -	30 49 N.	
Sum lat. -	64 29	
Mid. lat. -	32 14	
Co. mid. lat. -	57 46 N.	
Long. left -	16 20 W.	
Diff. long. -	1 36 W.	
Long. in -	17 56 W.	

Madeira's lat.	32° 30′ N.	M. paris 2064
Lat. in -	30 49 N.	1945
Diff. lat. -	1 41 = 101 miles	119
Sum. lats. -	63 19	
Mid. lat. -	31 39	
Co. mid. lat.	58 21	
Madeira's long.	17 26 W.	
Long. in -	17 56 W.	
Diff. long.	0 30 E.	
The course N.	14 30 E. dist. 104 miles.	

In the work for the amplitude, the latitude at sun-set was taken the same as at noon; for although there were about 46 miles of southing in that time, and so the latitude at sun-set was about 32° 54′, yet the amplitude being only about 15′ less, the alteration in variation would scarcely affect the difference of latitude and departure found from the courses so corrected.

EXAMPLE IV.

Yesterday at Noon we were in Latitude 19° 30′ S. and Longitude 0° 10′E. This Forenoon we observed the Sun's Altitude to be 10° 40′ when he was 80° 30′ from the North Point of the Compass, Declination being then 17° 27′N. we have sailed till this Day Noon, as per Log Board, in a Current setting by the Compass W. N. W. ½ Mile an Hour. Required the Ship's Place and her direct Course and Distance to the Island of St. Helena.

LOG-BOARD.

H	K	F	Courses.	Winds.	Leeway.
1	6	7	N. by E.	E. by N.	1
2	6	2			
3	6	4			
4	6	3			
5	6	1			
6	6	0			
7	5	8	North.	E. N. E.	1
8	5	4			
9	5	0			
10	5	3			
11	5	6			
12	5	9			
1	5	7			
2	6	4	N. N. W.	N. E.	1
3	6	8			
4	7	0			
5	7	3			
6	7	6			
7	7	5			
8	7	0			
9	7	2			
10	7	4			
11	6	3			
12	6	0			

TRAVERSE TABLE.

Courses.	Dist	N.	S.	E.	W.
N. 13° W.	38	37.0			8.5
N. 25 W.	39	35.3			16.5
N. 47 W.	76	51.8			55.6
N. 81 W.	12	1.9			11.9
		126.0	Diff. Lat	Dep.	92.5

Lat. 19° 30′S. Alt. 10° 40′ Dec. 17° 27′N.
90 00 90 00 90 00

Co. Alt. 79 20 P. Dist 107 27

Co. Lat. 70 30 Co. Sec. 0,02565
Co. Alt. 79 20 Co. Sec. 0,00757
P. Dist. 107 27

Sum 357 17

½ Sum 128 38 Log. Sine 9,89274
P. Dist. 107 27

Rem. 21 11 Log. Sine 9,55793

2)19,48389

Co. S. True Azimu. = 56° 30′ —9,74914
2

True Azimuth 113 00 from the S.
180 00

True ditto 67 00 from the N.
Mag. Azimuth 80 30 from the N.

Variation 13 30 W.
Lat in 17° 24′S. Long. in 1° 28′W. M.P. 1060
St. Hel. L. 15 55 S. St. Hel. lo. 5 46 W. M.P. 968

Diff. lat. 1 29 Diff. long. 4 18 M.D.Lat. 92
60 60

In Miles 89 In Miles 258

With the Meridional Difference of Latitude and Difference of Longitude, the direct Course to St. Helena is found S. 70° 22′ W. and with that Course and the proper Difference of Latitude the Distance is found 265 Miles.

Diff. Lat. 2° 06′N. M. Parts.
Lat. left. 19 30 S. 1193

Lat. in. 17 24 S. 1060

Sum. Lat. 2)36 54 Mer. diff. L. 133

Mid. Lat. 18 27
90 00

Co. Mid. Lat. 71 33
Longitude left 00° 10 E.
Diff. Long. 1 38 W.

Present long. 1 28 W.

In this Example the Azimuth is worked with Yesterday's Latitude and Declination, but had it been worked with this Day's, the Variation would have been 12° 26′ W.

A JOURNAL OF A VOYAGE FROM *LONDON TO MADEIRA*, AND TENERIFFE,

IN THE

FRANCES, OF LONDON;

WILLIAM JOHNSON, COMMANDER;

KEPT BY

JOSEPH MILLS, MATE.

Departure taken from the Lizard in Latitude 49° 57′ N. Longitude 5° 14′ W. bound for Funchal, in Madeira, in Latitude 32° 38′ N. Longitude 17° 5′ W. and to Teneriffe in Latitude 28° 13′ N. Longitude 16° 26′ W. bearing from the Lizard-Point S. 26° 58′ W. diſtance 1166 Miles.

Begun April 1, 1795.

In the following JOURNAL are exemplified, the Manner of allowing for the Variation, Lee-way, Lying-to, Calms, Currents, Heave of the Sea, &c. and to correct the Dead Reckoning, by an Obſervation, in all Caſes; with moſt of the Occurrences that commonly happen at Sea, and the Ship's Way pricked off on MERCATOR'S CHART.

Wednesday, April 1, 1795.	At 5 A. M. the pilot came on board; then weighed and sailed from Tower Wharf; at 11 came to with the best bower at Blackwall. Wind S. S. W.
Thursday 2.	Fresh gales and cloudy weather, with rain. At 5 A. M. weighed and sailed, at 9 came to an anchor at Gravesend, and cleared ship. Wind from S. S. W. to N. N. W.
Friday 3.	At 4 P. M. weighed and sailed, moderate weather; at 9 came to with the best bower at the Nore in 9½ fathoms, fresh gales; at 4 A. M. weighed and sailed; at 11 came to anchor in the Downs in 7 fathoms, Deal Castle bearing W. ½ S. distant 3 miles. Wind W. by S.
Saturday 4.	At 1 P. M. set the Pilot on shore. These 24 hours, the first and middle parts moderate and fair, the latter part strong gales and cloudy; hoisted the boats in.
Sunday 5.	Strong gales and cloudy; at 2 P. M. veered out the long service of the best bower, got top-gallant yards down; at 4 P. M. struck yards and top-masts. These 24 hours had very hard gales of wind. Wind W. by S.
Monday 6.	These 24 hours, for the most part, fresh gales: at 4 A. M. hove up the best bower, and let go the small bower; at 9 hove up the small bower, and let go the best bower again; people employed in making points and gaskets.
Tuesday 7.	At 6 P. M. strong gales with heavy rain; at 8 veered out the long service, and let go the sheet anchor under foot; at 9 A. M. hove up the sheet anchor. Wind variable from S. by W. to W.
Wednesday 8.	These 24 hours, for the first and middle parts, moderate and fair; the latter part, strong gales Wind W. by S.
Thursday 9.	These 24 hours, fresh gales and fair; at 3 P. M. got top-gallant mast down; at 10 A. M. got yards and top-mast up. Wind E. S. E.

H.	K.	F.	Courses.	Winds.	Lee way	Remarks on board, Friday, April 10th, 1795.
2			S. by W. ¼ W.	N. ½ W.		At 2 P. M. hove short.
4						At 4 weighed and sailed in Co. with a
6						40 Gun Man of War, and 20 Sail of
8						Merchantmen.
10			W.	N. by W.		At 6 S. Foreland bore N. N. W. dist. 4 M.
12			S. W. by W. ¼ W			At 2 A. M. Fairlee bore N dist. 6 M.
2						At 6 Beachy bore N by W. 6 Miles.
4			W N. W. ½ W	N. ½ W.		At 8 Beachy bore N. E. by E. 9 Miles.
6			W. S. W.	N. by E		Fresh Gales and clear, several Ships
8						standing up Channel; close reefed
10						both Topsails.
12						At 12 Bembridge P. bore W. N. W. 27 M.
						still in Company with the Fleet.

H.	K.	F.	Courses.	Winds.	Lee way.	Remarks on board, Saturday, Ap. 11
2	4	0	W. S. W.	N. by E.		
4	4	6	W. ¾ S.			
6	5	5				Fresh Gales and clear.
8	5	0				At 4 P. M. parted with the Fleet, they
10	5	1				being bound to Spithead. Dunnose
12	4	6				bearing W. N. W. distant 21 Miles.
2	5	0				At 5 let out one Reef of each Top-sail.
4	4	4				At 7 A. M. Portland Light bore W. N.
6	4	5				W. 9 Miles.
8	4	0				At 10 A. M. it bore N. E. 12 Miles, 14
10	4	2	S. by W. ½ W.	N. N. E.		Sail in Sight.
12	5	0				

Being upon the Coast this last Day, the Log is hove, and the Bearings and Distances of Lands, Rocks, Sands, &c. as you approach them, must always be set down, and are of the greatest consequence, especially in bad Weather, or when you are in Danger of being drove out of your true Course, in the Night, or in a Fog; so that you may at any Time determine, by your Reckoning, or the Chart, the Ship's Place, and sail Courses and Distances as Circumstances require, in order to pass Places of Danger, and to have it always in your Power to take your Departure from some known Place, in case you should be drove out to Sea in the Night or in foggy Weather, when no Land can be seen. For it sometimes happens, that in working to Windward in the English Channel, E. of Dunnose, Ships by making too long a Board, have got upon a Sand called the Ower, which lies from Dunnose E. ¾ N. 25 Miles. It is therefore absolutely necessary to have good Draughts of the Coasts you sail upon, unless you are well acquainted with them indeed.

H.	K.	F.	Courses.	Winds	Lee-way.	REMARKS on board, Sunday, Apr. 12, 1795.
2						These 24 Hours moderate Gales and fair Weather.
4						
6						
8	4		S.W. by W. ¾ W	N. E.		At 6 P. M. the Lizard bore N. by E. ¾ E. Distance 6 Leagues, from which I take my Depar. it being in the Lat. of 49° 57′ N. and Long. 5° 14′ West of London.
10	4	5				
12	5					
2	5					
4	5	5	S. W. ¾ W.			Several Sail in Sight, standing to Westward
6	5	5				
8	5	5				At Noon. Ushant N. 80° 26′ W. Distance 54 Miles.
10	5	5				
12	6					Variation 2¼ Points Westerly.

Course	Dist.	S.	S. W	Lat. by D. R.	Lat. by Obs.	Mer. Dist.	Diff. Lon.	Long. in.	Bearing and Dist.
26 30 W.	107	10	48	48. 21 N.		0° 48′	1° 14′	0° 28′ W.	Funch. S. 27 W. D 108 M

The Lizard bearing N. by E. ¾ E. Dist. 6 Leagues from the Ship, is the same as if the Ship had sailed from the Lizard 6 Leagues or 18 Miles upon the opposite, or S. by W. ¾ W. Point of the Compass, and allowing for the Variation, as before taught, makes it S. half E. dist. 18 M. which is to be set down as the first Course and Distance in the following Traverse Table.

The first Course steered by Compass is S. W. by W. ¾ W. which, allowing for the Variation, makes S. W. by S. half W. and the sum of all the Distances sailed on that Course till two o'Clock, when it alters, is 18 Miles and an half, which being doubled, because the Log is heaved every two Hours, gives 37 Miles; so the second Course and Dist. to be set down in the Traverse Table is S. W. by S. half W. 37 Miles. In like Manner the second Course steered is S. W. ¾ W. and the Variation allowed makes it S. S. W. half W. and the Dist. on that Course summed up and doubled, gives 56 Miles; therefore the third Course and Dist. to be set down in the Traverse Table is S. S. W. half W. 56 Miles. Having found the whole Difference of Latitude and Departure made upon the several Courses, I then mark down upon my Slate or Paper what every thing that is to be found comes to, and afterwards set them down in their proper Columns as above.

TRAVERSE TABLE.

COURSES.	DIST	N.	S.	E.	W.
S. ½ E.	18		17. 9	1. 8	
S.W. by S. ½ W.	37		28. 6		23. 5
S. S. W. ¼ W.	56		19. 4		26. 4
			65. 9		49. 9
					1. 8
					48. 1

Now to Diff. of Lat. 95. 9 S. and Dep. 48. 1 W. the Course is S. 26° 30′ W. Dist. 107 Miles; then Lat. sailed from, or Lizard's Lat. 49° 57′ N.

Diff. of Lat.	—	—	1 36 S.
Lat. in or Ship's Lat.	—	—	48 21 N.
Sum of Lats.	—	—	98 18
Middle Lat.	—	—	49 09
Com. of Middle Lat.	—	—	40 51

Then with this Com. of Mid. Lat. 40° 51′ or 41° found as a Course among the Degrees, and the Dep. 48. 1 in its Column, in the Dist. Col. stands 74, which is the Diff. of Long.

Or, with the Course 26 30 and Meridional Diff. of Lat. 147, the Diff. of Long is found to be nearly 74 by Mercator's sailing.

Longitude sailed from, or Lizard's Longitude	5° 14′ W.	This being the first Day since leaving the Land, the Departure is the Mer. Dist.
Difference of Longitude 74 Miles	1 14 W.	
Longitude in, or Ship's Longitude	6 28 W.	

To find the Bearing and Distance of Ushant.

Latitude in	48° 21′ N.	Mer. Parts	3323	Longitude in	6° 28′ W.
Ushant's Lat.	48 30 N.	Mer. Parts	3337	Ushant Long.	5 5 W.
Difference of Lat.	9	Mer. Diff. of Lat.	14	Diff. Long.	1 23

With the Mer. Diff. and Diff. Long. Ushant is found to bear N. 80° 26′ E. and with that Bearng, taken as a Course, and the proper Difference of Latitude, the Distance is found 54 Miles.—The bearing and distance to Funchal is found in the same manner.

H.	K.	F.	Courses.	Winds.	Lee-way	Remarks on board, Monday, Apr. 13, 1795
2	6		SWbyW¾W	N.		These 24 Hours moderate Gales and Cloudy Weather.
4	5	5				
6	5			N. W.		At 4 P. M. Spoke the Charming Nancy, from Carolina, bound to London.
8	5					
10	3	6	S. W. ¾ W.			
12	3	4				
2	3	4				
4	4	5				
6	4	6				At 6 A.M. got the Bower Anchors on the gunnel, and unbent the cables and stowed them
8	5		S.WbyS¾W	W.N.W.		
10	4	5				At Noon C. Ortegal bore S. 2° 26′ E. Dist 183 Miles.
12	4					Variation 2¼ Points Westerly.

Course.	Dist.	Diff. Lats.	Dep.	Lat. by D. R.	Lat. by Obs.	Mer. Distance.	Diff. Long.	Long. in.	Bearings and Dist
S. 30° W.	108	93 S.	53 W.	46 48.		1° 41′ W.	1°19′W	7° 47′ W.	Funchal S. 26° 39′ W. D. 961 M

The Variation being allowed on each Course, and the Distances summed up, as before taught, the Traverse Table will stand thus:

With the Difference of Latitude and Departure the Course is found S. 30° 0′ W. and the Distance 108 Miles.

Diff of Latitude	1° 33′ S.	Mer. Parts.
Latitude left	48 21 N.	3323
Latitude in	46 48 N.	318
Sum. Lat.	95 09	Mer. Diff. L. 138
Middle Lat.	47 34	
	90 00	
Com. Mid. Lat.	42 26	

Traverse Table.

Courses.	Dist	N.	S.	E.	W.
S.W. by S. ½ W.	43		33.2		27.3
S.S.W. ½ W.	39		34.4		18.4
S. by W. ½ W.	27		25.8		7.8
		Diff. Lat.	93.4	Dep.	53.5

The Diff. of Long. is found by Mercator's, or Middle Latitude Sailing, to be 1° 19′ W.

Yesterday's Longitude	6 28 W.
Longitude in —	7 47 W.

This Day's Departure being added to the Mer. Distance Yesterday, gives 1° 41′ the Mer. Distance to-day.

To find the Bearing and Distance of Cape Ortegal.

Latitude in	46° 48′ N.	Mer. Parts	3185	Longitude in	7° 47′ W.
Cape's Latitude	43 46 N.	Mer. Parts	2926	Cape's long.	7 36 W.
Diff. Lat.	3 2	Mer. Diff. lat.	259	Diff. long.	11
	60				
In Miles	182				

With the Meridional Difference of Latitude and Difference of Longitude, the direct Course to Cape Ortegal is S. 2° 26′ E. and with that Course and the proper Difference of Latitude the Distance is 183 Miles.

Note. As the Table of Difference of Latitude and Departure are only calculated to single Degrees, the nearest Degree to the Com. of Middle Latitude is to be taken in working by Inspection to find the Difference of Longitude by, which is near enough for all common Purposes at Sea; thus the Com. of Mid. Latitude is 42° 26′, for which I take 42° to find the Difference of Longitude. The same may be observed in finding the Course made good, the nearest Degree or ½ Degree to the Course is always set down, and will be found sufficiently exact.

H.	K.	F.	Courses.	Winds.	Leeway.	Remarks on board, Tuesday, April 14th, 1795.
2	4		S. W.	W.N.W.	0	These 24 hours moderate gales and clear weather.
4	4					
6	4					At 6 P. M. saw a ship to the westward.
8	4	4	S. W. by S.	W. by N.	½	90
10	4	5				Observed the sun's mer. alt. at noon 61 40
12	4	6				
2	4	5				Zenith distance — 28 20 S.
4	4		S. S. W.	West.	1	Declination — 17 03 N.
6	4					
8	4					Latitude — — 45 23 N.
10	4					At Noon C. Ortegal S. 10° 21 E. dist. 99 M.
12	4					Variation 1 ½ point westerly.

Course.	Dist.	Dif. Lat.	Dep	Lat. by D.R.	Lat. by Obs.	Mer. Dist.	Dif. long.	Long. in.	Bearing and Distance.
8° 30′ W.	07	96	14	45.12	45.23	1053′	00 21	8.01	Funchal S. 28° 47′ W. Dist. 873 miles.

By allowing for Variation and Leeway the Work will be as follows:

With the diff. of lat. and dep. the course is found S. 8° 30′ W. and the dist. 97 miles.

Dif. lat.	1° 36′ S.		Mer. parts.
Latitude left	46 48 N.		3185
			3047
Lat. in by D. R.	45 12	=	
		Mer. dif. lat.	138
Sum lat.	92 00		
Middle lat.	46 00		
	90 00		
Com. mid. lat.	44 00		

Traverse Table.

Courses.	Dist.	N.	S.	E.	W.
S. S. W. ½ W.	24		21.2		11.3
S. by W.	36		35.3		7.0
S. ½ E.	40		39.8	3.9	
	Dif. lat.		96.3	3.9	18.3
					3.9
				Dep.	14.4

Longitude left	7° 47′ W.
Diff. longitude	21 W.
Longitude in by account	8 08

Here the latitude by observation differing from the latitude by account, I correct for the true longitude; and as this is the first observation got since leaving the land, I correct by Case I. as follows;

Lizard's lat.	49° 57′ N.	Mer. parts	3470
Lat. by D.R.	45 12 N.	Mer. parts	3047
Mer. dif. lat. by account			423
Lizar 's longitude	5° 14′ W.		
Long. in by account	8 8 W.		
Dif. of long. by account	2 54		
	60		
In miles	— 174		
Lizard's lat.	49° 57′ N.	Mer. parts	3470
Obs. lat.	45 23 N.	Mer. parts	3063
Mer. dif. lat. by observation			407

With the mer. dif. of lat. and dif. long. by account, the ship's direct course from the Lizard is found to be S. 22° 22′ W. or S. S. W.

With that course, and the mer. dif. of lat. by observation, the dif. of long. since leaving the Lizard is found 167 miles equal to 2° 47′ W.

Lizard's longitude	5 14 W.
Longitude in	8 01

With the course 22° 22′ or 2 points, the proper dif. of lat. 274 miles, the true mer. dist. is found 113 miles.

To find the direct Course and Distance to Cape Ortegal.

Lat. in	45° 23′ N.	Mer. parts	3063	Longitude in	8° 01′ W.
Cape's lat.	43 46 N.	Mer. parts	2926	Cape's longitude	7 36 W.
Dif. lat.	1 37	Mer. dif.	137	Dif. longitude	0 25

With the mer dif. of lat. and dif. of long. the direct course to Cape Ortegal is found S. by E. and with that course and the proper dif. of lat. 67, the distance is found to be 99 miles.

H.	K.	F.	Courses.	Winds.	Lee-way.	REMARKS on board, Wednesday, April 15, 1795.
2	3	5	S. by W. ¾ W.	West.	1	These 24 Hours moderate Gales and clear Weather.
4	3	5				
6	3	5				
8	3					At 8 P. M. set up the Mizen Top-Mast Shrouds and Back-stays.
10	3	5				
12	3					At Noon Cape Ortegal S. 14° 28′ E. Distance 23 Miles.
2	3					
4	3					
6	3		S. by W.	W. by S.	1	
8	3					
10	3					
12	3					Variation 1½ point Westerly, per Ampli.

Course.	Dist.	Dif. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Mer. Dist.	Dif. of Long.	Long. in.	Bearing and distance.
S. 9° E.	76	75 S.	12 E.	44.08		1.41	17 E.	7° 44′ W.	Funchal, S. 32° 24′ W. Dist. 817 Miles.

With the difference of lat. and departure the Course is found S. 9° E. and the distance 76 Miles.

Diff. latitude	1° 15′ S.	Mer. Parts.
Yesterday's lat.	45 23 N.	3063
		2957
Latitude in	44 08 N.	
Sum lat.	89 31	106
Middle latitude	44 45	
	90 00	
Comp. mid lat.	45 15	

TRAVERSE TABLE.

COURSES.	Dist.	N.	S.	E.	W.
S. ¼ E.	46		45.8	4.5	
S. by E. ¼ E.	30		29.1	7.3	
	Diff. lat.		74.9	11.8	Dep.

Yesterday's longitude	8° 01′ W.
Diff. longitude	0 17 E.
Longitude in	7 44 W.

This day's departure being subtracted from the meridional distance of yesterday, gives 1° 41′ the meridional distance of to-day.

To find the Bearing and Distance of Cape Ortegal.

Latitude in	44° 08′ N.	Mer. parts	2957	Longitude in	7° 44′ W.
Cape's lat.	43 46 N.	Mer. parts	2926	Cape's longitude	7 36 W.
Diff. lat.	22	Mer. diff. lat.	31	Diff. longitude	8

With the mer. difference of latitude and difference of longitude, Cape Ortegal is found to bear S. 14° 28′ E. and with that bearing taken as a Course, and the proper difference of latitude, the distance is found 23 miles.

NOTE. When the Tenths on any side are more than 5, or half a mile, you must call that side one more than you found it to be; but when they are less than 5, then you need take no notice of them; as in the above the difference of latitude and departure are 74.9 and 11.8, which I call 75 and 12, because the Tenths are above 5.

But when you take the difference of latitude and departure to find the Course, then take them in Miles and Tenths; the same may be observed in casting-up the Knots and Fathoms.

If, when doubled, the Tenths are more than 5, set one mile more in the Traverse Table; but if less, omit them, as there are no Tenths in the distance column.

H.	K.	F.	Courses.	Winds.	Lee-way.	REMARKS on Board, Thursday, April 16, 1795.
2	3	5	West.	S. S. W.	3	These 24 hours hard gales and squally, with small rain.—Handed the Fore and Main Courses.
4	3	5				
6	3	5				
8	Lay to, up N. W. by N. off N. by E.				5	At 8 P. M. saw a ship to windward with Jury Masts up.
10	Drift 1 ½ mile per hour W.					
12						
2	Up N. W. off North			W. by S.	5	Set the courses close reefed—More moderate.
4	Drift 1 ½ mile per hour. Wore ship.					
6						
8	5		S. W.	N.W. by W. ½ W.	½	Set the Top sails close reefed.
10	5					C. Finisterre S. 28°37′W. dist. 82 M.
12	5					Variation 1 ¼ point westerly.

Course.	Dist	Diff Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Mer Diff.	Diff. of Long.	Long. in	Bearing and Dist.
S81°21W	25	4	25	44° 04′	·	2.6	36	8.20 W.	Funchal S. 30° 53′ W Distance 799 miles.

Taking the middle points (viz. N. by W. and N. N. W.) between the point to which the ship comes up to, add the point she fell off to for the second and third courses, as taught in the rules for lying to, and then allowing as before for variation and leeway, the Traverse Table will stand as follows:

With the diff. of lat. and dep. the course is found S. 81°21′ W. and the distance 25 M.

Diff. of lat.	00° 04′S.	Mer. parts.	
Yesterday's lat.	44 08 N.		2957
Lat. in	44 04 N.		2951
Sum lat.	88 12	Mer. dif. lat.	6
Middle latitude	44 06		
	90 00		
Comp. mid. lat.	45 54		

TRAVERSE TABLE.

Courses	Dist.	N.	S.	E.	W.
W.N.W. ¼W.	21	7.1			19.8
N.N.E. ¼E.	9	7.7		4.6	
N. by E. ¼E.	9	8.5		3.0	
S.S.W. ¼W.	30		27.1		12.8
		23.3	27.1	7.6	32.6
			23.3		7.6
	Diff. lat.		3.8	Dep.	25.0

The departure to-day being added to the mer. dist. yesterday, gives 2° 6′, the mer. dist. to-day.

With the course and mer. diff. of lat. the diff. of long. is found by Mercator to be 39 miles. Or, with the mid. lat. and dep. the diff. of long. is found by mid. lat. sailing 36 miles west.

Diff. longitude —	0° 36′	
Yesterday's longitude	7 44 W.	
Longitude in —	8 20 W.	
	0 . 36	

Here the dif. of long. found by mid. lat. differs considerably from that found by Mercator's sailing, but if the mer. parts were taken from a table of miles and tenths it would agree nearer with mid. lat. sailing; but in all cases where the course is so great, and the difference of latitude is in miles and tenths, middle latitude should be depended on.

To find the Bearing and Distance of Cape Finisterre.

Latitude in	44° 04′N.	Mer. parts	2951	Longitude in	8° 20′W.
Cape's latitude	42 52 N.	Mer. parts	2852	Cape's long.	9 14 W.
Diff. latitude 72 = 1 12		Mer. diff. of lat. 99		Diff. long.	54

With the mer. diff. of lat. and diff. of long. Cape Finisterre is found to bear S. 28° 37′ W. and with that bearing and the proper diff. of lat. the distance is found 82 miles.

H.	K.	F.	Courses.	Winds.	Lee-way.	REMARKS on board, Friday, April 17, 1795.
2				Calm.		The first eight hours calm and foggy.
4						
6						
8						
10	3	5	W. S. W.	South.	1	Fresh gales and clear.
12	4	4				Cape Finisterre S. 39° 57′E dist. 54 M.
2	4	6				Hoisted the boats out, and tried the current,
4	4	8				found it to set N. W. by N. 1 mile per
6	4	6				hour all day.
8	4	8				Variation 1 $\frac{1}{4}$ point westerly.
10	4	8				
12	4	5				

Course.	Dist	Dif. lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Mer. Dist	Dif. long.	Long. in.	Bearing & distance.
S. 79° 57′W. or 80°.	84	15	83	43.49	43.34	3.10	1.55	10.2	Funchal S. 26° 49′W. Distance 736 miles.

The variation and lee-way being allowed on the course steered, and the setting of the current and its drift in 24 hours being made a course and dist. the work will be as follows:

With the diff. of lat. and dep. the course is found S. 79° 57′W. and the distance 84 miles.

Diff. of latitude	00°	15′S.	Mer. parts
Lat. left.	44	4 N.	2951
Lat. in	43	49 N.	2931
Sum of lats.	87	53	Mer. dif. lat. 20
Mid. lat.	43	56	
	90	00	
Com. mid. lat.	46	04	

TRAVERSE TABLE.

COURSES.	Dist.	N.	S.	E.	W.
N. W. $\frac{1}{4}$ W.	24	16.1			17.8
S.W. by W. $\frac{1}{4}$ W.	72		30.8		65.1
		16.1	30.8	Dep.	82.9
			16.1		
	Dif. lat.		14.7		

The dif. of long. found by Mercator's sailing is 113 miles, but by mid. lat. it is found

115 miles, equal to	—	—	—	1° 55′W.
Longitude left	—	—	—	8 20 W.
Longitude in by account			—	10 15 W.

The dif. of long. found by mid. lat. still differs from that found by Mercator's sailing; the cause is the same as before, and as the ship has made so great a course we will still depend on mid. lat.

The lat. by observation differing from the lat. by account, I correct for the true longitude as follows, (it being three days since I had an observation before,) by Case II. page 182.

			Mer. parts.
Last obs. lat.	45°	23′N.	3063
Ship's lat. by acc.	43	49 N.	2931
Mer. dif. lat. by account			132
Ship's long. at last obs.			8° 1′W.
Ship's long. by acc. to-day			10 15 W.
Dif. long. since last obs.			2 14

With the mer. dif. of lat. by account 132 and dif. of long. by account 134, the direct course since last obs. is found S. 45° 13′W. or 45 and the dist. 187 miles.—With that dist. and the mer. dif. of lat. by obs. 153, the dif. of long. is found 198, this added to the dif. of long. by account 134, gives 241, which divided by 2, gives the true dif. of long. since last obs. 121 M. nearly equal to 2° 1′W.

Long. in at last obs.			8 1 W.
Longitude in			10 2 W.

Last obs. lat.	45°	23′N.	3063
Ship's lat. by obs.	43	34 N.	2910
Mer. dif. by observation			153

The course found since last observation 45° 13′ is of no farther use than to know what Case to correct by.

With the true course since last obs. 38° 20′ and the proper dif. of lat. 109, the dep. is 1° 26′ + 1° 53′W. = 3° 19′.

To find the Bearing and Distance of Cape Finisterre.

Latitude in	43°	34′N.	Mer. parts	2910	Longitude in	10° 02′W.
Cape's lat.	42	52 N.	Mer. parts	2852	Cape's long.	9 14 W.
Dif. of lat.		42	Mer. dif. of lat.	58	Dif. of longitude	48

With the mer. dif. of lat. and dif. of long. the direct course to Cape Finisterre is found S. 39° 57′E. and with that course and proper dif. of lat. the distance is found 54 miles.

H.	K.	F.	Courses.	Winds.	Leeway.	REMARKS on board, Saturday, April 18, 1795.
2	4	5	W. S. W.	South.		These 24 hours moderate gales, with small showers of rain.
4	4	5				
6	4	5				
8	4					
10	4					
12	4					
2	3	5				
4	3	5	S.W. by W.	S. by E.		
6	3	5				
8	3					A great swell from the S. W. for which I allow 6 miles.
10	3					
12	3					Varia. 1 Point west. per Azimuth.

Course.	Dist.	Dif. lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Mer. Dist.	Diff. Long.	Long. in.	Bearing & distance.
S. 53 30 W	84	50	67	42. 44.	.	4.26	1.33	11.35	Funchal S. 23° 15′ W. Distant 660 miles.

In this day's work the swell is considered as a current, whose drift in 24 hours is 6 miles, the allowance made for the swell; and as it comes from the S. W. it heaves the ship towards the N. E. and the variation allowed upon it makes the last course N. E. by N, as in the Traverse Table.

With the dif. of lat. and dep. the course is found S. 53° 30′ W. and the distance 84 miles.

Dif. lat.	0° 50′ S.	Mer. parts	
Latitude left	43 34′ N.		2910
Lat. in	42 44		2841
Sum of lat.	86 18	Mer. dif. lat.	69
Middle lat.	43 09		
	90 00		
Com. mid. lat.	46 51		

TRAVERSE TABLE.

Courses.	Dist.	N.	S.	E.	W.
S. W. by W.	58		32.2		48.2
S. W.	32		22.6		22.6
N. E. by N.	6	5.0		3.3	
		5.0	54.8	3.3	70.8
			5.0		3.3
	Dif. lat.		49.8	Dep.	67.5

The dep. 67 being added to yesterday's mer. dist. gives 4° 26′ the mer. dist. this day.

The difference of longitude is found as before to be	1°	33′ W.
Yesterday's longitude	10	2 W.
Longitude in this day	11	35 W.

To find the Bearings and Distance of Funchal.

Latitude in	42° 44′ N.	Mer. parts	2841	Longitude in	11° 35′ W.
Funchal's lat.	32 38 N.	Mer. parts	2073	Funchal's long.	17 5 W.
Dif. lat. 606 =	20 6	Mer. dif. lat.	768	Dif. long. 330 =	5. 30

With the mer. dif. of lat. and dif. long. Funchal is found to bear S. 23° 15′ W. and with that bearing taken as before, and the proper dif. of lat. the distance is 660 miles.

To find the Bearing and Distance of the intended Port on Mercator's Chart.

Lay a ruler across Mercator's Chart, in lat. 42° 44′, and set one foot of the compasses on the meridian of London, and the other in long. 11° 35′ W. lay off that same distance from the meridian of London, by the edge of the ruler, and that will shew the ship's place. Then lay the ruler over the ship's place and Funchal, and take the nearest distance between the ruler and the centre of the compass; slide one foot along the side of the ruler, and the other foot will shew the course to be S. S. W. Again, (keeping the ruler as before) take from the gradual parallel the dif. of lat. between the ship and port (10° 12′) in your compasses, and slide one foot along the ruler, holding both points parallel to the N. and S. lines, till the other cuts the E. and W. lines; passing through the ship's place; the distance between where the point rested, by the edge of the ruler, and Funchal, being measured upon the graduated parallel, gives nearly 11°, or 660 miles for the distance. In like manner find the bearing and distance of any other place from the ship; or take the distance between Funchal and the ship in your compasses, and lay it on the meridian, placing one foot as much above Funchal as the other is below the ship's place, and that will be the dist. in degrees or in leagues, if the merid. is marked so.

H.	K.	F.	Courses.	Winds.	Lee-way.	Remarks on board, Sunday, April 19, 1795.
2	4	5	W. by N.	S. W. by S.		These 24 hours fresh gales, and clear weather.
4	4	5				
6	4	5				
8	5					
10	5					
12	5					
2	5	5	W. ½ N.	S.S.W. ½ W.	½	
4	5	5				
6	5	5				
8	5	5				
10	5	5				
12	4					Variation 1 point westerly.

Course.	Dist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs	Mer Diff	Diff. of long	Long. in	Bearing & Distance
West.	120		120	42.44	42.30	6.20	2.43	14.12	Funchal S. 13° W. Distant 608 Miles.

The variation being allowed on both the courses, and the leeway upon the second, it will be found that the ship has sailed due West these last 24 hours, and by summing up the distances her whole distance is found to be 120 miles, which is also her departure; it is evident she has made no difference of latitude, therefore her latitude by account is the same as yesterday.

As the ship has sailed upon a parallel with the Equator, her difference of longitude is found by parallel sailing 2° 43′W.

Yesterday's longitude 11 35 W.

Longitude in by account 14 18 W.

The latitude by observation not agreeing with the latitude by account, and it being two days since my last observation, I correct as follows, by Case III. Page 182.

Last Obs lat. 43° 34′ Mer. parts 2910
Lat. in by acc. 42 44 Mer. parts 2841

Mer. dif. lat. by account since last obs. 69

With the Mer. diff. of lat. and dif. long. by account, the course since last obs. is found to be S. 75 W. and the distance 266 miles.

Long. in at last observation 10° 02′W.
Ship's long. by account 14 18 W.

Dif. long by acc. since last obs. 4 16 W.

With that dist. and the mer. diff. of lat. by obser. the true dif. of long. since last observation is found to be 250 = 4° 10′W.
Long. in at last observation 10 2 W.

Last obs. lat. 43° 34′ M. parts 2910
This day's lat. by obs. 42 30 M. parts 2822

Mer. dif. lat. by obs. since last obs. 88

Longitude in 14 12

With the course since last observation S. 70° 30′W. and the proper dif. of lat. 64 miles, the departure (or Mer. dist.) since last observation is found 181 miles, equal to 3° 01′W.
Mer. dist. at last obs. 3 19 W.

True Mer. dist. this day 6 20 W.

To find the Bearing and Distance of Funchal in Madeira.

Latitude in	42° 30′N.	Mer. parts	2822	Longitude in	14° 12′W.
Funchal's lat.	32 38 N.	Mer. parts	2073	Funchal's long.	17 5 W.
Dif. lat. 592 =	9 52	Mer. dif. lat.	749	Dif. longitude	2 53 = 173

With the mer. difference of latitude and difference of longitude the bearing of Funchal is found to be S. 13° W. and with that bearing taken as before, and the proper dif. of latitude, the distance is found 608 miles.

H.	K.	F.	Courses.	Winds.	Lee way.	REMARKS on board, Monday, April 20th, 1795.
2	8		S. S. W.	N. W. by W.		Stiff gales, with showers of rain.
4	8					From 2 P. M. fair weather and moderate gales.
6	8	5				
8	8	5				
10	8	5				
12	8	5				
2	9	0				
4	6	0	S. ¼ E.	S. W. by W. ¼ W.	½	
6	5	5				
8	5	5				
10	5					
12	5					
						Varia. 1 point westerly per Amplit.

Course	Dist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Mer. Dist.	Diff. Long.	Long. in.	Bearing and Dist.
South.	170	170		39.46	39.40	6.00		14.12	Funchal S. 18°16′ W. Distant 444 Miles.

Yesterday's lat. 4° 30′N.
Diff. lat. — 2 44 S.

Lat. in by account 39 46 N.

TRAVERSE TABLE.

Courses.	Dist.	N.	S.	E.	W.
S. by W.	118		115.7		23.0
S. S. E. ¼ E.	54		48.8	23.1	
	Diff. lat.		164.5	23.1	23.0
				23.0	
				0.1	Dep.

Proper allowances being made for variation and lee-way, it appears from the Traverse Table that the ship has sailed due South 164½ miles, and as she made no departure, her longitude in and mer. dist. is the same as Yesterday; but as by observation the ship is found to be in lat. 39° 40′N. it is plain she has got 6 miles a-head of her reckoning, which 6 miles being added to the distance by D. R. gives the true distance and difference of latitude as above.

To find the Bearing and Distance of Funchal.

Latitude in	39° 40′N.	Mer. parts	2597	Longitude in	14° 12′W.
Funchal's lat.	32 38 N.	Mer. parts	2073	Funchal's long.	17 5 W.
Dif lat. 422 =	7 2	Mer. diff lat.	524	Dif long. 173 =	2 53

With the mer. dif. lat. 524, and the dif. of long. in miles 173, the direct course to Funchal is found S. 18° 16′, or 18° W. and with that course and the proper dif. of lat. 422, the distance is found to be 444 miles.

Now a parallel of lat. through 39° 40′ on the variation chart, cuts the variation lines in 11° 15′ in longitude 14° 0′W. which confirms the longitude by account.

The variation charts might be of great use were they drawn upon a large scale, and the lines of variations well laid down, but as the variation in most places is continually altering, it renders them in a few years useless: I would therefore advise the Mariner to trust more to his reckoning and lunar observations, since the theory of the variation is not yet known.

H.	K.	F.	Courses.	Winds.	Lee-way.	Remarks on board, Tuesday, April 21, 1795.
2	8		S. S. W. ¾ W.	W.byN.¼W.	½	Fresh gales and clear weather.
4	8					
6	8	5				
8	8	5				
10	8					
12	8	5				
2	8	4				
4	8	4				
6	8	6				
8	8	6				
10	8	5				
12	8					Varia. ⅔ point W. per Azimuth.

Course.	Dist.	Dif. lat.	Dep.	Lat. by D. R.	Lat by Obs.	Mer Dist.	Dif. Long.	Long. in	Bearing and dist.
S.byW.¼W.	192	184	56	36.29	36.36	7.17	1.11	15.23	Funchal S. 19°33′ W. distant 253 M.

By examining the Log-board it appears that the ship has sailed S. S. W. ¾ W. 200 Miles.

Latitude left	39° 40′N.
Dif. latitude	3 11 S.
Lat. in by account	36 29 N.

Traverse Table.

Courses.	Dist.	N.	S.	E.	W.
S. by W. ¼ W.	200	Dif. lat.	191.0	Dep.	58.0

The latitude by observation not agreeing with the latitude by D. R. I correct as follows, by Case I. page 179.

With the course one point and a half, and the dif. of lat. by obs. 184, the dist. is found to be 192 miles, and the dep. 56, which being added to the mer. dist. yesterday 6° 21′ W. gives the mer. dist. to-day 7° 17′ W.

Yesterday's latitude	39° 40′N.	Mer. parts	2597
This day's obs. lat.	36 36 N.	Mer. parts	2363
Sum of latitudes	76 16	Mer. diff. lat.	234
Middle latitude	38 8		
	90 00		
Comp. mid. lat.	51 52		

The diff. of long. is found by Mercator or mid. lat. 1° 11′W.

Yesterday's long.	14 12 W.
Long. in this day	15 23 W.

To find the Bearing and Distance of Funchal.

Latitude in	36° 36′N.	Mer. parts	2363	Longitude in	18° 22′W.
Funchal's lat.	32 38 N.	Mer. parts	2073	Funchal's long.	17 05 W.
Dif. lat. 238	3 58	Mer. dif. lat.	290	Dif. long. 103 =	1 43

With the mer. dif. of lat. and the dif. of long. the bearing of Funchal is found, and with that bearing and the proper dif. of lat. the distance is found 253 miles.

H.	K.	F.	Courses.	Winds.	Lee-way.	REMARKS on Board, Wednesday, April 22, 1795.
2	4	3	W. by S. ½ W.	S. by W. ½ W.	½	These 24 hours moderate weather with rain.
4	4	5				
6	4	7				
8	5		W. S. W. ½ W.	S. ½ W.	½	
10	5	2				
12	5	3				
2	5	5	W. S. W.	South.	½	
4	5	5				
6	5	4				
8	5	1				
10	5		S. W. by W.	S. by E.	½	
12	4	5				Varia ¾ P. W. per equal alt. of the sun

Course.	Dist	Diff Lat.	Dep.	Lat. by D. R.	Lat. by Obs	Mer Dist.	Diff. of Long.	Long. in	Bearing and Dist.
S. 65° W.	119	50	108	35. 52	35. 46	9.05	2. 11	17.36	Funchal S. 7° 44′ E. Distance 190 miles.

With the diff. of lat. and dep. the course is found S. 68° 10′ W. and the dist. 118.6 miles.

Yesterday's lat. 36° 36′N.
Diff. of latitude 44 S.

Lat. by account 35 52 N.

Yesterday's lat. 36° 36′N. M. parts 2363
Obs. lat. 35 46 N. M. parts 2301

Diff. lat. by obs. 50 M. diff. lat. 62

Sum lats. 72 22

Middle latitude 36 11
90 00

Com. mid. lat. 53 49

TRAVERSE TABLE.

COURSES.	Dist	N.	S.	E.	W.
W. by S. ¼ W.	27		4.0		26.7
W. S. W. ½ W.	31		10.4		29.2
S. W. by W. ¼ W.	43		18.4		38.9
S. W. ¾ W.	19		11.3		15.3
		Diff. lat.	44.1	Dep.	110.1

The latitude by observation not agreeing with the latitude by account, I correct as follows, by Case III. page 180.

With the proper diff. of lat. by obs. 50′ and the distance 118.6 the true course is found 65° 04′, and the departure 108 miles nearly.

The departure 108 being added to the mer. dist. yesterday, gives 9° 5′ W. the mer. dist. to-day.

With the comp of mid. lat. and dep. or with the course and mer. diff. of lat. 62′ the diff. of long. is found by middle latitude or Mercator's sailing, to be 133 miles = 2° 13′W.

Yesterday's longitude 15 23 W.

Longitude in — 17 36 W.

To find the Bearing and Distance of Funchal in Madeira.

Latitude in	35° 46′N.	Mer. Parts	2301	Longitude in	17° 36′W.
Funchal's latitude	32 38 N.	Mer. Parts	2073	Funchal's long.	17 05 W.
Diff. latitude	3 . 8	Mer. diff. of lat.	228	Diff. long.	31 E.

With the mer. diff. of lat. 228, and the diff. of long. 31′, Funchal is found to bear S. 7° 44′ E. and with that bearing (taken as before) and the proper diff. of latitude, the distance is found 190 miles.

H.	K.	F.	Courses.	Winds.	Lee way	Remarks on board, Thursday, April 23, 1795.
2	6	6	S. by E. ½ E.	S. W. ½ W.	½	These 24 hours moderate gales, and clear weather.
4	5	8				
6	5	8				
8	5	8				
10	5		S. S. E.	S. W.	½	
12	5	2				
2	5	3				
4	5	5	S. S. E. ½ E.	S. W by S ½ W.	½	
6	5	5				
8	5	5				
10	5	6	S. E. by E.	S. W. by S.	½	
12	5	4				Variation ¾ point westerly.

Course.	Dist.	Diff. Lat.	Dep.	Lat. by D R.	Lat. by Obs.	Mer Dist.	Diff. long.	Long. in	Bearing and Distance.
S. 35° 20′ E	135	110	78	34.01	33.56	7.47	1.25	16.01	Funchal S. 34° 15′ W. Distance 94 Miles.

With the diff. of lat. and dep. the course is found S. 37° 48′ E. and the distance 133 miles.

Yesterday's lat.	35° 46′ N.		
Diff. of latitude	1 45 S.		
Lat. by account	34 01 N.		
Obs. lat.	33 56 N.	M. parts	2167
Yesterday's lat.	35 46 N.	M. parts	2301
Prop. diff. lat. obs.	1 50	M. dist.	134
Sum of lat.	69 42		
Middle latitude	34 51		
	98 00		
Comp. mid. lat.	55 09		

Traverse Table.

Courses.	Dist.	N.	S.	E.	W.
S. S. E. ¾ E.	48		41.2	24.7	
S. E. by S. ¼ E.	31		24.9	18.5	
S. E. by S. ¾ E.	33		24.4	22.2	
S. E. ¼ E.	22		14.8	16.3	
	Diff. lat.		105.25	81 7	Dep.

The latitude by obs. differing from the latitude by account, I correct as follows, by Case II. page 179.

With the diff. of lat. 110 and the dist. 133, the dep. is found to be 75, which being added to the former dep. 82, gives 157, half this sum is the true dep. 78 miles; with the dif. of lat. 110 and the dep. 78, the true course is found S. 35° 20′ E. and the dist. 135 miles.

The dep. 78 being subtracted from the mer. dist. yesterday, gives 7° 47′ W. the mer. dist. this day.

The dif. of long. is found by Mercator or middle latitude sailing, to be 1° 35′ E.

Yesterday's longitude	17	36 W.
Longitude in	16	01 W.

To find the Bearing and Distance of Funchal in Madeira.

Latitude in	33° 56′ N.	Mer. parts	2167	Longitude in	16° 01′ W.
Funchal's lat.	32 38 N.	Mer. parts	2073	Funchal's long.	17 05 W.
Difference of lat.	1 18	Mer. dif. of lat.	94	Dif. of long.	1 . 04

With the meridional difference of latitude and difference of longitude, the direct course to Funchal is S. 34° 15′ W. and with that course and the proper difference of latitude, the dist. is found 94 miles.

H.	K.	F.	Courses.	Winds.	Lee-way.	Remarks on board, Friday, April 24, 1795.
2	5	5	S.W. ¼ S.	E. by N.		Moderate gales and hazy.
4	5	5				At 6 P.M. more clear, saw Porto Santo
6	4	5		E.		bearing N.W. about 7 or 8 leagues.
8	4	5				At 10 P.M. saw Madeira, bearing S.W.
10	4					by S. Distance 15 leagues.
12	4			E.S.E.		Clear weather.
2	4					At 10 P.M. came to anchor off Funchal,
4	4			N.E.		the westernmost point W. by N. the
6	4					Loo-Rock N. by W. the Brazen Head
8	4					E. by S. the Deserters from E. to S.E
10	4					Distance about 9 leagues.
12	4					Variation ¾ point.

Course.	Dist.	S.	W	Lat. by D.R.	Lat. by Obs.	Mer. Dist.	Diff. Lon.	Long. in.	Bearing and dist.
S.33°45′W.	95	70	53	32° 37′		8.40	1.3	17.4	Funchal, N. 1 mile.

The variation allowed upon the course, and also upon the bearing of the land taken at ten o'clock, being put into a Traverse Table, and the distance run upon each course, with the distance you are from the land, will give the distance and difference of latitude and departure as above; with the complement of the middle latitude and departure, the difference of longitude is 63 = 1° 3′, which added to 16° 1′, the longitude in yesterday at noon, gives 17° 4′, the longitude in by account; and as it agrees with the longitude of Funchal in the table, I conclude that my reckoning is just, and Funchal well laid down.

The ship's place in the preceding Journal is pricked off, and the bearing and distance at noon are also found by the Chart, in order to shew the young Navigator the method, and may be done with a black lead pencil, which he may either let stand or rub out when he pleases.

Between April 24, and May 12, lay moored in Funchal Road, Madeira.

H.	K.	F.	Courses.	Winds.	Lee-way.	Remarks on board, Tuesday, May 12, 1795.
2				N.E.		Fresh breezes and clear. At 4 P.M.
4						unmoored ship and hove in to ½ of a
6						cable on the best bower.
8						
10						
12						Light breezes and clear.
2						At 6 A.M. weighed from Funchal Road
4						and made sail. Lat. obs. 32° 10′ N.
6						Variation 18° 30′ W.
8						
10						Ditto W. at noon the Southernmost Deserta,
12						N.W. 4 or 5 leagues.

Course.	Dist.	Dif. Lat.	Lat. by D.R.	Dep.	Lat. by Obs.	Mer. Dist.	Dif. of Long.	Long. in.	Bearing and Distance.
					32° 10′ N.				Southernmost Deserta. N. W. 5 leagues.

I take my departure from the Southernmost Deserta, which lies in latitude 32° 18′ N. long. 16° 25′ E.

Traverse Table.					

H.	K.	F.	Courses.	Winds.	Lee-way.	Remarks on board, Wednesday, May 13, 1795.
2	6	2	S. S. W.	N. N. E.		Light breezes and clear. Variation per
4	3		S.S. W. ¼ W.			amplitude 18° 30′ W.
6	2					
8	2					
10	2					Made and shortened sail occasionally.
12			Calm.			
2	4	4	S. S. W. ¼ W.	W. N. W.		
4	5	4				
6	6					
8	6	3				
10	5	6		N. W.		Fresh breezes and clear. Set studding
12	4					sails. Lat. by obs. 30° 31′N.

Course.	Dist.	Dif. lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Mer. Dist.	Dif. lon.	Long. in.	Bearing and distance.
S. 1° 30′E.	100	99	2.7	30.31N	30.31N	2.7	3 mi. E.	16°22′ W.	Salvages, S. 34° E. distance 28 miles.

By taking my departure from the southernmost Deserta, which is in lat. 32.18 N. long, 16.25 E. and bearing from me yesterday at noon N. W. 5 leagues; I find the course answering to that bearing, corrected for variation, to be S. 63° E. distant 15 miles, which I have set down in the Traverse Table as a course.

Traverse Table

Course per log.	Courses corrected.	Dist.	N.	S.	E.	W.
S.E.	S.63° E.	15		6.8	13.4	
S.S.W.	S.4° W.	12		12.0		0.8
S.S.W. ¼ W.	S.7° W.	81		80.4		9.9
		Diff. lat.		99.2	13.4	10.7
					10.7	
				Dep.	2.7	

With the difference of latitude and departure the course is found to be S. 1° 30′ E. distant 100 miles.

With the com. mid. lat. the diff. of long. is found to be 3 miles.

Dif. lat. 1° 39′ S.
Lat. left 32 10 N. Mer. pts. 2040

Lat. in 30 31 Mer. pts. 1924 — Lat. salv. 30° 8′N. Mer. pts. 1898 Long. 16° 4′

Sum lats. 62 41 Mer. dist. 116 Lat. in 30 31 N. Mer. pts. 1924 Lon. in 16 28

Mid. lat. 31 20 23 26 18

Co. m. lat. 58 40

With the mer. diff. lat. and diff. long. the salvages are found to bear S. 34° E. dist. 28 miles.

H.	K.	F.	Courses.	Winds.	Lee-way.	REMARKS on board, Thursday, May 14, 1795.
2	6	4	South.	West.		Fresh breezes and clear. All sails set.
4	6	2				
6	5	0				
8	4	2				Variation 18° west.
10	6	3				
12	5	4				
2	5	4	S. by W.	W. by N.		Fresh breezes and pleasant weather. Two sail in sight.
4	5					
6	3					
8	3	1				
10	2	4				Light breezes and cloudy. In studding sails.
12	2			W. by S.		Lat. obs. 28° 48′ N.

Course	Dist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Mer. Dist.	Diff. of Long.	Long in.	Bearing and Dist.
S. 14° E	107	104	26	28.47 N	28.48 N	29 F.	29 miles	15.53 W.	Sta. Cruz, Teneriffe S. 47° 23′ W. D. 30 M

Courses being corrected for variation, I find by the Traverse Table the direct course of the ship to be S. 14° E. and the distance 107 miles.

TRAVERSE TABLE.

Courses per log.	Courses corrected.	Dist.	N.	S.	E.	W.
South.	S. 18° E.	67		63.7	20.7	
S. by W.	S. 7 E.	41		40.7	5.0	
		Diff. lat.		104.4	25.7	Dep.

Dif. of lat. 1° 44′ S.
Lat. left 30 31 N. Mer. parts 1924

Lat. in 28 47 N. Mer. parts 1805

Mer. diff. 119

Sum of lat. 59 18 — Lat. Teneriffe 28.27 N.—1782 Long. Tene. 16° 18′ W.
Lat. in 28.47 N.—1805 Long. in 15 53 W.

Mid. lat. 29 39 — Diff. lat. 20 M. dif. 23 Diff. long 25

Co. mid. lat. 60 21

With the comp. of mid. lat. the diff. of long. is found to be 29 miles.

With the mer. dif. lat. and dif. long. by Mercator, the Bay of Santa Cruz in Teneriffe is S. 47. 23 W. dist. 30 miles.

As this Journal is only intended to shew the Learner how to keep his reckoning at sea, the true Variation is not particularly attended to.

H.	K.	F.	Courses.	Winds.	Lee-way.	Remarks on board, Friday, May 15, 1795.
2	3	4	S. S. E.	S. W.	1	Fresh breezes and cloudy.
4	3					
6	2	4				Handed top-gallant sails and in first reef top sails. At 6 the Peak of Teneriffe bore by compass W. S. W.
8	3					
10	3					
12	2	4	W. N. W.	Ditto.	1	Fresh breezes and clear. Variation 18° W.
2	2	4				
4	2					Set top-gallant sails. Hazy with rain. No land in sight. No observation.
6	2					
8	3					Light breezes and clear.
10	2	4	S. S. E.	Ditto.	1	At noon made Teneriffe, bearing W. by N. dist 12 leagues.
12	2	4				

Course.	Dist.	Dif. lat.	Dep.	Lat. by D. R.	Lat by Obs.	Mer Dist.	Dif. of Long.	Long. in	Bearing and dist.
S. 25° E.	20	18	8	28.30		37 E.	10m E.	15 43 W.	Sta. Cruz, Teneriffe S 84°26′W. D. 31 M.

The courses being corrected for one point leeway, and 18° W. variation all these 24 hours, I find by the Traverse Table the direct course of the ship to be S. 25° E. distance 20 miles.

Dif. of lat.	0°	18′S.
Lat. left.	28	48 N.
Lat. in	28	30 N.
Sum lats.	57	18
Mid. lat.	28	39
Com. mid. lat.	61	21

Traverse Table.

Courses per log.	Courses corrected.	Dist.	N.	S.	E.	W.
S. S. E.	S. 52° E.	30		18. 5	23.6	
W. N. W.	N. 74 W.	24	6.6			23. 1
S. S. E	S. 52 E.	10		6. 2	7.9	
			6.6	24.7	31.5	23.1
				0 6	23.1	
		Dif. lat.		18.1	8.4	Dep.

With the comp. of mid. lat. the dif. of long. is found to be 10 miles; and the bearing and distance of Santa Cruz by mid. lat. is found to be S. 84° 26′W. dist. 31 miles.

H.	K.	F.	Courses.	Winds.	Lee-way.	Remarks on board, Saturday, May 16, 1795.
2	5		W. by N.	S. S. E.		Light breezes and clear. Made all sail.
4	5	4				
6	6					At 5 the east end of Teneriffe N. W. 4 miles; at 7 anchored in 9 fathom in Santa Cruz Road, the town of Santa Cruz W. by N. ½ a mile.
8						
10						
12				Variable.		Variation 17° 30′ west.
2						
4				West.		At 8 A. M. hoisted out the boats and went on shore to wait on the Gov.
6						
8						Moored ship with the small bower to the S. W. in 19 fathom and stream anchor to the N. E. in 10 fathom.
10				Calm.		
12				South.		

Course.	Dist	Dif. lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Mer. Dist.	Dif. long.	Long. in.	Bearing & dist.
S. 84° W.	33	3	33	28.27 N		4 mi. E.	37m. W	16°20′W.	At anchor in San Cruz Rd, Tenerif

The Courses being corrected for 17° 30′W. variation, I find by the Traverse Table the true course to be S. 84° W. dist. 33 miles.

Dif. lat.	0°	3′S.
Lat. left	28	30 N.
Latitude	28	27
Com. mid lat.	61	33

Traverse Table.

Course per log.	Course corrected.	Dist.	N.	S.	E.	W.
W. by N.	S. 84° W.	33		3.4		32.8
		Diff. lat.		3.4	Dep.	32.8

With the com. of mid. lat. the diff. of long. is 37 miles.

AN ABSTRACT OF THE FOREGOING JOURNAL.

Days.	Months. 1795.	Courses.	Dist	Lat. by D. R.	Lat. by Obs.	Long. in	Bearings and Distances at Noon.
Sunday,	April 12	S. 26° 30′ W.	96	48° 21′ N.		6° 28′ W.	Funchal, S. 27° W. distant 1058 miles.
Monday,	April 13	S. 30° W.	108	46. 48 N.		7. 47 W.	Funchal, S. 26. 39 W. distant 951 miles.
Tuesday,	April 14	S. 8. 30 W.	97	45. 12 N.	45. 23 N.	8. 1 W.	Funchal, S. 28. 47 W. distant 873 miles.
Wednesday,	April 15	S. 9° E.	76	44. 8 N.		7. 44 W.	Funchal, S. 32. 24 W. distant 817 miles.
Thursday,	April 16	S. 81. 20 W.	25	44. 4 N.		8. 20 W.	Funchal, S. 30. 53 W. distant 799 miles.
Friday,	April 17	S. 80 W.	84	43. 49 N.	43. 34 N.	10. 2 W.	Funchal, S. 26. 49 W. distant 735 miles.
Saturday,	April 18	S. 53. 30 W.	84	42. 44 N.		11. 35 W.	Funchal, S. 23. 15 W. distant 660 miles.
Sunday,	April 19	West.	120	42. 44 N.	42. 30 N.	14. 12 W.	Funchal, S. 13. W. distant 608 miles.
Monday,	April 20	South.	170	39. 47 N.	39. 40 N.	14. 12 W.	Funchal, S. 18. 16 W. distant 444 miles.
Tuesday,	April 21	S. by W. ½ W.	192	39. 29 N.	39. 36 N.	15. 23 W.	Funchal, S. 19. 33 W. distant 253 miles.
Wednesday,	April 22	S. 65 W.	119	35. 52 N.	35. 46 N.	17. 36 W.	Funchal, S. 7. 44 W. distant 190 miles.
Thursday,	April 23	S. 75. 30 E	135	34. 1 N.	33. 56 N.	16. 1 W.	Funchal, S. 34. 15 W. distant 94 miles.
Friday,	April 24	Came to an anchor in Funchal Road, where we lay till May 12th, and then sailed for Teneriffe.					
Tuesday,	May 12	S. 1. 30 E.	100	30. 31 N.	30. 31 N.	16. 22 W.	Salvages, S. 37. 52 E. distant 39 miles.
Wednesday,	May 13	S. 14 E.	107	28. 47 N.	28. 48 N.	15. 35 W.	Teneriffe, S. 47. 23 W. distant 30 miles.
Thursday,	May 14	S. 25 E.	20	28. 30 N.		15. 43 W.	Teneriffe, S. 84. 26 W. distant 31 miles.
Friday,	May 15	S. 84 W.	33	28. 27 N.		16. 20 W.	Anchored in Santa Cruz Road.

The Method of finding the LATITUDE *at* SEA, *by taking two Altitudes, either in the Forenoon or Afternoon, having the intermediate Time measured by a common Watch, with Ease and Accuracy, independant of the Sun's Meridian Altitude.*

GENERAL RULES.

1st. TO the secant of the latitude by account, add the secant of the sun's declination, (rejecting their indexes) and call that sum the logarithm ratio.*

2d. From the natural sine of the greatest altitude, subtract the natural sine of the least altitude, and find the logarithm of their difference, and write it under the logarithm ratio.

3d. Subtract the hours and minutes when the altitudes were taken from each other, and half the difference call half elapsed time.

4th. With half the elapsed time enter the tables, and from the column of half-elapsed time take out the logarithm answering thereto, and set it down under the logarithm ratio.

5th. Add these three logarithms together, and with their sum enter the tables in the column of middle time, where, having found the logarithm nearest thereto, take out the time corresponding to it, and put it down under half the elapsed time.

6th. Subtract the less from the greater, and the difference will be the time from noon, when the greatest altitude was taken.

7th. With this time enter the tables, and from the column of rising, take out the logarithm corresponding to it; from this logarithm subtract the logarithm ratio, the remainder will be the logarithm of a natural number, which, being found in the common table of logarithms, and added to the natural sine of the greatest altitude, will give the natural sine of the sun's meridian altitude.

Having the meridian altitude of the sun at noon, the latitude is found by the usual method.

N. B. If the latitude, found by the above process, should differ widely from the latitude by account, it will be proper to repeat the operation, using the latitude last found instead of the latitude by account, till the result gives a latitude nearly agreeing with the latitude used in the computation.

* The arithmetical comp. of the co-sine of any angle is equal to the logarithmic secant of that angle, omitting the first figure in the index; thus the secant of 46° 50′ is 10.16487, and omitting the first figure 1, leaves 0,16487, the secant less radius, or the arithmet. comp. of co-sine 46° 50′.

EXAMPLE I.

Being at sea in latitude 46° 50′ north by account, when the sun's declination was 11° 17′ N. at 10 H. 2 M. in the forenoon, the sun's altitude was 46° 55′, and at 11 H. 27 M. in the forenoon, the second altitude was 54° 9′. Required the true latitude, and true time of the day when the greatest altitude was taken?

Times.			
H. M. s.	Lat. 46° 50′.	Secant	0.16487
11 27 0			
10 2 0	Dec. 11 17	Secant	0.00848
Ela. T. 1 25 0		Added gives the log. ratio	0.17335
½ El. T. 0 42 30			

The sun's gr. alt. at 11 H. 27 M. is 54° 9′ Its nat. sine 81055
The sun's least alt. at 10 H. 2 M. is 46 55 Its nat. sine 73036

The remainder of diff. of nat. sines 8019

Log. ratio		0.17335
The common log. of the diff. N. S.	8019	3.90412
In the tables in col. ½ ela. time for 42 M. 30 S. is		0.73429
Their sum of the log. in middle time		4.81176
		H. M. S.
The H. M. &c. for which by the tables is		1 15 30
Subtract half elapsed time		42 30
The diff. is the true space of time the sun had to rise to the meridian when the greatest altitude was taken		0 33 00

	H.	M.
Time per watch	11	27
Sub. from	12	0
	0	33

Finding they agree, the watch is right.

Enter the tables with 33 M. under col. of rising, and you will find the log.		3.01488
From which subtract the log. ratio		0.17335
The natural number of which is 694		2.84153
To the natural sine of the greatest alt.		81055
Add the natural number of the above log.		694
The sum is the natural sine of the sun's meridian altitude, 54° 50′		81749

The natural sines are found in table XVII.
The half elapsed time, &c. in table XVI.

	90° 0′	
	54 50	
The ſun's zen. diſt.	35 10 S.	By obſerving the ſun's merid. alt.
The ſun's declination	11 17 N.	the ſame day, the lat. was found to be 46° 28′ N.
Lat. —	46 27 N.	

EXAMPLE II.

Being at ſea in lat. 47° 19′ N. by account, when the ſun's declination was 12° 16′ N. at 10 H. 24 M. A. M. per watch, the ſun's alt. was 49° 9′, at 1 H. 14 M. P. M. his alt. was 51° 59′. Required the latitude?

	H. M. S.				
	12 0 0				
	10 24 0				
		Alt.	Nat. S. Lat.	47° 19	0.16880
	1 36 0	49° 9′	75642	Sun's decl. 12 16	0.01003
	1 14 0	51 59	78783		
				Log. ratio	17883
Ela. T.	2 50 0	Diff. N.S.	3141	Its log.	3.49707
½ El. T.	1 25 0	Its log. in col. of half elapſ. time is			0.44077
Sub.	0 15 0	Col. of mid. time correſponding to			4.11667
Tr. Ti.	1 10 0	Its log. in col. of riſing is		—	3.66542
Tr. p. W.	1 14 0	Log. ratio ſub.		—	0.17883
Wat. faſt.	0 4 0	3066 the nat. num. of this log.			3.48659
N. S. Sun's gr. alt.		78783	90 00		
N. S. S. mer. alt.		81849 =	54 56		
Sun's zen. diſt		—	35 4 South		
Sun's decl.		—	12 16 North		
Lat. in		—	47 20 North.		

Here the Latitude found by computation may be relied on, as it differs but one mile from that uſed in the operation.

EXAMPLE III.

Being at ſea in lat 50° 40′ North per account, when the ſun's declination was 20° 0′ ſouth, at 10 H. 17 M. A. M. per watch, the ſun's alt. was found 17° 13′, at 11 H. 17 M. A. M. per watch, it was found 19° 41′. Required the latitude?

Times.

	Times. H. M. S.	Alt.	Nat. S.			
				Lat.	50° 40′	0,19803
				Decl.	20 00	0,02701
	10 17 0	17° 13′	= 29599			
	11 17 0	19 41	= 33682	Log. ratio		0,22504
Ela. T.	1 0 0	Diff. N. S. 4083		Its com. log.		3,61098
½ El. T.	0 30 0	Its log. from col. half-elap. time is				0,88430
	1 1 0	In col. of mid. time correſponding to				4,72032
Tr. time	0 31 0	From noon, its log. from col. of riſing				2,96067
T. p. W.	0 43 0	log. ratio ſub.				0,22504
W. flow	0 12 0	544 N. num. of				2,73563
		33682 N. S, greateſt alt.				
	90° 0′					
	20 1	34226 N. S. of ſun's mer. alt. 20° 1′.				
Zen. diſt.	69 59					
Decl.	20 0 S.					
Lat.	49 59 N.					

But as this latitude differs 41 miles from that by account, it will be proper to repeat the operation, uſing the lat. laſt found inſtead of the lat. by account.

	H. M. S.				
		Lat.	49° 59′	0,19178
½ Elapſed time	0 30 0	Decl.	20 0	0,02701
	1 0 0			
		Log. ratio		0,21879
True time	0 30 0			3,61098
Time per watch	0 43 0			0,88430
			H. M.	
Watch flow	0 13 0	In col. mid. T.	1 0	4,71407
True time	0 30 0	Its log. in col. of riſing is		2,93223
		Log. ratio		0,21879
		517 Nat. num. of		2,71344
		33682 Nat. S. gr. alt.		
Nat. S. ſun's mer. alt.		34199 = 20° 0′		
	Zen. diſt.	70 0		
	Decl.	20 0 S.		
	The lat.	50 0 North.		

The latitude laſt found, differing only one mile from that uſed in the operation, may be depended on as the true latitude. Hence it is plain, that the operation is repeated with very little additional trouble, but few alterations being neceſſary.

EXAMPLE IV.

Being at ſea in the latitude 60° 0′ north by account, when the ſun was on the equator, and conſequently had no declination, at 1 H. 0 M. P. M. per watch, his altitude was 28° 53′, and at 3 H. 0 M. P. M. per watch, it was 20° 42′. Required the true altitude?

Times.					
H.	M.	S.	Alt.	N. S.	
1	0	0	28 53	= 48303	
3	0	0	20 42	= 35347	
Elap. T. 2	0	0		12956	
½ El. T. 1	0	0	Its log. in col. of ½ Elap. time		
2	0	0	Its log. in col. of mid. time		
T. fr. N. 1	0	0	Its log. from col. of riſing		
D. per W 1	0	0			

Lat. 60° 0′ = 0,30103
Dec. 0 0 = 0,00000
Log. ratio 0,30103
Its log. 4,11247
0,58700
5,00050
3,53243
Log. ratio 0,30103
3,23140

1704 N. num.
48303
90 0
Nat. S. Sun's mer. alt. 50007 = 30° 0′ Sun's meridian alt.
60 0 Latitude.

The latitude by computation, coming the ſame with the latitude by account, ſhews that the latitude by account was right. From the foregoing examples it is plain, that the operation is the ſame, whether the ſun hath north or ſouth declination. And it will be the ſame whether the ſhip is in a north or ſouth latitude. It is alſo clear, that when the ſun has no declination, the ſecant, rejecting the index of the latitude, is the log. ratio.

EXAMPLE. V.

Wanting to go through the N. Channel among the Maldives, and by account being in latitude 7° 40′ N. the declination being then 22° 47′ N. at 7 H. 25 M. 40 S. A. M. the true altitude of the ſun's centre was 22° 30′, and at 10 H. 31 M. 48 S. A. M. it was found 63° 40′. Required the ſhip's true latitude?

Times

	H. M. S.	Alt.	Nat. S.		
Times	10 31 48	63° 40′	89623	Lat. by ac. 7° 40′	0,00390
	7 25 40	22 30	38268	Declin. 22 47	0,03528
				Log. ratio	0,03918
Elap. T.	3 6 8		51355	Its log.	4,71058
½ El. T.	1 33 04	Its log. in col. of ½ elap. time is			0,40368
				H. M. S.	
	3 1 30			3 1 30	5,15344
True T.	1 28 26	Its log. in col. of rising is			3,86709
T. p. W.	1 28 12			Log. ratio	0,03918
W. flow	0 0 14		6728	Nat. num.	3,82791
		90 00	89623	N. S. gr. alt.	
	Mer. alt.	74 29			
			96351	N. S. Sun's mer. alt. = 74° 29′.	
	Zen. dist.	15 31 N.			
	Decl.	22 47 N.			
	Lat. in	7 16 north.			

N. B. As the tables are only calculated to 30 seconds, the log. for any intermediate seconds is found by taking the difference between the log. next greater and next less; and saying, as 30 seconds is to that difference, so is the given seconds to the difference of the logarithms; or, if it be any even part, take such a part of the difference, and apply it to the next less logarithm; but in these operations a few seconds are not regarded.

Second Operation.

			Lat. 7° 16′	0,00350
			Dec. 22 47	0,03528
			Log. ratio	0,03878
	H. M. S.			4,71058
	3 1 30			0,40368
	1 33 0		H. M. S.	
			3 1 30	5,15304
True time	1 28 30			3,86709
N. S. gr. alt.	89623		Log. ratio	0,03878
	6735	N. num.		
			Log.	3,82831
N. S. Sun's m. alt.	96358 = 74 29.		Hence the lat. in is 7° 16′ N.	

The latitude last found, agreeing with that used in the operation, it may be taken as the true latitude; and the operation is repeated

with

with very little additional trouble, few alterations being necessary. Hence it is plain, that if you are mistaken in the latitude by account, yet by repeating the work two or three times, making use of the latitude last found in the next operation, it will at last discover itself to be true, by being equal to the last supposition, which evidently shews the excellency of these tables.

In the former examples we have considered both altitudes taken at the same place or station; but as that is seldom the case at sea, the necessary correction for any alteration of station may be readily made as follows:

	H.	M.
Suppose the first altitude in the forenoon, at —	10	26
The second altitude in the afternoon, at 2 h. 43 m.	14	43
Difference of longitude made is 30 miles W. equal to	0	2
	14	41
	10	26
Subtracted is the elapsed time —— ——	4	15

If a ship has been sailing to the eastward, the above two minutes must be added; but unless the difference of longitude be considerable, it is not worth notice, as it will make a very inconsiderable error in the latitude.

Again, if the ship sails or makes towards that point of the compass which the sun bears upon, she must raise the sun's altitude as many minutes as the miles she has run towards it; therefore the miles run towards the sun must be added to the first altitude; but if sailing from the sun, the same must be subtracted; if they are but few, they are not worth minding; and then the seaman may make a very good estimation by looking at the log-board only, who, by that, will be able to ascertain the distance sailed to, or from the sun, between the observations, which will be of sufficient exactness in the practice of navigation; and if the ship makes an angle with the sun's bearing, it may be readily found by the table of difference of latitude and departure, and then either add or subtract, according as the case requires; as may be seen in the following examples, which are inserted for the benefit of those who require a greater degree of accuracy.

EXAMPLE VI.

Suppose a ship from the Bay of Biscay, bound to the English Channel, in a brisk gale running N. by E. ¼ E. per compass, at the rate of 9 knots per hour, at 10 H. 0 M. A. M. per watch; observed the sun's altitude 13° 18′ bearing South ¼ E. by compass, and at 1 H. 40 M. P. M. per watch, the sun's altitude again was found 14 15, the latitude by account being 49° 17′ N. and the sun's declination 23° 28′ S. Required the true latitude?

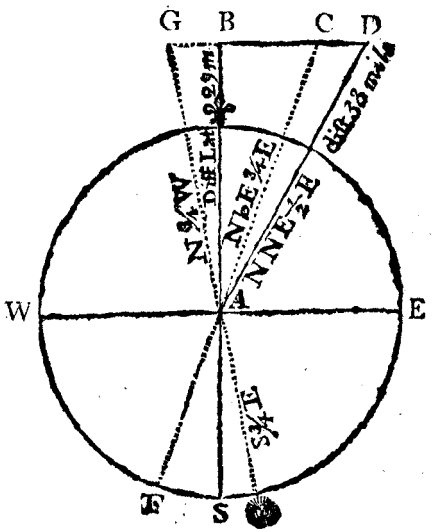
The

The Correction to the First Altitude.

The time of the first observation is 10 H. 0 M. A. M. and of the second 1 H. 40 M. P. M. the elapsed time is 3 H. 40 M. and the rate of sailing is 9 miles per hour; then say, by the Rule of Three, as 1 H. is to 9 miles, so is 3 H. 40 M. to 33 miles, the distance run in the elapsed time.

Again, the sun's bearing at the first observation is south $\frac{3}{4}$ E. the opposite point to which is N. $\frac{3}{4}$ W. or $\frac{3}{4}$ point, and the ship's course during the elap. time is N. by E. $\frac{3}{4}$ E. 1 $\frac{3}{4}$ points, so the angle of ship's course with the sun's bearing is 2 $\frac{1}{2}$ points.

Now in the table of difference of latitude and departure, to the course 2 $\frac{1}{2}$ points, and distance 33, the difference of latitude is 29, and the ship sails from the sun: therefore from the first observed altitude 13° 18′ take 29′, the remainder 12° 49′, the first altitude corrected, which is to be used in the operation, as follows:



Let the circle represent the compass N, S, E, W, and A the ship's place. Take the ship's course N. by E. $\frac{3}{4}$ E. or 1$\frac{3}{4}$ point, and set it off from the north towards the east; take the sun's bearing S. $\frac{3}{4}$ E. or $\frac{3}{4}$ of a point, and set it off from the south towards the east; the opposite point is A G, N $\frac{3}{4}$ W. then will G A C be the angle the ship has made during the elapsed time, which angle being set off from the north, (or meridian) to the east, will be the true course the ship has made from the sun, as the angle B A D. From A to D set off 33 miles, the distance sailed in the elapsed time, from D draw a line parallel to the E. and W. to cut the north or meridian line at B, then A B will be the difference of latitude 29 miles, that the ship has sailed from the sun during elapsed time; which being subtracted from the first altitude leaves the first altitude 12° 49′ which is to be used in the operation. Had the ship sailed towards the sun, the above 29 miles must have been added to the first altitude.

Alt.

	H. M. S.		Alt.	Nat. S.			
Times	10 0 0		14° 15′	= 24615	Lat.	49° 17′	0,18554
	1 40 0		12 49	= 22185	Decl.	23 28	0,03749
					Log. ratio		0,22303
Ela. T.	3 40 0		Diff. N. S.	2430	Its log.		3,38561
					Its log.		0,33559
½ El. T.	1 50 0						
	0 10 0		Time correſponding to				3,94423
	1 40 0		Its log. in col. of riſing is				3,97170
			Log. ratio —		—		0,22303
	90 0			5606	Nat. num. of		3,74867
	17 35			24615			
Zen. diſt.	72 25	N. S. M. Alt. 30221 = 17 35					
Declination	23 28						
Latitude	48 57 N.						

But as the latitude by computation differs conſiderably from that by account, the work muſt be repeated.

			Latitude	48° 57′	= 0,18262
			Declination	23 28	= 0,03749
			Log. ratio		0,22011
		H. M. S.	Diff.S.N.2430 Its log.		3,38561
		1 50 0	Its log.		0,33559
		0 10 0	Time anſwering to		3,94131
	90 0	1 40 0	Its log. in col. of riſing		3,97170
	17 37		Log. ratio —		0,22011
Zen. diſt.	72 23 S.	5644	Nat. num. of		3,75159
Declina.	23 28 S.	24615			
Tr. lat.	48 55 N.	30259 N. S. mer. alt. 17° 37′.			

This latitude differing only 2 miles from that uſed in the computation, it may be depended upon as the true latitude.

EXAMPLE VII.

A ſhip ſailing N. E. half E. by compaſs, at the rate of 9 knots an hour, at 0 H. 31 M. 40 S. P. M. per watch, I found the altitude of the ſun's lower limb 28° 20′ above the horizon of the ſea, the eye being elevated 20 feet above the ſurface of the water, and the ſun's bearing by compaſs being at the ſame time S. by W. and at 2 H. 58 M. 20 S. P. M. by watch, the altitude of the ſun's lower limb was 16° 41′ above the horizon, the eye being elevated as before, and the latitude by account, at the time of the laſt obſervation, was 48° 0′ north, and the declination 13° 17′ ſouth. Required the true latitude at taking the laſt obſervation?

Firſt

First observed alt. sun's lower limb.	28° 20′	Second ditto	16° 41′
Refraction to be subtracted	2		3
Correction for refraction	28 18		16 38
Dip of the horizon subtracted	4		4
App. alt.	28 14		16 34
Sun's semidiameter added	0 16		0 16
Correct altitude of sun's centre	28 30		16 50

Correction for the first Altitude.

The time of the first observation 0 H. 31 M. 40 S. P. M. of the second 2 H. 58 M. 20 S. P. M. so the elapsed time is 2 H. 26 M. 40 S. : the rate of sailing is 9 miles per hour. Then as 1 H. : 9 miles : : 2 H. 26 M. 40 S. : 22 miles, the distance run in the elapsed time.

Again, the sun's bearing at the first observation is S. by W. the opposite point to which is N. by E. or 1 point.

The ship's course during the ela. time is N. E. ½ E. or 4 ½ pts.

So the angle of the ship's course with the sun's bearing is } N. E. by N. ½ E. 3 ½ pts.

In the table of difference of latitude and departure, to the course 3½ points, and distance 22 miles, the difference of latitude is 17 miles. While the ship sails from the sun.

Wherefore, first observed altitude 28° 30′—17′ = 28° 13′ the first correct altitude to be used in the operation.

	H. M. S.	Alt.	N.			
				Lat. by ac.	48° 0′	0,17449
Times	0 31 40	28° 13′	47281	Declin.	13 17	0,01178
	2 58 20	16 50	28959			
				Log. ratio		0,18627
Ela. T.	2 26 40	Diff. N. S.	18322	Its log.		4,26297
½ El. T.	1 13 20	Its log. from col. of ½ elapsf. time				0,50232
	1 46 30	In col. of mid. time corresponding to				4,95156
	0 33 10	Its log. from col of rising				3,01923
				Log. ratio		0,18627
		N. S. gr. alt.	47281			
	90 0		681	N. num. of		2,83296
Mer. alt.	28 40					
		N. S. mer. alt.	47962	28° 40′		
Zen. dist.	61 20 S.					
Decl.	13 17 S.					
Lat.	48 3 N.					

And as it differs but three miles from the latitude by account, it may be taken as the true latitude.

Questions for Exercise.

1st. Being at sea in latitude by account 39° 28′ N. when the sun's declination was 20° 41′ N. at 11 H. 30 M. 15 S. A. M. per watch, the altitude of the sun's lower limb was observed to be 68° 18′ 45,″ and at 12 H. 26 M. 28 S. P. M. it was 70° 58′, the height of the eye being 21 feet above the surface of the sea. Required the true latitude of the ship? Answer, 39° 28′ N.

2d. Being at sea in lat. 50° 40′ N. by account, at 10 H. 17 M. 30 S. A. M. per watch, the altitude of the sun's lower limb was observed to be 17° 4′¼, and at 11 H. 17 M. 30 S. it was 19° 31′¼, the declination being then 20° N. and the height of the eye 21 feet above the sea. Required the latitude in? Answer, 50° 0′. N.

3d. Suppose a ship at sea in lat. 47° 34′ N. by account, at 9 H. 55 M. 30 S. by watch, the altitude of the sun's lower limb was 17° 24′, bearing by compass S. by E. ¼ E. and at 12 H. 54 M. 10 S. his altitude was 21° 45′ ½, the declin. being then 19° 30′ S. the height of the eye 20 feet above the sea, and the ship's course by compass was E. ½ S. at the rate of 7 knots per hour. What was the true latitude? Answer, 47° 24′ N.

4th. At 11 H. 28 M. 20 S. A. M. per watch, the altitude of the sun's lower limb was 28° 18′, the sun bearing then S. by W. by compass. At 2 H. 58 M. 20 S. P. M. his altitude was 16° 40′, the height of the eye 20 feet, his declination being then 13° 17′ N. and the latitude then by account 47° 50′ N. the ship's course during the elapsed time was N. E. with her larboard tacks on board, sailing at the rate of six knots, and made half a point lee-way. What latitude was she in when the last altitude was taken? Answer, 48° 9′ N.

By the ship's course per compass is to be understood, its course made good, lee-way, if any, being first allowed, or the course, by compass, corrected for the lee-way only, but not for the variation. Had the variation of the compass been applied, both to the ship's course and the sun's bearing, it would not have made any difference in the operation or result, as the angle formed by them will always be the same, whether they are both estimated by the compass, or when the variation is allowed on both.

This method of finding the latitude is of excellent use, since there are so many circumstances at sea, which deny the opportunity of having the sun's meridian altitude; and as the knowing the true latitude is of the greatest consequence, especially in coming into the English channel, &c. where there are frequent obstructions of clouds, every seaman ought to be ready at determining his latitude, by this method, whenever an opportunity offers, lest he should not see the sun upon the meridian.

NOTE. The nearer to noon the observations are taken, the better; provided the elapsed time be not much less than half the interval of time, when they are both taken on the same side of noon, nor much

greater than once and half the greater interval, when taken on different sides of noon.

To find the LATITUDE *by one* ALTITUDE *of the Sun, when the Time is not more distant than one Hour from Noon.*

RULE.

To find the true Time.

WHEN the sun's declination and complement of the latitude are both north or both south, their sum, but if one be north and the other south, their difference is the meridian altitude.

From the natural sine of the sun's meridian altitude, subtract the natural sine of the true altitude.

Then add together,

The log. co-secant of the comp. of the lat. } reject. their indexes
The log. secant of the sun's declination, }

and the common logarithm of the difference of natural sines into one sum. The sum of these three logarithms, being found in the column rising, the hours, minutes, and seconds corresponding to it, will be the true time from noon when the altitude was taken.

EXAMPLE.

Being at sea in lat. 50° 40′ N. by account when the sun's declination was 20° south, at 11 H. 17 M. A. M. per watch, sun's alt. was 19° 41′. Required the true time?

Comp. lat.	39. 20 N.	Co-sec.	0. 19803
Declination	20. 00 S.	Sec.	0.02701
Sup. in alt.	19. 20 Nat. sine 33106		
		L. ra.	0.22504
Obser. alt.	19. 41 Nat. sine 33682		
	576 Col. I.	2. 76042	H. M. S.
			12. 00. 00
	Log. in col. of rising	2. 98546 is =	00. 32. 00
		True time at sea	11. 28

Having the true time previous to the observation, to find the change of altitude.

Add together the logarithm found in the col. of rising answering to the minutes and seconds the sun had to rise when the altitude was taken, and the secant of the supposed meridian altitude from this sum, (the index being increased by 5*,) subtract the log. ratio, the remainder is the log. sine of the change of altitude from the time of observation to noon; which being added to the observed altitude gives the sun's meridian altitude.

* The 5 is the index of six hours in the column of rising.

Log. in col. of rising of 32 M.	2. 98820	Obser. alt.	19. 41
Log. sec. m. alt. 19° 20′	0. 02521	Cha. of alt.	+ 21
Increase index	5.	Tr. m. alt.	20. 02
	8. 01341		
Subtract log. ratio	0. 22504		
Log. sine chan. of alt. 21 min.	7. 78837		

EXAMPLE II.

Being at sea in lat. 60 north by account, when the sun was on the equator at 1 H. 0 M. P. per watch, the sun's alt. was 28° 53′. Required the true time and latitude in?

Com. Lat.	30. 00 N.	Nat. sine 50000	Co. sec. 0. 30103	Log. ratio.
Ob. alt.	28. 53	Nat. sine 48303		
Ch. of lat.	1. 08	1697	Com. log. 3. 22968	
T. m. alt.	30. 01	Log. in col. of rising is = 3. 53071 = 1. 00 (H. M.) Tr. T.		
Zen. dist.	59. 59 N.	Log. sec. mer. alt.	0. 06247	
The S. being on the equator.		Increase Index	5.	
			8. 59318	
		Subtract log. ratio	0. 30103	
		Log. sine chan. of alt. 1° 08′	8. 29215	

EXAMPLE II.

Being at sea in lat. 39° 28′ north by account, sun's declination 20° 41′ north at 26 M. 28 S. P. M. sun's alt. was 71° 10′. Required the true time and latitude at the ship?

Comp. lat.	50. 32 N.		Co. sec.	0. 11239
Declination	20. 41 N.	Nat. sine 94674	Secant	0. 02893
Sup. m. alt.	71. 13	Nat. sine 94646		0. 14132
		28	Com. log. 1. 44716	
Obser. alt.	71. 10	Lo. in col. of rising is = 1. 58848 = 6. 30 (M. S.) T. T.		
Chan. alt.	3	Log. sec. sup. mer. alt. 0. 49216		[at sh.
T. mer. alt.	71. 13	Increase index	5.	
Zen. dist.	18. 47 S.		7. 08064	
Declination	20. 41 N.	Subtract log. ratio	0. 14132	
Lat. in	39. 28 N.	L. sine chan. of alt. 3 m.	6. 93932	

NOTES

NOTES.

1ſt. The altitudes for determining how much the watch differs from apparent time had better be taken in the morning, or evening, when the ſun's altitude does not exceed 18 degrees.

2d. An error in the ſuppoſed latitude can make very ſmall difference in the change of altitude; and the nearer the altitude is taken to noon the better to find the change of altitude.

3d. This method is not to be depended on ſhould the apparent time exceed an hour from noon, and in ſome inſtances, not then; ſuch as altitudes taken near the equator; or when the meridian altitude exceeds 60 degrees; nor is there much occaſion for this method, or that of the double altitudes there, ſince there is generally a clear horizon, and conſequently a meridian altitude eaſily obtained.

To find the Latitude by the Meridian Altitude of the Moon.

IN page 6th of the month in the Nautical Almanac, find the time of the moon's paſſing over the meridian of Greenwich.

Turn the longitude into time, by Table XI. and add it to the above time, if it be weſt, but ſubtract it, if it be eaſt: the ſum or difference, will be nearly the time of her paſſage over the meridian of the place of obſervation; which call reduced time.

In page 7th of the month in the Almanac, find the moon's ſemidiameter and horizontal parallax, at the reduced time.

Take the difference between the moon's ſemidiameter and dip, and add it to the obſerved altitude, if the lower limb was obſerved, but ſubtract their ſum if the upper limb was obſerved; the ſum or difference will be the apparent altitude of her centre.

From the proportion logarithm of the moon's horizontal parallax, found in Table IX. increaſing its index by 10, ſubtract the log. coſine of the moon's apparent alt. the remainder will be the prop. log. of the moon's parallax in altitude, from which take her refraction, the difference will be a correction, which being added to the apparent altitude, will give the true altitude of her centre: hence the zenith diſtance, to which apply her declination, and you will have the latitude.

NOTE. The moon's declination is ſet down in page the 6th of the month for every noon and midnight in the Nautical Almanac.

Therefore find the declination for the neareſt noon and midnight both before and after the reduced time, and take the difference.

Then as 12 hours : is to the difference in 12 hours : : ſo is the reduced time : to a proportional part; which being added to, or ſubtracted from the declination, the noon or midnight before the reduced time, according as it is increaſing or decreaſing, will give the declination at the time and place of obſervation.

EXAMPLE. I.

Suppoſe on Sept. 21, 1796, in long. 45° weſt, the altitude of the moon's lower limb, when on the meridian ſouth of the obſerver, ſhould be 67° 43′½, the eye being 23 feet above the ſea. Required the latitude?

By

By the Almanac, the moon passes over the meridian of Greenwich that day at 16 H. 10 M. afternoon, and the 45° west turned into time and added to it, gives 19 H. 10 M. that is 7 H. 10 M. past midnight, the time she passes the meridian of the place of observation.

Hor. par. 59′ [illegible]″	Prop. log.	10,4826	Moon's obs. alt.		67° 43′ 30″
App. alt. 67 55	Log. cos.	0,5751	Sem. dia. 16° 8′		
			Dip. 4 34		11 34
Prop. l. of M's. p. in alt. 22′ 16″		9075			
Moon's refraction	23		App. alt.		67 55 4
	21 53		Correct. of moon's alt.		21 53
Sep. 21st,					
Moon's decl. at midnight	17° 37′	17° 37′	M's. tr. alt		68 16 57
Sept. 22d, ditto at noon	19 23	1 3			90
	1 46	18 40	Zen. dist.		21 43 3 S.
As 12 H.: 1° 46′ :: 7 H. 10 M.		; 1° 3′	Decl.		18 40 0 N.
			Lat. in		40 23 3 N.

NOTE. If the nearest minutes are taken and the seconds rejected, it will be sufficiently exact for the purpose of finding the latitude.

EXAMPLE II.

Suppose on Dec. 13, 1796, in long. 30° east, the alt. of the moon's upper limb should be observed when on the meridian, being then south 56° 15′, the eye 20 feet above the sea. Required the latitude?

The moon passes over the meridian of Greenwich that day, by the Almanac, at 11 H. 23 M. afternoon. The long. in time 2 H. subtracted from 11 H. 23 M. leaves 9 H. 23 M. for the time she passes the meridian at the place of observation.

At this time the moon's semi-diameter is found to be 16′ 41″, and her horizontal parallax 61′ 10″.

H. par. 61′ 10″	P. L.	10,4687	Alt. M.'s up. l.		56° 15′ 0″
Ap. alt. 55° 54′	Cos.	9,7487	Sem. diam. 16′ 41″		
			× Dip. 4 16		20 57
P. log. of P. in alt. 34′ 18″		7200			
Refraction	38		App. alt.		55 54 3
			Cor. of moon's alt.		33 40
	33 40				
			Moon's alt.		56 27 43
Moon's decl. Dec. 13, at noon		19° 18′			90 0 0
Ditto at midnight		20 59			
			Zen. dist.		33 32 17
	Diff.	1 41			
As 12 H.: 1° 41′ :: 9 H. 23 :		1° 19′	Decl.		20 37 0
Decl. at noon		19 18			
			Lat.		54 9 17 N.

To

To find the Latitude by the Meridian Altitude of a Planet.

In page 4th of the month in the Nautical Almanac are given the declinations and times of the planets' paſſage over the meridian of Greenwich every ſix days.

Reduce the longitude into time, and add it to, or ſubtract it from the times of their paſſage over the meridian of Greenwich, according as their longitude is eaſt or weſt: the ſum or difference will be the time they paſs the meridian of the place of obſervation: correct the obſerved altitude for the dip. and refraction, with this corrected altitude and declination find the latitude; as for

EXAMPLE.

Suppoſe in long. 45° W. on Oct. 1, 1796, the meridian altitude of Jupiter, when ſouth of the obſerver, ſhould be 41° 30′, the eye 22 feet above the ſea, and the latitude be required?

By the Almanac, Jupiter paſſes the meridian of Greenwich that day at 9 h. 53 m. afternoon; and 3 h. the long. in time, added to it gives 53 m. after 12 at night, when he paſſes over the meridian of the place of obſervation.

	Meridian alt.	41° 30′ 0″
Dip. 4′ 28″ +	Refract. 1′ 4″ =	0 5 32
	True alt.	41 24 28
		90
	Zen. diſt.	48 35 32 S.
	Declination	11 12 0 S.
	Latitude	37 23 32 N.

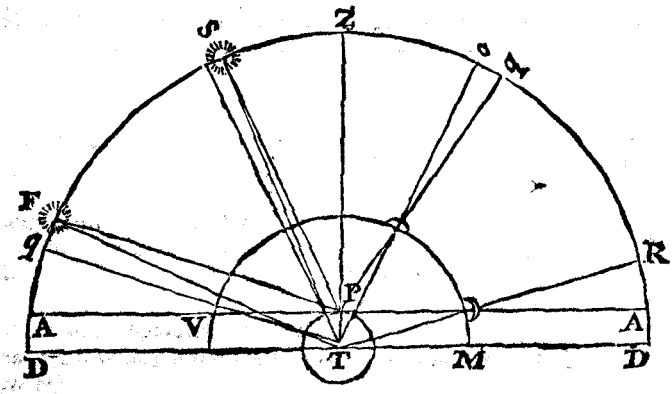
The declination of the planets are ſet down for every 6 days, but may be found for intermediate days by taking proportional parts.

OF THE PARALLAX.

PARALLAX is the difference between the altitude of the ſun, moon, or ſtar, and the altitude of the ſame object ſeen at the ſame time from the earth's ſurface; or it is the angle the earth's ſemi-diameter would appear under by an obſerver placed at the ſun, moon, or ſtar.

The parallax of the heavenly bodies are greateſt when in the horizon, hence called the horizontal parallax; that of the moon's is ſet down in the Nautical Almanac for every noon and midnight, and lies between 54′ and 62′; the parallax diminiſhes according to the altitude

altitude of the object until it comes to the zenith, where it is nothing; the difference of the elevation of objects is called the parallax in altitude, and it is easy calculated by saying, as radius is to the horizontal parallax, so is the co-sine of the altitude to the parallax in altitude: now, as all objects are depressed by their parallax, so they are elevated above their true altitudes by refraction.



Let PT represent the earth, T the centre, M ☽ V a part of the moon's orbit, DD part of the sun's orbit, and the rational as well as AA is the sensible horizon.

Now, an observer at T will see the moon in the line ☽ R, when another at P at the same time will see her in the line ☽ A in the sensible horizon, and the angle P ☽ T = M T ☽ = A ☽ R is the horizontal parallax set down in the Nautical Almanac for every noon and midnight, and lies between 54′ and 62′; this angle diminishes as the object approaches the zenith; for suppose the moon in the line P q the < q ☽ o = P ☽ T is less than the < A ☽ R = < T ☽ P, still diminishing until it comes to the zenith Z, where it is nothing. To find the diminution of parallax in altitude, say, as radius: is to the horizontal parallax: : so is the co-sine of the apparent altitude: to the parallax in altitude.

The parallax of the moon is greater than any of the rest of the planets, owing to her being nearest the earth, the vast distance of the sun and stars rendering their parallax so small, that they are often neglected in nautical calculations; for suppose the sun at F or S, then the < TFP = qTF is the sun's parallax, about 8 ½ seconds.

Having the earth's semi-diameter and the parallax of any of the planets, their distance may be found, by saying, : as the tangent of the parallax: is to the earth's semi-diameter in miles : : so is radius : to the distance.

Having the distance, the parallax is found by saying, As the distance

tance : is to radius : : so is the earth's semidiameter : to the tangent of the parallax.

The earth's semidiameter is 1146 nautical leagues, the sun's distance from the earth is 27,809,344, the moon 69,059, Mercury 10,764,563, Venus 20,115,400, Mars 42,372,897, Jupiter 144,635,833, and Saturn 265,283,603 leagues.

To reduce the Sun's Declination from Noon at Greenwich, to the NOON under any other Meridian. By Table XVIII.

RULE.

1st. WITH the longitude in from Greenwich, in the top column expressed both in time and degrees, look for that answering nearest to your longitude in.

2d. Look for the day of the month in the side column, the number of minutes, and seconds where that cuts (in the same col. of your longitude in) is either to be added to, or subtracted from the declination that day at Greenwich.

To know whether it is to be added, or subtracted, look at the top, and under the column of the day of the month you will see, add in east, or subtract in west, (and *vice versa*) which having done will give the true declination for the noon at the place of observation.

EXAMPLE.

Required the true declination, October 10, 1796, in longitude 52° E. of Greenwich.

Sun's decl. Oct. 10 at Greenwich	7° 1′ 32″	per Ephemeris.
Varia. of decl. per tables Oct. 9 and long. 52° east gives	0 3 15	to be sub. in east long.
True decl. Oct. 10, in long. 52 E.	6 58 17	

To reduce the Sun's Declination from Noon at any Meridian, to any other Time under that Meridian.

RULE.

1st. With the time from noon in the top of column, look for that answering nearest to this time.

2d. Look for the day of the month in the side column, the number of minutes and seconds, where that cuts (in the same column of the time from noon) is either to be added to, or subtracted from the declination that day at Greenwich, noon.

To know whether it is to be added or subtracted, look at the top, and under the column of the day of the month, you will see add afternoon, or subtract before noon, (and *vice versa*) which you having

 done,

done, will give you the true declination for any time differing from noon.

NOTE. In all calculations for determining the longitude, the sun's declination is taken out of the Nautical Almanac, as it is there calculated to the nearest second.

EXAMPLE I.

Required the sun's true declination October the 10th, 1796, at 8 H. 21 M. in the forenoon, in longitude 52° east of Greenwich?

Variation of decl. Oct. 10, per table in long. 52° E. subtract in east longitude - -	0° 3′ 15″
Variation of Decl. for 3h. 39m. from noon Oct. 10, per tables to be subtracted before noon,	0 3 26
Sum of variations subtract - -	0 6 41
Sun's declination per Naut. Al. Oct. 10, at Greenwich	7 13 2S.
True decli. Oct. 10, in long. 52 E. at 8 h. 21 m. A. M.	6 6 21S.

EXAMPLE II.

Required the sun's true declination, May 7, 1796, at 5 h. 30 m. P. M. and in longitude 35° 30′ west of Greenwich?

	H. M. S.
Varia. of declination May 7, in long. 53 30 west Add in west longitude	0 1 41
Varia. of decli. for 5 h. 30 m. from noon May 7, per tables to be added afternoon,	0 3 52
Sum of Varia. Add, or correction of declination	0 5 33
Sun's declination May 7, per Ephemeris	17 5 24
T. decl. May 7, long. 35. 30 W. at 3 h. 30 m. P. M.	17 10 57

The above method will give the sun's declination sufficiently correct for all nautical purposes; but those who wish to come to the greatest degree of exactness may use the following method.

Turn the ship's longitude into time by Table XI. and add to it the time per watch, if the longitude be west, but subtract it if the longitude be east, the sum or difference will be the time at Greenwich, which call the reduced time.

Look in the Nautical Almanac for the given day, and in page the 2d of the month stands the sun's declination.

If the reduced time be in the morning, take the difference of declination between the noon before, and noon after the reduced time.

Then say by the Rule of Three,

As 24 hours : is to the daily difference of declination : : so is the reduced time : to a number of minutes and seconds, which being added to the declination the noon before if it be increasing, or subtracting it if decreasing, the sum or difference will be the declination at the ship.

To

To find the apparent Time, and thereby regulate the going of the Watch, and First, by Equal Altitudes of the Sun.

AT the time when the watch ſtands in need of being regulated for the obſervations intended, let the ſun's altitude be taken at any convenient time in the forenoon, 2, 3, 4, or 5 hours diſtant from the meridian. Set down the altitude with the correſponding time exactly (the index being already ſet to the morning altitude:) note down the time of the ſame altitude in the afternoon; half the ſum of theſe two times is the apparent time ſhewn by the clock or watch when the ſun was upon the meridian of that place. But it muſt here be obſerved, that if the change of declination be conſiderable during the elapſed time, it muſt be allowed for, by adding the difference to, or ſubtracting it from, the ſecond altitude, according as it is increaſing or decreaſing. Leſt that an altitude taken in the forenoon cannot by the interpoſition of clouds have a correſponding one in the afternoon; it is therefore proper to take ſeveral in the forenoon, in order to ſecure a correſponding one in the afternoon. And, if ſeveral equal altitudes can be taken on both ſides of the meridian, it will be beſt to find the noons for each pair, and the means of all the noons thus found for the true one.

When there is reaſon to believe that the watch gains or loſes conſiderably, other ſets of obſervations may be taken on ſucceſſive days, whereby the daily variation may be found and allowed for; by which means the artiſt will have little more to do in finding his longitude by obſervation, than to reduce the obſerved diſtance of the objects to the true diſtance of their centres; the ſhip's time being ſhewn by the watch previouſly regulated.

EXAMPLES.

May 20, 1796, ſuppoſe that at 8 h. 40 m. in the forenoon, and 3 h. 16 m. afternoon by watch, the ſun had equal altitudes, and the going of the watch be required?

	H.	M.
Now add together	12	0
	8	40
	3	16
	2)23	56
½ gives noon per watch	11	58
True noon ——	12	0
Watch ſlow ——		2

March 18, 1796, in lat. 49° N. ſuppoſe at 8 h. 10 m. 58 s. forenoon, and at 3 h. 58 m. 34 s. you have equal altitudes of the ſun, Required the going of the watch?

The diſtance of the time from noon when the firſt was taken is 3 h. 49 m. 2 s. doubled is 7 h. 38 m. 4 s. and the daily decreaſe of declin. at this time is 23m. 41s.

Now as 24 h. : 23′ 41″ :: 7 h. 38′ 4″ : 7′ ½.

Hence the index of the quadrant muſt be ſet 7′ ½ forward on the arch, to correſpond with the morning alt. whence the watch will be found 4′ 46″ too faſt.

Here

Here it is ſuppoſed that the ſhip is lying by, or makes no way through the water; but if ſhe is ſailing to or from the ſun, proper allowance muſt be made for her run, during the elapſed time; but the following methods of finding the time will anſwer every purpoſe at ſea.

To find the apparent Time by the Sun's Altitude.

Find the ſhip's latitude and longitude by account, at the time of obſervation, by carrying the reckoning forward to that time.

With a quadrant well adjuſted, take the altitude of the ſun's lower limb.

Take the difference between the ſemidiameter and dip of the horizon, and add it to the obſerved altitude, the ſum will be the ſun's apparent altitude.

Take the difference between the ſun's refraction and parallax in altitude, and ſubtract it from the apparent altitude; the remainder will be the true altitude of the ſun's centre; hence the true zenith diſtance.

Turn the ſhip's longitude into time, and either add to or ſubtract from the time per watch, according as it is eaſt or weſt; the ſum, or difference, will be the reduced or ſuppoſed time at the place of obſervation.

Take the ſun's declination out of the Nautical Almanac, and proportion it to the reduced time: with the ſun's true declination find the polar diſtance: then,

Add together The zenith diſtance,
The co-latitude, and
Polar diſtance into one ſum.

From half this ſum ſubtract the zenith diſtance, noting the half ſum and remainder, then add together

The log. co-ſecant of the comp. of the latitude, } rejecting their
The log. co-ſecant of the polar diſtance, } indexes.
The log. ſine of the half ſum, and
The log. ſine of difference into one ſum.

Take the log. ſine of half the ſum of the four logarithms, which being doubled and brought into time as before, will give the times from the midnight before the altitude was taken.

Half the ſum of theſe four logarithms will give the log. co-ſine of half the hour angle; which being doubled and turned into time, by allowing 15 degrees for every hour, &c. or more briefly by the Table, will give the true time, if the altitude was taken in the afternoon; but if in the forenoon, its complement to 24 hours will be the true time, reckoned from the preceding, or noon before. Or, what perhaps will be found more eaſy to the learner:

NOTE, The refraction is found in Table XII. of this book.
The dip of the horizon, Table XIII. in ditto.

The ſun's parallax in alt. Table XIV. in ditto.
The ſun's decl. in page 2d of the month, and
The ſun's ſemidiameter in page 3d of the month in the Nautical Almanac.

EXAMPLE I.

Suppoſe on the 7th of May, 1796, at 5 h. 30 m. 32 s. P. M. or afternoon per watch, in latitude 39° 54′ N. and long. 35° 30′ weſt of Greenwich, by account, the altitude of the ſun's lower limb ſhould be found to be 15° 45′, the eye being 18 feet above the ſurface of the ſea, and the true apparent time when the obſervation was made was required?

Obſ. alt. S.'s L.L.	15°45′ 00″	Lat.	39°54′N.	
			90	
Dip 4′ 3″ ſemi. 155 3 diff.	11 50	Co-lat.	50 6	
Ap. alt. S.'s L.L.	15 56 50			
Refra. 3′ 17″ par. 8 diff.	3 9	Sun's decl. May 7, per N. A.		17° 5′ 24″
		V.dec.p.tab.for lon.35°30′W. add		1 42
Sun's true alt.	15 53 41	Ditto for 5 h. 30′ from noon add		3 52
90				
		True decl. cor. for lon. and time		17 10 58
Zenith diſt.	74 6 19			90
5 h 20		Polar diſt.		72 49 2
Co-lat.	50 6 00	Co-ſecant		0.11581
Polar diſt.	72 9 04	Co-ſecant		0.01918
Sum	2)197 01 21			
½ Sum	98 30 40	Log. ſine		9.99518
Zenith diſt. ſub.	74 6 19			
Remainder	24 24 21	Log. ſine		9.61616
Sum of 4 log.				19.74628
½ Sum log. co-ſi. ½ hour angle		=41° 41′ 44″		9.87314
		2		
Hour angle				5 33 34
Time at ſhip per watch		83 23 28 in time =		5 30 32
Watch ſlow				3 2

NOTE. The co-ſecant of any arch, [rejecting index) is equal to the arithmetical co-ſine of that angle.

By turning the longitude weſt into time, and adding to the time at the ſhip, gives the reduced time 7 h. 52 m. and the difference of declination between the 7th and 8th of May 16′ 10″; then by the Rule of Three, as 24 : 16′ 10″ :: 7 h. 52 m : 5′ 17″, which being added, the declination May 7 = 17° 5′ 24″ gives 17° 10′ 41″, hence the polar diſtance is 72° 49′ 19″ and working with which will give the true time, 5 h. 33 m. 32s.

EXAMPLE

EXAMPLE II.

Suppose that in the forenoon or A. M, on the 9th of Oct. 1796, in latitude 51° 30′ N. and long. 52° E. the altitude of the sun's lower limb should be found as under, the eye being 18 feet above the sea, and true apparent time of the day was required?

Times.	Altitudes.		
		Lat. 51° 30′ N.	
H. M.	° ′		
20 14			
20 19	13 20	S.'s decl. Oct. 10, per Naut. Alm.	7° 1′ 32″
20 30	14 51	Var. per tab. for lon. 52 E. sub.	3 15
3)61 3	40 39	Ditto for 3h. 39m. T. from N. sub.	3 26
Mea. 20 21	13 33		6 41

S.'s sem. 16′ 5″ diff. 4′ 28″ diff. 11′ 37″ Decl. at ship 6 54 51 S
90

App. alt.	13 44 37	Polar distance	96 54 51
Refr.—3′51″—par. 9″ diff.	3 42		
Sun's true alt.	13 40 55		
Zenith dist.	76 19 5		
Co-lat.	38 30 0	Co-sec. 0,20585	
Polar dist.	96 54 51	Co-sec. 0,00317	
Sum	211 43 56		
½ Sum	105 51 58	Log. sine 9,98313	
Zenith dist.	76 19 5		
Remainder	29 32 53	Log. sine 9,69298	
Sum		2)19,88513	

½ Sum = sine of 61° 10′ 34″ ½ the H. angle = 9,94256
2

Hour angle = 122 21 8 = 8h. 9m. 25s. = time from last midnight
Time per watch 8 21 0

Watch too fast 11 35

As the time is before noon, the sine of half the sum of the logs. is taken and doubled, which gives the hour angle reckoned from the last

last midnight; for there seems to be no necessity for taking the co-sine of half the four logs, unless the observation be made in the afternoon; and the learner perhaps will be less liable to make mistakes.

The declination may be found thus:

The time per watch is 20 h. 21 m. from last noon, the long. in time is 3 h. 28 m. which subtracted from 20 h. 21 m. leaves the apparent time 16 h. 53 m. the daily difference of declination is 22′ 44″. Now as 24 : 22′ 44″ : : 16 53 : 15′ 59″, which being added to the sun's declination Oct. the 9th, = 6° 38′ 48″ gives 6 hours 54 minutes 47 seconds, the true declination at the time and place of observation, whence the polar distance is 96° 54′ 47″.

Here again it may be proper to observe, that as the day in the Nautical Almanac begins 12 hours later than the civil-day, and 24 hours later than the sea-day, 20 h. 21 m. makes 8 h. 21 m. or 21 m. after 8 in the morning of Oct. 10th of the civil-day, and 8h. 21 m. A. M. Oct. 10th according to the sea account of time, therefore the end of the sea-day, the noon of the civil-day, and the beginning of the day in the Nautical Almanac are all at the same time.

To find the apparent Time by the Altitude of a fixed Star.

Correct the observed altitude for the dip and refraction.

Find the ship's latitude by account at the time of observation.

Find the star's right ascension and declination in Table XX.

Then add together

Zenith distance,
Co-latitude, and
Polar distance into one sum.

From half this sum subtract the zenith distance, noting the half sum and remainder.

Then add together

Log. co-sec. of complement of the lat. } rejecting their
Log. co-sec. of polar distance, } indexes.
Log. sine half the sum, and the
Log. sine remainder into one sum.

Half the sum of these four logarithms will be the log. co-sine of half hour angle.

Turn this hour angle into time, and apply it to the star's right ascension, by subtracting it when the star is east of the meridian, or adding it when it is west of the meridian, their sum or difference will be the right ascension of the meridian or mid-heaven.

From the right ascension of the meridian (increased by 24 if necessary) subtract the sun's right ascension the preceding noon at Greenwich, taken from page 2d of the month in the Nautical Almanac, the remainder will be the apparent time at ship nearly.

To

To this time apply the long. of the ſhip from Greenwich turned into time, by adding it when it is weſt, or ſubtracting it when it is eaſt, the ſum or difference will be the apparent time of the obſervation nearly by the meridian of Greenwich.

Then ſay, as 24 hours is to the daily variation of the ſun's right aſcenſion, ſo is this time to a number of minutes and ſeconds, which ſubtracted from the above time, leaves the correct apparent time at ſhip.

EXAMPLE I.

Suppoſe on Sept. 7th, 1796, in lat. 7° 45′ ſouth, and long. 30° 18′ eaſt of Greenwich, the altitude of the ſtar Procyon, being then eaſt of the meridian, ſhould be 28° 16′, and the eye 18 feet above the ſurface of the ſea. Required the true time?

Star's obſ. alt.	28° 16′ 0″	Lat. by account	7° 45′ 00″
Refrac. 1′ 47″			90
Dip 4 3	5 50		
		Co-lat.	82 15
Star's true altitude	28 10 10		
	90	Star's declination	5 44 58
			90
Zen. diſt.	61 49 50		
Polar diſtance	95 44 58	Polar diſtance	95 44 58
Co-latitude	82 15 0	Log. co-ſec. 0,00219	
		Log. co-ſec. 0,00398	
Sum	239 49 48		
Half ſum	119 54 54	Log. ſine 9,93789	
Zen. diſtance	61 49 50		
Remainder	58 5 4	Log. ſine 9,92881	
		Sum 2)19,87287	
Half-hour angle	30 15	Half ſum 9,93643	
	2		
		H. M. S.	
Hour angle	60 30 =	4 2 0	
Star's right aſcenſion		7 28 39	
Right aſcenſion of meridian		3 26 39	
Increaſed by		24	
		27 26 39	
Sun's right aſcenſion at noon		11 6 37	
Time at ſhip nearly		16 20 2	

Time

	H.	M.	S.
Time at ſhip nearly	16	20	2
Ship's lon. 30° 18′ eaſt in time	2	1	12
Time at Greenwich nearly	14	18	50
Sun's right aſcenſion, Sept. 7	11	6	37
Ditto 8	11	10	13
Daily difference		3	36

Then ſay, as 24 H. : 3 M. 36 S. : : 14 H. 18 M. 50 S. : 2 M. 9 S. which ſubtracted from 16 H. 20 M. 2 S. the time at ſhip nearly, leaves 16 H. 17 M. 53 S. the true time at ſhip after noon, or 4 H. 17 M. 53 S. after midnight.

EXAMPLE II.

Suppoſe on April 14, 1796, in lat. 48° 56′ N. long. 66° W. the obſ. alt. of Aldebaran, when weſt of the meridian, ſhould be 22° 24′ ½, the height of the obſerver's eye 21 feet above the ſurface of the ſea. Required the true apparent time at ſhip?

Obſ. Alt. Star Ald.		22°	24′	30″	Lat. by acc.	48° 56′	N.
Refrac. 2′ 18″						90	
Dip	4 22		6	40			
					Co. lat.	41 4	
Star's true alt.		22	17	50			
		90			Star's decl.	16 5 19	
						90	
Zen. diſt.		67	42	10			
					Polar diſt.	73 54 41	
Polar diſt.		73	54	41	Log. co-ſec. 0,01736		
Co. lat.		41	4	0	Log. co-ſec. 0,18248		
Sum		2)182	43	51			
Half Sum		91	20	25	Sine 9,99988		
Zen. diſt.		67	42	10			
Remainder		23	38	15	Sine 9,60309		
					Sum 2) 19,80281		
Half-hour angle	37° 10′ Co-ſine.				Half ſum 9,90140		
	2						
					H. M. S.		
Hour angle	74 20 = in time				4 57 20		

		H.	M.	S.
Hour angle 74 20 = in time		4	57	20
Star's right aſcenſion		4	24	14
Right aſcenſion of meridian		9	21	34
Sun's right aſcenſion		1	33	30
App. time at ſhip		7	48	4
Long. 66 W. in time		4	24	0
App. time at Greenwich		12	12	4
Sun's right aſcenſion, April 14		1	33	30
Ditto 15		1	37	11
Daily difference	——		3	41

Then ſay, as 24 H. : 3 M. 41 S. : : 12 H. 12 M. 4 S. : 1 M. 52 S. which ſubtracted from 7 H. 48 M. 4 S. the apparent time at ſhip nearly, leaves 7 H. 46 M. 12 S. the correct app. time at ſhip.

NOTE. This method of finding the time is certain, could a good horizon be obtained in the night; but as that is not always the caſe, it is beſt to regulate the watch by the ſun.

Another Method of finding the apparent Time.

R U L E.

When the ſun or ſtar's declination, and complement of lat. are both north or both ſouth, their ſum*, but if one be north, and the other ſouth, their difference is the meridian altitude.

From the natural ſine of the ſun or ſtar's mer. alt. ſubtract the natural ſine of the true altitude.

Then add together

The log. co-ſec. of the comp. of the lat. } rejecting their
The log. ſec. of the ſun or ſtar's decl. and } indexes.
The log. of the diff. of the natural ſines into one ſum.

The ſum of theſe three logarithms, being found in the column of riſing, the hours, minutes, and ſeconds correſponding to it, will be the true time from the noon when the altitude was taken.

The four laſt examples may be worked by the above method.

* If the ſum exceeds 90° ſubtract it from 180, and the remainder will be the meridian altitude. (See the two laſt examples of the ſun.)

EXAMPLE

EXAMPLE I.

Co-latitude	50° 6′ N.		Log. co-secant	0,11511
Declination	17 11		Log. secant	0,01983
Meridian alt.	67 17	N. sine	92243	
True alt.	15 54	N. sine	27396	
Diff. of nat. sines			64847 Its log.	4,81189
In col. of rising gives true time 5 h. 33′ 30″ differing 2″ from the former method				4,94683

EXAMPLE II.

Co-latitude	38° 30′ N.		Log. co-secant	0,20585
Declination	6 55 S.		Log. secant	0,00317
Meridian alt.	31 35	N. sine	52374	
True alt.	13 41	N. sine	23656	
Diff. of nat. sines			28718 Its log.	4,45815
In col. of rising gives true time 3 h. 50′ 30″				4,66717

Here we find the time found by this method differs 2 seconds from that found by the former, but it may be found to the nearest second by taking proportional parts.

Thus the difference between the log. of 3 h. 50′ 30″ and 3 h. 51′ is 172, and the difference between the log. of 3 h. 50′ 30″ and that in the calculation is 15.

Now as 172 : 30″ : : 15 : 2″, which being added to 3 h. 50′ 30″, gives 3 h. 50′ 32″, (see the two last examples of the stars.)

EXAMPLE III.

Co-latitude	82° 15′		Co-secant	0,00398
Declination	5 45		Secant	0,00219
Meridian alt.	76 30	N. sine	97237	
True alt.	28 10	N. sine	47204	
Diff. of nat. sines			50033 Its log.	4,69926
In col. of rising gives 4 h. 2 m.				4,70543

EXAMPLE

EXAMPLE IV.

Co. lat.	41° 4′ 0″	Co-sec.			0,18248
Declination	16 5 19	Secant			0,01735
Mer. alt.	57 9 19	N. sine	84014		
True alt.	22 17 50	N. sine	37933		
Difference	—	—	46081	Its log.	4,66346
In col. of rising gives 4 H. 57 M. 20 S.				—	4,86329

Having found the hour angle, proceed to find the true time by the stars, as has been shewn in the two last examples, worked by the former method.

How to know the Stars.

It sometimes happens that for want of a map of the stars, or a celestial globe, many are at a loss to know whether they have observed by the right star or not, as there may some other stars come to the meridian nearly at the same time. But this may be easily proved, by finding the star's meridian altitude as above; and if it nearly agrees with that on the quadrant, it must certainly be the right star, otherwise not. The same may be observed of any of the planets.

To know when any star comes to the meridian, or what star will be on the meridian at any given time, see the explanation following Table XX. and for their rising and setting, with that of the moon and planets, see the directions following Table XXII. in this book.

NOTE 1. If an observation of the sun has not been taken the preceding noon, or two altitudes to find the latitude, it may be ascertained by taking the meridian altitude of the star, either before or after the observation is made for finding the time.

NOTE 2. If the ship's longitude east of Greenwich in time be greater than the apparent time at the ship, the apparent time must be increased by 24 hours before subtracting the longitude; and in this case, the sun's right ascension must be taken out of the Ephemeris for the preceding day of the month. And if the ship's longitude west of Greenwich in time, added to the apparent time at the place of the ship, makes more than 24 hours, 24 must be subtracted from the sum, to obtain the apparent time at Greenwich; and the sun's right ascension must be taken out of the Ephemeris for the subsequent day of the month. The object, whether sun or star, whose altitude is taken for finding the time, must be at least three or four points of the compass distant from the meridian; because, when near to the meridian, the alteration in altitude is too slow for ascertaining the time with proper exactness: but the nearer the object is to the east or west the better, provided it be not less than

than 6° high; for the refraction is so variable and irregular near to the horizon, that the effect of refraction upon objects cannot be determined with sufficient accuracy, when their altitudes are less than 6 degrees.

The Method of finding the LONGITUDE *at* SEA.

THE surprising improvements made in navigation within the last thirty years, is beyond the most sanguine expectation; and though several nations have contributed towards this important end, the English have (by the encouragement given by parliament, and the great improvements made in nautical instruments and calculations) outdone them all, so that, by help of the improved Sextant, the Nautical Almanac, and the Requisite Tables, contained in this book, a skilful and expert observer can determine the longitude to a degree of certainty, that people unacquainted with the operation would scarcely think possible.

What is here meant by a skilful and expert observer, is, an artist who can in an instant bring the two limbs of the objects whose angular distance is to be measured into contact, in the centre of the inverted telescope, and, that can rectify any little defects, or errors that the instrument is liable to on account of its being handled or moved about, &c. To do which the following instructions may be found useful to the young artist.

1st. The instrument must be adjusted thus: bring ☉ on the nonius to coincide with ☉ on the arch, then see if the index glass stands perpendicular to the plane of the instrument, if it does not alter it by means of the screws for that purpose: after which, the reflected image of the sun must be brought directly over the true image, so that but one image appears; this being done, which is by no means difficult, the instrument is properly adjusted, as the little speculum will stand parallel to the great one.

But to prove the instrument after this adjustment, and to find if there is any index error, move the index forward on the arch, and bring the true and reflected images of the sun's limbs into contact, and note what his diameter measures. Again, move the index backward on the part of the arch behind the ☉ and bring the reflected and true images of their limbs into contact as before, and note what his diameter measures; half the difference between the two diameters is the index error, which must be subtracted when the diameter measures more on the arch than on the extra arch, otherwise it must be added.

Suppose, for example, the sun's diameter measures when the index is advanced on the arch 34′, and at the same time when the index is put back on the extra arch 30′, the difference is 4′, then 2′ is the index error, which must be subtracted from all altitudes or angular

angular diſtance taken, becauſe the ſun's diameter meaſured more on the arch before ☉ than behind it.

After the index error is found, yet before the inſtrument is fit to take the angular diſtance between any objects, there is another adjuſtment requiſite, which is, to ſet the axis of the teleſcope parallel to the plane of the inſtrument.

The method of doing this is, making obſervations of angles as much above 90° as poſſible, uſing the inverted teleſcope; in doing of which the wires in the focus of the eye-glaſs muſt be firſt placed parallel to the plane of the ſextant, after which bring the ſun and moon into very nice contact, on the centre of the wire neareſt the ſextant, taking care that the index is not the leaſt moved, then direct the teleſcope in an inſtant ſo that the images may appear in the centre of the outer wire which is fartheſt from the ſextant, and if the contact appear the ſame at this wire, the axis of the teleſcope is parallel to the plane of the ſextant; on the contrary, if the limbs of the objects appear to ſeparate at the wire which is fartheſt from the ſextant, it is plain the object-end of the teleſcope is too far from the plane of the ſextant, and muſt be corrected by turning one of the two ſcrews of the ring into which the teleſcope is ſcrewed and fixed, having previouſly unturned the other ſcrew.

If the limbs of the images over-top each other at the aforeſaid wire, it ſhews that the object-end of the teleſcope is too near the plane of the inſtrument, and conſequently muſt be brought parallel, by means of the ſcrews, and this method muſt be purſued until the diſtance of objects are found perfectly the ſame at each wire, which ſtands equi-diſtant from the centre of the teleſcope and parallel to each other, in which caſe the axis of the teleſcope will be exactly parallel to the plane of the ſextant, and then you may proceed to meaſure the angles for the obſervations, obſerving to bring the limbs of the objects in exact contact, in the centre between the two wires before-mentioned.

To take the Obſervations requiſite for determining the Longitude.

Firſt, find the apparent time at the place of obſervation, by taking one or more altitudes of the ſun, and noting the times by a good watch, from each obſerved altitude, or, from the mean of ſeveral altitudes compute the time; the difference between this time and that by the watch, will ſhew how much the watch is too faſt or too ſlow, for in all caſes the mean of ſeveral obſervations is moſt to be depended on, and the beſt time for making theſe obſervations of the ſun's altitude is, when it changes quickeſt, or when he bears nearly eaſt or weſt.

In obſerving the diſtance between the objects, three obſervers muſt be in readineſs with their ſextants or quadrants, well adjuſted, as before directed; and the watch either ſuſpended near one of the

obſervers, or put into the hands of a fourth perſon appointed to note the times. The obſerver who takes the angular diſtance giving previous notice to the others to be ready with the altitudes by the time he has finiſhed his obſervation, which being done, the time, altitudes and diſtance ſhould be carefully noted; and other ſets of obſervations taken, which muſt be done within the ſpace of 15 minutes, and then take the means, which will be preferable to any ſingle obſervation. In taking the altitude of the moon, the limb that is the beſt defined, whether it be the upper or lower, muſt be brought to the horizon; if there are not a ſufficient number of obſervers, then take the altitudes, the deficiency may be ſupplied by computing the altitudes after the diſtance is taken; the method of doing it will be ſhewn hereafter.

To meaſure the Diſtance between the Sun and Moon.

Turn down one of the ſcrews, and hold the quadrant or ſextant, ſo that its plane ſhall paſs through the ſun and moon; look at the moon through the tranſparent part of the horizon glaſs; and keeping her there, move the index gently until the ſun's image is brought into the ſilvered part of the horizon glaſs, bring the neareſt limbs of both objects into contact; move the arch of the inſtrument gently up and down, and the ſun will appear to riſe and fall by the ſide of the moon. Move the index until their limbs exactly touch each other, when this is done the obſervation is made, and the index will ſhew the angular diſtance, which is beſt read off by a magnifying glaſs.

To take the Diſtance between the Moon and a Star.

Direct the plane of the inſtrument through both objects, look at the ſtar through the bright part of the horizon glaſs; keep it there, and bring the moon's image into the ſilvered part of the ſame glaſs; move the index gently, until the enlightened limb of the moon juſt touches the centre of the ſtar, keep the ſtar in ſight, and move the arch of the inſtrument gently up and down, and the moon will appear to paſs over the ſtar, and then the obſervation is completed.

The round or well-defined limb of the moon, whether it be the neareſt or fartheſt from the ſtar, muſt be brought into contact with it. When the object to be ſeen by reflection is to the right hand of that ſeen directly, the inſtrument is held with its face upward; but when the object to be ſeen by reflection is to the left hand of that ſeen directly, the inſtrument is held with its face downward.

A readineſs in the uſe of the quadrant and ſextant is beſt gained by practice, which the learner may render familiar to himſelf by obſerving

obſerving the angular diſtance of objects on land, or by candles placed in various poſitions in a room.

Remark 1ſt. The taking the angular diſtance may be rendered more eaſy and accurate, by bringing the objects nearly into contact in the common way, and then fixing the index tight to a certain degree and minute, and then waiting until the objects are nearly in contact; giving notice to the aſſiſtants to get ready with the altitudes, and when the objects are exactly in contact to call for the altitudes, and exact time by the watch. The obſerver may then prepare for taking another diſtance, by ſetting his index three or four minutes forwards or backwards according as the objects are approaching to, or receding from each other, and then proceed to take the diſtance, the altitudes and time by the watch as before. Thus may as many diſtances and altitudes be taken as the obſervers think proper, and then take the means to determine his longitude by.

This mode of taking the diſtance, will not only eaſe the eye of the obſerver, but alſo enable him to manage his inſtrument with greater facility in every direction. If the obſervation be made, as it ought to be, at the diſtance of two hours before or after noon, the true time may be found by the altitude of the ſun, taken at the preciſe time of taking the diſtance; thus will any irregularity in the going of the watch be prevented from affecting the reſult of the obſervations.

If a night obſervation is to be taken, the watch ſhould be regulated by the altitude of the ſun the evening before, and its going compared with another taken the next morning; for the time found by the altitude of a ſtar cannot ſo well be depended on, as the atmoſphere in the night is precarious, though it may be ſufficiently correct for finding the refraction uſed in determining the angular diſtance.

Remark 2d. The obſerver muſt take the moon's diſtance from thoſe ſtars only, whoſe diſtance from her are ſet down in the Nautical Almanac, and the diſtances there ſet down afford him a ready means of knowing the ſtar from which her diſtance ought to be obſerved: by ſetting his index to the diſtance computed roughly at the apparent time, eſtimated nearly for the meridian of Greenwich, and then look to the eaſt or weſt of the moon, according as the diſtance of the ſtar is ſet down in the 8th, 9th, 10th, or 11th pages of the month in the Nautical Almanac, and having found the moon on the horizon-glaſs he will, by ſweeping with the quadrant or ſextant, to the right, or left, find the ſtar he wants, if above the horizon, and the air be clear, in a line, perpendicular to that joining the moon's horns or her ſhorteſt axis produced.

The time at Greenwich is eſtimated roughly by turning the ſhip's ſuppoſed longitude from Greenwich into time, and adding it

it to, or ſubtracting it from the apparent time at the ſhip, according as the longitude is eaſt or weſt, will give the apparent time nearly at Greenwich.

Take the diſtance of the objects out of the Nautical Almanac, both before and after this time;

Then ſay, as 3 hours, or 180 minutes: is to the difference of diſtance in 3 hours : : ſo is the difference between this nearly eſtimated time, and the next preceding time ſet down in the Nautical Almanac: to a number of minutes; which being added to the next preceding diſtance, if it is increaſing, or ſubtracting it, if it is decreaſing, will give the diſtance nearly at the time the obſervation is intended to be made, and to which the index of the ſextant or quadrant muſt be ſet.

Care muſt be taken not to confound the days in the Nautical Almanac with the civil days, as the civil day begins 12 hours before it, nor with the ſea day which begins 24 hours before it.

To reduce the obſerved Diſtance of the Moon from the Sun, or a Star, to the true Diſtance.

The neceſſary preparations:

TURN the longitude in to time, and add it to the apparent time at the ſhip, if it be weſt, but ſubtract it if it be eaſt; the ſum, or difference, will be the ſuppoſed time at Greenwich, which call reduced time.

In page 7th of the month in the Nautical Almanac, find the neareſt noon or midnight, both before and after the reduced time.

Take out the moon's ſemidiameters and horizontal parallaxes correſponding with this noon and midnight, and find their differences.

Then ſay, as 12 hours: is to the difference of the moon's horizontal parallax in 12 hours : : ſo is the reduced time to a fourth number, which being added to the moon's horizontal parallax for noon or midnight, if it is increaſing, but if decreaſing ſubtracted from it; this ſum, or difference, will be the moon's horizontal parallax at the reduced time.

And, as 12 hours : is to the difference of the moon's ſemidiameter in 12 hours : : ſo is the reduced time to a number of ſeconds, which being added to, or ſubtracted from the moon's ſemidiameter the noon or midnight before the reduced time, will give the moon's ſemidiameter at the reduced time.

To which add the augmentation of her ſemidiameter according to her altitude, and the ſum will be the moon's true apparent ſemidiameter. When the reduced time is any even part of 12 hours, as, $\frac{1}{2}$ $\frac{1}{3}$ $\frac{1}{4}$ or $\frac{3}{4}$, &c. ſuch parts of the difference of the ſemidiameter and horizontal parallax may be taken and added to, or ſubtracted as

 above,

above, without being at the trouble of working by the Rule of Three.

To the obſerved altitude of the ſun's lower limb, add the difference between his ſemidiameter and the dip of the horizon, the ſum will be his apparent altitude.

From the ſun's refraction, take his parallax in altitude, the remainder will be the *correction of the ſun's altitude.*

From the ſtar's obſerved altitude take the dip of the horizon, and the remainder will be its apparent altitude.

The refraction is the *correction of the ſtar's altitude.*

Take the difference between the moon's ſemidiameter and the dip, and add it to the obſerved altitude, if her lower limb was taken, or ſubtract their ſum, if her upper limb was taken, the ſum, or difference will be the moon's apparent altitude.

From the proportional logarithm of the moon's horizontal parallax, found in the Nautical Almanac, (increaſing its index by 10) take the logarithm co-ſine of the moon's apparent altitude, the remainder will be the proportional logarithm of her parallax, in altitude. From which, take her refraction, and the remainder *will be the correction of the moon's altitude.*

To the obſerved diſtance of the moon from a ſtar, add the moon's ſemidiameter, if her neareſt limb was taken, but ſubtract it, if her fartheſt limb was taken, the ſum, or difference, will be the apparent diſtance. But,

To the obſerved diſtance of the ſun and moon's neareſt limbs add both their ſemidiameters, and the ſum will be the apparent diſtance of their centres.

NOTE. There are 12 pages in each month in the Nautical Almanac.

The ſun's declination is found in page	II.
The ſun's ſemidiameter in	III.
The moon's ſemidiam. and horizontal parallax	VII.
The diſtance of the moon from the ſun, &c.	VIII. IX. X. XI,

The Tables in this Book.

	Table.
The proportional logarithms	IX.
The effect of parallax, on the moon's diſtance	X.
To turn time into degrees, and the contrary	XI.
Refraction of the heavenly bodies	XII.
Dip of the horizon	XIII.
The ſun's parallax in altitude	XIV.
The augmentation of the moon's ſemidiameter	XV.
To correct the ſun's decl. under any meridian	XVIII.

Having

Having the apparent Altitudes of the Objects, and their apparent Distance, to find their true Distance.

1ſt. Add together

THE proportional logarithm of the correction of the ſun or ſtar's altitude.

The log. co-ſine of the ſun or ſtar's apparent altitude,

The log. ſine of the apparent diſtance,

The log. co-ſecant of the moon's apparent altitude,

Their ſum (rejecting 30 in the index) will be the proportional logarithm of the firſt arch:

2dly. Add together

The proportional log. of the correction of the ſun or ſtar's altitude,

The log. co-tangent of the ſun or ſtar's apparent altitude,

The log. tangent of the apparent diſtance,

Their ſum (rejecting 20 in the index) will be the proportional logarithm of the ſecond arch:

Take the difference between the firſt and ſecond arches, and add it to the apparent diſt. if leſs than 90°, and the firſt arch be greater than the ſecond, but if it be leſs ſubtract it;

But, if the diſt. be more than 90°, the ſum of the arches added to the apparent diſt. will give the diſt. corrected for the refraction of ſun or ſtar.

3dly. Add together

The proportional logarithm of the correction of the moon's altitude,

The log. co-ſine of the moon's apparent altitude,

The log. ſine of the diſtance corrected for the ſun or ſtar's refraction,

The log. co-ſecant of the ſun or ſtar's apparent altitude;

Their ſum (rejecting 30 in the index) will be the proportional logarithm of the third arch.

4thly. Add together

The proportional log. of the correction of the moon's appa. altitude,

The log. co-tangent of the moon's apparent altitude,

The log. tangent of the diſt corrected for the ſun or ſtar's refraction;

Their ſum (rejecting 20 in the index) will be the proportional logarithm of the fourth arch.

Take the difference between the third and fourth arches, and ſubtract it from the diſtance corrected for the ſun or ſtar's refraction, if leſs than 90, and the third arch be greater than the fourth; or, add it to the diſtance corrected, if the fourth arch be greater than the third; but, if the diſtance be more than 90°, the ſum of both arches muſt be ſubtracted from it; and the ſum or difference will be the diſtance corrected for the ſun or ſtar's refraction, and the principal effect of the moon's parallax.

In Table X. look for this laſt corrected diſtance in the top column, and the correction of the moon's altitude in the left-hand ſide column; take out the number of ſeconds that ſtand under the former and oppoſite to the latter.

Look again in the ſame table for the corrected diſtance in the top column, and the principal effect of the moon's parallax in the left-hand ſide column, and take out the number of ſeconds that ſtand under the former and oppoſite the latter. The difference between theſe two numbers muſt be added to the corrected diſtance if leſs than 90°, but ſubtracted from it if more than 90°;

The ſum, or difference, will be the true diſtance.

NOTE. This laſt correction may be omitted without affecting the diſtance much.

Having the true Diſtance and Time, to determine the Longitude.

IN the Nautical Almanac, among the diſtances of the objects, look for the computed diſtance between the moon and the other object obſerved on the given day, if it is found there, the time at Greenwich will be at the top of the column, but if it falls between two diſtances, as it generally will, take the difference between the diſtances that ſtand immediately before and after the computed diſtance, and alſo the difference between the diſtance ſtanding before it and the computed diſtance.

Then take the proportional logarithm of the firſt difference, which is the difference in three hours, and the proportional logarithm of the ſecond difference, which is the difference between the computed diſtance and the diſtance before it.

The difference between theſe two logarithms will be the proportional logarithm of a number of hours, minutes, and ſeconds, which being added to the time ſtanding over the firſt diſtance in the Nautical Almanac, will give the true time at Greenwich.

The difference between Green. time and that at the ſhip turned into longitude, will be the longitude in, at the time the obſervations were made, which will be eaſt if the time at the ſhip be greater than that at Greenwich, but if it be leſs, the longitude will be weſt.

Or the proportional part of time may be found by ſaying;

As the firſt difference : is to 3 hours : : ſo is the ſecond difference : to a proportional part of time, which being added as above directed will give the true time at Greenwich.

The foregoing rules will be rendered eaſy by the following examples, which are only here ſuppoſed, but will anſwer the purpoſe of inſtructing the learner as well as if the altitudes and diſtances had been actually taken.

NOTE. *In working the following examples, it will ſave ſome time, if all the* logarithmic ſines, tangents, ſecants, and proportional logarithms, which fall at the ſame opening of the book, be taken out at the ſame time, both in the firſt and ſecond parts of the operation.

Thus, the co-ſine and co tangent of the ſtar's apparent altitude, and co-ſecant of its altitude may all be taken out at the ſame time, and written down in different parts of the paper (or in a formula) and ſo may the co-ſine, co-tangent, and co-ſecant of the moon's apparent altitude, the ſine and tangent of the apparent diſtance, and the ſine and tangent of the diſtance corrected, for the refraction of the ſun or ſtar.

In order to ſhorten the following work, ☉ *ſignifies the ſun;* ☽ *the moon;* * *a ſtar; P. L. proportional logarithm; L. L. lower limb; Up. L. upper limb; Hor. P. horizontal parallax; N. A. Nautical Almanac.*

EXAMPLE I.

Suppose on Jan. 30, 1796, in long. 11° E. by account, at 10 h. 15′ P. M. per watch, the distance of the moon's farthest limb from the star Regulus was 63° 50′ 20″, when the alt. of the moon's lower limb was 24° 18′ 40″, and the star's 45° 13′ 15″, the eye being 18 feet above the surface of the sea: required the true longitude?

	H. M. S.				
Time per watch	10 15 00	☽'s semid. at noon	15′ 3″	Hor. par.	55′ 14″
Long. 11° in T.	0 44 00	Ditto at midnight	14 59	Hor. par.	54 59
Reduced time	9° 31′ 00	Diff. in 12 hours	4	Diff. in 12 hours	15

as 12 : 4″ : : 9 : 3″ and as 12 : 15″ : : 9 : 12″ the P. parts

☽'s alt.	24 18 40	☽'s sem. at N.	15′ 3	Hor. par. at noon	55 14
Sem. 15′ 7″ } Dip 4 3 }	0 11 4	Ditto at red. t.	15 0	Ditto at red. time	55 2 P. L. 10,5146
App. alt.	24 29 44	Augmentation	7	☽'s ap. al. 24° 29′ 44″ l. cos.	9,9590
☽'s true semidiameter			15 7	☽'s par. in alt. 50′ 5″	0,5556
✱'s obs. alt.			45° 13 15	☽'s refraction 2 5	
Dip			4 3	Cor. of ☽'s alt. 48 0	
✱'s app. altitude			45 9 12	Observed distance	63° 50′ 20″
✱'s refraction 57″ is its correction.				☽'s semidiameter	0 15 7
				App. dist. of ☽ and ✱	63 35 13

To find the Distance.

Cor. of ✱'s alt.	57″	Pr. log.	2,2775			P. L.	2,2775
✱'s app. alt.	45° 9′ 0	Log. cos.	9,8483			Co tang.	9,9977
App. dist.	63 35 0	Log. sine	9,9521			Tang.	10,3038
☽'s app. alt.	24 30 0	L. co sec.	10,3822				
				Reject 20, 2d Cor. 29″		P. L. =	2,5790
Reject 30 1st cor.	37 = P.		2,4601	1st Cor. 37			
				Diff. 1st and 2d cor.	8		
				App. dist.	63 35 13		
Distance corrected for ✱'s refraction					63 35 21		
Cor. of ☽'s alt.	48 0	Pr. log	0,5740			P. L.	0,5740
☽'s alt.	24 30 0	Log. cos.	9,9590			Log. Co-tang.	10,3413
Corrected dist.	63 35 0	Log. sine	9,9521			Log. tang.	10,3038
✱'s alt.	45 9 0	Co sec.	10,1493				
				Reject 20 4th cor. 10′ 52″		P. L.	1,2191
Reject 30 = 3d cor. 41 46		P. L. =	0,6344	3d cor. 41 46			

	Principal effect of ☽'s parallax	30 54
	Corrected distance	63 35 21
Cortab. X. gives	9	
Second in ditto gives	4 Dist. cor. for princ. effect of refr. and par.	63 4 27
	5 Difference to be added	5
	True distance	63 4 32

By the Ephemeris,	1st dist. at 9 h.	62° 49′ 15″	Dist. at 9 h.	62 49 15			
Jan. 30, 1796,	Ditto at 12	64 19 56	2d diff.	0 15 17	P. L.	1,0710	
		1 30 41	1st diff.	1 30 41	P. L.	0,2977	
	H. M. S.						
Time standing over 1st dist.	9 0 0	Diff. of T. bet. Sh. and Gr.	30 20	P. L.	0,7733		
Diff. of time	30 20						
	9 30 20	Now 44′ 40″ turned into long. gives 11° 10′ 00′ and it is E. because the time at ship is more than that at Greenwich.					
Time at Ship	10 15 0						
Diff. of T. betw. Sh. and Gr.	44 40						

EXAMPLE II.

Suppose that on the 31st of May, 1796, a ship at sea in long. 23° east of Greenwich by account, at 5 hours 36 minutes in the afternoon by a watch well regulated, the distance of the sun and moon's nearest limbs should be observed to be 68° 10 M. 24 S. at the same time the altitude of the sun's lower limb was 31° 48 M. ¼, and that of the moon's lower limb 33° 48 M. ¼, the eye being 18 feet above the surface of the sea, and the ship's true longitude be required?

Time per watch	5 36	☽'s semi diam. at noon	15 49	Hor. paral.	58 1
Long. 23° E. in Ti.	1 32	Ditto at midnight	15 56	Ditto	58 29
Reduced time	4 4	Diff. in 12 hours	7	Diff.	28″

☉'s obs. alt. 31° 48′ 15″ Now as 12h. : 7″ : : 4h. : 2″ and as 12h. : 28″ : : 4h. : 9

Semidi. 15′ 49″

Dip	4 3	Diff 11 16	Semidiam. at noon	15 49	Hor. par. 58 1
☉'s app. alt.	32 0 1		Semidi. at red. time	15 51	Hor. par. at. red. T. 58 10
Ref. 1′ 31″—par. 8 =			Augmentation	7	Obs. dist. 68° 10′ 24″
Cor. ☉'s alt.	1′ 23″				
			☽'s semidiam.	15 58	
			☉'s ditto	15 49	Sum 31 47

☽'s hor. par.	58 10	P. L. 10,4906				
☽'s app. alt.	24 0	L. cos. 9,9607	Ap. dist. of ☉'s and ☽'s centres			68 42 11
☽'s par. in alt.	53 8	P. L. 5299	☽'s obs. alt.			23 48 15
Refract	2 7		Semidi. 15′ 58″—dip 4′ 3″ diff.			11 55
Cor. ☽'s alt.	51 1		☽'s app. alt.			24 00 10

Cor. of ☉'s alt.	0 1 23	P. L. 2,1143	0 1 23	P. L.	2,1143
☉'s app. alt.	32 0 0	L co-si. 9,9284	32 0 0	C. tan.	10,2042
App. dist.	68 42 0	L. sine 9,9692	68 42 0	Tan.	10,4090
☽'s app. alt.	24 0 0	L co-sec. 10,3907	Reject 20 P L. 2d. ang. 20″		2,7275
			First angle	43	
Reject 30 = 1st ang. 43″		Pro log. 2,4026			
			Difference	23	
			App. dist.	68° 42′ 11	

Dist. corrected for principal effect of ☉'s ref.						68 42 34	
Cor. of ☽'s alt.	51′ 1″	P. L. 0,5475		51′ 1″		P. L.	0,5475
☽'s app. alt.	24° 0 0	L. co-sec. 9,9607		24° 0 0		C. tang.	10,3514
Dist. corr.	68 42 34	L. sine 9,9692		68 42 34		Tan.	10,4092
☉'s app. alt.	32 0 0	L. co-se. 10,2758					
				Reject 20 P. L. 4th an. 8′ 51″			1,3081
Reject 30 P L. of 3d an.	31′ 46	7532		3d. ang.	31 46		
Cor. from tab. X. gives	8″						
Cor. from ditto gives	1	Principal effect of para.			22 55		
		—Dist. cor. for princ. eff. of ref. and pa.			68 42 34		
Diff. of corrections	7						
			2d. cor for dist.		68 19 39		
			Correction		7		

By the Ephemeris for May 31, 1796			True dist.	68 19 46
First dist at 3 h.	68° 57′ 44″		Ditto at 3 hour	68 57 44
Second dist. at 6 h.	67 23 15			
Diff in 3 hours	1 34 29	P L. 0,2799		37 58
Computed diff.	37 58	P. L. 0,6759		
	H. M. S.			
Prop log. of	1 12 19	= 3560		
T. over 1st dist.	3			
		H. M. S.		
T. at Greenwich	4 12 19	1 23 41 the diff. of time between the ship and Greenwich, being brought into long. by allowing 15 degrees, &c. for every hour, briefly by table XI. gives 20° 55′ 15″ the long. in; and it is east, because the time at the ship is more than that at Greenwich.		
T. at ship	5 36 0			
	1 23 41			

EXAMPLE III.

Suppose that on the 20th of Nov. 1796, a ship at sea, in long. 9° west of Greenwich, by account, at 6 H. 10 M. P. M. per watch well regulated, the distance of the ☉'s and ☽'s nearest limbs should be observed 102° 57′½, when the alt. of the ☉'s lower limb was 18° 47′½, and that of the ☽'s lower limb 70° 32′, the eye being 20 feet above the sea, and the longitude be required?

	M. M.		M. S.		
Time per watch	6 10	☽'s sem. n.	16 11	Hor. par. n.	59 25
Long. 9° W.	36	Ditto at m.	16 6	Ditto at m.	59 5
Red. time	6 46		5	P. part 3	20 P. part 11″
				16 11	
					Hor. par. 59 25″
				16 8	
☽'s obs. alt.		70° 32′ 0″	Ang.	15	Hor. p. red. time 59 14″
Sem. 16′ 23″—Dip. 4′ 16″ =		0 12 7			
			Sem. red. time	16 23	
☽'s app. alt.		70 44 7	☉'s sem.	16 15	Sum 0 32 38
					Obs. dist 102 57 30

	M. S.				
☽'s hor. par.	59 14	P. log.	10,4827	App. dist. of cent.	103 30 8
☽'s app. alt.	70 44 0	Co sine	9,5184	☉'s obs. alt.	18 47 30
				Sem. 16″ 15″—dip 4″ 16″ =	11 59
☽'s P. in alt.	19 33	P. log.	9643		
Ref.	19			☉'s app. alt.	18 59 29
		Ref. 2′ 44″		Par. 8″ = 2″ 36″ Cor. ☉'s alt.	
Cor. ☽'s alt.	19 14				
Cor. of ☉'s alt.	0° 2 36	P. log.	1,8403	P. log.	1,8403
☉'s alt.	18 59 0	Co-sine	9,9757	Co-tang.	10,4634
App. dist.	103 30 0	S.	9,9878	Tang.	10,6196
☽'s alt.	70 44 0	Co-sec.	10,0250		
				Reject 20 P. log. 2d ang. 13″	2,9238
Reject 30 Pro. log. 1st ang. 2′ 40″			1,8288	Pro. log. 1st ang. 2 40	
				Sum 2 53	
				App. dist. 103 30 8	
				Dist. cor. for ☉'s ref. 103 33 1	
Cor. ☽'s alt.	19′ 14″	P. L.	0,9712	P. L.	0,9712
☽'s appa. alt.	70°44	Co-sine	9,5184	Co t.	9,5435
Dist. cor.	103 33	Sine	9,9877	Tang.	10,6179
☉'s alt.	18 59	Co se.	10,4877		
				Reject 20 P. L. 4th ang. 13′ 16″	1,1326
Reject 30 P. log. 3d ang. 19′ 30″			0,9650	P. L. 3d ang. 19 30	
				Prin. eff. of para. 32 46	
				Dist. corrected 103 33 1	
Dist. cor. for the prin. eff of para. and ref.				103 0 15	
1st Cor. Table X.		0		2	
2d Cor. ditto		2 Diff.			
Dist. at 6 h.	103 24 28			True dist. 103 0 13	
Dist. at 9 h.	101 46 52			Dist. at 6 h. 103 24 28	
				2d Diff. 24 15	P. L. 8706
1st Diff.	1 37 36	P. L.			2658
					P. L. = 6048

Diff. of time between ship and Greenwich	44 43
Time standing over first dist.	6 0 0
True time at Greenwich	6 44 43
Time at ship	6 10 0
Diff. of time between ship and Greenwich	34 43 = 8° 40′ 45″ the longitude in, and it is west, because the time at ship is less than that at Greenwich.

EXAMPLE IV.

Suppose a ship at sea, in long. 45° 30′ W. by acc. on June 13, 1796, at 3 H. 17′ 20″ P. M. the following observations were taken, when the eye was 21 feet above the sea, and the corrections of several quadrants as underneath.

Alt. ☉'s L. L.	Alt. of ☽'s Up. limb.	Dist. of ☉ & ☽, N. L.
D. M. S.	D. M. S.	D. M. S.
45 54 0	19 32 0	106 16 45
45 45 0	19 52 0	106 17 45
45 18 45	20 5 0	106 18 30
45 4 0	20 17 30	106 18 45
44 48 30	20 34 0	106 19 15
5,226 50 15	100 20 30	531 31 0
Mean 45 22 3	20 4 6	106 18 12
Er. quad. — 48	— 1 0	— 2 37
45 21 15	20 3 6	106 15 35
Dip. — 4 22	4 22	
45 16 53	19 58 44	106 15 35

Observed dist. of ☉ and ☽ 106° 15′ 35″
Sum semid. ☉ and ☽ 31 8

App. dist. of their centres 106 46 43

Time at ship H. M. S. 3 17 20
Long. 45° 30′ W. 3 2 0

Red. T. 6 19 20
☽'s Sem. at N. 15′ 18″ Hor. par. 56 9
Ditto midn. 15 13 Hor. par. 55 49

Diff. in 12 hours 5 Diff. in 12 hours 20
☽'s Sem. 15′ 18″
Prop. part 3

15 15
Augmentation 6

☽'s Sem. 15 21
☽'s obs. alt. 19 58 44

☽'s ap. alt. 19 43 23
☽'s hor. par. N. 56′ 9″
Prop. part 11

Ditto at red. ti. 55 58 Prop. log. 10,5073
☽'s ap. alt. 19 43 23 Co-sine 9,9737

Par. in alt 52 41 P. L. 533
Ref. 2 37
Ref. ☉'s alt. 56″
Cor. ☽'s alt. 50 4 Par. 7

☉'s alt. 45 16 53 Cor. ☉'s alt. 49
Ditto Sem. 15 47

☉'s ap. alt. 45 32 40

Cor. of ☉'s alt. 49″	P. L.	2,3432	P. L.	2,3432
☉'s App. alt. 45° 32′ 40″	Co-sine	9,8454	Co-t.	9,9917
App. dist 106 47	Sine	9,9810	T.	10,5206
☽'s App. alt. 19 43	Co sec.	10,4718		
			Reject 20 P. L. 2d ang. 15″	2,8555
Reject 30 P. L. of 1st ang. 25″		2,6414	1st ang. 25	
			App. dist. 106 46 43	
			Corrected dist. 106 47 23	
Cor. of ☽'s alt. 50′ 4″	P. L.	0,5557	P. L.	0,5557
☽'s alt. 19°43	Co-sine	9,9737	Co-t.	10,4456
Cor. dist. 106 47	Sine	9,9810	T.	10,5205
☽'s app. alt. 45 33	Co-sec.	10,1464		
			Rej. 20 P. L. 4th ang. 5′ 25″	1,5218
Pr. log. of 3d ang. 39′ 40″ reject 30		0,6569	3d ang 39 40	
			Prin. eff. of par. 45 5	
			Cor. dist. 106 47 23	

Dist. corrected for principal effect of ref. and par. 106 2 18
First cor. from Table X. 6″
Second cor. from ditto 4

Diff. 2 Diff. 2

True dist. 106 2 16

1ſt diſt. at 6 h.	105° 58′ 3″	True diſt.	106° 2′ 16″		
2d ditto at 9 h.	107 24 54	Firſt diſt.	105 58 3		
1ſt Dif.	1 26 51 P. L.	—	—	—	0,3165
P. L. dif. time	8 44				
T. ſtand. over the 1ſt diſt.	6 0 0 P. L.	—	—		1,3138
True time at Green.	6 8 44				
Time at ſhip	3 17 20				
Dif. time	2 51 24 = 42° 51′ the long. in, and it is weſt becauſe the time at ſhip is leſs than at Greenwich.				

EXAMPLE V.

Suppoſe that on the 15th of May, 1796, in long. 2° E. the eye 21 feet above the ſea, the following obſervations were made, and the true longitude be required?

Times.	Alt. of Spica.	Alt. ☽'s L. L.	Diſt. ☽'s far. L.
H. M. S.	D. M. S.	D. M. S.	D. M. S.
12 36 14	19 50 30	18 6 0	31 30 45
12 39 5	20 2 0	18 21 0	31 31 30
12 41 41	20 15 0	18 39 30	31 34 0
12 43 45	20 29 0	18 55 0	31 33 0
12 45 53	20 40 0	19 9 0	31 35 45
5)63 26 38	101 16 30	93 10 30	157 45 0
Mean 12 41 19	20 15 18	18 38 6	31 33 0
Er. of quadrant.		+ 7 30	+ 24
12 41 19	20 15 18	18 45 36	31 33 24

	H. M. SS
Time per watch	12 41 19
Long. 2° E.	8
Sup. time at Green.	21 33 19

☽'s Semi. 15° 25′, and the ang. 6″ added, gives the true ſemi. 15′ 31″ and her H. P. is 56′ 35″.

		D. M. S.
☽'s obſ. alt.		18 45 36
Semi.	15′ 31″	
Dip.	4 22 = dif.	11 9
App. alt.		18 56 45

Obſ. diſt.	31° 33′ 24	H. P.	56′ 35″	P.L.	10,5026
☽'s ſemi.	15 31	Ap. alt.	18° 56 45	L. co-ſine	9,9758
Ap. diſt. of centres	31 17 53	P. in alt.	53 31	P. L.	0,5268
✱'s obſ. alt.	20 15 18	Ref.	2 45		
Dip	4 22				
		Cor. ☽'s alt.	50 46		
App. alt.	20 10 56				

Cor. of ✱'s alt.	2 34	P. L.	1,8459	P. L.	1,8459
✱'s alt.	20 11 0	Co-ſine	9,9725	Co-tan.	10,4346
App. diſt.	31 18	Sine	9,7156	Tan.	9,7839
☽'s alt.	18 57	Co-ſec.	10,4885		
			P.L. 2d ang.	1′ 33″	2,0644
Prop. log. of 1ſt ang. 1′ 43″			2,0225	1ſt ang. 1 43	
			Diſ.	10	
			Ap. diſt.	31 17 53	
			Diſt.	31 18 3	C. for Re.

Cor. of ☽'s alt.	50′ 46″	P. L.	0,5497	P. L.	0,5497
☽'s alt.	18° 57	Co-ſi.	9,9758	Co-tan.	10,4642
Cor. diſt.	31 18	Sine	9,7156	Tan.	9,7839
✱'s alt.	20 11	Co-ſec.	10,4621		
			4th ang. P. L.	28′ 40″	0,7978
Reject 30 P. L. 3d ang. 35′ 39″			0,7032 3d ang.	35 39	
			Prin. eff. of par.	6 59	
			Cor. diſt.	31 18 3	
Diſt. cor. for prin. eff. of par. and ref.				31 11 4	

Cor. from Table X.	37				31 11 4
Cor. from Ditto	1 diff.				36
Dist. at 12 hours	31° 33′ 38″			Comp. dist.	31 11 40
Dist. at 15 hours	30 0 21			Dist. at 12	31 33 38
1st diff.	1 33 17	P. L.	2855 2 Diff.		21 58
2d diff.	0 21 58	P. L.	9132		
		P. L.	6280 =	H. M. S. 0 42 24	
Time standing over 1st distance				12	
True time at Green.				12 42 24	
Time at ship				12 41 19	
Dif. of time between ship and Greenwich				1 5 = 16′ 15″ the long.	

in, and it is west, the time at the ship being less than at Greenwich.

EXAMPLE VI.

Suppose the dist. of the ☉ and ☽'s nearest limbs, with the respective altitudes of their lower limbs, were observed as under, on the 13th of April 1796, the eye being 18 feet above the sea, in lat. 34° 17′ N. and long. by account 8° 30′ W. of Greenwich, the watch not previously regulated, and the ship's true longitude be required?

As the ☉ must be then at a sufficient distance from the meridian, the mean of the three altitudes may be supposed preferable to any single alt. taken for finding the time.

Times.			Dist.		☉'s Alt.		☽'s Alt.	
H.	M.	S.	D.	M.	D.	M.	D.	M.
4	47	14	77	11	22	51	80	18
4	50	11	77	13	22	12	80	36
4	55	26	77	18	21	6	81	9
Su. 14	32	51	231	42	66	9	242	3
M. 4	50	57	77	14	22	3	80	41

T. at. sh.	H. M. S. 4 50 57	☉'s alt.	22 3 0
Lon. in T.	34	sem. 15 58 } Dif.	11 55
Sup. T.	5 24 57	Dip 4 3 } App. alt.	22 14 55
☉'s ref. 2°19′—P. 8′ = 2′ 11″ cor. of ☉'s alt.			
☽'s obs. alt.			80 41 0
☽'s sem. 16′ 27″ → dip. 4′ 3″ =			0 12 24
☽'s app. alt.			80 53 24
☽'s hor. par. 0° 59′ 22″		P. L.	10,4817
☽'s app. alt. 80 53 24		L. co-s.	9,1998

Obs. dist. of ☉ and ☽	77° 14′ 0″		
☽'s semi. 15′ 58″ } =	0 32 25	P. L. of ☽'s par. in alt.	9′ 24″ 2,2819
☽'s ditto 16 27 }		Ref.	9
App. dist. of centres	77 46 25	Cor. of ☽'s alt.	9 15
Cor. ☉'s alt. 0° 2′ 11″	P. L.	1,9161	P. L. 1,9161
☉'s alt. 22 15 0	Co-s.	9,1664	Co-tan. 10,3881
App. dist. 77 46 0	Si.	9,9900	T. 10,6639
☽'s alt. 80 53 0	Co-sec.	10,0055	
			P. L. 2d ang. 12″ 2,9681
Reject 30 first ang. 2 23	P. L.	1,8780	2 23
		Diff.	0 2 11
		App. dist.	77 46 25
			77 48 36

Dist. cor. for ☉'s ref.					
Cor. ☽'s alt	0° 9′ 15″	P. L.	1,2891	P. L.	1,2891
☽'s alt.	80 53 0	Co-si.	9,1998	Co-tan.	9,2054
Cor. dist.	77 48 36	Sine	9,9201	Tang.	10,6654
☉'s alt.	22 15 0	Co-sec.	10,4218		
				4th ang. P. L. 12′ 27″ =	1,1599
3d ang.	22 37	P. L. =	0,9008	22 37	
			Dif.	10 10	
			Cog. dist.	17 48 36	

Dist. cor. prin. for effect of par. and ref. = true dist. 77 38 26 the corrections from Table X, will give nothing.

To find the time.

	D. M. S.			
☉'s app. alt.	22 14 55	Dec. 9° 30′	lat. 34 17	
Cor.	0 2 11	90	90	
True alt.	22 12 44	P. D. 80 30	C. l. 55 43	
	90			
Z. D.	67 47 16			
Co lat.	55 43 0	Co-sec.	0,08288	
Pol. dist.	80 30 0	Co-sec.	0,04600	
	204 0 16			
½ Sum	102 0 8	Sine	9,99040	
Z. dist.	67 47 16			
Rem.	34 12 52	Sine	9,74980	
		Sum	19,82908	
½ H. ang.	34 46 40 =	Cos.	9,91454	
	2			
		H. M. S.		
H. ang.	69 33 20 =	4 38 13	Tr.	
Time.				

y the second method thus:

Co. lat.	55 43	Co-sec.	08288
Dec.	9 30	Sec.	00600
M. alt.	65 13 N. S.	90790	L. R. 08688
T. alt.	22 13 N. S.	37811	
		52979	Log. 472511
In col. rising = 4h 38′ 4″			4,81299

By the Ephemeris.

	D. M. S.		
Dist. at 3 hours	76 27 23		
Dist. at 6 hours	78 5 44		
True dist.	77 38 26		
Diff. in 3 hours	1 38 21	P. L.	2615
Comp. diff.	1 11 03	P. L.	4037
	2 10 02 =		1412
Time over 1st dist.	3 00 00		
Ti. at Greenwich	5 10 02		
Tr. time at ship	4 38 13		
Long. in time	31 49 = 7° 57′ 15″ W.		

In finding the time the declination is proportioned to the reduced time 6h. 54′.

Here I have given one method of finding the longitude, illustrated by a sufficient number of examples, all of which are reduced to the year 1796, in order that the reader, or teacher, may have sufficient time to furnish himself with a N. A. for this year, which is now printed. But as many would wish to have some other method of reducing the distance, that, by comparing them together, they may not only have the advantage of proving their calculations, but also of making choice of which they prefer to work by.

The second method I shall present the reader with, is chiefly deduced from that invented by Mr. Witchell, late Master of the Royal Academy at Portsmouth, and as it is short, requires but four places of figures in the logarithms, besides the index; the preparations in both methods being exactly the same.

To find the true Distance, observe this general Rule.

First. Add the ☉ or ✳ and ☽'s apparent altitudes together, and take half the sum; and subtract the less from the greater, and take half the difference; then add together

The co-tangent of half the sum,
The tangent of half the difference, and
The co-tangent of half the apparent distance,

Their sum, rejecting 20 in the index, will be the log. tangent of an angle, which call A.

Secondly. When the ☉ or ✱'s altitude is greater than the ☽'s, take the difference between the angle A and half the apparent distance, but if less take their sum. Then add together

The co-tangent of this sum or difference,
The co-tangent of ☉ or ✱'s apparent altitude, and
The proportional log. of the correction of the ☉ or ✱'s altitude;

Their sum, rejecting 20 in the index, will be the proportional logarithm of the first correction.

Thirdly. If the sum of angle A and half the apparent distance was taken in the last article, take now their difference; but if their difference, take now their sum. Then add together

The co-tangent of their sum or difference,
The co-tangent of ☽'s apparent altitude, and
The proportional log. of the correction of the ☽'s apparent altitude;

Their sum, rejecting 20 in the index, will be the proportional log. of the second correction.

Fourthly. When the angle A is less than half the apparent distance, the first correction must be added to, and the second subtracted from the apparent distance: but, when the angle A is greatest, their sum must be added to the apparent distance, when the ☉ or ✱'s altitude is less than the ☽'s; but when the ☽'s altitude is least, their sum must be subtracted to give the corrected distance.

Fifthly. In Table X. look for the corrected dist. in the top column and the correction of ☽'s alt. in the left-hand side column; take out the number of seconds that stand under the former and opposite to the latter. Look again in the same table for the corrected distance in top column, and the second correction in the left-hand side column; take out the number of seconds that stand under the former and opposite the latter, the difference between these two numbers will be the third correction, which must be added to the corrected distance, if less than 90°, but subtracted from it, if more than 90°; the sum, or difference, will be the true distance.

To illustrate this last method of reducing the apparent distance to the true distance, I shall take the apparent altitudes and distances as they stand in the three first examples, worked by the former method.

EXAMPLE I. See page 243.

Given the apparent distance of the ☽'s centre from the ✱ 63° 35′ 13″, the ☽'s apparent altitude 24° 29′ 44″, and that of the ✱ Regulus 45° 9′ 12″, the ☽'s horizontal parallax 55′ 2″. Required the true distance?

	D. M. S.				
✱'s altitude	45 19 12	☽'s Hor. par.	55′ 2″	P. L.	10,5146
Ref. or cor. of ✱'s alt.	57	App. alt.	24° 30	Log. cos.	9,9590
		☽'s Par. in alt	50′ 5″	P. L.	0,5556
		Ref.	2 4		
		Cor. of ☽'s alt.	48 1		

✱'s appa. alt.	45° 9′ 12″
☽'s appa. alt	24 29 44
Sum	69 38 56

Sum

Sum	69° 38′ 56″	Half is	34° 49′ 28″	Co-tan. 10,1577
Difference	20 39 28	Half is	10 19 44	Tang. 9,2601
App. dist.	63 35 13	Half is	31 47 36	Co-tan. 10,2078
1st Cor. add	9	Ang. A.	22 54 0	Tang. 9,6256
	63 35 22	Diff.	8 53 36	Co-tan. 10,8056
2d. Cor. sub.	30 54	✱'s Alt.	45 9 12	Co-tan. 9,9977
		✱'s Cor.	57	P. L. 2,2775
Corrected dist.	63 4 28			
3d Correction add	5	1st Cor.	9	P. L. 3,0808
True distance	63 4 33	Half app. dist.	31 47 36	
		Angle A	22 54 0	
Differing 2″ from that found by the former method.		Sum	54 41 36	Co-tang. 9,8501
		☽'s Alt.	24 29 44	Co-tan. 10,3413
		Cor. ☽'s alt.	48 1	P. L. 0,5739
		2d Cor.	30 54	P. L. 0,7653
		1st Cor. tab. X.	9	
		2d Cor. ditto	4	
		3d Cor. of distance	5	

EXAMPLE II. See page 244.

Given the apparent altitude of the ☉'s centre 32°, that of the ☽'s 24°, and the apparent distance of their centres 68° 42′ 11″, and the ☽'s horizontal parallax 58′ 10″. Required the true distance?

Ref. of ☉'s alt.	1′ 31″	☽'s Hor. par.	58′ 10″	P. L. 10,4906
Par. in alt.	8	☽'s Alt.	24° 0 0	Co-sine 9,9607
Cor. of ☉'s alt.	1 23	Par. in alt.	53 8	P. L. 0,5299
		Ref.	2 7	
		Cor. ☽'s alt.	51 1	
☉'s Alt.	32°			
☽'s Alt.	24			
Sum	56	Half is	28	Co-tan. 10,2743
Difference	8	Half is	4	Tang. 1,8446
App. dist.	68 42 11	Half is	34 21 5	Co-tan. 10,1653
1st Cor. add	23	Ang. A.	10 54	Tang. 9,2842
Corrected dist.	68 42 34	Diff.	23 27 5	Co-tan. 10,3627
2d Cor. sub.	22 55	☉'s Alt.	32	Co-tan. 10,2042
				P. L. 2,1143
1st Cor. tab. X. 8	68 19 39	Cor. ☉'s alt.	1 23	
2d Cor. ditto 1	Diff. 7	1st Cor.	23	P. L. 2,6812
True dist.	68 19 46	Half dist.	34 21	
		Ang. A.	10 54	
Differing 2″ from that found by the former method.		Sum	45 15	Co-tan. 9,9962
		☽'s alt.	24 0	Co-tan. 10,3514
		Cor. ☽'s al.	51 1	P. L. 0,5475
		2d Correction	2 55	P. L. 0,8951

EXAMPLE III. See page 245.

Given the ☉'s apparent altitude 18° 59 ½, the ☽'s 70° 44″, the apparent distance of their centres 103° 30′ 8″, and the ☽'s horizontal parallax 59′ 15″. Required the true distance?

Refrac. of ☉'s alt.	2′ 44″	☽'s Hor. par.	59′ 15″	P. L.	10,4826
Par. in alt.	8′	☽'s alt.	70° 44	Co fine	9,5185
Cor. of ☉'s alt.	2 36	Par. in alt.	19 33	P. L.	0,9641
		Ref.	19		
☉'s App. alt.	18° 59 30				
		Cor. ☽'s alt.	19 14		
☽'s Ditto	70 44 0				
Sum	89 43 30	Half is	44 51 45	Co-tan.	10,0020
Diff.	51 44 30	Half is	25 52 15	Tang.	9,6857
App. dist.	103 30 8	Half is	51 45 4	Co-tan.	9,8967
		Angle A	21 1	Tang.	9,5844
1st Cor. add	2 53				
		Sum ang. A. and ½ dif.	72 46 4	Co tan.	9,4916
	103 33 1	☉'s app. alt.	18 59 30	Co-tan.	10,4632
2d Cor. sub.	32 43				
		Cor. ☉'s alt.	2 36	P. L.	1,8403
Cor. dist.	103 0 18				
1st Cor. tab. X. 0		1st Cor.	2 53	P. L.	1,7951
2d Cor. ditto 2 diff.	2				
		Angle A 21 1			
True dist.	103 0 16	½ App. dist. 51 45 4			
Differing 3″ from that found by the first method.		Diff. 30 44 4		Co-tan.	10,2258
		☽'s alt. 70 44 0		Co-tan.	9,5435
		Cor. ☽'s alt. 19 14		P. L.	0,9712
		2d Cor. 32 43		P. L.	7405

I shall leave the working of the other examples by this method, to exercise the learner, and proceed to shew how to find the true altitudes of the ☉, ☽, or a ✱ by calculation.

To find the Sun's true Altitude.

It sometimes happens, that the distance of the celestial objects may be taken, but for want of a good horizon, or assistants, their altitudes cannot be taken at the same time; to supply such deficiences, observe the three following cases.

CASE I.

The apparent time, the ship's latitude, longitude, and the ☉'s declination given, to find the true altitude of his centre.

RULE.

If the ship's co. latitude and the ☉'s declination be both north or both south, take their sum; but if one be north and the other south, their difference is the ☉'s meridian altitude.

With the apparent time from noon, enter table VI. and from the column of rising take out the logarithm corresponding to it.

To this logarithm, add the log. co-sine of the latitude, and the log. co-sine of the ☉'s declination.

Their

Their sum rejecting, 20 in the index, will be the logarithm of a natural number, which being subtracted from the natural sine of the ⊙'s meridian altitude, will leave the natural sine of his true altitude at the given time.

EXAMPLE I.

Required the true altitude of the ⊙'s centre, in lat. 49° 57′ N. July 25, 1796, at 6 H. 56 M. 30 S. in the morning.

	12 0 0		
App. time	6 56 30		
Time from noon	5 3 30	Its log. in col. of rising	4,87850
Latitude	49 57 0	N. its log. co-sine	9,80852
Decl. at that time	19 26 0	N. its log. co-sine	9,97452
Co. lat.	40 3	Reject 20 N. N. 45871 = log.	= 4,66154
Mer. alt.	59 29	Nat. sine 86148	
		Nat. sine true alt. 40277 = 23° 45′.	

EXAMPLE II.

What will be the true altitude of the ⊙'s centre at London, November 24, 1796, at 3 H. 21 M. 30 S. apparent time in the afternoon?

	H. M. S.		
App. time from N.	3 21 30	Its log. in col. of rising	4,55900
Latitude	51°32′N.	Log. co-sine	9,79383
Decl. at that time	20 49 S.	Log. co-sine	9,97068
Co. lat.	38 28 N.	Nat. num. 21062 = log.	= 432351.
Mer. alt.	17 39	Nat. sine 30320	
Nat. sine true alt.	5 19	Nat. sine 09258	

CASE II.

The apparent Time, the Latitude and Longitude given, to find the Altitude of any of the known fixed Stars.

RULE.

Turn the longitude into time, and add it to or subtract it from the time at the ship, according as it is east or west, the sum or difference will be the time at Greenwich.

Take the ⊙'s Rt. Ascen. from the N. A. and proportion it to the time at Greenwich, and add it to the apparent time at the ship, which will give the Rt. Ascen. of the meridian, or mid-heaven.

Find the ✱'s Rt. Ascen. and declination in Table XX. and take the difference between its Rt. Ascen. and the Rt. Ascen. of the meridian, which will be the distance of the ✱ from the meridian.

Having

Having the ✱'s diſtance from the meridian, with its declination and the ſhip's latitude, the true altitude is found in the ſame manner as has been ſhewn in the laſt examples of finding the true altitude of the ſun.

EXAMPLE.

What will be the true altitude of Aldebaran at Edinburgh, April 11, 1796, at 5 H. 56 M. 20 S. apparent time.

	H. M. S.		H. M. S.
Apparent time	5 56 20	☉'s Rt. Aſcen. at Noon	1 22 27
Long. 3° 6′ W. in time	12 24	Pro. part for 6 hours	55
App. time at Green.	6 8 44	Rt. Aſcen. at Edinburgh	1 23 22
Rt. Aſcen. at Edin.	1 23 22		
Rt. Aſcen. Merid.	7 32 6		
✱'s Rt. Aſcen.	4 24 14		
✱'s diſt. from merid.	3 7 52	Its log. in col. of riſing	4,50184
Edinburgh's lat.	55° 58′ N.	Log. co-ſine	9,74794
✱'s declination	16 5 19 N.	Log. co-ſine	9,98266
Co. lat.	34 2 N.	Nat. num. 17078 log.	4,23244
Meridian altitude	50 7 19	Nat. ſine 76735	
True altitude	36 37	Nat. ſine 59657	

NOTE. As the table is calculated only to 30″ the difference between the log. of 3 H. 7 M. 30 S. and 3 H. 8 M. muſt be taken, which is 218: Then ſay, as 30 : 218 : : 22 : 159, which being added to 4,50025 the log. of 3 H. 7 M. 30 S. gives 4,50184, the log. of 3 H. 7 M. 52 S. as above.

CASE III.

The apparent Time, the Latitude and Longitude of the ſhip being given, to find the true Altitude of the Moon's Centre.

RULE.

Turn the longitude into time, and if it be weſt add it to, but if it be eaſt ſubtract it from the apparent time at the ſhip, and it will give the time at Greenwich.

Take the ☉'s Rt. Aſcen. out of N. A. and proportion it to Greenwich time, which being added to the time at the ſhip, the ſum will be the right Aſcenſion of the meridian or mid-heaven.

Take out of the N. A. the ☽'s Rt. Aſcen. and declination, and proportion them to the time at Greenwich. Turn the ☽'s Rt. Aſcen. into time, and take the difference between it and the Rt. Aſcen. of the mid-heaven, which will be the diſtance in time of the ☽ from the meridian.

Having the ſhip's latitude, together with the ☽'s declination and diſtance from the meridian, the true altitude is found, in the ſame manner as has been ſhewn in finding the true altitude of the ☉ and ✱.

EXAMPLE.

EXAMPLE.

What will be the ☽'s true altitude at 19 H. 16 M. 52 S. apparent time in latitude 14° 45′ S. and longitude 167° E. on August 24, 1796?

App. time at ship	19 16 52			
Long. 167° E. in time	11 8 0			
App. time at Greenwich	8 8 52			
☉'s Right ascension	10 16 58		☽'s ditto	47° 14′
App. time at ship	19 16 52			
	29 33 50			
	24			
Right ascension of the merid.	5 33 50			
☽'s right ascen. in time	3 8 56			
☽'s dist. from the merid.	2 24 54		Log. rising	4,28623
Latitude	14° 45		Log. co-sine	9,98545
☽'s decl. at ship	13° 30′ N.		Log. co-sine	9,98783
Co. latitude	75 15 S.	Nat. num.	18182	Log. 4,25951
Meridian altitude	61 45	Nat. sine	88089	
N. sine of ☽'s true alt. 44° 21′ =		N. sine	69907	

In the last example proportional parts are taken in finding the right ascension, declination and log. rising.

By the three last cases the true altitudes of the objects are found, therefore if the apparent altitudes be wanted, the difference between the ☉'s parallax and refraction must be added to the ☉'s true altitude, the refraction must be added to the true altitude of a star, and the difference between the ☽'s refraction and parallax in altitude must be subtracted from the true altitude of the ☽ thus found, to obtain the respective apparent altitudes of their centres.

To find the Longitude by the Eclipses of Jupiter's Satellites.

On the day preceding the evening on which it is proposed to observe an eclipse, look for the time when it will happen at Greenwich, in page 3d of the month in the Ephemeris. Find the diff. of longitude, either by a good map, sea chart, or dead reckoning.

Let the watch be regulated by the ☉ with all possible exactness to the apparent time. Turn the difference of longitude into time, and add it to, or subtract it from the apparent time, according as it is east or west of Greenwich, the sum or difference will be nearly the time when the eclipse is to be looked for in that place. But as the longitude is uncertain, it will be proper to begin 20 or 30 minutes before.

Observe the hours, minutes and seconds of the beginning of the eclipse, called immersion, that is, the very instant that the satellite appears to enter into the shadow of Jupiter; or the emersion, that is,

 when

when it appears to come out of the ſame. The difference of time between the obſerved immerſion, or emerſion, and that ſet down in the N. A. being turned into degrees, will give the difference of longitude between Greenwich and the place of obſervation.

Theſe obſervations made on the firſt ſatellite, or that which moves neareſt to the body of Jupiter, is the moſt proper for determining the longitude; and here it may be obſerved, that its emerſions are not viſible from the time of Jupiter's conjunction with the ☉ to the time of his oppoſition to the ☉, and that its immerſions are not viſible from the time of planet's oppoſition to the ☉, to the time of its conjunction.

The configurations, or the poſitions in which Jupiter's ſatellites appear at Greenwich, are laid down every night when viſible, in the page the 12th of the month in the Ephemeris.

EXAMPLE.

Suppoſe that on the 17th of Auguſt, 1796, in long. 88° 30′ weſt by account, an immerſion of Jupiter's firſt ſatellite was obſerved at 12 H. 30 M. 20 S. apparent time. Required the longitude?

	H.	M.	S.
At Greenwich, the immer. of 1ſt ſatellite that day will be	18	20	30
Obſerved immerſion at — —	12	30	20
Difference in time — — —	5	50	10

Turned into longitude gives 87° 32′ ½, and is weſt, becauſe the time at Greenwich is more than at the place of obſervation; the error in longitude 58 ½ miles.

As theſe eclipſes happen almoſt daily, they afford the moſt ready means of determining the longitude of places on land, and then the longitudes of ſea coaſts might be better aſcertained than they are at preſent; they might alſo be applied at ſea, could they be obſerved with ſufficient accuracy in a ſhip under ſail, which can hardly be done, ſince the leaſt motion of a teleſcope that magnifies ſufficiently to make theſe obſervations, would throw the objects out of the field of view.

The eclipſes of Jupiter's ſatellites may be well obſerved by one of Dolland's new achromatic teleſcopes of three feet in length, or by a reflecting teleſcope of 18 or 20 inches focal length.

To find the Longitude by the Eclipſes of the Moon.

This is performed by comparing the times of the beginning or ending, as alſo the times when any number of digits are eclipſed, or when the earth's ſhadow begins to touch or leave any remarkable ſpot on the moon's face.

Then will the difference of time between the like obſervations made at different places, turned into degrees, be their difference of longitude.

But theſe eclipſes happen too ſeldom to be of any general uſe at ſea.

OBLIQUE

OBLIQUE TRIGONOMETRY.

AXIOM I.

IN all plane triangles the sides are in direct proportion to the sines of their opposite angles.

To find a Side.

As the sine of an angle
Is to its opposite side,
So is the sine of either of the other angles in the same triangle
To the side opposite thereto.

To find an Angle.

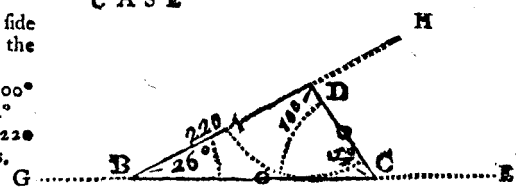
As any side given
Is to the sine of its opposite angle,
So is either of the other sides in the same iangle
To the sine of its opposite angle.

CASE

Two angles and one side given, to find either of the legs?

The angle B D C = 100° and angle D C B = 54°

And the leg. B D = 220 are given to find the sides.



CONSTRUCTION.

Draw an indefinite line GE, add the two angles D and C together, and subtracting their sum from 180° leaves the remaning angle B 26° on the line G E; on any point, as at B, describe the angle B 26°, and on B H set off B D 220. On D make the angle B D C 100°, then D C will intersect the line G E in the point C, which completes the triangle, and B C will measure on the same scale from which B D was laid down 268 nearly, and D C 119 also on the same scale.

To find C B.		To find D C.	
As the sine of the angle C 54°	9.90796	As sine ang. C 54°	9.90796
Is to the side B D 220	2.34242	Is to the side B D 220	2.34242
So is supt. si. of ang. B C D 80°	9.99335	So is sine ang. B 26°	9.64184
	12.33577		11.98426
	9.90796		9.90796
To the side B C 267.8	2.42781	To side D C 119.2	2.07630

By the Gunter.

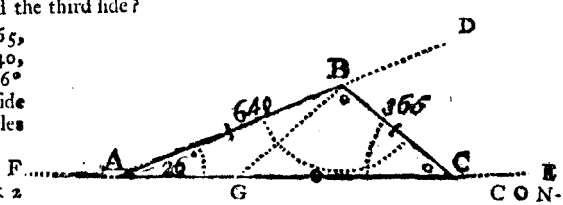
1st. The extent from 80° to 54° on the line of sines will reach from 220 to 267, on the line of numbers for B C.

2d. The extent from 54° to 26° on the line of sines will reach from 220 to 119, on the line of numbers for the side D C.

CASE II. and III.

Two sides and an angle opposite to one of them being given, to find the other opposite angles and the third side?

The side B C 365, and the side A B 640, and angle A 26° given to find the side A C, and angles ABC and BCA.



 CON-

CONSTRUCTION.

Draw the indefinite line F E, and on any point therein, as at A, draw the angle D A E 26°. On A D set off A B = 640, then on B, with 365 in your compasses taken from the same scale, describe an arch which will cut F E in the point C. Join B C, and it is done. A C will measure on the scale before used 809 nearly, the angle B will measure on the scale of chords 103¼, and angle C 50¾ nearly.

Proportion by Axiom II.

To find the angle C.			To find A C.	
As the side B C 365		2,56229	As sine ang. C 50° 14′	9,88573
Is to the sine of angle A 26°		9,64184	Is to a B 640	2,80618
So is the side A B 640		2,80618	So is si. ang. B, or its suppl. 76° 14′	9,98734
		12,44802		12,79352
		2,56229		9,88573
To sine angle C	50° 14′	9,88573	To side A C 808,7	2,90779
Angle A add	26 0			
Subtract	76 14			
from	180			
Angle B	103 46			

It may be proper to observe, that if the given angle be obtuse, the angle sought will be acute; but when the given angle is acute, and opposite a given lesser side, then the required angle is doubtful whether acute or obtuse, it ought therefore to be determined before the operation; for it is plain the above proportion produces 59° 17′ for the required angle, but as it is obtuse, its supplement to 180° must be taken, viz. 120° 43′.

By the Gunter.

1st. The extent from 365 to 640 on the line of numbers will reach from 26° to 50° 14′, on the line of sines equal the angle B.

2d. The extent from 50° 14′ to 76° 14′ on the sines, will reach from 640 to 809, on the line of numbers equal A C.

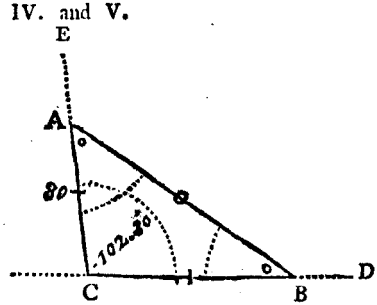
AXIOM II.

In every plane triangle it will be as the sum of any two sides is to their difference, so is the tangent of half the sum of the angles opposite these sides, to the tangent of half their difference, which half difference being added to half the sum of the angles gives the greater angle, but being subtracted, the remainder will be the lesser angles.

CASE IV. and V.

Two sides and their contained angle being given, to find either of the other angles, and the third side?

The side B C 110°, A C 80°, and angle B C A 102° 30′, to find the angle BAC and CBA.



CONSTRUCTION.

Draw the indefinite right line C D, on which set off C B = 110, make the angle A C B = 102° 30′, then on A C, set off C A 80, join A B, and it is done, for A B will measure on the former scale 149, and the angles A and B will measure 45° 58′, and 31° 32′ respectively on the line of chords.

The

The proportion by axiom III. will be,

To find the angles B and A.			To find the side A B by axiom II.		
As the sum of the sides A C and B C	190	2.27875	As sine ang. B	31 32	9.71850
Is to their difference,	30	1.47712	Is to A C	80	1.90309
So is tan. half sum oppo. angles	38° 45′	9.90449	So is sine ang. C or its sup.	102 30 } 77 30 }	9.98958
		11.38161			11.89267
		2.27875			9.71850
To tang. half diff.		7° 13′=9.10286	To side A B 149.3		2.17417

By Gunter.

1st. The extent from 190 to 30, on the line of numbers, will reach from 38° 45′ to 7° 13′, on the line of tangents for half difference.

2d. The extent from 77° 30′, which is the supplement of 102° 30′ to 180° to 31° 32′, on the line of sines will reach from 80° to 149° 3′, on the line of numbers for the side A B required.

The learner may be at a loss how to know to which angles the above sum and difference belong, but let him remember the biggest angle is opposite the biggest side, and the contrary, which will determine it.

AXIOM III.

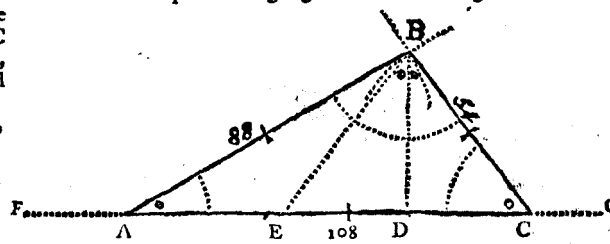
In any plane triangle, it will be
As the greatest side
Is to the sum of the other two sides,
So is the difference of those sides
To the difference of the segments of the base made by a perpendicular, let fall from the angle opposite the base.

And half the difference of the segments added to half their sum will give the greater segment, but if subtracted from their half sum will leave the lesser segment, the triangle being thus cut, becomes a right-angled triangles, the hypothenuses and bases of which are given, to find the angles by axiom I.

CASE VI.

The three sides of a plane triangle given to find the angles?

The side B A 88, B C 54, A C 108, given, to find the angles A B C, B A C, B C A.



CONSTRUCTION.

Draw the indefinite right line F G, on which from any point therein, as at A, set off A C 108, then 88 in your compasses, and one foot on the point A, sweep an arch also with the distance 54 in your compasses, and one point on C, sweep another arch intersecting the former arch in the point B, and it is done; B A, B C, A C, will measure 88 54 108 respectively on the same scale.

The proportion by axiom III.

			To find A E = A D — D C the diff. of segments.		
88					
54					
142	Sum of shortest sides		As the side A C	108	2.03342
34	Diff. ditto		Is to the sum of sides A B and B C	142	2.15229
			So is diff. sides A B and B C	34	1.53148
Half base	54				3.68377
Half diff. segm.	22, 35				2.03342
A D	76, 35	Great segment			
D C	31, 65	Least segm.	To A E the diff. of segmt. of base 44, 7 Half 22, 35		1.65035

Having divided the triangle into two right-angled triangles, the hypothenuse and bases of which are given, to find the angles by axiom I. as follows:

To find the angle D A B.

As the hypothenuse A B 88		1.94448
Is to radius		10
So is side A D the great. seg. 76 35		1.88281
To sine ang. A B D	60° 11′	9.93833
	90	
The com. is ang. A = 29 49		

To find the angle D B C.

As hypoth. B C 54		1.73239
Is to radius		10
So is D C 31 65		1.50037
To si. ang. B D C	35° 53′	9.76798
	90	

Its com. ang. C = 54 07 + ang. A 29° 49′ = 83° 56′ and 180 — 83° 56′ = ang. B 96° 4′.

OBLIQUE SAILING.

WE come next to the doctrine of oblique triangles applied to problems of sailing: and though it may be applied to the measuring of inaccessible objects, yet we shall confine it to those problems which are more immediately necessary in navigation, and is chiefly used in taking the maps of harbours, sea-coasts, &c. as follows:

Oblique Sailing exemplified by proper Examples.

CASE I.

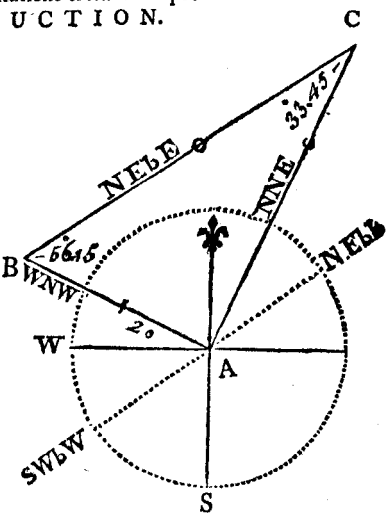
The bearing and distance of two places from each other, as also the bearing of each of them from a third place, being given, to find the distance from the said third place to each of the other two places.

EXAMPLE.

Coasting along shore, I saw a cape of land which bore from me N. N. E. I stood away W. N. W. 20 miles, and the same cape bore from me N. E. by E. I would know the distance of the ship at both stations from the cape?

CONSTRUCTION.

Having drawn the compass N. E. S. W. let A represent the place of the ship at her first station, from whence, through the N. N. E. point, draw the indefinite right line C A, also through the W. N. W. point, draw another indefinite right line, B A, and set off thereon 20 miles from a scale of equal parts from A to B, through the centre of the compass also draw the N. E. by E. and S. W. by W. points, and parallel thereto from the point B, draw the line B C, meeting the N. N. E. in the point C, and it is done; now from the N. eastward 2 points, and from the N. westward 6 points, together make 8 points for the ∠ B A C, also the difference between the N. E. by E. and N. N. E. points are 3, or = 33° 45′ = ∠ B C A, the other ∠ being a right ∠, the angle C B A will be the complement of 33° 45′ = 56° 15′.



To find the distance A C.

Radius	10.00000
: A B 20 miles	1.30103
: : Tang. ∠ B = 56° 15′	10.17511
: A C dist. from her 1st station 29 : 93 miles.	1.47614

To find the distance B C.

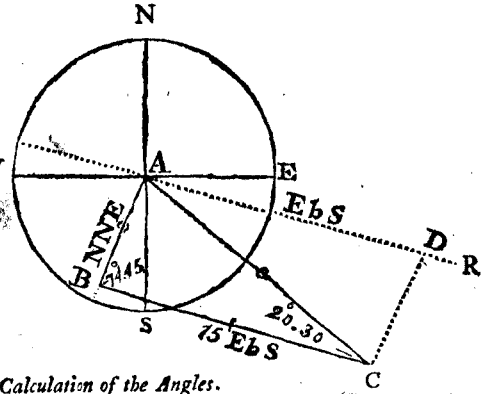
Radius	10.00000
: B A = 20 miles	1.30103
: : Sec. ∠ B 56° 15′	10.25526
: Dist. B C = 36 miles =	1.55629

EXAMPLE II.

Being at sea, I saw two headlands, whose bearing from one another I find by the chart to be W. by N. and E. by S. distance 15 miles, the northermost bore from me S. S. W. and southermost S. E. by E. I demand my distance to each of the said headlands?

CONSTRUCTION.

Having drawn the compass, set off the bearings as AB the S. S. W. bearingand AC the S. E. by E. course, draw through the centre the dotted line representing the bearings of the two places from one another, and from A towards R, on this line, set off from any scale of equal parts, 15 miles, from A to B, and draw B, draw D C parallel to B A until it cuts A C at the point C, through C draw B C parallel to A D and it is done.



Calculation of the Angles.

Between N. N. E. and E. by S. is 7 points, or 78° 45′ = ∠ ABC, between S.S. W. and S.E. by E. is 7 points, or 78° 45′ = the ∠BAC, consequently the ∠s ABC, and BAC = 14 points taken together, wherefore taking 14 from 16 the numbers of points in a triangle remains 2 points, or 22° 30′ for the remaining ∠ BAC.

Calculation of the Sides.

As sine 78 45 =	9.99157	It being an isosceles triangle,
Is to B C = 15 miles	9.17609	A C = B C = 15 miles.
So is sine ∠ 22 30 = ∠ C	9.58284	
	10.75893	
	9.99157	
To — AB = ,5853 miles	0.76736	

This example and the first, are used for finding the distance of a ship from any head-land, &c. when the ship is about to take her departure from the land.

CASE II.

The bearings and distance of two places from each other, and the distance of one of those places and the bearing of the other, from a third place being given, to find the bearing of the first, and the distance of the second from the third place.

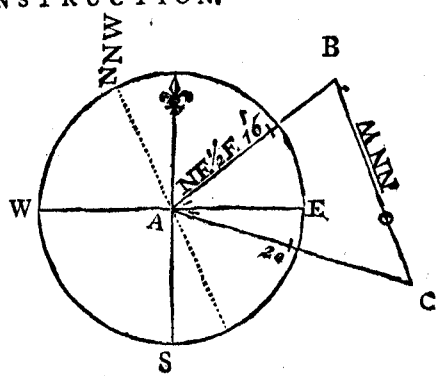
EXAMPLE I.

Admit two ships sail from the said road, one sails N. E. ½ E. eastery 16 miles, the other sails 20 miles, and then finds the first to bear N. N. W. I demand the distance between the two ships?

CONSTRUCTION.

1st. Having drawn the compass, let A be the place the ships departed from, and draw the N. E. ½ E. line AB equal 16 miles.

2d. From B draw the right line BC parallel to N. N. W. then with 20 miles between the compasses, setting one foot in A, with the other cross the line B C as in C, and join AC, then is the ∠ BAC the course which the second ship steered, reckoned from the N.E ½ E. southerly, to find which,



Calculation of the Angles.

From B to C bears S. S. E. the oppoſite point to N. N. W. which is 2 points, alſo A bears from the ſame point B, S. W. ½ W. the oppoſite point to N. E. ½ E. which is 4 ½ points and two from the S. eaſterly, make 6 ½ points for the ∠ A B C, from whence you find the ∠ C thus:

As the ſide AC = 20 miles		1.30103
Is to ſine of the ∠ A B C = 73°		9.98087
So is the ſide A B 16 miles		1.20412
		11.18499
		1.30103
To ſine of the ∠ C	49° 57′	9.88396
For N. N. W. add	22 30	
Sum makes	72 27 from the N. [illegible]terly.	

Which being counted from the N. N. W. makes A C to bear from N. 72° 27′ weſterly, whence the ſhip's courſe was from A to C. 72° 27′ eaſterly, or E. S. E. ½ E. nearly.

To find the Diſtance of the two Ships from one another.

The ∠ A B C = 73° 07′		As ſine ∠ A B C = 73° 07′	9.98087
∠ C =	49 57	Is to ſide A C = 20	1.30103
Sum	123 4	So is ſine ∠ 56 56	9.92326
	180		11.22429
∠ A.	56 56		9.98087
		To ſide B C = 17° 52 miles	1.24342

CASE III.

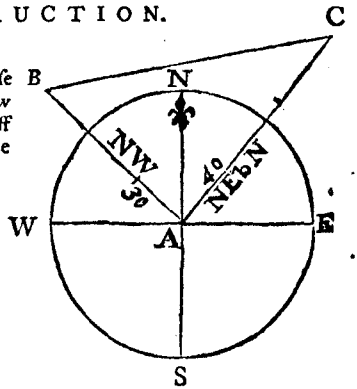
The bearings and diſtances of any two places from a third being given, to find the bearings of the ſaid places, and their diſtance from each other.

EXAMPLE I.

Admit two ſhips ſet ſail from the ſame port, one whereof ſails N. W. 30 miles, the other ſails N. E. by N. 40 miles. I demand their bearings and diſtance from each other?

CONSTRUCTION.

From A ſet off the N. W. courſe A B, which make 30 miles, alſo draw the ſecond ſhip's courſe A C, and ſet off thereon 40 miles, from the ſame ſcale before uſed, join B C, and it is done.



To calculate the Angles.

N. E. by N. 3 points	33° 45′
N. W. 4 points	45
∠ B A C	78 45
	180
	2)101 15
½ ſum opp. angles	50 37

As sum of si. AB & AC = 70		1,84510
Is to their difference	10	1,00000
So is tang. ½ sum opp. ∠s	50 37 ∠	10,08570
		11,08570
		1,84510
To tang. ½ diff.	9 52½	9,24060

Angle B	Sum	60 30
Angle C	Diff.	40 45
Angle A		78 45
	Sum	180 0

Angle C	40 45
N. E. by N.	33 45
Sum	74 30 the bearing from C, or W. by S. ½ S. nearly.

To find the Distance from each other.

As the si. ang. B 60° 30′	9,93970
Is to side AC 40′	1,60206
So is sine ang. A 78° 45′	9,99157
	11,59363
	9,93970
To their dist. BC = 45.8	1,65393

CASE IV.

The mutual distances of three places from each other, and also the bearing of any two of them being given, to find the several bearings of these two from the third place.

EXAMPLE.

Admit there be two ports lying E. by N. and W. by S. distance 400 miles, a ship from the easternmost sails northerly, 450,7 miles, another from the westernmost sails 300 miles and meets the first, I demand the course steered by each ship?

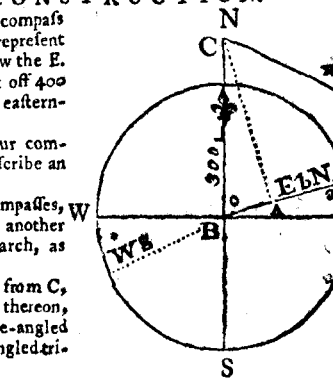
CONSTRUCTION.

1st. Having drawn the compass N. E. S. W. let B, the centre, represent the westernmost port, and draw the E. by N. line BD, on which set off 400 miles to D, then will D be the easternmost port.

2d. With 300 between your compasses, and one foot on B, describe an arch.

3d. With 450 in your compasses, and one foot on D, describe another arch intersecting the former arch, as at C, join CB and CD.

4th. Making BD the base from C, let fall the perpendicular CA thereon, which will divide the oblique-angled triangle BCD into two right-angled triangles BCA and ACD.



By Axiom III.

As the base BD 400		2,60206
Is to sum of sides BC and CD 750,7		2,87547
So is diff. of sides BC and CD 150,7		2,17811
		5,05358
		2,60206
To diff. segts. of base	282 8	2,45152
Half which	141 4	
Add to ½ base	200 0	
Sum is gr. segt. AD =	341 4	
Diff. = the less. segt. AB	58 6	

To find the Course from B, *in* ∠ BCA.

As hypoth.	300	2,47712
Is to radius	90	10,00000
So is AB	58.6	1,76790
		11,76790
		2,47712
Co-sine ang. B	78° 44′	9,29078
Add. E. by N.	11 15	
Sum E.	89 59 N. or the course is N. from B, the westernmost ship's port.	

To find the Course from D, *in* ∠ ACD.

As the hypoth.	450,7	2,65382
Is to radius	90	10,00000
So is AD	341,4	2,53326
		12,53326
		2,65389
To co-sine ang. D	40.46	9,87937
Subtract E. by N.	11.15	
Remains W.	29.31 N. for the ship's course from D, the easternmost port.	

CASE V.

The bearings of two or more places from two different ſtations, as alſo the bearings and diſtance of the ſaid ſtations from each other being given, to find the bearings and diſtance of the ſaid places from each other.

This caſe is a compound of the firſt and ſecond caſes.

EXAMPLE I.

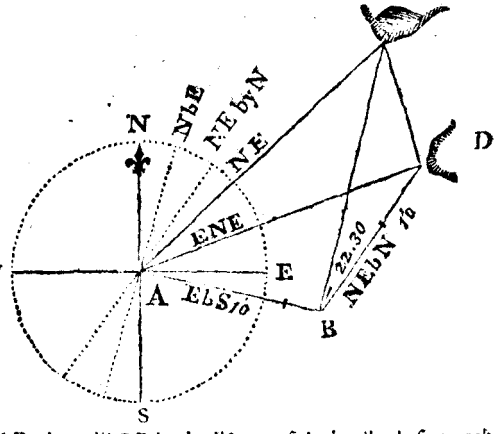
Coaſting along ſhore, I ſaw two headlands, the firſt bore from me N. E. the ſecond E.N.E. and after I had ſailed E. by S. 10 miles, the firſt bore from me N. by E. and the ſecond N. E. by N. I demand the bearings of the two headlands from each other?

CONSTRUCTION.

1ſt. Having drawn the compaſs N. E. S. W. let A repreſent the place of the ſhip, from whence draw the N. E. line A C, the E. N. E. line A D, and the E. by S. line A B = 10 miles, then will B be the ſecond ſhip's ſtation.

2d. From B draw the line B C parallel to the N. by E. where this interſects the N. E. line, as in C, gives the firſt headland.

3d. Alſo from B draw the line B D parallel to the N. E. by N. where this interſects the E.N.E. line, as in D, gives the ſecond headland.



4th. Join the points C and D, then will C D be the diſtance of the headlands from each other, and the ∠ A C D their bearing from the N. E. line, to find which by

CALCULATION.

Firſt you muſt find the diſtance of both headlands from both ſtations.

1. In the △ ABC all the ∠s are given, and one ſide AB 10 miles.

Betwixt E. by S. and N. by E. are eight points, conſequently, the ∠ ABC is right-angled.

Betwixt N. E. and E. by S. is 5 points, or ∠ C A B = 56° 15′. Its comp. = ∠ A C B = 33° 45′. In △ A C B.

As ſine ∠ A C B = 33° 45′ =		9,74474
: ſide A B = 10		1,00000
: : ſine ∠ C A B = 56 15		9,91985
BC	14,96	1,17511

or 15 miles nearly.

Laſtly, In the △ C B D is given the ſide CB 14,96, the ſide BD 10 miles, and ∠ CBD.

For betwixt the N. by E. and N. E. by N. is 2 points, or the ∠ CBD = 22° 30′.

As ſum of ſides BC & BD =	24,96	1,39724
: diff. ſides BC and BD	4,96	0,69548
: : tang. ½ ſum opp. ∠s = 78° 45′		10,70134
		11,39682
		1,39724
: tang. ½ difference	44, 58	9,99958
∠ CDB	123 43	
∠ BCD	33 47	

2. In the △ A D B.

Betwixt E.N.E. and E. by S. = 3 points = ∠ D A B 33° 45′.

Betwixt E. N. E. and N. E. by N. is 3 points, ſo that the ∠ ADB = 33° 45′, now there are 2 ∠s equal, conſequently there muſt be two ſides equal, viz. the ſides oppoſite thoſe angles, that is, the ſide A B = the ſide B D = 10 miles; and the △ ABD is an iſoſceles △.

		180
		22 30
		2)157 30
		78 45
As ſine ∠ BCD	33 47	9,74512
: to B D	10 0	1,00000
: : ſine ∠ CBD	22 30	9,58284
: C D = the diſtance of both	68,82	1,83772

Again,

From ∠ B C D = 33 47

Subtract N. by E. 11 15

22 32 that is CD bears from C. S. 22 32 E. or S. S. E. and the contrary from D.

The Manner of Surveying Coasts and Harbours.

HAVING, in the former part of this work, treated on those branches of knowledge, which ought to be acquired by every one who undertakes the conducting of ships to remote parts; I think it is incumbent on me to give some directions concerning another branch, which, though of great importance, seems to be too much neglected; namely, the drawing of Drafts or Charts of the several Coasts along which they sail, and also of those Harbours into which they go.

Those who have the charge of conducting ships frequently complain, that few of the sea charts are found to be correct. Supposing the complaint to be justly founded, we may reasonably presume, that such incorrectness has arisen from the following causes; namely, the Authors having too much recourse to those charts which were drawn when the latitudes and longitudes of places were but ill determined, and when the necessary instruments were not sufficiently correct for the purpose of taking the different bearings; or it may have been owing to an impropriety in the manner of surveying the several parts.

When a voyage is finished, the Journal of that voyage, however applicable it may be to public purposes, is seldom regarded. Were the Lords of the Admiralty to establish a Repository for observations, drawings, appearances of the land, and other useful articles, such materials might be applied to the improvement of navigation. Proper persons might be appointed to arrange and apply them in the constructing of useful sea charts; and such charts, if not given to the public, should be delivered to the officers of the Royal Navy. When a ship of war is ordered to go abroad, the Master who has the charge of navigating her is under a strong temptation, not to say necessity, to purchase such charts as will best suit his present circumstances, though not the most correct; and the valuable ship, with the still more valuable lives of the people on board, are thereby greatly hazarded.

Having some time ago waited on the First Lord of the Admiralty, I took the liberty to recommend the furnishing the Masters with proper charts, when ordered upon distance services; and observed that such charts might be returnable in the same manner as the ship's stores are now; which has long been the custom in France. His Lordship thought proper to say, "He hoped the Admiralty would think of it." I told his Lordship that I was then speaking to the First Lord of the Admiralty, and a Seaman.—Having never heard any thing of the matter since, I shall proceed to shew the reader how the business of taking the bearing of any part of a coast, and of plotting or delineating it may be performed.

1. Bring the ship to the most convenient place from whence you can see the most distinguished points of land, and the most remarkable objects on shore, and note their bearings down in your station book, as also keep a rough draft on a sheet of paper, note thereon the station 1.

2. Bring the ship to the most convenient station or spot you find, and take the bearings of the most remarkable points and spots you before observed when at first station, and obtain if you can the distance of your

veſſel, from your firſt ſtation, from the bearings and diſtance of ſome noted points on ſhore, it will be preferable; but if you have no diſtances on ſhore of objects from one another, you muſt, in this caſe, obtain it carefully by your log; alſo note theſe bearings down in your rough draft as well as in your book, making a baſe line to repreſent the bearing of your ſhip at her firſt ſtation, and placing from ſome ſcale thereon the diſtance and bearing of your former ſtation, which will be ſtation 2, from whence draw the laſt mentioned bearings, and note their interſections with the ſame objects before ſeen; a line drawn through all theſe interſections, making it reſemble as much as you can all the turnings and windings of the land you ſee, carrying your eye from point to point on ſhore, and making the ſame wavings or windings in your draft.

3. Note particularly on ſhore ſuch remarkable objects that lie in one line, for objects that are in leading marks, as houſes, churches, ſteeples, mountains, &c.

As alſo ſuch particular objects as open from one another, one, two, or three points or more, it will aſſiſt to correct thereby.

4. If you can from a third ſtation take in like manner the bearing and diſtance of your former two ſtations, and alſo of all the former objects, you will from thence be able to detect if any error ſhould have been committed; each ſtation ſhould be if poſſible in the bearing of two remarkable ſpots in one, what opening theſe make with one another at 3d ſtation, will determine.

To take a Draft of a Coaſt in ſailing along Shore.

HAVING brought the ſhip to the moſt convenient place from whence the principal points of the Coaſt or Bay may be ſeen, either caſt anchor if it is convenient, or lie as ſteady as poſſible; or, if the coaſt is too ſhoal, let the obſervations and meaſures be done in a boat; then, while the veſſel is in a ſtationary ſituation, take with the azimuth compaſs, or ſextant, the bearings in degrees, &c. of ſuch points of the coaſt as form the moſt material projections or hollows; write down theſe bearings, and make a rough ſketch of the coaſt, obſerving carefully to mark the points whoſe bearings were taken with letters, for the ſake of reference.

Then let the ſhip or boat run in a direct line along, which muſt be carefully meaſured by the log, or otherwiſe, one, two, or three miles, more or leſs, until ſhe comes to a ſituation from whence the ſame points before obſerved can be ſeen again: there let the veſſel lie as in the foregoing ſtation, and again obſerve the reſpective bearings and leading-marks where two points or bearings, as mountains, churches, trees and houſes, any two remarkable objects in one, in degrees, &c. of the ſame noted points, which are alſo to be wrote down, and a rough ſketch of the coaſt ſhould be alſo taken from this ſtation, for which purpoſe prepare an obſervation table, in which write diſtinctly and regularly the ſeveral celeſtial obſervations, bearings, diſtances, meaſured by the log-line, the rocks, ſhoals, ſoundings, overfalls, races of tides, and other remarks that may be made along the coaſt; the table may conſiſt of ſeven or 8 columns diſpoſed in the following order:

Note.

Note. The sextant will be found the readiest and most correct instrument to take the angles, by being held in an horizontal position, by which means any two objects not exceeding 120° may be brought into contact; it will not be amiss to take material points by the compass, and intermediate ones by the sextant or quadrant.

Observations in Navigating the Coast——, from Cape——— to Point-——,being ——Miles, measured by the Log, the Course from Station I. to II. being S. ¼ W.

Remarks on the Tides and the Nature and Dimensions of Rocks, Shoals and Anchorage.	Bearings of Rocks, Shoals, and these estimated Distances, when on a line with the Points or Heads of the Coasts.	Bearings and Distances taken at these Distances.	Time and Distance sailed from Station I.	Bearings at Station I.	Meridia. Altitude of ☉	Year, Month, and Day.
	Points and Heads. M.	Fath.	H.M.Mi.		D. M.	
This rock is dry at low water, and seemed 100 yards in length, from N. W. to S. W. & heading Mark to it is.—		A.N. 5°W. 22 B.W.20°S.	1 27 ¼ 11 45 5			

In like manner proceed to the second Station, and so on, until the whole Survey is completed.

While the vessel is running the base line from station to station, an accurate appearance of the coast should be made, to do which let four expert persons be appointed, one to take the bearing exactly with an azimuth compass; one to oversee the running out of the log-line, and to keep an account of the ship's way, so as to be readily able to tell the distance run when required; the third to attend the heaving of the lead, to write down the soundings and bearings of one or two head points, or remarkable points of the coast, taking at each depth; the fourth a draftsman, to draw out the necessary bearings and distances, and delineate the figures and windings

windings of the coast at each station, and to correct their forms and dimensions when the ship is sailing along the land. Then let the several bearings be corrected by the variation to reduce them to their true positions; then in some convenient part of a sheet of paper, describe a circle, the larger the better, on which lay off the several bearings taken from the first station, and let them be numbered 1, 2, 3, &c. on the outside of the circle; also, lay down the several bearings taken at the 2d station, let these be numbered with the same figures on the inside of the circle.

Draw a line to express the ship's run, both in length and course, and from the end of the line, expressing the first station, draw lines parallel to the respective bearings taken at that end, and note it in the circle; mark the intersection of each pair of lines, directed to the same point with the numbers annexed to their bearings; and through the intersection so marked, draw by hand a curved line; observe to wave the line in and out, as near as can be like the bending of the coast itself.

Against each part draw the appearance of the elevated, or low ground, in the sketches, distinguishing rocks, cliffs, or high lands, low lands, sand hills, &c. If there are any currents, or eddies, express them in their proper places, by darts or arrows, the points being turned that way the currents set; put in the several soundings at low water, in small figures, distinguishing whether fathoms, or feet; shew the time of high water on the full and change days, by Roman figures, and tell the rise in feet, put in a compass, with a scale of miles or leagues, such as the vessel's run was laid down by; add the name of the place, the coast, and the latitude and longitude, as true as can be obtained.

If there is a shoal or sand on the coast, let it be taken by a boat sailing round it, and keeping an account of the courses, distances and soundings, to be put in the draft; the boat must, from some part of the sand or shoal, take the bearings of two points on the coast, where bearings have been taken from the ship, or the bearing of the boat or some part of the shoal, or some beacon in that place must be taken by the ship, at the stations where she takes the bearings of the shore; for by either of these means one point of the sand being obtained, the rest of it can be laid down from the boat's account.

If the coast to be drawn is a bay or harbour winding in such a manner, that all its parts cannot be seen at two stations; let as many bases or lines be drawn and exactly measured, as may be found necessary, observing that the several distances run should join to one another, in the nature of a traverse; that each new set of objects, or points observed, should be taken from two stations at the end of a known distance, and that the objects whose bearings are taken do not so much extend beyond the limits of the base, as to make angles with it less than about $\frac{1}{2}$ or $\frac{3}{4}$ of a point, but rather reserve such objects for the next measured base line; for when lines lie very obliquely to one another their intersections are not easily ascertained.

Thus may a coast of any extent be surveyed, by carefully measuring of stationary base lines, and from their ends drawing angles to each other.

If any particular parts of the harbour cannot be conveniently seen from either station, take the boat into those places, and having well examined

 them,

them, make ſketches thereof, eſtimating the length and breadth of the ſeveral inlets, either by the rowing or ſailing of the boat; take as many bearings, ſoundings, and other notes as may be thought neceſſary; then annex theſe particular views in their proper places in the general draft.

If there are any dangerous ſands or rocks, beſides inſerting them in their proper places, there ſhould be a double line drawn through that point, on one or more objects aſhore; and for this purpoſe chooſe a church, mill, houſe, noted tree, a clift, or any remarkable thing that can be diſtinctly ſeen at ſea, and which can be brought to bear in the ſame right line with the point to be avoided; but if that point is under water, there muſt be two land marks brought to bear with the danger, either in a right line, when it can be, or in two lines, and thoſe two lines, and thoſe land marks may be put down in their proper places, by their interſection of two objects in one bearing, and two objects in another bearing; which will give the ſtation of the ſhip, and the diſtance and the bearing of the danger from that ſtation noted, when near or on it; but if two ſuch interſections cannot be obtained, it muſt be put down from the two points on ſhore, in one with the computed diſtance therefrom, or from the interſection bearings of two ſingle points on ſhore.

It ſhould be remarked in the draft, what places, if any, are unfit for anchorage, and what are fit, by writing rocky ground, foul anchorage, good anchorage; and in the latter, to draw the figure of an anchor. Alſo if there is any particular channel more convenient to ſail through than another, it is to be pointed out by lines drawn to its entrance, from two or more noted marks on ſhore.

The foregoing method of ſurveying a coaſt ſuppoſes in general, that it is taken by a ſhip in her paſſage along, not having an opportunity of going aſhore.—But when circumſtances will permit the meaſures and obſervations to be made on land, the ſurvey can be more accurately taken than on the water.

To Survey an Harbour by Obſervation Aſhore.

MAKE an eye-draft of the place to be ſurveyed; and in going round its coaſt, fix in the moſt remarkable points and bends of the ſhore ſtation ſtaves, or ſtrait poles, tall enough to be ſeen at a conſiderable diſtance: but if at any of thoſe places there is a noted tree, houſe, or any other remarkable thing, that object may ſerve inſtead of a ſtation ſtaff; and it will be convenient to black the ſtaves, and tie a piece of white bunting to the top of each; then in the eye-draft put letters at the noted points, or marks, for diſtinction ſake.

Chooſe the moſt level ſpot of ground, wherein a baſe line may be meaſured, of one or more half miles in length, or a length of not leſs than a tenth part of the diſtance of the two extreme objects marked for obſerving, and let the direction of the meaſured baſe line be ſo laid out, that from both ends of it as many of the ſtation ſtaves before planted, or the objects before remarked, may be ſeen; the bearing or poſition of this baſe muſt be determined by degrees and minutes, and alſo its length muſt be accurately meaſured to feet and parts, either by a meaſuring chain, or by a piece of log-line of 100 feet long, properly marked at the end of every 10 feet.

From

From one end of the base observe, with any instrument proper to take bearings, the position or bearing in degrees and minutes, of all the staves or objects within view, and write them down orderly; do the same from the end of the base, and let all the bearings be corrected by the variation of the compass.

Then these measures and corrected bearings being plotted or laid down, will give the most conspicuous points on shore, the intermediate spaces are to be filled up from the sketches of them made on the spot.

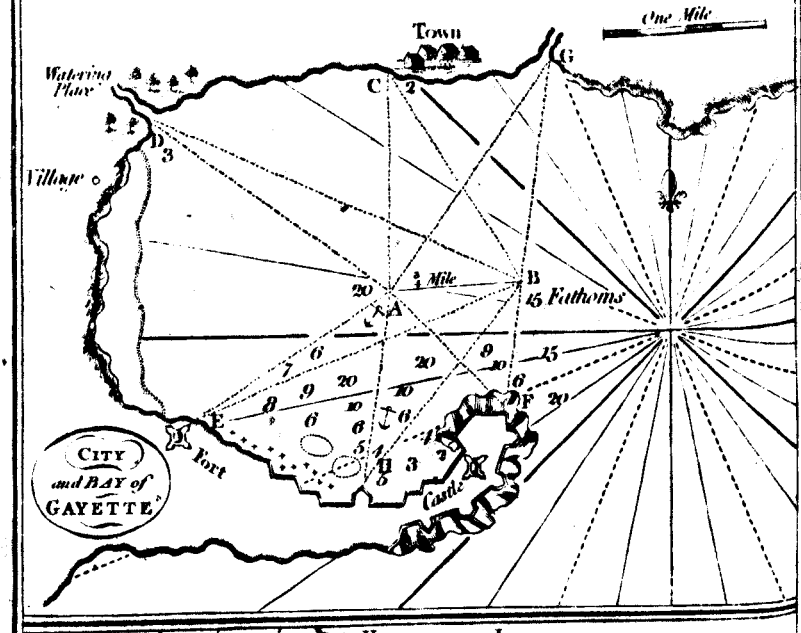
But if any such objects should spread on either hand, so far from beyond the limits of the base, that at either end thereof, the other end and those objects or staves should appear nearly in the same direction, or to make <s of, not exceeding 10°: or, if some of the remarked objects can be seen only from one end of the base, then let the bearings of such objects be taken from a place whose position has been determined from both ends of the measured base; or, if there are several remarked objects which cannot be seen from neither end of the base lines, let the bearings of such objects be taken from each of the two points whose position has been taken from both ends of the base, or it may on some occasions be proper to choose another place on which another base of a convenient length may be measured, and from the extremities of which the ends of the first base may be seen, and also as many as can be of the remaining objects which lay too obliquely for the first base, or which could not be seen from it; in such manner proceed until the bearings are taken of all the points judged necessary for completing the survey of the limits of the harbour.

If a base line of a sufficient length cannot be measured in one right line, it may be taken in two adjoining lines, as the two sides of a triangle, the included angle being accurately taken, and the bearing of either line.

When the outlines or limits of an harbour, bay, road, &c. are delineated by the preceding precepts, let a small vessel go out to sea to take drawings of the appearance of the land, and its bearings, sail likewise into the harbour, and draw the appearance of its entrance, take particular notice if there are any false resemblance of the entrance by which ships may be deceived and run into danger; or when any two objects being brought in a line, or in one, will lead into the harbour without danger; when it can be done, search for the best anchoring places, and if possible denote those places, by bringing two objects in one, if not the exact bearings of two or three other objects, so that the places may be easily determined, the chart being correctly drawn, a compass, with the variation, and scale properly fitted to the plan, the isles, rocks, sands, &c. marked in their proper places, with their soundings at low water, and the winds open to them, the best track with the soundings all the way to those anchoring places, the proper sailing marks to avoid dangers; the winds, if any troublesome ones, which prevail, and at what seasons; the places where fresh water can be got, the name of the place, the country in, on what sea, the latitude and longitude, a sketch of the appearance the place makes at sea upon a known rhumb, and at an estimated distance, and whatever else a judicious seaman shall think proper to insert; then is the plan fit for all nautical purposes, and may be embellished with proper colours, if necessary.

Sea-

SURVEYING.


One Mile
Town
Watering Place
Village
C
G
D
B
A
E
F
H
Fort
Castle
¾ Mile
45 Fathoms
CITY and BAY of GAYETTE.

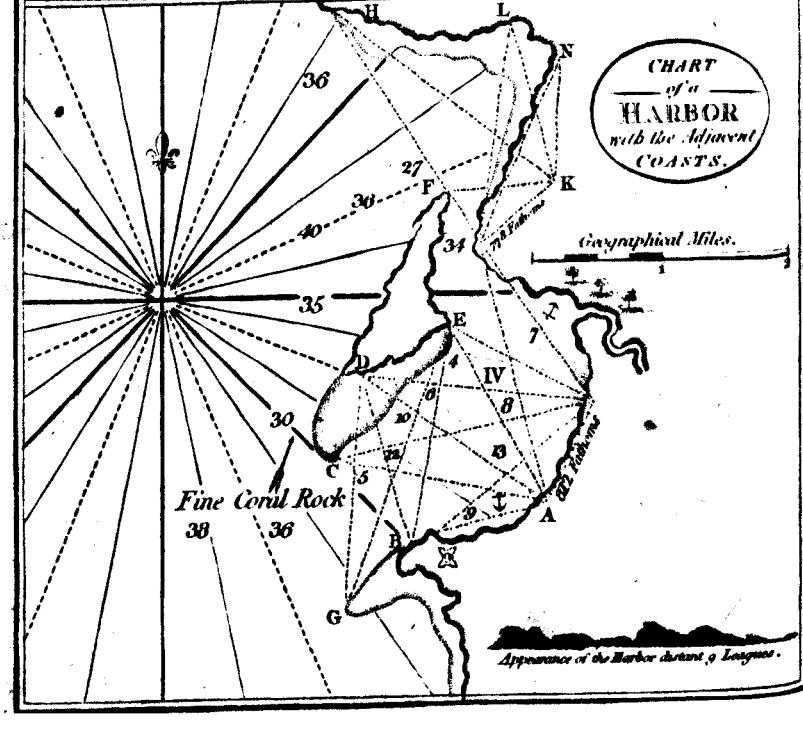


CHART of a HARBOR with the Adjacent COASTS.
Geographical Miles.
H
L
N
K
F
E
D
C
B
A
G
IV
Fine Coral Rock
Appearance of the Harbor distant 9 Leagues.

Sea drawings, taken according to the foregoing precepts, besides the real use they are of, cannot fail to recommend the young mariner, who surveys and constructs them, to the notice of his Superiors.

To reduce a Draft to a smaller Scale.

WITH a black lead pencil draw the draft to be reduced all over with cross lines, forming exact squares, draw the clean paper for the copy all over with the same number of squares, but their sides larger or smaller in proportion to the intended size of the scale, such as $\frac{1}{2}$, $\frac{1}{4}$, &c. length of the other, distinguish by a stronger mark, with a figure every fifth or sixth row of squares in both, so that the several corresponding squares may be readily perceived, then, in each of the squares of the draft, draw, by the eye, a curve on the paper, similar to that in the square of your copying draft, till the whole is copied, make the black lines with India or other ink, and when drawn, the black-lead lines may be rubbed out with bread or India rubber.

I here give two Examples as an elucidation of what has last been said.

EXAMPLE I.

AB is the Base Line, equal to $\frac{3}{4}$ Mile.

BG = N. 5° E.	1	Station at B, with Bearings	AG = N.E. by N.	1	Station at A, with Bearings.
BC = N. 25 W.	2		AC = N.	2	
BD = N. 53 W.	3		AD = S. by W.	3	
BE = W. S. W.	4		AE = S.W. by W.	4	
BH = S.W. by S. $\frac{1}{2}$ W.	5		AH = S. $\frac{1}{2}$ W.	5	
BF = S.	6		AF = S. E.	6	

These instruments give the points GC DE HF in order from each station; that is, BG and AG intersects, as also BC and AC, &c.

Observe, the last letter must be the same in both bearings, and it will be the best to follow the bearings one way all round the compass from the first station; as also when arrived at the second station, begin with your first object seen at first station, and follow the letters round belonging to each object, by which the last letter in each bearing will successively follow in order.

This is an example when on board ship, but in the following

EXAMPLE II.

This harbour was surveyed by base lines taken on shore, which, when it can be done, is far preferable.

The base line AB 812 fathoms was taken, as by directions on the most even spot on shore; now, beginning from the point A:

AB = W. by S. $\frac{1}{2}$ S.	Bearings from Station A	GB = S. S. W.	Bearings from Station G.
AC = W. by N.		GC = W. by S. $\frac{1}{4}$ S.	
AD = W.N.W. $\frac{3}{4}$ N.		GD = W. $\frac{3}{4}$ N.	
AE = N.N.W. $\frac{3}{4}$ W.		GE = W.N.W. $\frac{1}{4}$ N.	
AF = N. by W. $\frac{1}{2}$ W.		GF = N.W. by N. $\frac{1}{4}$ N.	
AG = N. N. E.	812 fathom		

Bearings from Station F.	Bearings from Station K.
FE and FH = N.W. by N. $\frac{1}{4}$ N. in one.	KF = S.W. $\frac{1}{4}$ W.
FI = N. $\frac{1}{4}$ E.	KE = W. $\frac{1}{2}$ S.
FK = N.E. $\frac{1}{4}$ E. 773 fathom.	KH = N.W. $\frac{3}{4}$ N.
	KT = N. by W. $\frac{1}{2}$ W.
	NN = N. $\frac{1}{4}$ E.

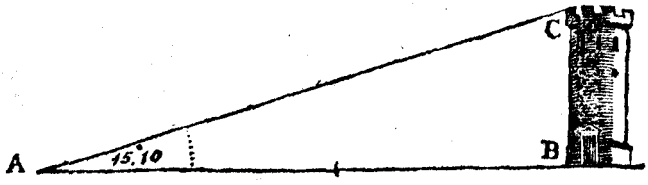
Through the intersections of the bearing draw the configuration of the land, as before directed, and finish the drawing by the instructions there given, which, if well heeded, no difficulty will materially occur.

To find the Height and Distances of Objects at Sea.

WHEN the object is perpendicular, and the distance to it can be measured, find the angle of latitude with a quadrant, and measure the distance to it as exact as possible, and then you have the <s and base, to find the perpendicular; or, if you go backward or forward until the angle of altitude be 45°, the distance between you and the object will be the perpendicular height.

EXAMPLE I.

Being 69 fathoms from the bottom of a tower, I find its altitude, after allowing for the height of my eye, above the water 50° 10′. Required the height?

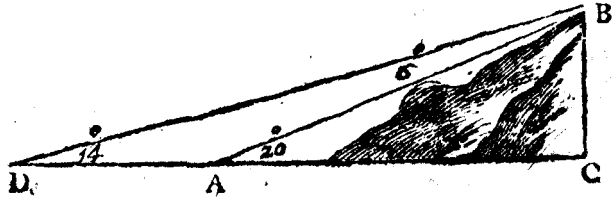


Draw A B = 96, upon B erect the perpendicular B C, and draw A C, making an angle with A B = 15° 10′ till it cuts B C in C, then will B C be the height of the tower.

As *radius*	10.00000
Is to the distance 96	1.98227
So is tang. ang. A. 15° 10′	9.43308
To the height B C 26.2	1.41535

EXAMPLE II.

Being at sea, I observed the altitude of a mountain, and found it 20°, and then sailing from it in a direct line four miles, I found the altitude of the mountain to be 14°, dip and refraction allowed for. I require the perpendicular height?



CON-

CONSTRUCTION.

Draw the horizontal line D C

On any point A make the ∠BAC=20°, from A set off 4 miles to D, on D make the ∠BDC=14°, and from where the line DB cuts the line AB as at B, let fall the perpendicular BC on the base DC, and DC measured will be the perpendicular height required.

∠A = 160°
∠D = 14°
Sum 174° which taken from 180° gives the ∠ DBA=6°. Then it will be

As sine ∠ DBA=6°	9.01922
: BB = 4 miles	0.60206
: : Sine ∠BDA 14°	9.38368
	9.98574
	9.01923
: AB = 9.258	= 0.96651

Then △ ABC given AB = 9.258 and ∠ A find BC.

Radius	10.00000
: AB 9.258	0.96651
: : Sine ∠20	9.53405
: BC = 3.166	0.50056

So that the height of the mountain is 3 miles $\frac{166}{1000}$ = 1 furlong, 13 poles, &c.

NOTE. In finding the ∠ DAB see Prob. 5th in Geometry.

Of the Curvature of the Earth.

MOST persons know, that if they are raised above the surface of the adjacent land or water, they can not only see different objects that lie on that surface better, but also see those more and more remote as they advance higher. The irregularity of the surface of the land will not be subjected to any one rule that will give the distance to which objects may be seen at different elevations; but at sea, where there is generally an uniform curvature of the water, upon the supposition of the spherical form of the earth, those distances may be easily computed.

RULE.

To the earth's semidiameter add the height of the eye, multiply the sum by the height, then the square root of the product is the distance at which an object on the surface of the water can be seen by an eye so elevated; and by this rule was table XXIII. computed, the diameter of the earth being taken at 41798117 feet, according to Sir Isaac Newton's measures. This table may be usefully applied to estimate the distance of an object at sea, the elevation of that object above its horizon being known.

EXAMPLE I.

Sailing towards a head-land, on which is a light-house elevated 600 feet above the surface of the water, we saw the lights at night just appear in the horizon, how far were we at that time distant from that light-house.

Look in table XXIII. for 600 feet in the column marked height in feet, and right against it, in the column marked distance in miles, is 29.994. So that the distance may be reckoned about 30 miles.

EXAMPLE II.

Being in company with some merchants walking on a sandy shore, on the look-out for a vessel which was expected, whose top-gallant mast was 140 feet above the surface, allowance being made for her immersion in the water, we observed through the telescope a ship's vane just appearing in the horizon. How far off is that ship, supposing it the vessel expected? Answer, against 140 feet, the height, stands 14.488, that is her distance; here is no allowance made for the height of the eye above the horizon; but it is obvious, that the higher the eye, the farther it can see: now as objects are seen in a straight line, and that line is a tangent to the earth's surface, therefore it follows, that to find the distance of two elevated objects, when the right line joining them touches the surface of the earth, between those objects look for the distance answering each height, and their sum is the distance required.

Thus, in the second example, suppose the eye raised six feet above the water's edge, it can see an object on the surface 2.999, or 3 miles off. This distance added to $14\frac{1}{2}$ miles, makes the distance of the ship to be $17\frac{1}{2}$ miles.

EXAMPLE III.

A man being on the main-top-gallant mast of a man of war 200 feet above the water, sees an 100 gun ship she had engaged the day before hull-to, how far were those ships distant from one another?

A ship of 100 guns, or a first rate man of war, is above 60 feet from the keel to the rails, from which deduct about 20, leaves 40 for the height of her quarter above water. Now a ship is seen to hull-to when her upper works just appear.

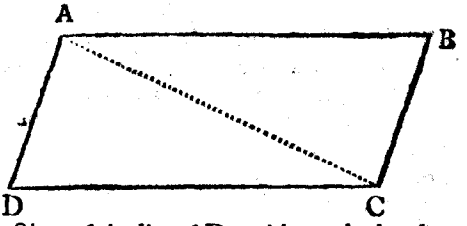
Then 200 feet high gives	17.316 miles.
And against 40 stands	7.744
	25.060 miles is her distance.

CURRENT SAILING.

CURRENTS are certain settings of the stream, by means of which all bodies moving therein are compelled to alter their course, and submit to the motion impressed upon them by it; whence, if a current sets with the course of a ship, it augments her motion by as much as the drift or rate of driving it.

Thus, if a ship sails N. N. E. 20 miles, in a current that sets N.N.E. 8 miles, in the same time her true course will be N.N.E. 28 miles in that time; but if a current sets against a ship, it lessens her velocity by just as much as the current's drift is.

So that if the ship sails N. E. 49 miles, in a current that sets S.W. 10 miles in that time, then her true course will be N. E. 39 miles; and if in the same time that the ship sails N. E. 49 miles in a current that sets S. W. 59 miles, then the ship will fall a-stern, and her true course will be S. W. 10 miles; but if the ship thwarts the current, it not only lessens or augments her velocity, but gives her a new motion, compounded of that of the ship and current, that is,



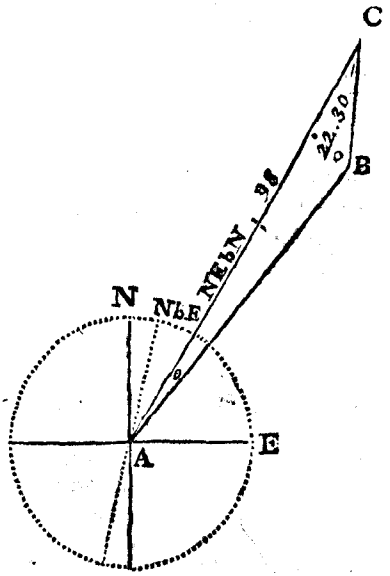
If a body be agitated by two motions at the ſame time, the one with a certain velocity that will carry it according to the direction of the line AB, the length AB in a certain ſpace of time, the other according to the direction of the line AD, with a velocity that will carry it to the diſtance AD in the ſame time, then the body will deſcribe the diagonal AC, and at the end of that time will be found in the point C.

The ſetting and drifts of the moſt remarkable tides and currents are pretty well known, but if in unknown currents, the uſual way to find the ſetting and drift is thus:

Let three or four men take a boat a little way from the ſhip, and by a rope faſtened to the boat's ſtern, let down an heavy iron pot, or loaded kettle, into the ſea, to the depth of 80 or 100 fathoms when it can be, whereby the boat will ride almoſt as ſteady as at anchor, then heave the log, and the number of knots run out in half a minute will give the miles which the current runs per hour, and the bearing of the log ſhews the ſetting of the current.

EXAMPLE I.

If a ſhip ſails 98 miles N.E. by N. in a current that ſets S. by W. 27 miles in the ſame time. What is her true courſe and diſtance?




```
 180
  22 30
 ------
2)157 30
 ------
  78 45
```

CALCULA-

CALCULATION.

The oppofite point to S. by W. is N. by E. which taken from N.E. by N. leaves 2 points = 22° 30′ between them for the < C, being thus given in the △ A C B together with the two fides including it A C, C B to find <ˢ C A B and A B C, and diftance A B by Axiom III.

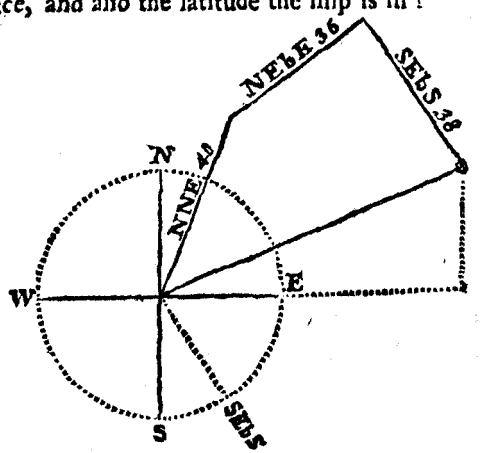
98 } 27 }	125	As fum of the fides	125	2.09691
Diff.	71	Is to their difference	71	1.85126
		So is tang. ½ fum opp.	<ˢ 78° 45′	10.70134
				12.55260
				2.09691
		To tang. ½ their difference	70 42	10.45569
		< B =	149 27	
		< A =	8 3	
		< C =	22 30	
		Sum <ˢ	180 0	

To find the Diftance by Axiom I.

As fine < A	8° 3′	=	9.14624
Is to CA	27′		1.43136
So is fine < C	22° 30′		9.58284
			11.01420
			9.14624
To diftance AB	73.78		1.86796

EXAMPLE II.

If a fhip from the latitude 38° 40′ fails N.N.E. 40, then N.N.E. by E. 36 miles, in a current that fets S.E. by S. 20 miles, in the fame time that the fhip fails 40 miles; I demand the diftance from her firft place, and alfo the latitude the fhip is in?



CONSTRUCTION.

Having drawn the compaſs, draw the N. N. E. courſe equal to 40 miles, to the end of which join the N. E. by E. line, and ſet off thereon 36 from the ſame ſale, from the end of the laſt N. E. by E. line ſet off the diſtance the current's drift, viz. S. E. by S. 38 miles, that is, as 40 the ſtern of the ſhip is to 20 the run of the current, ſo is 76 the whole run of the ſhip to 38 the drift of the current, then to the end of that line to the ſhip's firſt place, will be the diſtance, and the < being meaſured will be the ſhip's courſe, and a line let fall from this laſt point on the parallel of the ſhip's firſt place, will give on that parallel the departure from her firſt meridian.

This may be done by calculation, but that being tedious we ſhall omit it, and ſhew how it may be done by a traverſe, in which we ſhall conſider the current as a ſingle courſe.

Courſes Miles	Northing	Southing	Eaſting	Weſting
N.N.E. 40	37.0		15.3	
N.E. by E. 30	20.0		29.9	
S.E. by S. 38		31.6	21.1	
	57.0	31.6	66.3	
	31.6			
	25.4			

As diff. lat.	25.4	1.40483
Is to radius		10.00000
So is departure	66.3	1.82151
To tang. courſe 69° 3′ from N. Eaſterly or nearly E.N.E. ¼ E.		10.41668
As ſine of courſe 69° 3′		9.97030
Is to dep.	66.3	1.82151
So is radius		10
To diſtance 70 miles		1.85121

Many more queſtions might be added, but theſe, being well underſtood, are ſufficient for the ſeaman's purpoſe; and that the ſtudent ſhall not meet with any thing unneceſſary which might lead him out of the plain path, I have avoided thoſe things which tend to puzzle more than improve.

EXPLANATION

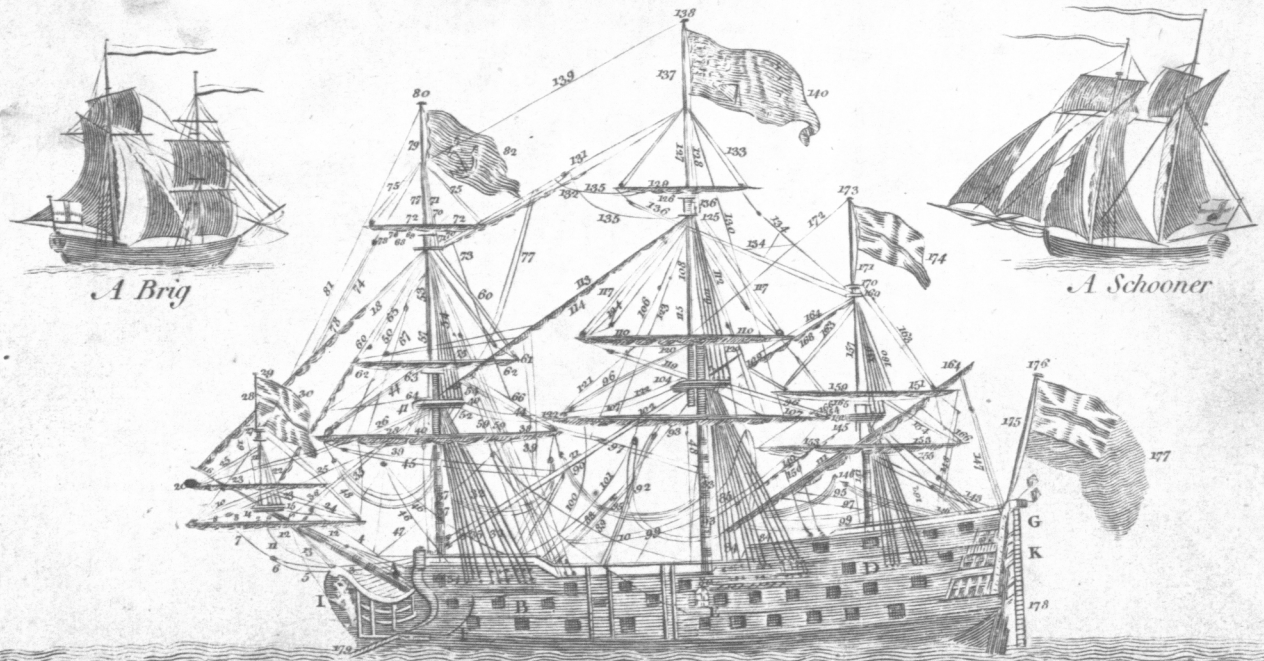
EXPLANATION of the PLATE describing the RIGGING, &c. of a FIRST-RATE SHIP of WAR.

1 BOWSPRIT
2 Yard and sail
3 Gammoning
4 Horse
5 Bobstay
6 Spritsail sheets
7 Pendants
8 Braces and pendants
9 Halyards
10 Liffts
11 Clewlines
12 Spritsail horses
13 Buntlines
14 Standing liffts
15 Spritsail tops
16 Flying jibboom
17 Flying jib, stay, and sails
18 Halyards
19 Sheets
20 Horses
21 SPRIT-SAIL TOP-MAST
22 Shrouds
23 Yard and sail
24 Sheets
25 Liffts
26 Braces and pendants
27 Cap
28 Jack-staff
29 Truck
30 Jack-flag
31 FORE-MAST
32 Runner and tackle
33 Shrouds
34 Lanyards
35 Stay and lanyard
36 Preventer stay and lanyard
37 Woolding the mast
38 Yard and sail
39 Horses
40 Top
41 Crowfoot
42 Jeers
43 Yard-tackles
44 Liffts
45 Braces and pendants
46 Sheets
47 Fore tacks
48 Bowlines and bridles
49 Fore buntlines
50 Fore leechlines
51 Fore top-rope
52 Puttock shrouds
53 FORE TOP-MAST
54 Shrouds and lanyards
55 Yard and sail
56 Stay and sail
57 Runner
58 Backstays
59 Halyards
60 Liffts
61 Braces and pendants
62 Horses
63 Clewlines
64 Bowlines and bridles
65 Reef-tackles
66 Sheets
67 Buntlines
68 Crosstrees
69 Cap
70 FORETOPGAL. MAST
71 Shrouds and lanyards
72 Yard and sail
73 Backstays
74 Stay
75 Liffts
76 Clewlines
77 Braces and pendants
78 Bowlines and bridles
79 Flag-staff
80 Truck
81 Flag-staff stay
82 Flag Lord High-Admiral
83 MAIN-MAST
84 Shrouds
85 Lanyards
86 Runner and tackle
87 Pendant of the gornet
88 Guy of ditto
89 Fall of ditto
90 Stay
91 Preventer stay
92 Stay-tackle
93 Woolding the mast
94 Jeers
95 Yard tackles
96 Liffts
97 Braces and pendants
98 Horses
99 Sheets
100 Tacks
101 Bowlines and bridles
102 Crowfoot
103 Top-rope
104 Top
105 Buntlines
106 Leechlines
107 Yard and sail
108 MAIN TOP-MAST
109 Shrouds and lanyard
110 Yard and sail
111 Puttock shrouds
112 Backstays
113 Stay
114 Stayfail & stay & halyard
115 Runners
116 Halyards
117 Liffts
118 Clewlines
119 Braces and pendants
120 Horses
121 Sheets
122 Bowlines and bridles
123 Buntlines
124 Reef-tackles
125 Crosstrees
126 Caps
127 MAINTOP GAL. MAST
128 Shrouds and halyards
129 Yard and sail
130 Backstays
131 Stay
132 Stayfail and halyards
133 Liffts
134 Braces and pendants
135 Bowlines and bridles
136 Clewlines
137 Flag-staff
138 Truck
139 Flag-staff stay
140 Flag standard
141 MIZEN MAST
142 Shrouds and lanyards
143 Pendants and burtons
144 Yard and sail
145 Crowfoot
146 Sheet
147 Pendant lines
148 Peekbrails
149 Stayfail
150 Stay
151 Derrick and spann
152 Top
153 Cross-jack ya
154 Cross-jack liftsrd
155 Cross-jack braces
156 Cross-jack slings
157 MIZEN TOP-MAST
158 Shrouds and lanyards
159 Yard and sail
160 Backstays
161 Stay
162 Halyards
163 Liffts
164 Braces and pendant
165 Bowlines and bridles
166 Sheets
167 Clewlines
168 Stayfail
169 Crosstrees
170 Cap
171 Flag-staff
172 Flag-staff stay
173 Truck
174 Flag union
175 Ensign staff
176 Truck
177 Ensign
178 Poop ladder
179 Bower cable

HULL.

A Cat-head
B Fore channels
C Main channels
D Mizen channel
E Entering-port
F Hause-holes
G Poop lanthorns
H Chesstrees
I Head
K Stern

A FIRST RATE SHIP OF WAR.



[*Though the following may be thought uselefs to Seamen, it may not be to many Teachers and Learners, as there are excellent Mathematicians who, on account of their being far diſtant from any Sea-port, are at a Loſs for the Terms made uſe of at Sea.*]

AN EXPLANATION OF SEA TERMS.

AFT, or *Abaft*. The ſternmoſt part of the ſhip: carry aft any thing; that is, carry towards the ſtern. The maſt rakes aft, that is, hangs towards the ſtern. How chear ye fore and aft? That is, how fares all the ſhip's company?

Amain. The old term for yield, uſed by men of war to an enemy; but it now ſignifies any thing done ſuddenly, or at once, by a number of men.

Aloft. Over head, or above.

Anchor. The inſtrument by which a ſhip is held. The anchor is foul: that is, the cable has got about the fluke of the anchor. The anchor is a peek: that is, directly under the hawſe-hole of the ſhip. The anchor is a cock-bill, that is, hangs up and down the ſhip's ſide.

Awning. A ſhelter or ſcreen of canvas, ſpread over the decks of a ſhip to keep off the heat of the ſun. Spread the awning, extend it ſo as to cover the deck. Furl the awning, that is, roll it up.

Aloof, is diſtance. Keep aloof, that is, keep at a diſtance.

Avaſt. A term uſed for ſtop, or ſtay; as, avaſt heaving, don't heave any more.

Athwart. Acroſs.

Bale. Bale the boat; that is, to lade or throw the water out of her.

Ballaſt, is either pigs of iron, ſtones, or gravel, which laſt is called ſhingle ballaſt; and their uſe is to bring the ſhip down to her bearings in the water, which her proviſions and ſtores will not do. Trim the ballaſt, that is, ſpread it about, and lay it even. The ballaſt ſhoots, that is, it ſhifts, or runs over from one ſide of the hold to the other.

Barge. A carvel-built boat, that rows with ten or twelve oars.

Bearing, ſignifies the point of the compaſs which any two or more places bear from each other, or how any place bears from the ſhip by the compaſs; or it may be ſaid to bear on the beam, abaft the beam, on the bow, the head or ſtern, &c.

Bearings of a ſhip, is that line which is formed by the water upon her ſides when ſhe is at anchor, with her proportion of ballaſt, and ſtores on board. To bear to, is to ſail into an harbour, &c. Bear round up; that is, put her right before the wind. Bring your guns to bear, is to point them to the object.

Bearing-up, or *Bearing-away*. The act of changing the courſe of a ſhip, in order to make her run before the wind, after ſhe had ſailed ſome time with a ſide wind, or cloſe hauled: it is generally performed to arrive at ſome port under the lee, or to avoid ſome imminent danger occaſioned by a violent ſtorm, leak, or enemy in ſight. This phraſe, which is abſurd enough, ſeems to have been derived from the motion of the helm by which this effect is produced; as the helm is then borne up to the windward or weather ſide of the ſhip. Otherwiſe it is a direct contradiction in terms, to ſay that a ſhip bears up, when ſhe goes before the wind; ſince the current of the wind as well as that of a river is always

 under,

underſtood to determine the ſituation of objects or places within its limits. In the firſt ſenſe we ſay, up to windward and down to leeward; as in the latter we ſay, up or down the river. This expreſſion, however, although extremely improper, is commonly adopted in the general inſtructions of our navy, printed by authority, inſtead of bearing down, or bearing away.

Belay. To make faſt any running rope; as belay the main brace, or make it faſt.

Bend. To apply to, and faſten; as, bend the ſails, apply them to the yards, and faſten them; unbend the ſails, that is, caſt them off, and take them from the yards; her ſails are unbent, ſhe has none fixed; bend the cable, make it faſt to the anchor.

Birth. A place; as the ſhip's birth, the place where ſhe is moored; an officer's birth, his place in the ſhip to eat or ſleep in; birth the ſhip s company, that is, allot them their places to meſs in; birth the hammocks, point out where each man's hammock is to hang.

Bight of a rope. Any part between the two ends. Bight, a narrow inlet of the ſea.

Bilge. To break. The ſhip is bilged, that is, her planks are broken in by violence.

Binnacle. A kind of box to contain the compaſſes in upon deck.

Bitts. Very large pieces of timber in the fore part of a ſhip, round which the cables are faſtened when the ſhip is at anchor. After bitts, a ſmaller kind of bitts upon the quarter deck, for belaying the running rigging to.

Bonnet of a ſail. Is an additional piece of canvas put to the ſail in moderate weather to hold more wind. Lace on the bonnet, that is, faſten it to the ſail. Shake off the bonnet, take it off.

Board. To board a ſhip, is to enter it into an hoſtile manner by force.

Board and *Board*, is when two ſhips touch each other. To make a board, is making a ſtretch upon any tack, when a ſhip is working upon a wind. To board it up, that is, to turn to windward. The ſhip has made a ſtern-board, that is, when ſhe loſes ground in working upon a wind.

Break-bulk. To open the hold and take goods thereout.

Batten. A thin piece of wood. Batten down the hatches, is to lay battens upon the tarpaulins, which are over the hatches in bad weather, nail them down, that they may not be waſhed off.

Buoy. A floating conical caſk, moored upon ſhoals, to ſhew where the danger is; alſo uſed to anchors to ſhew where they lie, in caſe of the cable breaking.

Block. A piece of wood with running ſheaves or wheels in it, through which the running rigged is paſſed, to add to the purchaſe.

Braces. The ropes by which the yards are turned about to form the ſails to the wind.

Bowſprit. A large maſt or piece of timber which ſtands out from the bows of a ſhip.

Bulk-head. A partition.

Bolt-rope. The rope which goes round a ſail, and to which the canvas is ſewed.

Bow-lines. Lines made faſt to the ſides of the ſails to haul them forward when upon a wind, which being hauled tort, enables the ſhip to come nearer to the wind.

Bunt-lines.

Bunt-lines. Lines that come down from the top of the maſt to the beam of the outſide of the ſail, and by which the bunt or belly of the ſail is hauled up outwards.

Broach-to. Is when a ſhip on a ſudden lays her broadſide to the ſea, and is dangerous in bad weather.

Chace. A purſuit. To chace, to purſue. The chace, the veſſel purſued.

Careening. To bring a ſhip down on one ſide, ſo as to get at the other ſide to repair or clean it.

Caulking. Filling the ſeams of a ſhip with oakum.

Cun. To direct. To cun a ſhip, is to direct the man at the helm how to ſteer.

Courſe. The point of the compaſs upon which the ſhip ſails. Courſes, a ſhip's lower ſails; as the fore-ſail is the fore courſe, the main-ſail the main courſe, &c. The ſhip is under her courſes, that is, has no ſail ſet but the main-ſail, foreſail, and mizen.

Coxſwain. The perſon who ſteers the boat.

Come no near. Is ſaid by the man at the cun when the ſhip is upon a wind, and is coming to near the wind.

Chains. A place built on the ſides of the ſhip projecting out, and at which the ſhrouds are faſtened, for the purpoſe of giving them a greater angle than they could have if faſtened to the ſhip's ſide, and of courſe giving them greater power to ſecure the maſt.

Chain-plates, are plates of iron faſtened to the ſhip's ſides under the chains, and to theſe plates the dead eyes are faſtened by other plates.

Capſtan. An inſtrument by which the anchor is weighed out of the ground, it being a great mechanical power, and is uſed for ſetting up the ſhrouds, and other work where great purchaſes are required.

Cat-heads. The timbers on ſhips-bows, with ſheaves in them, by which the anchor is purchaſed from the hawſe, and to which it is ſecured to the ſhip's ſide.

Capſiſe. Overturn. The boat capſiſed, that is, overſet. Capſiſe the quoil of rope, that is, turn it over.

Call. A ſilver pipe uſed by the boatſwain and his mates when on duty.

Clew. To haul up the ſails by the clew-lines.

Clew-lines, are ropes which come down from the maſt to the lower corners of the ſails, and by which the corners or clews of the ſails are hauled up.

Crow foot, is a number of ſmall lines ſpread from the fore parts of the tops, by means of the piece of wood through which they paſs, and being hauled tort upon the ſtays, they prevent the foot of the top ſails catching upon the top rim; they are alſo uſed to ſuſpend the awnings.

Crank. The ſhip is crank, that is, ſhe has not a ſufficient cargo or ballaſt to render her capable of bearing ſail, without being expoſed to the danger of overſetting.

Dead-water. The eddie water at the ſtern of a ſhip.

Douce. To ſtrike or haul down; as, douce the top-gallant ſails, that is, lower them.

Dunnage. A quantity of looſe wood, &c. laid at the bottom of a ſhip, to keep the goods from being damaged.

Dog-vane. A ſmall vane with feathers and cork, and placed on the ſhip's quarter for the men at the cun and helm, to ſee the courſe of the wind by.

Dog-watch. The watches from four to ſix, and from ſix to eight in the evening.

Diſpart. A piece of ordnance to find the difference of the diameters betwixt the breach and the mouth of the cannon.

Dead lights. A kind of window ſhutter for the windows in the ſtern of a ſhip, uſed in very bad weather only.

Dead-wind. The wind right againſt the ſhip, or blowing from the very point to which ſhe wants to go.

Dead eyes. Blocks of wood through which the lanyards of the ſhrouds are reeved.

Driver. A large ſail ſet upon the mizen yards in light winds.

Drive. The ſhip drives, that is, her anchor comes through the ground.

Down-hall. The rope by which any ſail is hauled down; as the jibb down haul.

Enſign. The flag worn at the ſtern of a ſhip.

Engagement. Action or fight.

Entering-port. A large port in the ſides of three-deckers leading into the middle deck, to ſave the trouble of going up the ſhip's ſide to get on board.

End for end. A term uſed when a rope runs all out a block, and is unreeved; or in coming to an anchor, if the ſtoppers are not well put on, and the cable runs all out, it is ſaid to have gone out end for end.

Elbow, in the hawſe. Is when a ſhip being moored, has gone round upon the ſhifting of the tides, twice the wrong way, ſo as to lay the cables one over the other: having gone once wrong, ſhe makes a croſs in the hawſe, and going three times wrong, ſhe makes a round turn.

Fathom. A meaſure of ſix feet.

Fack, or *Fake.* One circle of any rope or cable quoiled.

Furl the ſail. Wrap it up cloſe, and bind it upon the yard.

Fiſh. A large piece of wood. Fiſh the maſt, apply a large piece of wood to it to ſtrengthen it.

Flag. A general name for colours worn and uſed by ſhips of war.

Fall-off. To fall to leeward, or a-ſtern.

Foreward. To the fore part of the ſhip.

Forecaſtle. The upper deck in the fore part of the ſhip.

Freſhen the Ballaſt. Divide or ſeparate it.

Fid. A ſquare bar of wood or iron, with ſhoulders at one end; it is uſed to ſupport the weight of the top-maſt, when erected at the head of a lower-maſt.

Fid for *ſplicing.* A large piece of wood of a conical figure, uſed to extend the ſtrands and layers of cables in ſplicing.

Forereach. To ſhoot a-head, or go paſt another veſſel.

Fiſh-hook. A large hook by which the anchor is received from under the hawſe, and brought to the cat-head: and the tackle which is uſed for this purpoſe is called the fiſh-tackle.

Gage of the ſhip. Her depth of water, or what water ſhe draws.

Greave. To burn off the filth from her bottom.

Gripe of a ſhip. That thin part of her which is under counter; and to which the ſtern-poſt joins. The ſhip gripes, that is, turns her head too much to the wind.

Ground-tier. That is, the tier of water-caſks which is loweſt in the hold, and is among the ſhingle ballaſt.

Ground-

Ground-tackle. Is cables, anchors, grapenels, hawſers, &c.
Grappling-iron. A thing in the nature of an anchor, with four or ſix flukes to it.
Gammon the bowſprit. Secure it by turns of a ſtrong rope paſſed round it, and into the catwater, to prevent it from having too much motion.
Girt. The ſhip is girt with her cables when ſhe is too tight moored.
Gun-Room. A diviſion of the lower-deck abaft, incloſed with net-work, for the uſe of the gunner and junior-lieutenant, and in which their cabins ſtand.
Gunnel. The large timber that runs along upon the upper part of a ſhip's ſide.
Gaſket. The rope which is paſſed round the ſail to bind it to the yard when it is furled.
Grummet. A piece of rope laid into a circular form, and uſed for large boats, oars inſtead of rowlocks, and alſo for many other purpoſes.
Helm. The inſtrument by which the ſhip is ſteered, and includes both the wheel and the tiller, as one general term.
Helm's-a-lee. That is, the tiller is quite down to leeward.
Hard-a-weather. Put the tiller quite up to windward.
Haul. Pull.
Heave the capſtan. That is, turn it round with the bars.
Heave handſomely. Heave gently or leiſurely.
Heave hearty. Heave ſtrong and quick.
Heave of the ſea, is the power that the ſwell of the ſea has upon a ſhip in driving her out, or faſter on, in her courſe, and for which allowance is made in the day's work.
Hail. To call to another ſhip.
Halyards. The ropes by which the ſails are hoiſted, as the topſail halyards, the jibb holyards, &c.
Hawſe-holes. The holes in the bows of the ſhip through which the cables paſs. Freſher hawſe, veer out more cable. Clap a ſervice in the hawſe, put ſomewhat round the cable at the hawſe-hole to prevent its chafing. To clear hawſe, is to untwiſt the cables where a ſhip is moored, and has got a foul hawſe. Athwart hawſe is to be acroſs or before another ſhip's head.
Hawſer. A ſmall kind of cable.
Hitch. To make faſt.
Hoiſt. To hawl, ſway, or lift up.
Heel, or incline. She heels to port, that is, inclines or lays down upon her larboard or left ſide.
Hold, is the ſpace between the lower deck and the bottom of a ſhip, and where her ſtores, &c. lie. To ſtow the hold, is to place the things in it.
Hull of the ſhip. The body of it. To lay a hull, is to lay to, with only a ſmall ſail in a gale of wind. To hull a veſſel, is to fire a ſhot into any part of her hull.
Hull-down, is when a ſhip is ſo far off, that you can only ſee her masts.
Hulk. A ſhip without maſts or rigging; alſo a veſſel to remove maſts into or out of ſhips by means of ſheers, from whence they are called ſheer hulks.
Jeer-blocks. The blocks through which jeers are drove.
Jeers. The ropes by which the lower yards are ſuſpended.
Jolly-boat. A ſmall boat,

Jibb.

Jibb. The foremoſt ſail of a ſhip, ſet upon a boom which runs out from the bowſprit.

Jibb-boom. A ſpar that runs out upon the bowſprit.

Junk. Old cable, or old rope.

Knot, ſignifies a mile.

Keel-haul. To drag a perſon backwards and forwards under a ſhip's keel for certain offences. This practice is now laid aſide in the Britiſh Navy, but is uſed by other powers.

Knippers. A large kind of plated rope, which being twiſted round the meſſenger and cable in weighing, bind them together.

Log, and *Log-line*, by which the ſhip's path is meaſured, and her rate of going aſcertained. Log board, on which is marked the tranſactions of the ſhip, and from thence it is copied into the log-book every twelve hours.

Larboard. Left; as, larboard ſide, left ſide.

Labours. That is, the ſhip rolls and tumbles much.

Landfall. The diſcovery of the land.

Land-locked. Sheltered all round by the land, ſo that there is no view of the ſea.

Laſh. To bind.

Lanch-ho, ſignifies high enough, or avaſt.

Lee-ward. With the wind, or towards the point to which the wind blows.

Lee-ſhore, is that upon or againſt which the wind blows.

Luff, or *Looſe*, ſignifies come nearer to the wind, or bring the ſhip's head up more to windward.

Liſt. Incline. The ſhip has a liſt to port, that is, ſhe heels to the larboard.

Lanyards of the ſhrouds, are the ſmall ropes at the ends of them, by which they are hove taught, or tight.

Liſts. The ropes which come to the ends of the yards from the maſt-heads, and by which the yards are toſſed up and down.

Maſt. The upright timber or trees on which the yards and ſails are ſet.

Mizen-maſt. The maſt which ſtands abaft, and from which its rigging and ſails are named; as of the ſails, mizen, mizen-top-ſail, &c. and ſo alſo are the other ſails, &c. named from the other maſts.

Moor, is to ſecure a ſhip with two anchors.

Mend the ſervice. Put on more ſervice.

Mouſe. A kind of ball or knob, wrought upon the collar of the ſtays.

Muſter. To aſſemble.

Meſſenger. A ſmall kind of cable, which being brought to the capſtan, and the cable by which the ſhip rides made faſt to it, it purchaſes the anchor.

Nun-buoy. The kind of buoys uſed by ſhips of war.

Neap-tides. The tides in the firſt and laſt quarter of the moon, and are not either ſo high, ſo low, or ſo rapid as ſpring tides. A ſhip is ſaid to be benciped, when ſhe has not water enough to take her off the ground, or over the bar, &c.

Nothing-off. A term uſed by the man at the cun to the ſteerſman, directing him not to go from the wind.

Narrows. A ſmall paſſage between two lands.

Offing. To ſeaward from the land. A ſhip is in the offing, that is, ſhe is to ſeaward, at a diſtance from the land. She ſtands for the offing, that is, towards the ſea.

Over-board. Out of the ſhip; as, he fell over-board, meaning, he fell out of, or from the ſhip.
On board. Within the ſhip; as, he is come on board.
Oakum. Old rope untwiſted and pulled open.
Orlop. The deck on which the cables are ſtowed.
Over-haul. To clear away and diſentangle any rope; alſo to come up with the chaſe: as, we over-haul her, that is, we gain ground of her.
Pay the ſeams. That is, to pour hot pitch and tar upon the ſeams after caulking.
Purchaſe. To purchaſe the anchor, is to looſen it out of the ground.
Peck. To ride a ſtay-peck, is when the cable and the fore-ſtay form a line. To ride a ſhort peck, is when the cable is ſo much in as to deſtroy the line formed by the ſtay peck. To ride with the yards a peck, is to have them topped up by contrary lifts, ſo as to repreſent a St. Andrew's croſs.
Ports. The holes in the ſhip's ſides from which the guns are fired.
Pudding and dolphin. A large and leſſer pad made of ropes, and put round the maſts under the lower yards.
Pay out the cable. That is ſhove it out at the hawſe holes.
Pendant. The long narrow flag worn at the maſt head by all ſhips of the royal navy. Brace pendants are thoſe ropes which ſecure the brace-blocks to the yard arms, and are always double, in caſe of one being ſhot away, the other may ſecure the yards in its proper poſition.
Parcel a rope. Is to put a quantity of old canvas round it before the ſervice is put on.
Parcel a ſeam. Is to lay a narrow piece of canvas over it after it is caulked, before it is payed.
Port. Uſed for larboard, or the left ſide; alſo a harbour or haven.
Points. A number of plaited ropes made faſt to the ſails for the purpoſe of reefing.
Quoil, is a rope or cable laid up round, one fake over another.
Quarters. The reſpective ſtations of the officers and people in time of action. Quartering, diſtributing the men into different places. Quarter bill, the liſt of the ſhip's company, with their ſtations for action noticed.
Quarter-wind, is when the wind blows in abaft the main ſhrouds.
Reeve. To reeve a rope, is to put it through a block, and to unreeve it, is to take it out of the block.
Rouſe in the cable. Haul it in, and make it taught, or tight.
Reach of a river. The diſtance between any two points of land that lie in a right line from each other.
Ride at anchor, is when a ſhip is held by her anchors, and is not driven by wind or tide. To ride athwart, is to ride with the ſhip's ſide to the tide. To ride hawſe fallen, is when the water breaks into the hawſe in a rough ſea.
Road. A place near the land where ſhips may anchor, but which is not ſheltered.
Rounding. Old ropes uſed to put in between the layers of the cable before it is ſewed.
Ratlines. The ſmall ropes faſtened to the ſhrouds, by which the men go aloft.
Rother, or *Rudder.* The machine by which the ſhip is ſteered.
Rullock. The nitch in a boat's ſide, in which the oars are uſed.
Strike. A term for yield, or ſurrender, uſed to an enemy.

Splice.

Splice. To make two ends of ropes faſt together by untwiſting them, and then putting the ſtrands of one piece with the ſtrands of the other.

Serve. To wind ſomething about a rope to prevent it from chafing or fretting. The ſervice is the thing ſo wound about the rope.

Seaze. To bind or make faſt.

She ſands, or *ſends.* When the ſhip's head or ſtern falls deep in the trough of the ſea.

Settle. To lower; as ſettle the top-ſail halyards, lower them.

Sound. To try the depth of water; alſo a deep bay.

Sheer. The ſheer of the ſhip is the curve that is between the head and the ſtern, upon her ſide. The ſhip ſheers about, that is, ſhe goes in and out.

Sheers, are ſpars laſhed together, and raiſed up for the purpoſe of getting out or in a maſt.

Scudd. To go right before the wind; and going in this direction without any ſail ſet is called ſpooning.

Steeve. Turning up. The bowſprit ſteeves too much, that is, it is too upright.

Spring-tides, are the tides at new and full moon, which flow higheſt, and ebb loweſt.

Spilling-lines, are ropes contrived to keep the ſails from being blown away when they are clewed up, in blowing weather.

Starboard. The right ſide.

Spur-ſhoes, are large pieces of timber which comes abaft the pump well.

Spurling-line, is a line that goes round a ſmall barrel, abaft the barrel of the wheel, and coming to the front beam of the poop deck, moves the tell-tale with the turning of the wheel, and keeps it always in ſuch poſition, as to ſhew the poſition of the tiller.

Spear of the pump. The handle of an hand-pump.

Steady. A term uſed by the man at the cun to the ſteerſman, when ſailing before the wind, to keep her as ſhe goes.

Sway away. Hoiſt.

Stretch out. A term uſed to men in a boat when they ſhould pull ſtrong.

Swabb. A kind of large mop made of junk to clean a ſhip's deck with.

Sinnett. A ſmall platted rope, made from rope yarns.

Stem. She does not ſtem the tide; that is, ſhe does not go through it, or cannot make head againſt it, for want of wind.

Sued or *Sewed.* When a ſhip is on ſhore, and the water leaves her, ſhe is ſaid to be ſued: if the water leaves her two feet, ſhe ſues, or is ſued two feet.

Stays. Large ropes coming from the maſt heads down before the maſts, to prevent them from ſpringing, when the ſhip is ſending deep.

Spring-Stays, are rather ſmaller than the ſtays, and placed above them, and intended to anſwer the purpoſe of the ſtay if it ſhould be ſhot away, &c.

Spring. To break; as to ſpring a maſt or yard, is to ſplit or break it.

Shank-painter. The rope by which the ſhank of the anchor is held up to the ſhip's ſide; is alſo made faſt to a piece of iron chain, in which the ſhank of the anchor lodges.

Stoppers. Large kind of ropes, which being faſtened to the cable in different places abaft the bitts, are an additional ſecurity to the ſhip at anchor.

Tack. To go about.

Tray

Trey-sail. A small sail used by cutters and brigs in blowing weather.
Tell tale. An instrument which traverses upon an index in the front of the poop deck, to shew the position of the tiller.
Traverse. To go backwards and forwards.
Tiller. A large piece of wood, or beam, put into the head of the rudder, and by means of which the rudder is moved.
Tort, or *taut*, signifies tight.
Trice, *trice up.* To haul up and fasten.
Tarpaulin. A cloth of canvas covered with tar and saw-dust, or some other composition, so as to make it water proof.
Tide-gate. A place where the tide runs strong.
Tide it up. To go with the tide against the wind.
Tow. To drag. The ship tows her boats, that is, drags or draws them after her.
Truck. A round piece of wood put upon the top of flag-staves, with sheaves, on each side for the halyards of the flags to reeve in.
Tier. A row; as a tier of guns, a tier of casks, a tier of ships, &c.
Trunions of a gun, are the arms or pieces of iron by which it hangs on the carriage.
Tampions, or *Tomkins.* The bung, or piece of wood, by which the mouth of the cannon is filled to keep out wet.
Truck of a gun carriage, is the wheel upon which it runs.
Uvrou. The piece of wood by which the legs of the crow-foot are extended.
Unfurl. Cast loose the gasket of the sail.
Unbend. Cast off the sail from the yard.
Under way. When a ship is sailing, she is said to be under way.
Veer. Let out, as veer away the cable.
Veer, or wear the ship. That is, put her about with her head to leeward, the contrary way to tacking.
Veer. Shift. The wind veers, that is, it shifts or changes.
Viol, or *Voyol.* A block through which the messenger passes in weighing the anchor. A large messenger is called a viol.
Vane. A small kind of flag worn at each mast-head.
Wake. The path or track impressed on the water by the ship's passing through it, leaving a smoothness in the sea behind it. A ship is said to come into the wake of another when she follows her in the same track, and is chiefly done in bringing ships to, or in forming the line of battle.
Weather. To weather any thing, is to go to windward of it.
Wales, are strong timbers that go round a ship a little above her water-line.
Water-line. The line made by the water's edge when a ship has her full proportion of stores, &c. on board.
Warp. To warp a ship is to draw her against the wind, &c. by means of anchors and hawsers carried out.
Warp. A hawser, or small cable.
Would. To would is to bind round with ropes, as the mast is woulded.
Weigh. To haul up, as weigh the anchor.
Yaws. The ship yaws, that is, goes in and out, not steady.
Yards. The timbers upon which the sails are spread.

The following Questions and Answers are recommended to the Perusal of young Gentlemen belonging to the Sea, in order to refresh their Memories, previous to that Examination which they must pass through, before they are appointed to a Commission in the Royal Navy, or an Officer in the East-India Service; as it is probable similar ones may be asked by those appointed to examine them, at the Navy Office and the East-India House.

Quest. HOW do you find the golden number?

A. I add one to the given year, and divide the sum by 19, the remainder will be the golden number.

Q. How do you find the epact for any year?

A. By dividing the given year by 19, and multiplying the remainder by 11, the product will be the epact, if it does not exceed 30; but if it does, I subtract 30 from it as often as I can, and the remainder will be the epact.

Q. How do you find the moon's age?

A. To the epact I add the day of the month, and the number of the month; their sum will be the moon's age, if it does not exceed 30; but if it does, I substract 30 from it as often as I can, and the remainder will be her age.

Q. How do you find the moon's southing, or the time of her coming to the meridian?

A. I multiply the moon's age by 48, and divide the product by 60; the quotient will be the hours, and the remainder the minutes when she is on the meridian past noon: Or, I may multiply the moon's age by 4, and divide the product by 5, the quotient will be the hours and the remainder multiplied by 12 will be the minutes when she souths, or is on the meridian, in the afternoon: But if this time should exceed 12, I subtract 12 from it, and the remainder will be the time of her southing in the morning.

Q. How do you find the time of high water at any place?

A. To the moon's southing on the given day, I add the time of high water, full and change, at the given place, and the sum will be the time of high water there in the afternoon: But if this time should exceed 12, I subtract 12 from it, and the remainder will be the time of high water in the morning; and if it exceeds 24 I subtract 24 from it, and the remainder will be the time of high water in the afternoon *.

Q. Suppose that you go into an harbour, and find by your watch that it is high water at any hour of the day; by what means do you find the times when it is high water on full and change days in that place?

A. I find the time of the moon's southing on that day, and subtract it from the time of high water at the given place, if I can, and that will be the time of high water. If I cannot, I add 12 to it, and then subtract the above time; the remainder will be the time of high water at the given place, on full and change days.

* The time of high water is found more correct by the tables, see page 141.

Q. How

Q. How do you find the zenith diſtance of any object?

A. By correcting the altitude for the dip, refraction and ſemidiameter, and then ſubtracting it from 90°, the remainder will be the zenith diſtance, which will be either north or ſouth, according as the object bears of me.

Q. Suppoſe the zenith diſtance 10° north, and the declination 20° north, what latitude are you in, and of what name?

A. Ten degrees north.

Q. The ſun is in your zenith, what latitude are you in?

A. The ſame as the declination is, whether north or ſouth.

Q. Your zenith diſtance is 20° north, and your declination is 20° north, what latitude are you in?

A. Upon the equator, and conſequently in no latitude.

Q. Suppoſe that your zenith diſtance is 50° ſouth, and the declination 10° north, what latitude are you in?

A. Sixty degrees north.

Q. Suppoſe your zenith diſtance be 45° north, and the declination 15° ſouth, what latitude are you in?

A. Sixty degrees ſouth.

Q. Suppoſe your zenith diſtance is 45° north, and the declination 15° north, what latitude are you in?

A. Thirty degrees ſouth.

Q. What do you mean by the word amplitude?

A. The true amplitude is the number of degrees that the ſun, moon, or ſtars, riſe and ſet, to the northward or ſouthward of the true eaſt or weſt. The magnetic amplitude is the number of degrees they riſe or ſet to the northward or ſouthward of the eaſt or weſt point of the compaſs.

Q. How do you find the true amplitude?

A. As the co ſine of the latitude: is to the radius: ſo is the ſine of the ſun or ſtar's declination to the ſine of the true amplitude. Or if the ſecant of the latitude be added to the ſine of the ſun or ſtar's declination, the ſum (rejecting 10 in the index) will be the log. ſine of the true amplitude.

Q. But ſuppoſing the evening or morning proves cloudy, and you cannot ſee the ſun or ſtar, how will you find the variation of the compaſs?

A. By an azimuth.

Q. What do you mean by an azimuth?

A. The true azimuth is the diſtance of the ſun or ſtar from the true north or ſouth at every degree and minute of altitude.

The magnetic azimuth is their diſtance, at each degree and minute of altitude from the north or ſouth point of the compaſs.

Q. How do you find the true azimuth?

A. By adding the complement of the latitude, the complement of the altitude, and the ſun or ſtar's polar diſtance into one ſum; from half this ſum I ſubtract the polar diſtance, noting the half-ſum and the remainder: Then, to the arithmetical complement of the co-ſine of the latitude, I add the arithmetical complement of the co-ſine of the altitude; the log. ſines of the half ſum and the remainder; half the ſum theſe four logarithms will give the co-ſine of half the true azimuth, which being doubled is the true azimuth, reckoned from the north in north latitude, and from the ſouth in ſouth latitude.

Or, it may be found thus:

To the log. co-ſecants of the co-latitude and altitude, add the log. ſines of the half ſum and the remainder; half the ſum of theſe four logarithms (rejecting 20 in the index) will be the log. co-ſine of half the true azimuth, as before.

Q. You have given the true amplitude or azimuth by calculation, and the magnetic amplitude or azimuth by obſervation; how do you find the variation?

A. By placing both the amplitudes or azimuth before me, then, if the true amplitude or azimuth be to the right hand of the magnetic, or obſerved, the variation is eaſt, but if it be to the left hand, it is weſt.

Q. You have the latitude and longitude the ſhip is in, conſequently her place, how do you ſhape her courſe, or in other words, find her courſe and diſtance to any other place, whoſe latitude and longitude is known?

A. It may be found briefly by the tables of difference of latitude and departure, but by logarithms I will ſay,

As the meridional difference of latitude: is to radius:: ſo is the difference of longitude: to the tangent of the courſe. And,

As the co-ſine of the courſe: is to the proper difference of latitude:: ſo is radius to the diſtance.

Q. You have the difference of latitude and departure made good in the 24 hours, how do you find the courſe and diſtance, and the ſhip's place, by logarithms?

A. As the difference of latitude: is to radius:: ſo is the departure: to the tangent of the courſe. And,

As the co-ſine of the courſe: is to the difference of latitude: ſo is radius: to the diſtance made good in the 24 hours.

Having the latitude and longitude left, and the difference of latitude, I find the latitude in, and the meridional difference of latitude; I then ſay,

As the co-ſine of the courſe: is to the meridional difference of latitude, :: ſo is the ſine of the courſe: to the difference of longitude. Or, as the proper difference of latitude: is to the departure:: ſo is the meridional difference of latitude: to the difference of longitude. Having the longitude left, and the difference, the longitude in is found by addition or ſubtraction, as the caſe requires.

Q. You have now the ſhip's place by calculation, how do you find it on a Mercator's Chart?

A. By laying a rule acroſs the Chart on the ſhip's latitude, and taking her longitude in my compaſſes, and ſetting one point on the meridian, by the ſide of the ruler, I turn the other eaſt or weſt, according as the longitude is, (by the ſide of the ruler) and it will point out the ſhip's place.

Q. You have now the ſhip's place, how do you find her bearing and diſtance to any other known place?

A. By laying a ruler over the point where the ſhip is, and the given place, and with the compaſſes I take the neareſt diſtance between the ruler and the center of ſome compaſs on the Chart; and ſlide the compaſſes along the ruler, (keeping both points perpendicular to it) the fartheſt point from the ruler will ſhew the courſe, or bearing, between the ſhip and place. Again,

I take the diſtance between the ſhip and place in the compaſſes, and then lay one point on the meridian as much below the ſhip's place, as the other is above the given place: that diſtance, reckoned in degrees, leagues or miles on the meridian, according as it is divided, will be the diſtance.

Q. You are ordered to a ſhip, ſhe is lying in dock; prepare to take her out of dock.

A. I would take on board what kentledge was neceſſary, ſtream-anchor and cable, kedge-anchor, hawſer, and towline, with ſome ſpare ropes for guys, to keep her fair for the dock gates; buoy and buoy ropes, for ſteam and kedge.

Q. When your ſhip is out of dock, what is firſt to be done?

A. I would

A. I would take on board the remainder of the kentledge and level the hold; by laying the kentledge from the fore part of the fore-hatchway to the after-part of the after-hatchway.

Q. If you are taking in bales, how would you dunnage, and which part of the ship most?

A. I would dunnage six inches and mostly about the well, main hatchway, the wake of the chains and floor timbers.

Q. Suppose you have one and a half foot water in your hold, and your ship leels four streaks; what dunnage ought you to have to preserve the cargo?

A. Three feet.

Q. How would you moor your ship at Gravesend?

A. I would come to with my small bower, veer the service into the hawse, and then hang my best bower anchor to the long boat, and with the tide drop her a-stern: when the cable is taut, let go the anchor, first letting go the shank-rope, to keep the cable more taut.

Q. How would you hang the anchor to the long-boat?

A. Take the buoy rope over the roller (which is in the middle of the stern of the long-boat), bring the bight round the main thwart, cockbill the anchor, hook the cat to the anchor, and lower away, until the flukes of the anchor are clear of the boats bottom, then make fast the buoy-rope, have a shank-rope through the ring, (which is at the boat's stern-post), pass it round the shank of the anchor, make it fast to the after-thwart, lower away and unhook the cat, then veer away the cable; be careful to heave the buoy over-board before you let go the anchor.

Q. How do you moor in the Downs?

A. With my best bower to the S. W. I would veer away with the last quarter flood, and moor with the small bower to the N. E.

Q. Where is the best anchoring in the Downs?

A. Upper Deal church and castle in one, in eight or nine fathoms water.

Q. What are the marks for anchoring in the Downs?

A. The South Foreland S. S. W. Deal castle bearing West, and Sandown castle N. W.

Q. How would you unmoor in the Downs with the wind at north?

A. I would splice my stream cable to my small bower, and veer away at half ebb, that I might have time to stow my best bower, and shorten in my small bower cable, before the ship tends to windward.

Q. Proceed to unmoor ship as it is done in the navy.

A. I would send for the master to see the hawse is clear, turn all hands up to unmoor ship, lay the capstan-bars for shipping, call the mate to see the messenger passed for the best bower, rig the davit out, because I will

NOTE. All cables ought to be 120 fathoms in length, and are in proportion to each other, as the cubes of their diameters. The number of threads of which a cable is composed being always proportioned to the length and thickness, and the weight and value of it is determined by this number. The number of threads and weight of cables of different circumferences may be seen in the following table:

Circumference in Inches	Threads or Rope Yarns.	Weight in Pounds	Circumference in Inches.	Threads or Rope Yarns.	Weight in Pounds
9	393	1572	15	1095	4372
10	485	1940	16	1244	4976
11	598	2394	17	1404	5616
12	699	2796	18	1574	6295
13	821	3284	19	1754	7016
14	952	3808	20	1943	7772

will take it up the firſt quarter flood, get the cat and fiſh to paſs for the beſt bower, ſtretch along the fiſh tackle; quarter maſters down in the tier, and ſtand by to veer away the ſmall bower cable; ſhip the capſtan-bars, pin and ſwift them; clap on the ſtoppers before the bitts, and bring to the meſſenger. At the ſame time unbit the beſt bower, rowſe aft the ſlack of the cable; heave taught, take off the ſtoppers, hold on the meſſenger, and heave away; veer away the ſmall bower-cable; clap on the nippers: Thick and dry for weighing, heave chearly; the anchor's away, keep faſt the ſmall bower cable; quarter maſter take hold of the helm; look out for the anchor; the anchor is in ſight; heave and paul the capſtan; hook the cat; haul taught, and take a turn; ſurge the meſſenger round the capſtan; take off the nippers; out cable; cable enough; haul cat; belay the catfall; paſs the ſtoppers; hook the fiſh; try fiſh by hand; haul away the fiſh; belay the fiſh tackle-fall; paſs the ſhank painter; bowſe to the ſtock-tackle; belay the ſhank painter; make faſt the ſtopper and ſtock laſhing; come up cat and fiſh; unhook both; haul the buoy in; then ſhift the meſſenger for the ſmall bower and bring to, clap on the ſtoppers before the bitts and unbit the cable; rowſe aft the ſlack of the cable; man the capſtan; hold on the meſſenger; forecaſtle-men; rig out the davit for the ſmall bower; when the anchor is a-peak, ſend the top men to looſe the ſails: man the yards; ſtretch along the top ſail ſheets; let go the topſail; reef tackles, bunt-lines and clue-lines; ſoot the ſails out of the top; haul home the top-ſail ſheets; ſtretch along the top-ſail halyards and man them; quarter-maſter and boatſwain's mates attend to the braces; hoiſt away the top-ſails; belay the halyards; trim the ſails; heave up the anchor; ſtow it as before, and haul the buoy in.

Q. How would you unmoor with the wind S. E. or S.?

A. Veer on the beſt bower-cable, and take the ſmall bower-anchor up firſt; and proceed as before, then to heave in to the ſhort ſervice on the beſt bower, &c. If the anchor has great hold and afraid of ſtranding the meſſenger, clear away the main capſtan and laſh a block, or purchaſe blocks, on the cable, and one to the main-maſt, or one to the two ports abreaſt of the main-maſt; reeve a hawſer through them, and heave on both capſtans together.

Q. Suppoſe you are cloſe upon a wind, in moderate weather, with all your ſails [illegible], how will you tack the ſhip?

A. I would hand down the lee-bow-lines, ſtretch along the weather-braces, the weather-ſheets and lee-tacks; then put the helm a-lee, let go the fore-ſheet, lee fore-top-ſail, brace and fore-top-bow-line, jib, and ſtay-ſail-ſheets: and haul them taught. When the fore-top-ſail touches, brace to and help her; when aback brace up and help her; when the wind is out of the after-ſails, raiſe tacks and ſheets; ſhift the ſtay-ſail tacks, and haul over the ſtay-ſail-ſheets; cant ſprit-ſail-yard, when the wind is rather $\frac{1}{2}$ a point on the bow if ſure of coming about, haul the main-ſail. *N. B.* One watch of the top-men on the quarter-deck, and fore-caſtle to ſet up the weather-breaſt-back-ſtays: If ſhe has ſtern-way, ſhift the helm and ſquare the ſprit-ſail-yard; haul on board the main tack and aft the main ſheet. Brace up the main yard when the after-ſails are full; haul off all; and haul on board the fore-tack; keep in the weather-braces forward, and let her come to, then brace up; haul aft the fore ſheet, jib and ſtay-ſail ſheets; ſet the back-ſtays when head to the wind up, and haul

haul the bow-lines; then haul taught the weather-braces, lee-tacks and weather-sheets; have the braces let go at once; when the word is given to haul main-sail, (all the hands on the braces should keep hauling taught in for the run), the yards will swing of themselves.

Q. How would you tack a ship under her three top-sails?

A. I would put the helm a-lee, ease off the fore-top-sail brace, keep fast the fore top bow-line; when the fore-top-sail touches, brace to and help her; when the wind is a-head, haul the main top-sail and shift the helm: then brace up the main-yard, and haul the main-top bowline; when the after-sails are full, let go and haul; keep in the weather-braces forward, and when she comes to brace sharp up, haul the main and fore-top bow-lines, and haul taught the weather braces.

Q. How do you veer, or, wear a ship with all her sails set?

A. I would haul the mizen up, and the mizen-stay-sail down, or trail it up, hard a weather the helm, shiver the mizen-top-sail, let go the main and main-top bow-lines, ease off the main-sheet, the lee main brace, and round in the weather-brace. When the wind is abaft the beam, raise the main-tack; when the wind is aft, square the head-yards, and get the other tacks on board; haul aft the sheets, shift the jib and stay-sail sheets over the stays, and as she comes to, haul the mizen out; hoist the mizen stay-sail, and haul aft the sheet; brace the head-yards up, haul the bow-lines, and trim all sharp. If a fresh wind, and should be proper to shorten sail, in top-gallant-sails, down jib and stay-sails, take one or two reefs in the top-sails.

Q. It blows hard, would have you proceed to close reef the top-sails?

A. I would let run the halyards, and haul the yards close down by the clue-lines and down-haul tackles; if the wind is large, man the clue-lines and bunt-lines, let go the sheets, and clue them close up; haul in the weather-brace, and spill the sail as much as possible; then haul out the reef tackles, send men up and haul out the weather earing first, then the lee one, and reef away, hauling the other reefs up before the yard: If the ship is upon a wind when the top-sail yard is down, let go the bow-line. It is mostly the way to man the clue-lines and the bunt lines, to ease off the lee-sheet and clue it up; then man the weather-brace, let go the lee-brace, ease off the weather-sheet and clue it up; hauling in the weather-brace and bunt-lines at the same time; when the sail is spilled, haul out the reef-tackles, and reef as before. But to keep the sail from splitting or shaking (especially if it be wet) it is the best way to man the clue-lines, bunt-lines, and weather-brace, let go the lee-brace, ease off the weather sheet, hauling up the clue-line, and in with the weather-brace at the same time; when in enough, ease off the lee-sheet, clue up, &c. N. B. To set a top-sail on a wind when it blows strong, always haul the lee sheet home first, then the weather one, &c. &c. as before.

Q. It blows harder, you must take in your top-sails?

A. I would take in the fore and mizen top-sails first, because it will ease the ship forward, (for when it blows hard we generally have a head sea, and she keeps to the better) let go the fore-top bow-line, lower away the halyards, man the clue-lines and bunt-lines, clue close up, and haul out the reef-tackles, haul in the weather-brace, steady the lee brace, haul taught the top-sail halyards; send the people up to hand the sail, and when up, before they go on the yard, I'll clap the rolling tackle on to steady her, (all the top-sails should be taken in the same way) after that, if squally, take in the main top-sail, and then the ship is under her courses.

Q. How would you veer a ship under her courses?

A. I would haul the mizen and main-sail up, and down with the mizen-stay-sail, square the after yards, hard a weather the helm, man the weather fore-brace, and ease off the lee-brace and fore bow-line; ease off the fore-tack, and stand by to haul on board the other: keep her large if room, until I get the tack on board and belay it; then luff up to the wind, haul aft the fore-sheet and brace up the fore yard, set the after-sails, aboard main tack, aft the main sheet, brace all up, and haul the bow-lines; when my sails are trimmed, shift the rolling tackles on the top-sail yards.

Q. Suppose you are lying to in a hard gale of wind, under a reef main-sail, you want the ship's head on the other track; how will you veer in a great sea?

A. I will watch her falling off, and put the helm a-weather, when she does, ease off the main-sheet; if that will not do, I'll man the fore shrouds, and get tarpaulins and hammocks or spare canvas up, and spread it: If that will not do, I will haul aft the main-sheet, and put the helm a-lee, then send hands out to the sprit-sail yard with hammocks and gaskets to stop the sprit-sail (called balancing) within the lee clue-line; block and loose the lee yard-arm, then haul aft the sheet, clap the helm hard a-weather, ease off the main-sheet, round in the weather-brace, gather aft the other sheet, haul the main tack on board; when she is before the wind, square the sprit-sail yard, clue the sail up and furl it; ease the helm down a-lee, brace the yards up, haul the main-sheet aft, bowse the bow-line up, lash the helm three parts a-lee, and she will lay to as before.

Q. Suppose she will not veer after all you have done?

A. I will loose the goose wings of the fore-sail; if that will not do, set the fore-sail and veer her under her courses, or haul the main-sail up; if by hauling the main-sail up and furling it she does not veer, lower down the mizen-yard; if that will not do, lower down the cross jack yard and mizen-top-mast; if that will not do, cut away the mizen mast.

Q. How do you cast a ship, when intending to get under way?

A. If I am to cast her to starboard, I would haul in my larboard braces forward, and let my after-yards lay square; I may hoist the fore top-mast stay sail, and keep the sheet to windward to help her; if I am to cast her to port, I would haul in the contrary braces, when cast, fill the head-sails and brace up as circumstances require. *N. B.* If a ship is wind rode, as soon as the anchor is right up and down, put the helm the way you would have her cast, seting in the same braces abaft, and the contrary forward: but if she is tide rode, the helm must be put the contrary way to which you would have her cast, and set in the braces forward; which ever way the helm is, the braces abaft must be the contrary.

Q. It blows hard, and you split your top-sail?

A. I would let go the bow line, haul in the weather-brace, and lower away the halyards, clue up the lee-sheet, haul up the bunt-lines, start the weather-sheet, belay the clue lines and bunt-lines, unbend the sail, bend another: then either furl or set it, as circumstances require.

Q. You are lying to in a hard gale of wind, and split your main-sail?

A. I will haul it up carefully, unbend the sail, and bend another, get on board the main tack, and haul aft the sheet; when the sail is set, get a tackle on the weather leach to secure the tack, and a preventer sheet; but in small ships they get the lee tack aft for a preventer sheet.

Q. Suppose you are on a wind, and let the ship come up in the wind, and are all aback, what will you do?

A. I will

A. I will box her off, and suppose she will not box off, I will haul the mizen up, let go the main and main top bow-lines, the lee-main and main-top-sail braces, and lay all square abaft, put the helm to leeward, if she has stern-way, when the wind is abaft the beam shift the helm; and, as she gets head-way, haul in a little of the after braces, haul the mizen out, brace up sharp abaft, and haul the bow-lines; and then I am on the same tack as before.

Q. Suppose you are on a wind, close upon the land, and standing on must run on shore, and you can clear the land on the other tack; but it blows hard and a head swell, that she will not stay; and should you veer you would be on shore, how would you get upon the other tack?

A. I would club haul her; this is done by putting the helm a lee, and letting go the lee anchor, and bringing her head up to wind; then cut the cable and haul about the after-sails; and when they are full, brace about the head-sails, haul on board the fore-tack, and brace up the otherway.

Q. If by accident your ship is brought by the lee, what would you do?

A. When a ship is brought by the lee, it is commonly occasioned by a large sea, and by the neglect of the helm's-man. When the wind is two or three points on the quarter, the ship taking a lurch, brings the wind on the other side, and lays the sails all dead to the mast; as the yards are braced up, she then having little way, and the helm being of little service. I would therefore brace about the head-sails the other way and keep the main-top-sail shivering; when she gathers way, and brings the wind aft again, raise the fore tack and square the head-sails; trim the sails as they were before, and bring her to her course again. *N. B.* It is dangerous to bring a ship by the lee in a gale of wind, for she lying entirely against the sea, her sails can be of little service till they are braced about.

Q. Coming into soundings from a long voyage, I would have you prepare for going into port and anchoring.

A. I'll order the cables to be bent; thus get their ends up, reeve, hause, and ring ropes to haul them out, the forecastle men to clinch them, and quarter-master to clap the bends on, reeve the runners and tackles, unstow the anchors, bend the buoys and bow-ropes, single the stoppers and shank painters, bit the bower-cables with a long range, have the dog stoppers to pass, see the tiers clear, have hand leads and lines in the chains, send down the top-ropes, reeve the top-tackle-falls, unsling the lower yards, when the cables are bent, &c. clap the hawse bucklers on.

Q. You are off the Eddystone, the wind at S. W. in a hard gale, under a reef fore-sail, and you must anchor in Plymouth sound, how will you bring up for the safety of the ship, and with what anchor?

A. To give myself time for anchoring, I will haul my fore-sail up, get the sheet anchor over the side, and bit the cable to the after-bits with a range, get down top gallant masts, and sprit-sail yard, in fore and aft, unfid the top-masts and stretch along the jeers, clap the wing stopper on the second cable of the best bower; being all clear, I'll set my fore sail and steer in for the Sound, and when I am near the place I intend to anchor in, I'll man the fore-clue garnets, and stand by to lower the yards and top-mast, being ready, lower away, haul the fore-sail close up, and furl it a Portland, clap rolling tackles on the lower yards, and heel ropes on the top-masts; having the marks on to anchor, stream the best bower buoy, and see that it goes clear of the ship, and when I intend to bring up, put the helm down, and haul the mizen out, then let go the anchor and veer away at least one and a half cable before I check her; should the

ſhip drive with two cables out, on the beſt bower, ſtream the ſmall bower-buoy and let go the anchor, which will allow me to veer a cable on the ſmall bower, this will bring her up if it blows ever ſo hard, and I have ſtill the ſheet anchor to ſtand by; when I have brought up, and double-bitted and ſtopped the cables, I'll get the top-ſail yards fore and aft in the tops, and make the ſhip as ſnug as poſſible; as ſoon as the gale is over, get the anchors up and moor properly. The beſt method is to unbend the ſmall bower buoy rope from the anchor, it being liable to get foul of the beſt bower cable, by the buoy going over and over again of the ſaid cable, which has been often the caſe.

N. B. In coming from the weſtward with a hard gale of wind, and bound into the Downs, take the ſame method.

Q. Suppoſe you are on a lee ſhore, and had neither room to veer or ſtay, nor any anchoring ground, how would you put the ſhip's head round the other way.

A. I would put my helm hard a-lee, when ſhe comes head to wind raiſe the fore and main tacks directly, make a run with my weather braces and lay all aback at once, then haul forwards my lee-tacks and bow-lines as far as I can, that the ſhip may fall round on her heel, and when the main-ſail begins to ſhiver, I would haul it up, fill my head ſails, and ſhift the helm hard a weather; when the wind comes on the other quarter, haul on board the main tack, and bring her cloſe to the wind.

Q. Suppoſe you were on a lee-ſhore, and could clear the danger on the other tack, although not room to veer and a ſea on ſhe will not ſtay, and you had good anchoring ground, what would you do;

A. When I ſaw the danger I would take a good hawſer and lead it out of one of the quarter ports, and bend it to the anchor to lee-ward; the other part I would bring to the capſtan, ſhip the bars, and when I clap the helm a-lee, and as ſoon as the wind is out of the main-ſail haul it up, let go the anchor, and heave on the ſpring to caſt her, becauſe the cable ſhould not check her. When ſhe comes head to wind, brace about the main-yard, haul on board the tack, and cut away the cable and ſpring; when the main-ſail fills, ſet the fore-ſail, haul on board the tack; and trim her to the wind.

Q. Suppoſe it blows hard, you cannot carry your courſes, night coming on, and it is likely to blow harder, what will you do?

A. I will haul the fore-ſail up and furl it, balance the mizen, haul it out to keep her to, then haul up the weather main clue-garnet and bunt-line, then the lee-clue-garnet-bunt-lines and leach-lines, ſquare the yards, and get ſtrops round the maſt above the booms to hook the yard tackles to for rolling tackles, then reef the ſail, when reefed, haul on board the tack, get aft the ſheet handſomely, tend the braces, bowſe up the bow-line and haul up the mizen.

Q. You are juſt abreaſt of Portland, the wind has taken you back; you have all ſails ſet, and you have no time to take them in, for you will be on ſhore or in the Race preſently, how will you proceed?

A. If ſhe has head way, I will put the helm-a-port, let go the fore-ſheet and larboard braces; as ſoon as the after-ſails ſhiver, haul down all the ſtudding-ſails; if it blows freſh take in top-gallant-ſails, brace up the after yards; when full, brace up forward and haul on board the fore-tack, trim all ſharp, haul taut the weather-braces and haul the bow-lines, the bow-lines firſt, then the weather braces.

Q. Suppoſe

Q. Suppose you are turning over the Flats with your top-sails and fore-sail, you endeavour to put about, but she will not stay, there is a sand a-head within a cable's length of you, what will you do?

A. I will heave all aback, and when she has stern-way shift the helm; when she has paid well off, brace about the head-sails and shiver the after-sails; then she will veer round and stand off.

Q. You are in a gale of wind, and split your fore course, what will you do?

A. I'll man the weather fore clue-garnet, bunt-lines and leach-lines, ease off the fore-tack, and when clued up, man the lee-clue-garnet and haul it close up; then let go the lee-brace, haul taut the lifts and braces, send hands to unbend the sail; when another is bent, and I want to set it, I will haul on board the fore-tack, and haul aft the fore-sheet, brace the yard up and haul the bow-line.

Q. It blows hard, and you want to reef your courses, how would you proceed?

A. I will clear away the top-sail sheets and lifts, man the down-haul tackles, lower away the jeers, let go the bow-lines, and clue the sails up round the weather-braces, haul taut the lifts, braces, and rolling-tackles; then send hands up to reef the sails; when I want to set them, I will proceed with the sails as before.

Q. Suppose it blows hard at S. W. and you are drove from your anchors in the Downs, what would you do?

A. I would steer for the Gull-stream, which I shall know by having the upper Light on the South Foreland to bear S. W. by S. then steer away between the N. E. and N. E. by N. which will carry me between the Brake and the Goodwin Sands, keeping to the Goodwin in nine or ten fathom, and to the Brake in seven or six.

Q. You are standing on a wind with all your sails set; your enemy is in sight, standing towards you, how do you clear your ship for action?

A. I will turn all hands up to clear ship, up all hammocks, the quarter-masters to stow them in the netting, and on the gang-way; get the top-men's hammocks up in the top; down all chests in the hold; quarter-masters stow them; take in all the small sails; sling the lower yard with top-chains, get the puddings and dolphins up; then sling the top-sail yards half-mast or close up; stop the top-sail sheets, stoppers on the jeers, or else rack them; gunners get the the match-tubs between every two guns, matches, powder-horns, crows, and handspikes sufficient for every gun; all hands to quarters, keep silence and mind the word of command, fire not a gun until the word of command is given; mind you do not fire a shot in vain. Now I have all the three masts in one, fire!

Q. Suppose you are in chase of an enemy's ship of war, upon a wind, with all your sails set; she is right a-head, on which side will you engage her?

A. I will engage her to leeward, by reason she cannot put away before the wind, and if there is any thing of a sea, she may not be able to fight her lower tier of guns. If light breezes and hot weather, it would be better to engage to windward, to let them receive the smoak and heat of the fire.

Q. You are chasing from the wind, and carry away your main-top-mast, how will you proceed?

A. I would haul up the main-sail and send hands up into the top with a rope or hawser, to clap on that part of the mast that hangs down, then cut the lanyards of the main top-mast shrouds, and lower away, cast off the hawser, reeve it to send the stump down, clear away the rigging, unsling

the main yard, get the foretackle on it and bowse forward the yard, then lower the stump upon deck, and get the spare top-mast ready for the cross-trees; clap the hawser on and sway it up high enough for the rigging.

Q. You are lying to in a hard gale of wind under your main course, you carry away your main-mast, how will you proceed to clear the wreck?

A. I will clap my helm a-weather, brace my fore and fore top-sail yards full, then call all hands to get pole-axes, &c. to clear away the rigging.

Q. Why will you put the ship before the wind?

A. Because the mast will go a-stern clear of the rudder, and prevent its damaging the ship.

Q. You are going large and see a ship in the wind's eye, how will you proceed to chase her?

A. I will turn all hands up, get my tacks on board, brace up my yards and haul aft the sheets; haul the bow-lines, set the jib and stay-sails, keep her full, and by making short boards and turn directly to windward, which will prevent her putting away large.

Q. Suppose you were to carry away your bowsprit, what would you do?

A. I would immediately veer ship, and keep her before the wind; and then, for the security of the fore-mast, I would carry forward the fore-runners and tackles, and bowse them well taut, till I can get a hawser or sufficient rope, and clinch it round the mast-head, and secure it to the bits of the forecastle or the cat-heads: then take the best spar I have, and make a jury bowsprit of it.

Q. Having a fair wind, how will you set your fore-top-mast studding-sail, on the larboard side?

A. First haul taut the truss tackles, and bowse the fore yard close to; then haul taut the larboard fore-lift, and starboard fore-top-sail clue-line, on board his Majesty's ships the top burtons are on the top-sail yards to keep them square when studding sails are set, (the top-sails, lifts, and clue-lines not thought of) the fore-top men down on the fore-yard, and rig out the larboard studding-sail boom, first sending down the studding-sail tack and outer halyards up to the fore-top-sail larboard yard-arm; and reef the halyards, send them down and bend them; the tack being bent and all ready, man the halyards and hoist away, haul out the tack, &c. If the wind is on the beam or quartering, set it abaft the topsail; if right aft, before the topsail, (which is done by a man standing on the fore yard arm, with the leach of the studding-sail in his hands.)

Q. Suppose you are in an engagement, and your main-top-mast stay is shot away, how will you secure your mast?

A. I will send my shifting back-stay forward by the main-top-mast stay-sail halyards, and reeve it through a block abaft the fore-mast head, bowse it taut, and that will secure the mast.

Q. Your ship comes to against her helm, what will you do?

A. I will haul my mizen up, and shiver the after-sails.

Q. She comes to yet, if she stays she will be on board some other ship?

A. I'll let go the lee-fore and fore-top-sail braces, raise the fore tack and let go the bow-lines, haul in the weather braces and box her off.

Q. How do you splice your cables?

A. I will put the whole strands of the best or small bower cables twice each way, and point each strand with a tail of three fathoms each; then seize them with quarter and end seizing to make them lie snug, which is the readiest way for clearing the hawse. They being soon spliced and unspliced when pointed.

Q. How

Q. How would you mark the lead-line?

A. Black leather at 2 and 3 fathoms, white at 5, red at 7, black at 10, white at 13, (ſome ſeamen uſe black at 10 and 13) white at 15 as at 5, red at 17 as at 7, two knots at 20 fathoms, and ſo on, an additional knot at every 10 fathoms, with a ſingle knot between each 10 fathoms to mark the line at every 5 fathoms.

Q. You are ſent down in the dark for a top-ſail, how do you know a main ſail from a fore-ſail, or a main-top-ſail from a fore-top-ſail?

A. If it has three bow-line cringles it is a main-ſail, if it has but two, it is a fore-ſail; if it is marled abaft the foot rope, it is a main-ſail, if before, it is a fore-ſail: If a main top-ſail, it has four bow-line cringles, if a fore-top-ſail but three; all top-ſails are marled to the rope, becauſe the foot-rope is ſerved.

Q. The ſheers are alongſide, how do you get them in?

A. Par-buckle them in with their heads aft on the poop, and get the fore and main runners on them for guys; laſh on two fourfold blocks, reeve the maſting-falls, get girt-lines on the head of the ſheers to ſteady the maſt-head, put heel laſhings on the ſheers, with good oak planks under them, to tranſport them forward on; laſh one of the fourfold blocks forward to the ſtem, and bring the fall to the capſtan; heave the ſheers high enough: when done, I'll take forward two runners and tackles to aſſiſt the ſheers, take the mizen-maſt firſt in, then raiſe the ſheers erect, take in the main-maſt, bowſe the heels of the ſheers forward, and keep them upright to take in the fore-maſt.

Q. How do you rigg a lower maſt?

A. I will laſh on the girt-line-blocks, put on the bolſters, parcel and tar them, put over the runner and tackle-pendants, then the foremoſt of the ſtarboard-ſhrouds, then the larboard, and ſo on; then the ſtay and ſpring ſtay, ſeize in the dead eyes for the ſhrouds, and the harts for the ſtay, reeve the lanyards, ſet up the rigging, get the top over head, and bolt it, rattle down the ſhrouds, and ſeize on the cat-harpin-legs, hook the ſuttock ſhrouds, and hitch them, ſeize down the ends, laſh the hanging jeer-blocks under the top, with the ſtrops under the ſtays, lead up and laſh to the maſt-head, get the cap into the top for the head of the top-maſt, and laſh the blocks on for the main-lifts.

Q. How do you get a top and cap over?

A. Make faſt a girt line-block, on each ſide of the maſt-head, reeve the girt-lines and paſs them under the top, and make them faſt to the after-part of the top, ſtop them to the bolt holes in the middle and fore-part of the top, then ſway away: when high enough, cut the upper ſtops having a guy on the after part of the top-brim, and the top will fall over the maſt-head, then lower away, and put it in its birth, haul upon the guy and bolt it, lay the cap ſteady over the truſſel-trees for the top-maſt-head, to receive it; when the top-maſt-head is through it, laſh the cap to the top-maſt-head, ſway away the top-maſt till high enough, then place the cap on the maſt-head, and drive it down.

Q. How do you rig a main-top-maſt?

A. I will tar the maſt-head, get the croſs-trees over, fix the bolſters and parcel them, put over burton-pendants, then the ſhrouds, breaſt-back-ſtay, proper and ſpring-ſtay, and cap, ſway up the maſt and fid it, ſeize in the dead eyes, ſtay the maſt, ſet up the ſhrouds, rattle them down, laſh the bullock-blocks to the maſt-head.

Q. How do you rig a top-gallant-maſt?

A. I will

A. I will ſend down the top-rope, reeve it through the ſheave-hole, and make it faſt round the hounds of the maſt, and ſtanding part of the rope, leaving enough end to make faſt to the cap, which done, ſway away, when the head is through the cap, make faſt the ſpare end or ſtanding part of the top-rope to the cap, cut the ſeizing clap on the grommet, then the ſhrouds, back-ſtays and ſtay, ſway up the maſt, fid it, and ſet the rigging up.

Q. How do you rig a bowſprit?

A. I will laſh the collar fore ſtay for the bob-ſtays and bowſprit ſhrouds, then the collar for the ſpring ſtays, then the block for the top-maſt-ſtay, fix the man-rope, gammon the bowſprit, and ſet bob-ſtays and ſhrouds up.

Q. How do you rig a jib boom?

A. I will put over the traveller, horſes, and guys, the top-gallant ſtay-block, and laſh on the blocks for the top gallant-bowline, and jibb-down-haul-block to the traveller.

Q. How do you rig a lower-yard?

A. I will get athwart the gunwale, laſh the jeers, quarter clue-garnets, bunt-lines, leach-lines and ſlab-line-blocks, then put over the yard-arms the horſes brace pendants, the yard-tackle pendants, then the top ſail ſheet, and lift-blocks, reeve the jeers, braces, lifts, and yard-tackle falls, truſs parcels, ſway the yard up, and haul all taut.

Q. How do you rig a fore top-ſail yard?

A. I will reeve a hawſer for a top-rope, through the bollock block, and ſend it down, and having put over the horſes, make the top-rope faſt to the middle of the yard, ſtopping it to the yard-arm, ſway it up above the top, put over the brace pendants and lift-blocks, reeve the lifts and braces, cut the yard-arm-ſeizing, and croſs the yard, laſh the tye, bunt-line and clue-line blocks, reeve the tye and halyards, ſway it up above the cap, and parcel it, reeve the clue lines, bunt-lines and reef-tackles.

Q. How do you rigg a top-gallant-yard?

A. I will ſeize the clue-line-blocks on, put the horſes over the yard-arms, ſway it up on the cap, and rigg the yard arms, by putting on the brace-pendants and lifts, then croſs the yard and parcel it.

Q. You have loſt your rudder at ſea, what method will you take to ſteer the ſhip?

A. I will take a large ſpar, or part of a top-maſt, and cut it flat in the form of a ſtern-poſt, bore holes at proper diſtances in that part which is to be the fore part of the preventer, or additional ſtern-poſt, then take the thickeſt plank I have on board, and make it as near as I can into the form of a rudder, bore holes at proper diſtances in the fore part of it, and in the after part of the preventer ſtern-poſt to correſpond with each other; and reeve rope grammots through thoſe holes in the rudder and after-part of the ſtern-poſt for the rudder to play upon.

Through the preventer ſtern-poſt reeve guys, and at the fore-part of them fix tackles, and then put the machine over-board; when I get it in proper poſition or in a line with the ſhip's ſtern-poſt, laſh the upper part of the preventer-poſt to the upper part of the ſhip's ſtern-poſt, then hook tackles at or near the main-chains, and bowſe taut on the guys to confine it to the lower part of the preventer ſtern-poſt;—having holes bored through the preventer and proper ſtern-poſt, I will run an iron bolt through both, taking care not to touch the rudder, which will prevent the falſe ſtern-poſt from riſing up or falling down.

By the guys on the after-part of the rudder, and tackles fixed to them, I may ſteer the ſhip. I muſt take care to bowſe taut the tackles on the preventer ſtern-poſt to keep it cloſe to the proper ſtern-poſt.

Q. Your

Q. Your ship is leaky, you cannot keep her free by the pumps, what will you do?

A. I will take a spare top-sail, or some other sail, and spread it upon the deck, cover it all over with oakum, and bind it to the sail with a needle and twine in several places to keep it fast to the sail, then take an hawser and cut it into proper lengths to go under the ship's bottom, and come in over the gunnel, put these hawsers about four feet distant under the sail, and make them fast with their middle to the middle of the sails, each leach beginning at the head and leaving off at the clues:—Then put the sail over board keeping the oakum side to the ship's bottom, and haul up the ends of the hawsers on the other side by a hauling line which I have swept the ship with, numbering each end fore and aft; then ease away on the hawser's ends on that side I have put the sail over, and keep hauling at the same time on the hawser's ends on the opposite side when the sail is properly down, which is known by marking the hawser, I will then clap on tackles and bowse all taut, keeping the sail close to the ship's bottom the oakum will be drawn in, and stop the leak. The sail may be covered with horse dung or any filth I have on board, which will be drawn in and stop the leak.

Q. Suppose the wind northerly, and you were in a ship's hawse in the Downs, what would you do?

A. I would wait until the ship tends to windward, and heave up my anchor as she is tending.

Q. How would you work a ship out of the Downs with the wind southerly?

A. I would stand to the Goodwin Sand in 10 or 11 fathoms, it being steep too; and to the shore in 8 fathoms water.

Q. Is there any danger in going out of the Downs?

A. Yes; between Deal and Walmer Castles there are shoals near the shore, not having more than 16 or 17 feet of water on them at spring tides; as I draw towards the Foreland, I would stand in shore, to 10 or 9 fathoms, and off to the South Sand-head, Upper Deal and Walmer Castles in one, will lead me clear off; Deal Church being open with Walmer Castle about a ship's length, I must stand out till I bring the lights in one, then I am clear off the South Sand-head; and when the light-house opens to the westward of Folkstone Church with Hay Clifts, it leads me clear. I must take care not to shut in the Hope land, and the South Sand-head will lie off three miles—To sail out of the Downs to the westward, and the wind at S. W. I will begin to unmoor at a quarter flood, weigh at high water, and cast her in shore. But to sail to the eastward with the wind westerly, I would begin to unmoor at half ebb, take up my best bower, and weigh at low water.

Q. The wind at N. E. in moderate weather you mean to turn up the Swin, at what time of the tide would you weigh?

A. At slack water, loose the sails and up anchor.

Q. What are the marks for running through the Gull Stream?

A. To keep the upper light-house on the South Foreland, in one with the westermost end of the southernmost clift in Old Stains Bay; which is a swamp that lies between the two clifts a large half mile to the southward of Kingsdown upon the South Foreland.

Q. How do you know when you can weather the South Sand-head!

A. When Upper Deal Mill is open to the Southward of Walmer Castle, or when the light-houses are in one, and Folkstone Church is open with Hay-Clift, I am clear.

Q. Suppose

Q. Suppose you were coming into the Downs with the wind at S. W. blowing hard, which way would you lay your ship's head to bring her up?

A. I would lay the ship's head to the eastward, and come to with my best bower, *but if with the small bower, I would heave her head in shore.*

Q. For what reason would you do so?

A. I should then keep the cable clear of the cut-water.

Q. What is the course from the South Foreland to Dungeness, and what are the dangers?

A. From the South Foreland to Dungeness, *the course is* S. W. by W. ½ W. distance 7 leagues.

The Ripraps lie N. E. and S. W. about 5 leagues in length, the N. E. End bears from Dover Castle S. S. E. 4 leagues, from Folkstone S. E. by S. Calais steeple bears from it S. E. and Calais Clifts S. S. E. 3 leagues, the S. W. end bears from Dungeness E. S. E. 4 leagues, *on the* N. E. part there are about 15 or 16 feet at low water, on the S. W. end 4 or 5 fathoms, it is steep too on both sides, having 20 and 22 fathoms close to it. To the westward of Folkstone, *there is* a ledge of rocks that runs a large mile off the shore, I would come no nearer in than 14 fathoms.

About 4 miles E. by N. from Dungeness, *there is a shoal with not more* than 12 feet on it, which I shall avoid by keeping in 10 fathoms.

Q. Where will you anchor, and in what depth of water under Dungeness?

A. I would anchor with the Ness Point S. W. by W. the light-house W. S. W. athwart Romney Town, in 8, 9, or 10 fathom water.

There is a shoal about two miles to the westward of *the Ness, with only* 18 feet on it at low spring tides the Ness Light bears from it N. E. by E. 12 fathoms close to it.

Q. What is the course from Dungeness to Beachy-head and what are the dangers?

A. W. ½ S. distance about nine leagues.

Off the high land of Fairleigh there is a shoal of rocky ground with 14 feet on it, and lies pretty close in. In the channel off Dungeness, there is 24 fathoms and off *Beachy-head, from 26 to 30 fathoms*; I will, in thick weather, keep in 15 or 20 fathoms, from the Ness to Beachy-head. When I deepen my water, haul to the Northward, but if I shoal it, haul to the southward. In clear weather I may stand in shore until Beachy-head bears W. by N. and not have less than 10 fathoms of water, must then tack to avoid Pemsey Shoal, *which lies about two miles off the shore,* with Pemsey Church bearing N. and Beachy-head W. by S. 14 feet on it.

There is a shoal with 14 feet on it and lies with Beachy-head W. ½ N. 7 *or* 8 miles, Pemsey Church N. N. W. 7 miles, and Fairleigh E. by N. 12 miles; E. by S. 6 miles from Beachy-head is the Horse of Willington, a small shoal, having 16 *feet on it at low water.*

Q. Being off Beachy-head, at the close of a winter's even, in a gale of wind at N. E. bound to Spithead, what is best to be done?

A. I *would lie to with* my ship's head to the N. N. W. till morning, then she will drive about a channel course at the rate of two knots an hour, allowing that what she would loose in the ebb, *she would gain in the flood,* and be in a fair way in the morning; I would come no nearer to the Owers than 18 or 20 fathoms.

Q. What is the course and dangers between Beachy-head and Dunnose?

A. The course is W. by N. ¼ N. distance about 20 leagues.

The dangers are, Owers, the mark to go clear off the east part of them, is the white way on Brow Hill in one with Chichester Church, a little to the

the eastward of Pegham Church, and the mark to clear the west-end, is St. Rook's Hill in one with Chichester Church, they bear from Culver Cliff E. S. E. ½ S. about 4 leagues; *there is a floating light on them which has been shifted several Times*; in going down Channel, if I keep Dunnose W. N. W. Northerly, will carry me without them, I will come no nearer to them in thick weather than 18 or 20 fathoms.

Q. You are coming from the westward and off Dunnose, what would you do?

A. I would steer N. E. keeping Sandown Castle clear of Culver Cliff until St. Helen's Mark, which is a white building, is open of the Red Cliff bearing W. by N. then I may run in between Bembridge Ledge and the Princessa Shoal, but with a ship of a great draught of water, it is best to go without the Princessa Shoal, until I get the Kickergill on the S. W. part of Monkton Fort, and run into Spithead between the Buoy of the Dean and the Buoy of the Warner.

N. B. In going for Spithead from the eastward, there are 5 black buoys lying on the Dean and Horse, they must be all left on the starboard-side, the outer one is called the East Buoy of Dean, it lies in 27 feet water, the marks for it are, the flagstaff of Portsmouth platform, a little open to the westward of a round sentry-box of South Sea Castle, bearing N. by W. ¾ W. with Dunnose open of Culver Cliff.

From the outer buoy to the next, is W. N. W. about one mile and a quarter, it lies in 6 fathoms; the third, formerly the first buoy of the Dean, lies in 4 fathoms; the buoy of the Warner bears west southerly from this buoy about 1¼ mile, from the third to the fourth or Elbow buoy, is S. E. and N. W.; it lies in three fathoms.

The Buoy of the Horse bears from the third buoy N. N. W. about 1½ mile, and lies in 3½ fathoms; from this last buoy to the first buoy of Sturbridge, is W. ¼ N. the Royal George lies in 13 fathoms, ¾ of a mile to the N. W. of the Edgar, the buoy of the Royal George, that of Noman's Land, and the Kickergill lie all in a line.

The two buoys of the Princessa Shoal, lie N. E. by N. and S. W. by S. of each other, distance about a mile; they lie each in five fathoms with 4½ between them, the marks for the inner buoy, which is white, are Sandown Castle in one with Culver white Cliff, and Nettlestone point on Bembridge Point, the buoy of Bembridge Ledge is black, and the Nob buoy is red, they lie E. N. E. and W. S. W. of each other, with Dunnose open of Culver Cliffs.

Q. Suppose you were to the northward of Bembridge Point, bound to Spithead, and the buoys were all gone, what would you do?

A. I would bring St. Helen's Church to bear W. and keep in twelve fathoms, and steer N. by W. towards the Dean, keeping Ashdown mark above the trees, will lead me into Spithead abreast of Ride; if it is thick weather and the wind southerly, I will come no nearer to Bembridge Ledge than six fathoms, and steer N. W. by N. but if the wind is on the other side, I would come no nearer the Dean and Horse than 10 fathoms; observing the course and tides, I will anchor at Spithead with South Sea Castle N. E. by E. and the Kicker Point N. W. in 14 fathoms. East India-men and Merchant ships generally anchor on the Mother Bank to the westward of the Sturbridge buoy in 10 or 15 fathoms; if I am obliged to turn into Spithead, I may turn the Kickergill on each side of Fort Monkton and come no nearer the Warner than 12 fathoms, nor to the Dean than 9 or 10 fathoms, nor to Noman's Land than 16 or 18 fathoms being close to it.

Q. How do you come to anchor at St. Helen's?

A. I would keep Sandown Castle just open of Culver Cliffs, and bring St. Helen's Church a sail's breadth open of the Red Cliffs of Bembridge Point, and anchor in 8 or 9 fathoms.

 Q. Suppose

Q. Suppose you were moored at Spithead with a cable and an half on the best bower, and one on the small bower, you have orders to sail, at what time of the tide would you unmoor, and which anchor would you take up first?

A. I would begin to unmoor at the first of the flood, and take up my small bower first.

Q. In sailing within the Isle of White and through the Needles, what are your observations?

A. To keep clear of the West Middle, I would keep South Sea Castle a sail's breadth open of the Kicker Point until I open West Cowes Castle, then steer directly for Hurst Castle, and when abreast of it, borrow pretty near it, then steer for the Needles Point; the leading mark through the Needles is the Light-house in one with Hurst Castle, bearing N. E. by E. ¼ E. I must be careful to keep the Vanes of the Windmill which stands on the island in sight, to keep me clear of Wardings Ledge; great regard must be had to the tides, for the flood sets on the Needles, and the ebb on the Shingles with great velocity. *N. B.* To the northward of the West Middle lies the Bramble; the Bramble and West Middle have each two buoys on them, if I sail to the northward of the West Middle I must sail between it and the Bramble, leaving the Bramble on the starboard side; when I come to West Cowes Castle, I must give it a good birth, as there is a ledge of rocks that lie off it: Warding Rock lies on the Island Side with a buoy on it, when I come near the Needles, must give them a good birth to avoid the Chalk Rock *.

Q. What is your course from Dunnose to Portland?

A. W. by N. 16 leagues.

Q. If you are forced into Portland, what precautions are necessary?

A. I must take care of the Shambles, they bear from Portland Lights, which lie north and south of each other; N. W. by W. 4 miles with only 14 feet on them at low water; to sail into the Road from the westward, I must keep close to the Bill, and keep my lead going; when I am round the East Point, haul up and anchor against the Pier, in 9 or 10 fathoms, with the Bill bearing S. S. E. Portland Castle S. S. W. and Weymouth Castle N. W. In sailing out of Portland Road, I must keep Week Church open of the Stone Pier, and that will carry me clear to the eastward of the Shambles.

It flows hard from the Road to the Bill E. S. E. 7 hours, and the flood sets right of the Bill 9 hours.

N. B. In case I should be embayed to the westward of Portland, and no possibility of getting out, between Burton and Chiswell, were it ebbs 9 hours and flows only 3 hours, there is a steep beach of pebbles, I would there run my ship on shore with as much sail as I could carry, especially at the beginning of an ebb, and remain on board for three or four seas, when I may get on shore with safety.

Q. What is the course from Portland to Torbay, and how do you anchor there?

A. The course is W. N. W. and distance about 14 leagues; to anchor in the bay, I would bring the Berry Head to bear S. by E. or S. S. E. and Brixham Church on with the Pier Head; the best anchoring for small ships is 1½ miles from Brixham Pier Head, in 7 fathoms.

Q. What is your course from the Berry Head to the Start?

A. S. W. about 6 leagues.

Q. Is there any danger near the Start?

* For a more particular account, see the DIRECTIONS published by JOHN HAMILTON MOORE. Price 2s 6d.

A. Yes,

A. Yes, about 2 miles to the eastward of the Start, there is a shoal with not more than 3 fathoms on it, the Bolt Head being kept open of the Start Point will carry me clear of it.

Q. What is your course from the Start to the Edistone?

A. W. ½ S. 7 leagues.

A. What is your course from the Start to the Ramhead?

Q. W. N. W. 7 leagues.

Q. What is to be observed in sailing into Plymouth Sound?

A. If coming from the westward and am got round the Ramhead, I must give Penlee Point a good birth, by reason of a ledge of rocks that lies off from it, then haul N. N. E. ½ E. for anchoring; the leading mark in is Plymouth Church, open with the west part of the Citadel.

In going into the Sound I may anchor in Causand Bay, in 20 fathoms, with Penlee Point S. W. and the town of Causand W. N. W.

The leading mark to carry me in between the Knap and Shovel, is Plymouth old Church, on with a white patch on the Hoa.

I may go into the Sound on the east side, between the Tinker and Shagstone, by keeping Mount Batton a sail's breadth open of Staden Point, and keep in that direction until Maker's Church bears N. W. and Withy Edge open, then haul over to the eastward and anchor.

Q. How do you sail into Hamoaze?

A. I would keep Kingsand open of Redding Point, until the large House at Stoke touches the East side of Mill Bay; steer in until the Obelisk comes on with Block house Point; keep in that direction, till the easternmost Summer House on Mount Edgecomb Side, comes open with the point within which it stands; then steer for it, until the east point of Mount Wise comes open with Block-house Point; then steer mid-channel for Stone-house Pool, till Drake's Island is shut within Block-house Point: I must not open it till South Down comes open with the Obelisk, then steer up the harbour with the side of Drake's Island just touching Passage Point, which will lead me to the southward of the Harbour Shoal, on the outer part of which there is a rock, with only 16 feet on it, but on any other part, there is 3½ fathoms.

N. B. The marks to know the Sound when I am coming from sea in the day time, are, Ram Church, which stands to the northward of the Ramhead, and a square tower standing on the highest part of the land.

Q. You are bound into Falmouth, how would you proceed?

A. In going to Falmouth, there is a rock, called the Block Rock, with a pole on it, and shews itself at half tide; it lies nearest to the west shore; I may sail in on either side of it, but the east side is the best. If I would sail into Carrick Road, I must keep in the fair way, and my lead going as there is a narrow deep channel all the way, of 16 or 18 fathoms. I may borrow on St. Maw's side in 5 or 6 fathom. The best anchoring in Carrick Road, is St. Maw's Castle E. S. E. and lay my easternmost anchor in 16 or 18 fathoms, and my westernmost anchor in 4 or 5 fathoms. Just past St. Maw's there is a sand that is steep to, called St. Maw's Sand, and lies almost half channel over.

N. B. Great ship's anchor, with Manacle Point, on with the Point of Falmouth, or a great house, that is to the westward of Penryn, just open Trefusis Point in 18 fathoms.—The Manacles lie from Falmouth about S. S.E.

Q. How do you know the Lizard when you first make it?

A. It is the southernmost land on the coast, and may be seen 7 or 8 leagues off, in 42 fathoms.

Q. How does the Land's-End appear when you make it?

A. It appears in hummocks with a church on it, and may be seen 7 or 8 leagues off, in 54 fathoms.

Q. What are the dangers off the Land's End?

A. Many:—1st. The Runnel-stone lies about 16 miles S. S. W. from Toll-peden-penwith.

2d, N. E. by N. from the Runnel stone, there is a rock, called the Leaw-mean, which appears at half ebb, with a passage between it and the main, seldom used by any but coasters.

3d, The Wolf Rock; bears from the Land's-End S. W. by W. distance 3 leagues; it is small and may be seen at half tide; the largest of the Brazen Rocks, kept open of the outermost of the Long Ships (*on which there is a light-house erected*) will lead me clean to the westward of the Wolf.

4th, The Long Ships lie N. W. by N. about 3 miles from the S. W. point of the Land's End, and 1 mile W. N. W. from the westernmost point, they are high, and may be seen 4 or 5 leagues off.

5th, The Kettle-bottom, is a shoal with only 6 feet on it, and lies about half way between the northernmost part of the Long Ships, and the west point of the Land's End.

6th, The Bresam Rocks lie about 3 miles N. E. by N. from the Long Ships.

7th, The seven Stones, are a row of rocks that come not above water, but the sea always breaks over them; they lie from the Land's-End W. S. W. ½ S. dist. 7 leagues; and from St. Martin's Head, Scilly, N. N. E. dist. 3 leagues.

Q. If you are forced into Mount's Bay, where would be the safest anchoring ground?

A. Mount's Bay lies between the Lizard and the Land's-End; there is a high Island on the east side, and a Castle on the west side of it, called St. Michael's Mount; from the east side of it lies a ledge of rocks, near a league into the sea; the Coast is full of rocks, and not safe to anchor in. To sail into the Bay I must bring St. Paul's Steeple W. and keep over to the west shore, and make St. Clement's Island, which is before the town of Mousehole, having the castle on the starboard side; I shall then see a large sandy bay, and, when within the Island, there is a good anchoring in 7 or 8 fathoms, land-locked from winds but a S. E. wind.

Q. If you are bound, or forced to go into Scilly, what would you do?

A. I would steer for St. Mary's Sound, and run in for the southernmost point of St. Mary's Island, called Penninis Point, minding to keep the lead going, and approach no nearer than 5 fathoms water; about N. W. of Penninis Point, a little more than half a mile, is the Woolpack, the shoal lies near to the shore; I must continue to run in 5 or 6 fathoms, keeping pretty close to St. Mary's Island, to avoid the Spanish Ledge, which lies about half a mile W. by S. from Penninis Point; some part of this shoal may be seen at low water, and part of the Woolpack shews itself before low water; when I have got abreast of the Woolpack, to which I must give a good birth, about a cable's length, and steer for the Stevel Rock which is bold to; when I am abreast of the Stevel, must steer N. W. by W. until little Crow Island comes on with Bantscarren Point; then steer N. N. E. until Crow Island comes open a ship's length of Bantscarren Point, or bring the castle, which is on St. Mary's Island, to bear S. S. E. and anchor in 6 or 5 fathoms water.

N. B. *The foregoing Questions and Answers have been examined by several experienced Naval Officers, who only disagreed in some particulars respecting the working of a ship at sea. Others, indeed,* who pretend to great Nautical Knowledge, *could do little more than* quibble *and* carp *at parts they seemed unable to answer. As I do not take upon myself to determine which of them was right; it is hoped every judicious mariner will excuse any errors he may find in the above, which is principally intended to fix the attention and facilitate the speedy improvement of young practitioners in seamanship.*

REMARKS

REMARKS

CALCULATED TO ASSIST

COMMANDERS

WHEN COMING INTO

THE BRITISH CHANNEL.

AS Mariners know that their reckonings are always uncertain, in proportion to the length of their several passages from the times of their last departures, it is natural to suppose, that they must, when approaching to any difficult and dangerous navigation, experience great anxiety of mind for the issue. As the British Channel has proved fatal to many, it may fairly be ranked among those places which are deemed dangerous to ships, in their approach after long passages; and, therefore, all those who are entrusted with the conducting of ships thro' it, ought to acquire such knowledge as may enable them to perform the duties of their important office. Channel coasters, by the frequency of their passing and repassing through it, acquire such knowledge as those who are employed in foreign voyages cannot pretend to: hence it becomes necessary to furnish the latter with some useful information; more especially, as it is next to impossible for the human mind, when engaged in various pursuits, to remember every necessary article, such as the course and distance from one place to another, the precise situation of rocks and shoals, and the direction and strength of the tide in the various places. Commanders of ships, when coming from abroad, and about to enter the British Channel, must be exceedingly anxious to accomplish the ultimate design of their voyage, by bringing their respective ships safely into port. To the assistance of such, the following observations are intended to contribute: they are founded on experience, and will, if properly observed, prove highly serviceable; especially when long nights, or thick weather, augment those dangers which attend the Channel navigation.

Ships, in approaching the Channel from a long passage, should not only try for soundings in time, but run, if possible, in the latitude of 49° 25 North. Having, in that parallel, got soundings in 82 fathoms, fine white sand with black and yellow specks, you may be sure that you are near the outer edge of the Bank; and about 50 leagues to the westward of Scilly. By running 16 or 17 leagues further to the eastward, in the same parallel of latitude, you will have 90 fathoms, fine white sand; and continuing to run 4 leagues more to the eastward, you will shoalen your water to 82 fathoms. Soon afterwards, you will have 72 and 75 fathoms, fine white sand with sometimes a mixture of green; and in proceeding 16 or 17 leagues further to the eastward, in this latitude, you will have 72, 75, 77, and 80 fathoms. The soundings will be, for the most part, fine sand, but different in colour: some of them will be white sand, mixed with yellow specks; and others fine green sand, with some mud. In the latitude of 48° 23′ North, and 61 leagues to the westward of Ushant, lies the Sole Bank. It stretches about S. S. E. and N. N. W. 12 leagues in length and 4 in breadth; and has 64 fathoms on it, fine grey sand.

The

The following are the Soundings in the Parallels of 48° 20′, and 48° 30′, with their several Depths of Water and Distances from the Island of USHANT.

Dist. from USHANT.	QUALITY OF THE SOUNDINGS.	Depth in Fathoms.
Leagues.		
52 —	Fine grey sand, mixed with black - - -	— 92
49 —	Fine grey sand, mixed with small shells and broken bits - - - - - -	— 106
46 —	Grey sand mixed with bits of brown shells - -	— 110
43 —	Grey sand, mixed with bits of shells and brown sand - - - - - - -	— 108
40 —	Grey sand, mixed with bits of shells and gravel -	— 117
37 —	Grey sand, mixed with shells and gravel - -	— 104
35 —	Grey sand, mixed with small cornet shells - -	— 110
32 —	Sand mixed with gravel, shells, and small cornets -	— 108
29 —	Whitish grey sand and flat stones - - - - -	— 108
24 —	Light grey sand, with bits of shells - - - -	— 100
21 —	Coarse sand, with bits of cockle shells - - -	— 98
18 —	Light grey sand, with bits of brown and yellow shells, and small stones - - -	— 90
15 —	Light grey sand, mixed with barley beards - -	— 84
14 —	Whitish grey sand, bits of shells and fine cornets -	— 80
11 —	Light grey sand, mixed with barley beards and small shells - - - - - -	— 79
9 —	Fine grey sand, with bits of shells - - -	— 75
8 —	Grey sand, spotted with red, and mixed with bits of shells - - - - - -	— 75
6 —	Whitish coarse shining sand, with fine shells - -	— 70
4 —	Whitish coarse shining sand, mixed with barley beards and coral - - - - -	— 65
2 —	Whitish coarse sand - - - - - -	— 64

When running for the channel in latitude 49° 25′, which is the best latitude, and you have run so far to the eastward as to shoalen your water to 65 or 67 fathoms, and the soundings are shells and small yellow stones or red sand, you may thence conclude that you are abreast of Scilly; or if you have 68 fathoms, white sand with grey specks, and sometimes shells and stones, Scilly will then bear about N. E. from you, distance 10 leagues. Your soundings will always inform you whether you are to the northward or southward of Scilly. In the latitude of Scilly you will have oazey ground, in 60, 65, 75, or 80 fathoms. W. N. W. 10 leagues from Scilly, lies Jones's Bank, on which you will have but 30, 35, and 40 fathoms; and, a little to the southward of it, you will have 72 and 75 fathoms. In running for the channel, in the latitude of 49° 30′, you will have the following depths of water and soundings, when you are abreast Scilly; namely, 60 fathoms, oaze and broken shells; 64 fathoms, white sand with grey specks; 65 fathoms, shells and stones; and 55 fathoms, fine grey sand. The soundings

soundings near Scilly, are very different from all others in this latitude: pieces of rotten rock as broad as a small bean, and of a stone colour, will come up with the lead, which will not be the case any where else in the same parallel. More to the southward you will have deep water, with fine sand, interspersed with black specks like ground pepper. In the night, or in foggy weather, you should come no nearer Scilly than 60 fathoms; for, in that depth, you will not be more than 6 or 7 leagues from it. Abreast of Scilly, in the latitude of 49° 20′, you will have 70 fathoms, branny or yellow and white sand; and to the eastward of Scilly, in the latitude of 49° 8′, you will have 56 or 58 fathoms, coarse sand. You should then steer more to the northward, and endeavour to make the land about the Lizard; you may safely make it in the night, as well as in the day, if the weather be clear: for the Lighthouses stand so high, and the Coast is so clear, that you may, without danger, come within half a mile of the point. If the weather proves so thick that you cannot safely make the land, come no nearer to the Lizard than 45 fathoms; for, in that depth you will not be more than three leagues off the point: your soundings there will be pebble stones and scallop shells.

Ships, when coming into the channel, ought always, if possible, to make the land about the Lizard; because it is the propereſt place for a land fall: and should they afterwards meet with thick weather, which frequently happens, they will not only know how to steer, but also how they advance up the channel, which will become more and more necessary in proportion to the contraction of its boundaries. Some, by neglecting this precaution, have, contrary to their expectation, got on the south side of the channel. This error is greatly owing to the strong indraught between the islands of Guernsey and Jersey, and the coast of Britanny, which ought always to be guarded against, especially in thick weather. It frequently happens that ships, coming into the channel, have not had an observation for some days back, which, together with the operation of scant and contrary winds, and the setting of the tides, tend to perplex and bewilder the most experienced mariner, when thick weather prevents him from getting a sight of the land. The variation of the compass in the entrance of the channel, taken on board of his Majesty's ship Europe, in October, 1782, was 23° 14′ W, but as the variation is continually increasing, at the rate of about a degree in every 5 years and a half, it will be necessary to add 11 minutes for every year, subsequent to the year 1782, which will give you the variation at any time pretty exact.

THE

THE TABLES

ARE ARRANGED IN THE FOLLOWING ORDER.

	TABLE
MERIDIONAL Parts	I
Difference of Latitude and Departure for Points	II
Ditto for Degrees	III
Logarithms	IV
Artificial Sines, Tangents and Secants	V
Finding the Latitude by two Altitudes of the Sun	VI
For computing the Altitude and Time when the Sun or Star is more than six Hours distant from the Meridian	VII
Natural Sines	VIII
Proportional Logarithms	IX
For computing the Effects of Parallax on the Moon's Distance from the Sun or fixed Stars	X
Turning Degrees and Minutes into Time, and the contrary	XI
The Refraction of the Heavenly Bodies in Altitude	XII
Dip of the Horizon	XIII
Sun's Parallax in Altitude	XIV
Augmentation of the Moon's Semidiameter	XV
Dip of the Sea	XVI
Sun's Declination	XVII
For reducing the Sun's Declination	XVIII
Sun's right Ascension	XIX
Right Ascension and Declination of the fixed Stars	XX
Amplitudes	XXI
Sun, Moon and Stars Rising and Setting	XXII
Distance of Terrestrial Objects	XXIII
Latitudes and Longitudes of Places	XXIV

M	0d	1d	2d	3d	4d	5d	6d	7d	8d	9d	10d	11d	12d	13d	M
0	0	60	120	180	240	300	361	421	482	542	603	664	726	787	0
1	1	61	121	181	241	301	362	422	483	543	604	665	726	788	1
2	2	62	122	182	242	302	363	423	484	544	605	666	727	789	2
3	3	63	123	183	243	303	364	424	485	545	606	667	728	790	3
4	4	64	124	184	244	304	365	425	486	546	607	668	729	791	4
5	5	65	125	185	245	305	366	426	487	547	608	669	730	792	5
6	6	66	126	186	246	306	367	427	488	548	609	670	731	793	6
7	7	67	127	187	247	307	368	428	489	549	610	671	732	794	7
8	8	68	128	188	248	30	369	429	490	550	611	672	733	795	8
9	9	69	129	189	249	309	370	430	491	551	612	673	735	796	9
10	10	70	130	190	250	310	371	431	492	552	613	674	736	797	10
11	11	71	131	191	251	311	372	432	493	553	614	675	737	798	11
12	12	72	132	192	252	312	373	433	494	554	615	676	738	799	12
13	13	73	133	193	253	313	374	434	495	555	616	677	739	800	13
14	14	74	134	194	254	314	375	435	496	556	617	678	740	801	14
15	15	75	135	195	255	315	376	436	497	557	618	679	741	802	15
16	16	76	136	196	256	316	377	437	498	558	619	680	742	803	16
17	17	77	137	197	257	317	378	438	499	559	620	681	743	804	17
18	18	78	138	198	258	318	379	439	500	560	621	682	744	805	18
19	19	79	139	199	259	319	380	440	501	561	622	683	745	806	19
20	20	80	140	200	260	320	381	441	502	562	623	684	746	807	20
21	21	81	141	201	261	321	382	442	503	563	624	685	747	808	21
22	22	82	142	202	262	322	383	443	504	564	625	686	748	809	22
23	23	83	143	203	263	323	384	444	505	565	626	688	749	810	23
24	24	84	144	204	264	324	385	445	506	566	627	689	750	811	24
25	25	85	145	205	265	325	386	446	507	567	628	690	751	812	25
26	26	86	146	206	266	326	387	447	508	568	629	691	752	813	26
27	27	87	147	207	267	327	388	448	509	569	630	692	753	814	27
28	28	88	148	208	268	328	389	449	510	570	632	693	754	816	28
29	29	89	149	209	269	329	390	450	511	571	633	694	755	817	29
30	30	90	150	210	270	330	391	451	512	573	634	695	756	818	30
31	31	91	151	211	271	332	392	452	513	574	635	696	757	819	31
32	32	92	152	212	272	333	393	453	514	575	636	697	758	820	32
33	33	93	153	213	273	334	394	454	515	576	637	698	759	821	33
34	34	94	154	214	274	335	395	455	516	577	638	699	760	822	34
35	35	95	155	215	275	336	396	456	517	578	639	700	761	823	35
36	36	96	156	216	276	337	397	457	518	579	640	701	762	824	36
37	37	97	157	217	277	338	398	458	519	580	641	702	763	825	37
38	38	98	158	218	278	339	399	459	520	581	642	703	764	826	38
39	39	99	159	219	279	340	400	460	521	582	643	704	765	827	39
40	46	100	160	220	280	341	401	461	522	583	644	705	766	828	40
41	41	101	161	221	281	342	402	462	523	584	645	706	767	829	41
42	42	102	162	222	282	343	403	463	524	585	646	707	768	830	42
43	43	103	163	223	283	344	404	464	525	586	647	708	769	831	43
44	44	104	164	224	284	345	405	465	526	587	648	709	770	832	44
45	45	105	165	225	285	346	406	466	527	588	649	710	771	833	45
46	46	106	166	226	286	347	407	467	528	589	650	711	772	834	46
47	47	107	167	227	287	348	408	468	529	590	651	712	773	835	47
48	48	108	168	228	288	349	409	469	530	591	652	713	774	836	48
49	49	109	169	229	289	350	410	470	531	592	653	714	775	837	49
50	50	110	170	230	290	351	411	471	532	593	654	715	776	838	50
51	51	111	171	231	291	352	412	472	533	594	655	716	777	839	51
52	52	112	172	232	292	353	413	473	534	595	656	717	779	840	52
53	53	113	173	233	293	354	414	474	535	596	657	718	780	841	53
54	54	114	174	234	294	355	415	475	536	597	658	719	781	842	54
55	55	115	175	235	295	356	416	477	537	598	659	720	782	843	55
56	56	116	176	236	296	357	417	478	538	599	660	721	783	844	56
57	57	117	177	237	297	358	418	479	539	600	661	722	784	845	57
58	58	118	178	238	298	359	419	480	540	601	662	723	785	846	58
59	59	119	179	239	299	360	420	481	541	602	663	724	786	847	59

Table I. Meridional Parts.

M	14d	15d	16d	17d	18d	19d	20d	21d	22d	23d	24d	25d	26d	27d	M
0	848	910	973	1035	1098	1161	1225	1289	1354	1419	1484	1550	1616	1684	0
1	849	911	974	36	99	63	26	90	55	20	85	51	18	85	1
2	851	913	975	37	1100	64	27	91	56	21	86	52	19	86	2
3	852	914	976	38	01	65	28	92	57	22	87	53	20	87	3
4	853	915	977	39	02	66	29	93	58	23	88	54	21	88	4
5	854	916	978	41	03	67	30	94	59	24	90	56	22	89	5
6	855	917	979	42	05	68	32	96	60	25	91	57	23	90	6
7	856	918	980	43	06	69	33	97	61	26	92	58	24	91	7
8	857	919	981	44	07	70	34	98	62	27	93	59	25	93	8
9	858	920	982	45	08	71	35	99	63	28	94	60	26	94	9
10	859	921	983	1046	1109	1172	1236	1300	1364	1429	1495	1561	1628	1695	10
11	860	922	984	47	10	73	37	01	66	31	96	62	29	96	11
12	861	923	985	48	11	74	38	02	67	32	97	63	30	97	12
13	862	924	986	49	12	75	39	03	68	33	98	64	31	98	13
14	863	925	987	50	13	76	40	04	69	34	99	65	32	99	14
15	864	926	988	51	14	77	41	05	70	35	1500	67	33	1700	15
16	865	927	989	52	15	78	42	06	71	36	02	68	34	01	16
17	866	928	990	53	16	80	43	07	72	37	03	69	35	03	17
18	867	929	991	54	17	81	44	08	73	38	04	70	37	04	18
19	868	930	992	55	18	82	45	10	74	39	05	71	38	05	19
20	869	931	994	1056	1119	1183	1247	1311	1375	1440	1506	1572	1639	1706	20
21	870	932	995	57	20	84	48	12	76	41	07	73	40	07	21
22	871	933	996	58	21	85	49	13	77	43	08	74	41	08	22
23	872	934	997	59	22	86	50	14	79	44	09	75	42	09	23
24	873	935	998	60	23	87	51	15	80	45	10	77	43	10	24
25	874	936	999	61	25	88	52	16	81	46	11	78	44	12	25
26	875	937	1000	63	26	89	53	17	82	47	13	79	45	13	26
27	876	938	1001	64	27	90	54	18	83	48	14	80	47	14	27
28	877	939	1002	65	28	91	55	19	84	49	15	81	48	15	28
29	878	941	1003	66	29	92	56	20	85	50	16	82	49	16	29
30	879	942	1004	1067	1130	1193	1257	1321	1386	1451	1517	1583	1650	1717	30
31	880	943	05	68	31	94	58	22	87	52	18	84	51	18	31
32	881	944	06	69	32	95	59	24	88	53	19	85	52	20	32
33	883	945	07	70	33	96	60	25	89	55	20	86	53	21	33
34	884	946	08	71	34	97	61	26	90	56	21	88	54	22	34
35	885	947	09	72	35	99	62	27	92	57	22	89	56	23	35
36	886	948	10	73	36	1200	64	28	93	58	24	90	57	24	36
37	887	949	11	74	37	01	65	29	94	59	25	91	58	25	37
38	888	950	12	75	38	02	66	30	95	60	26	92	59	26	38
39	889	951	13	76	39	03	67	31	96	61	27	93	60	27	39
40	890	952	1014	1077	1140	1204	1268	1332	1397	1462	1528	1594	1661	1729	40
41	891	953	15	78	41	05	69	33	98	63	29	95	62	30	41
42	892	954	16	79	42	06	70	34	99	64	30	96	63	31	42
43	893	955	18	80	44	07	71	35	1400	65	31	98	64	32	43
44	894	956	19	81	45	08	72	36	01	67	32	99	66	33	44
45	895	957	20	82	46	09	73	38	02	68	33	1600	67	34	45
46	896	958	21	83	47	10	74	39	03	69	35	01	68	35	46
47	897	959	22	85	48	11	75	40	05	70	36	02	69	36	47
48	898	960	23	86	49	12	76	41	06	71	37	03	70	38	48
49	899	961	24	87	50	13	77	42	07	72	38	04	71	39	49
50	900	962	1025	1088	1151	1214	1278	1343	1408	1473	1539	1605	1672	1740	50
51	901	963	26	89	52	16	80	44	09	74	40	06	73	41	51
52	902	964	27	90	53	17	81	45	10	75	41	08	75	42	52
53	903	965	28	91	54	18	82	46	11	76	42	09	76	43	53
54	904	966	29	92	55	19	83	47	12	77	43	10	77	44	54
55	905	968	30	93	56	20	84	48	13	79	44	11	78	45	55
56	906	969	31	94	57	21	85	49	14	80	46	12	79	47	56
57	907	970	32	95	58	22	86	50	15	81	47	13	80	48	57
58	908	971	33	96	59	23	87	52	16	82	48	14	81	49	58
59	909	972	34	97	60	24	88	53	18	83	49	15	82	50	59

M	28d	29d	30d	31d	32d	33d	34d	35d	36d	37d	38d	39d	40d	41d	M
0	1751	1819	1888	1958	2028	2100	2171	2244	2318	2393	2468	2545	2623	2702	0
1	52	21	90	59	30	01	73	45	19	94	70	46	24	03	1
2	53	22	91	60	31	02	74	47	20	95	71	48	25	04	2
3	55	23	92	62	32	03	75	48	22	96	72	49	27	06	3
4	56	24	93	63	33	04	76	49	23	98	73	50	28	07	4
5	57	25	94	64	34	05	78	50	24	99	75	51	29	08	5
6	58	26	95	65	36	07	79	52	25	2400	76	53	31	10	6
7	59	27	96	66	37	08	80	53	27	01	77	54	32	11	7
8	60	29	98	67	38	09	81	54	28	03	78	55	33	12	8
9	61	30	99	69	39	10	82	55	29	04	80	57	34	14	9
10	1762	1831	1900	1970	2040	2111	2184	2256	2330	2405	2481	2558	2636	2715	10
11	64	32	01	71	41	13	85	58	32	06	82	59	37	16	11
12	65	33	02	72	43	14	86	59	33	08	84	60	38	18	12
13	66	34	03	73	44	15	87	60	34	09	85	62	40	19	13
14	67	35	05	74	45	16	88	61	35	10	86	63	41	20	14
15	68	37	06	76	46	17	90	63	37	11	87	64	42	22	15
16	69	38	07	77	47	19	91	64	38	13	89	66	44	23	16
17	70	39	08	78	48	20	92	65	39	14	90	67	45	24	17
18	72	40	09	79	50	21	93	66	40	15	91	68	46	26	18
19	73	41	10	80	51	22	94	68	42	16	92	69	48	27	19
20	1774	1842	1911	1981	2052	2123	2196	2269	2343	2418	2494	2571	2649	2728	20
21	75	43	13	83	53	25	97	70	44	19	95	72	50	29	21
22	76	45	14	84	54	26	98	71	45	20	96	73	51	31	22
23	77	46	15	85	56	27	99	72	46	21	98	75	53	32	23
24	78	47	16	86	57	28	2200	74	48	23	99	76	54	33	24
25	80	48	17	87	58	29	02	75	49	24	2500	77	55	35	25
26	81	49	18	88	59	31	03	76	50	25	01	78	57	36	26
27	82	50	20	90	60	32	04	77	51	27	03	80	58	37	27
28	83	52	21	91	61	33	05	79	53	28	04	81	59	39	28
29	84	53	22	92	63	34	07	80	54	29	05	82	61	40	29
30	1785	1854	1923	1993	2064	2135	2208	2281	2355	2430	2506	2584	2662	2742	30
31	86	55	24	94	65	37	09	82	56	32	08	85	63	43	31
32	87	56	25	95	66	38	10	83	58	33	09	86	65	44	32
33	89	57	27	97	67	39	11	85	59	34	10	88	66	46	33
34	90	58	28	98	69	40	13	86	60	35	12	89	67	47	34
35	91	60	29	99	70	41	14	87	61	37	13	90	69	48	35
36	92	61	30	2000	71	43	15	88	63	38	14	91	70	50	36
37	93	62	31	01	72	44	16	90	64	39	15	93	71	51	37
38	94	63	32	02	73	45	17	91	65	40	17	94	73	52	38
39	96	64	34	04	75	46	19	92	66	42	18	95	74	54	39
40	1797	1865	1935	2005	2076	2147	2220	2293	2368	2443	2519	2597	2675	2755	40
41	98	66	36	06	77	49	21	95	69	44	21	98	76	56	41
42	99	68	37	07	78	50	22	96	70	45	22	99	78	58	42
43	1800	69	38	08	79	51	24	97	71	47	23	2601	79	59	43
44	01	70	39	10	80	52	25	98	73	48	24	02	80	60	44
45	02	71	41	11	82	53	26	99	74	49	26	03	82	62	45
46	03	72	42	12	83	55	27	2301	75	51	27	04	83	63	46
47	05	73	43	13	84	56	28	02	76	52	28	06	84	64	47
48	06	75	44	14	85	57	30	03	78	53	30	07	86	66	48
49	07	76	45	15	86	58	31	04	79	54	31	08	87	67	49
50	1808	1877	1946	2017	2088	2159	2232	2306	2380	2456	2532	2610	2688	2768	50
51	09	78	48	18	89	61	33	07	81	57	33	11	90	70	51
52	10	79	49	19	90	62	35	08	83	58	35	12	91	71	52
53	11	80	50	20	91	63	36	09	84	59	36	14	92	72	53
54	13	81	51	21	92	64	37	11	85	61	37	15	94	74	54
55	14	83	52	22	94	65	38	12	86	62	38	16	95	75	55
56	15	84	53	24	95	67	39	13	88	63	40	17	96	76	56
57	16	85	55	25	96	68	41	14	89	64	41	19	98	78	57
58	17	86	56	26	97	69	42	16	90	66	42	20	99	79	58
59	18	87	57	27	98	70	43	17	91	67	44	21	2700	80	59

M	42d	43d	44d	45d	46d	47d	48d	49d	50d	51d	52d	53d	54d	55d	M
0	2782	2863	2946	3030	3116	3203	3292	3382	3474	3569	3665	3764	386	3968	0
1	83	64	47	31	17	04	93	84	76	70	67	65	66	70	1
2	84	66	49	33	18	06	95	85	78	72	68	67	68	71	2
3	86	67	50	34	20	07	96	87	79	74	70	69	70	73	3
4	87	69	51	36	21	09	98	88	81	75	72	70	71	75	4
5	88	70	53	37	23	10	99	90	82	77	73	72	73	77	5
6	90	71	54	38	24	12	3301	91	84	78	75	74	75	78	6
7	91	73	56	40	26	13	02	93	85	80	77	75	77	80	7
8	92	74	57	41	27	14	03	94	87	82	78	77	78	82	8
9	94	75	58	43	29	16	05	96	88	83	80	79	80	84	9
10	2795	2877	2960	3044	3130	3217	3306	3397	3490	3585	3681	3780	3882	3985	10
11	97	78	61	46	31	19	08	99	92	86	83	82	83	87	11
12	98	80	63	47	33	20	09	3400	93	88	85	84	85	89	12
13	99	81	64	48	34	22	11	02	95	90	86	85	87	91	13
14	2801	82	65	50	36	23	12	03	96	91	88	86	89	92	14
15	02	84	67	51	37	25	14	05	98	93	90	88	90	94	15
16	03	85	68	53	39	26	16	07	99	94	91	90	92	96	16
17	05	86	70	54	40	28	17	08	3501	96	93	91	94	98	17
18	06	88	71	55	42	29	19	10	03	98	95	94	95	99	18
19	07	89	72	57	43	31	20	11	04	99	96	95	97	4001	19
20	2809	2891	2974	3058	3144	3232	3322	3413	3506	3601	3698	3797	3899	4003	20
21	10	92	75	60	46	34	23	14	07	02	99	99	3901	05	21
22	11	93	76	61	47	35	25	16	09	04	3701	3800	02	06	22
23	13	95	78	63	49	37	26	17	10	06	03	02	04	08	23
24	14	96	79	64	50	38	28	19	12	07	04	04	06	10	24
25	15	97	81	65	52	40	29	20	14	09	06	06	07	12	25
26	17	99	82	67	53	41	31	22	15	10	08	07	09	14	26
27	18	2900	83	68	55	42	32	23	17	12	09	09	11	15	27
28	20	01	85	70	56	44	34	25	18	14	11	11	13	17	28
29	21	03	86	71	57	45	35	27	20	15	13	12	14	19	29
30	2822	2904	2988	3073	3159	3247	3337	3428	3521	3617	3714	3814	3916	4021	30
31	24	06	89	74	60	48	38	30	23	18	16	16	18	22	31
32	25	07	91	75	62	50	40	31	25	20	17	17	19	24	32
33	26	08	92	77	63	51	41	33	26	22	19	19	21	26	33
34	28	10	93	78	65	53	43	34	28	23	21	21	23	28	34
35	29	11	95	80	66	54	44	36	29	25	22	22	25	29	35
36	30	13	96	81	68	56	46	37	31	26	24	24	26	31	36
37	32	14	98	83	69	57	47	39	32	28	26	26	28	33	37
38	33	15	99	84	71	59	49	40	34	30	27	27	30	35	38
39	34	17	3000	85	72	60	50	42	36	31	29	29	32	37	39
40	2836	2918	3002	3087	3173	3262	3352	3443	3537	3633	3731	3831	3933	4038	40
41	37	19	03	88	75	63	53	45	39	34	32	32	35	40	41
42	39	21	05	90	76	65	55	47	40	36	34	34	37	42	42
43	40	22	06	91	78	66	56	48	42	38	36	36	38	44	43
44	41	24	07	93	79	68	58	50	43	39	37	38	40	45	44
45	43	25	09	94	81	69	59	51	45	41	39	39	42	47	45
46	44	26	10	95	82	71	61	53	47	43	41	41	44	49	46
47	45	28	12	97	84	72	62	54	48	44	42	43	45	51	47
48	47	29	13	98	85	74	64	56	50	46	44	44	47	52	48
49	48	31	14	3100	87	75	65	57	51	47	46	46	49	54	49
50	2849	2932	3016	3101	3188	3277	3367	3459	3553	3649	3747	3848	3951	4056	50
51	51	33	17	03	90	78	68	60	55	51	49	49	52	58	51
52	52	35	19	04	91	80	70	62	56	52	50	51	54	60	52
53	54	36	20	06	92	81	71	64	58	54	52	53	56	61	53
54	55	37	21	07	94	83	73	65	59	55	54	55	58	63	54
55	56	39	23	08	95	84	74	67	61	57	55	56	59	65	55
56	58	40	24	10	97	86	76	68	62	59	57	58	61	67	56
57	59	42	26	11	98	87	78	70	64	60	59	60	63	69	57
58	60	43	27	13	3200	89	79	71	66	62	60	61	64	70	58
59	62	44	28	14	01	90	81	73	67	64	62	63	66	72	59

M	56°	57°	58°	59°	60°	61°	62°	63	64°	65°	66°	67°	68	69°	M
0	4074	4183	4294	4409	4527	4649	4775	4905	5039	5179	5324	5474	5631	5795	0
1	76	84	96	11	29	51	77	07	42	81	26	77	33	97	1
2	78	86	98	13	31	53	79	09	44	84	28	79	36	5800	2
3	79	88	4300	15	33	55	81	12	46	86	31	82	39	03	3
4	81	90	02	17	35	57	84	14	49	88	33	84	41	06	4
5	83	92	04	19	37	60	86	16	51	91	36	87	44	09	5
6	85	94	06	21	39	62	88	18	53	93	38	89	47	11	6
7	86	95	08	23	41	64	90	20	55	95	41	92	50	14	7
8	88	97	09	25	43	66	92	23	58	98	43	95	52	17	8
9	90	99	11	27	45	68	94	25	60	5200	46	97	55	20	9
10	4092	4201	4313	4429	4547	4670	4796	4927	5062	5203	5348	5500	5658	5823	10
11	94	03	15	31	49	72	98	29	65	05	51	02	60	25	11
12	95	05	17	33	51	74	4801	31	67	07	53	05	63	28	12
13	97	07	19	34	53	76	03	34	69	10	56	07	66	31	13
14	99	08	21	36	55	78	05	36	71	12	58	10	68	34	14
15	4101	10	23	38	57	80	07	38	74	14	61	13	71	37	15
16	03	12	25	40	59	82	09	40	76	17	63	15	74	39	16
17	04	14	27	42	61	84	11	43	78	19	66	18	76	42	17
18	06	16	28	44	64	87	14	45	81	22	63	20	79	45	18
19	08	18	30	46	66	89	16	47	83	24	71	22	82	48	19
20	4110	4220	4332	4448	4568	4691	4818	4949	5085	5226	5373	5526	5685	5851	20
21	12	21	34	50	70	93	20	51	88	29	76	28	87	54	21
22	13	23	36	52	72	95	22	54	90	31	78	31	90	56	22
23	15	25	38	54	74	97	24	56	92	34	80	33	93	59	23
24	17	27	40	56	76	99	26	58	95	36	83	36	95	62	24
25	19	29	42	58	78	4701	29	60	97	38	85	39	98	65	25
26	21	31	44	60	80	03	31	63	99	41	88	41	5701	68	26
27	22	32	46	62	82	05	33	65	5102	43	90	44	04	71	27
28	24	34	47	64	84	07	35	67	04	46	93	46	06	74	28
29	26	36	49	66	86	10	37	69	06	48	95	49	09	76	29
30	4128	4238	4351	4468	4588	4712	4839	4972	5108	5250	5398	5552	5712	5879	30
31	30	40	53	70	90	14	42	73	11	53	5401	54	15	82	31
32	32	42	55	72	92	16	44	76	13	55	03	57	17	85	32
33	33	44	57	74	94	18	46	78	15	58	06	59	20	88	33
34	35	46	59	76	96	20	48	81	18	60	08	62	23	91	34
35	37	47	61	78	98	22	50	83	20	63	11	65	25	94	35
36	39	49	63	80	4600	24	52	85	22	65	13	67	28	96	36
37	41	51	65	82	02	26	55	87	25	67	16	70	31	99	37
38	42	53	67	84	04	28	57	90	27	70	18	73	34	5902	38
39	44	55	69	86	06	31	59	92	30	72	21	75	36	05	39
40	4146	4257	4370	4488	4608	4733	4861	4994	5132	5275	5423	5578	5739	5906	40
41	48	59	72	90	10	35	63	96	34	77	26	80	42	11	41
42	50	60	74	92	12	37	65	99	36	80	28	83	45	14	42
43	52	62	76	94	14	39	68	5001	39	82	31	86	47	17	43
44	53	64	78	95	16	41	70	03	41	84	33	88	50	19	44
45	55	66	80	97	18	43	72	05	43	87	36	91	53	22	45
46	57	68	82	99	20	45	74	08	46	89	38	94	56	25	46
47	59	70	84	4501	23	47	76	10	48	92	41	96	58	28	47
48	61	72	86	03	25	50	79	12	51	94	43	99	61	31	48
49	62	74	88	05	27	52	81	14	53	97	46	5602	64	34	49
50	4164	4275	4390	4507	4629	4754	4883	5017	5155	5299	5448	5604	5767	5937	50
51	66	77	92	09	31	56	85	19	58	5301	51	07	70	40	51
52	68	79	94	11	33	58	87	21	60	04	54	10	72	43	52
53	70	81	96	13	35	60	90	23	62	06	56	12	75	46	53
54	72	83	98	15	37	62	92	26	65	09	59	15	78	48	54
55	73	85	99	17	39	64	94	28	67	11	61	17	81	51	55
56	75	87	4401	19	41	66	96	30	69	14	64	20	83	54	56
57	77	89	03	21	43	69	98	33	72	16	66	23	86	57	57
58	79	91	05	23	45	71	4901	35	74	19	69	25	89	60	58
59	81	93	07	25	47	73	03	37	76	21	71	28	92	63	59

TABLE I. MERIDIONAL PARTS.

M	70d	71d	72d	73d	74d	75d	76	77d	78d	79	80	81d	82d	83	M
0	5966	6146	6335	6534	6746	6970	7210	7467	7745	8046	8375	8739	9145	9606	0
1	69	49	38	38	49	74	14	72	49	51	81	45	53	14	1
2	72	52	41	41	53	78	18	76	54	56	87	52	60	22	2
3	75	55	45	45	57	82	22	81	59	61	93	58	67	31	3
4	78	58	48	48	60	86	27	85	64	67	98	65	74	39	4
5	81	61	51	52	64	90	31	90	69	72	8404	71	82	47	5
6	84	64	54	55	68	94	35	94	74	77	10	78	89	55	6
7	86	67	58	58	71	97	39	98	78	83	16	84	96	64	7
8	89	70	61	62	75	7001	43	7503	83	88	22	91	9203	72	8
9	92	73	64	65	79	05	47	07	88	93	27	97	11	81	9
10	5995	6177	6307	6569	6782	7009	7254	7512	7793	8099	8433	8804	9218	9689	10
11	98	80	71	72	86	13	56	16	98	8104	39	10	25	97	11
12	6001	83	74	76	90	17	60	21	7803	09	45	17	33	9706	12
13	04	86	77	79	93	21	64	25	08	15	51	23	40	14	13
14	07	89	80	83	97	25	68	30	13	20	57	30	48	23	14
15	10	92	84	86	0801	29	73	35	17	25	63	36	55	31	15
16	13	95	87	90	04	33	77	39	22	31	69	43	62	40	16
17	16	98	90	93	08	37	81	44	25	36	74	49	70	48	17
18	19	6201	94	96	12	41	85	48	32	41	80	56	77	57	18
19	22	05	97	6600	15	45	89	53	37	47	86	63	85	65	19
20	6025	6208	6400	6603	6819	7049	7294	7557	7842	8152	8492	8869	9292	9774	20
21	28	11	03	07	23	52	98	62	47	58	98	76	9300	83	21
22	31	14	07	10	26	56	7302	66	52	63	8504	83	07	91	22
23	34	17	10	14	30	60	06	71	57	68	10	89	15	9800	23
24	37	20	13	17	34	64	11	76	62	74	16	96	22	09	24
25	40	23	17	21	38	68	15	80	67	79	22	8903	30	17	25
26	43	26	20	24	41	72	19	85	72	85	28	09	38	26	26
27	46	30	23	28	45	76	23	89	77	90	34	16	45	35	27
28	49	33	27	31	49	80	28	94	82	96	40	23	53	44	28
29	52	36	30	35	53	84	32	98	87	8201	46	30	60	52	29
30	6055	6239	6433	6639	6856	7088	7336	7603	7892	8207	8552	8930	9368	9861	30
31	58	42	37	42	60	92	40	08	97	12	58	43	76	70	31
32	61	45	40	46	64	96	45	12	7902	18	64	50	83	79	32
33	64	49	43	49	68	7100	49	17	07	23	71	57	91	88	33
34	67	52	47	53	71	04	53	22	12	29	77	63	99	97	34
35	70	55	50	56	75	08	58	26	17	34	83	70	9407	9906	35
36	73	58	53	60	79	12	62	31	22	40	89	77	14	15	36
37	76	61	57	63	83	16	66	36	27	45	95	84	22	24	37
38	79	64	60	67	86	20	71	40	32	51	8601	91	30	33	38
39	82	68	63	70	90	24	75	45	37	56	07	98	38	42	39
40	6085	6271	6467	6674	6894	7128	7379	7650	7942	8262	8614	9005	9445	9951	40
41	88	74	70	77	98	32	84	54	48	67	20	12	53	60	41
42	91	77	73	81	6901	36	88	59	53	73	26	18	61	69	42
43	94	80	77	85	05	40	92	64	58	79	32	25	69	78	43
44	97	83	80	88	09	45	97	68	63	84	38	32	77	87	44
45	6100	87	83	92	13	49	7401	73	68	90	44	39	85	9996	45
46	04	90	87	95	17	53	06	78	73	95	51	46	93	10005	46
47	06	93	90	99	20	57	10	83	78	8301	57	53	9501	10015	47
48	09	96	94	6702	24	61	14	87	83	07	63	60	09	10024	48
49	12	99	97	06	28	65	19	92	80	12	69	67	17	10033	49
50	6115	6303	6500	6710	6932	7169	7423	7697	7994	8318	8676	9074	9525	10043	50
51	18	06	04	13	36	73	27	7702	99	24	82	81	33	10052	51
52	21	09	07	17	40	77	32	06	8004	29	88	88	41	10061	52
53	24	12	11	20	43	81	36	11	09	35	95	96	49	10071	53
54	27	15	14	24	47	85	41	16	14	41	8701	9103	57	10080	54
55	30	19	17	28	51	89	45	21	20	47	07	10	65	10089	55
56	33	22	21	31	55	94	49	26	25	52	14	17	73	10099	56
57	36	25	24	35	59	98	54	30	30	58	20	24	81	10108	57
58	40	28	28	38	63	7202	58	35	35	64	26	31	89	10118	58
59	43	32	31	42	66	06	63	40	40	69	33	38	98	10127	59

TABLE II. Difference of Latitude and Departure for ¼ Point.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep
1	01.0	00.0	61	60.9	03.0	121	120.9	05.9	181	180.8	08.9	241	240.7	11.8
2	02.0	00.1	62	61.9	03.0	22	121.9	06.0	82	181.8	08.9	42	241.7	11.9
3	03.0	00.1	63	62.9	03.1	23	122.9	06.0	83	182.8	09.0	43	242.7	11.9
4	04.0	00.2	64	63.9	03.1	24	123.9	06.1	84	183.8	09.0	44	243.7	12.0
5	05.0	00.2	65	64.9	03.2	25	124.9	06.1	85	184.8	09.1	45	244.7	12.0
6	06.0	00.3	66	65.9	03.2	26	125.8	06.2	86	185.8	09.1	46	245.7	12.1
7	07.0	00.3	67	66.9	03.3	27	126.8	06.2	87	186.8	09.2	47	246.7	12.1
8	08.0	00.4	68	67.9	03.3	28	127.8	06.3	88	187.8	09.2	48	247.7	12.2
9	09.0	00.4	69	68.9	03.4	29	128.8	06.3	89	188.8	09.3	49	248.7	12.2
10	10.0	00.5	70	69.9	03.4	30	129.8	06.4	90	189.8	09.3	50	249.7	12.3
11	11.0	00.5	71	70.9	03.5	131	130.8	06.4	191	190.8	09.4	251	250.7	12.3
12	12.0	00.6	72	71.9	03.5	32	131.8	06.5	92	191.8	09.4	52	251.7	12.4
13	13.0	00.6	73	72.9	03.6	33	132.8	06.5	93	192.8	09.5	53	252.7	12.4
14	14.0	00.7	74	73.9	03.6	34	133.8	06.6	94	193.8	09.5	54	253.7	12.5
15	15.0	00.7	75	74.9	03.7	35	134.8	06.6	95	194.8	09.6	55	254.7	12.5
16	16.0	00.8	76	75.9	03.7	36	135.8	06.7	96	195.8	09.6	56	255.7	12.6
17	17.0	00.8	77	76.9	03.8	37	136.8	06.7	97	196.8	09.7	57	256.7	12.6
18	18.0	00.9	78	77.9	03.8	38	137.8	06.8	98	197.8	09.7	58	257.7	12.7
19	19.0	00.9	79	78.9	03.9	39	138.8	06.8	99	198.8	09.8	59	258.7	12.7
20	20.0	01.0	80	79.9	03.9	40	139.8	06.9	200	199.8	09.8	60	259.7	12.8
21	21.0	01.0	81	80.9	04.0	141	140.8	06.9	201	200.8	09.9	261	260.7	12.8
22	22.0	01.1	82	81.9	04.0	42	141.8	07.0	02	201.8	09.9	62	261.7	12.9
23	23.0	01.1	83	82.9	04.1	43	142.8	07.0	03	202.8	10.0	63	262.7	12.9
24	24.0	01.2	84	83.9	04.1	44	143.8	07.1	04	203.8	10.0	64	263.7	13.0
25	25.0	01.2	85	84.9	04.2	45	144.8	07.1	05	204.8	10.1	65	264.7	13.0
26	26.0	01.3	86	85.9	04.2	46	145.8	07.2	06	205.8	10.1	66	265.7	13.1
27	27.0	01.3	87	86.9	04.3	47	146.8	07.2	07	206.8	10.2	67	266.7	13.1
28	28.0	01.4	88	87.9	04.3	48	147.8	07.3	08	207.7	10.2	68	267.7	13.2
29	29.0	01.4	89	88.9	04.4	49	148.8	07.3	09	208.7	10.3	69	268.7	13.2
30	30.0	01.5	90	89.9	04.4	50	149.8	07.4	10	209.7	10.3	70	269.7	13.3
31	31.0	01.5	91	90.9	04.5	151	150.8	07.4	211	210.7	10.4	271	270.7	13.3
32	32.0	01.6	92	91.9	04.5	52	151.8	07.5	12	211.7	10.4	72	271.7	13.4
33	33.0	01.6	93	92.9	04.6	53	152.8	07.5	13	212.7	10.5	73	272.7	13.4
34	34.0	01.7	94	93.9	04.6	54	153.8	07.6	14	213.7	10.5	74	273.7	13.5
35	35.0	01.7	95	94.9	04.7	55	154.8	07.6	15	214.7	10.6	75	274.7	13.5
36	36.0	01.8	96	95.9	04.7	56	155.8	07.7	16	215.7	10.6	76	275.7	13.6
37	37.0	01.8	97	96.9	04.8	57	156.8	07.7	17	216.7	10.7	77	276.7	13.6
38	38.0	01.9	98	97.9	04.8	58	157.8	07.8	18	217.7	10.7	78	277.7	13.7
39	39.0	01.9	99	98.9	04.9	59	158.8	07.8	19	218.7	10.8	79	278.7	13.7
40	40.0	02.0	100	99.9	04.9	60	159.8	07.9	20	219.7	10.8	80	279.7	13.8
41	41.0	02.0	101	100.9	05.0	161	160.8	07.9	221	220.7	10.9	281	280.7	13.8
42	41.9	02.1	02	101.9	05.0	62	161.8	08.0	22	221.7	10.9	82	281.7	13.9
43	42.9	02.1	03	102.9	05.1	63	162.8	08.0	23	222.7	11.0	83	282.7	13.9
44	43.9	02.2	04	103.9	05.1	64	163.8	08.1	24	223.7	11.0	84	283.7	14.0
45	44.9	02.2	05	104.9	05.2	65	164.8	08.1	25	224.7	11.1	85	284.7	14.0
46	45.9	02.3	06	105.9	05.2	66	165.8	08.2	26	225.7	11.1	86	285.7	14.1
47	46.9	02.3	07	106.9	05.3	67	166.8	08.2	27	226.7	11.2	87	286.7	14.1
48	47.9	02.4	08	107.9	05.3	68	167.8	08.3	28	227.7	11.2	88	287.7	14.2
49	48.9	02.4	09	108.9	05.4	69	168.8	08.3	29	228.7	11.3	89	288.7	14.2
50	49.9	02.5	10	109.9	05.4	70	169.8	08.4	30	229.7	11.3	90	289.7	14.3
51	50.9	02.5	111	110.9	05.5	171	170.8	08.4	231	230.7	11.4	291	290.7	14.3
52	51.9	02.6	12	111.9	05.5	72	171.8	08.5	32	231.7	11.4	92	291.6	14.4
53	52.9	02.6	13	112.9	05.5	73	172.8	08.5	33	232.7	11.5	93	292.6	14.4
54	53.9	02.7	14	113.9	05.6	74	173.8	08.5	34	233.7	11.5	94	293.6	14.5
55	54.9	02.7	15	114.9	05.6	75	174.8	08.6	35	234.7	11.5	95	294.6	14.5
56	55.9	02.8	16	115.9	05.7	76	175.8	08.6	36	235.7	11.6	96	295.6	14.5
57	56.9	02.8	17	116.9	05.7	77	176.8	08.7	37	236.7	11.6	97	296.6	14.6
58	57.9	02.9	18	117.9	05.8	78	177.8	08.7	38	237.7	11.7	98	297.6	14.6
59	58.9	02.9	19	118.9	05.8	79	178.8	08.8	39	238.7	11.7	99	298.6	14.7
60	59.9	02.9	20	119.9	05.9	80	179.8	08.8	40	239.7	11.8	300	299.6	14.7
Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 7 ¾ Points.

TABLE II. Difference of Latitude and Departure for ½ Point.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep
1	01.0	00.1	61	60.7	06.0	121	120.4	11.8	181	180.1	17.7	241	239.8	23.6
2	02.0	00.2	62	61.7	06.1	22	121.4	11.9	82	181.1	17.8	42	240.8	23.7
3	03.0	00.3	63	62.7	06.2	23	122.4	12.0	83	182.1	17.9	43	241.8	23.8
4	04.0	00.4	64	63.7	06.3	24	123.4	12.1	84	183.1	18.0	44	242.8	23.9
5	05.0	00.5	65	64.7	06.4	25	124.4	12.2	85	184.1	18.1	45	243.8	24.0
6	06.0	00.6	66	65.7	06.5	26	125.4	12.3	86	185.1	18.2	46	244.8	24.1
7	07.0	00.7	67	66.7	06.6	27	126.4	12.4	87	186.1	18.3	47	245.8	24.2
8	08.0	00.8	68	67.7	06.7	28	127.4	12.5	88	187.1	18.4	48	246.8	24.3
9	09.0	00.9	69	68.7	06.7	29	128.4	12.6	89	188.1	18.5	49	247.8	24.4
10	10.0	01.0	70	69.7	06.8	30	129.4	12.7	90	189.1	18.6	50	248.8	24.5
11	10.9	01.1	71	70.7	06.9	131	130.4	12.8	191	190.1	18.7	251	249.8	24.6
12	11.9	01.2	72	71.7	07.0	32	131.4	12.9	92	191.1	18.8	52	250.8	24.7
13	12.9	01.3	73	72.6	07.1	33	132.4	13.0	93	192.1	18.9	53	251.8	24.8
14	13.9	01.4	74	73.6	07.2	34	133.4	13.1	94	193.1	19.0	54	252.8	24.9
15	14.9	01.5	75	74.6	07.3	35	134.4	13.2	95	194.1	19.1	55	253.8	25.0
16	15.9	01.6	76	75.6	07.4	36	135.3	13.3	96	195.1	19.2	56	254.8	25.1
17	16.9	01.7	77	76.6	07.5	37	136.3	13.4	97	196.1	19.3	57	255.8	25.2
18	17.9	01.8	78	77.6	07.6	38	137.3	13.5	98	197.0	19.4	58	256.8	25.3
19	18.0	01.9	79	78.6	07.7	39	138.3	13.6	99	198.0	19.5	59	257.8	25.4
20	19.9	02.0	80	79.6	07.8	40	139.3	13.7	200	199.0	19.6	60	258.8	25.5
21	20.9	02.1	81	80.6	07.9	141	140.3	13.8	201	200.0	19.7	261	259.7	25.6
22	21.9	02.2	82	81.6	08.0	42	141.3	13.9	02	201.0	19.8	62	260.7	25.7
23	22.9	02.2	83	82.6	08.1	43	142.3	14.0	03	202.0	19.9	63	261.7	25.8
24	23.9	02.3	84	83.6	08.2	44	143.3	14.1	04	203.0	20.0	64	262.7	25.9
25	24.9	02.4	85	84.6	08.3	45	144.3	14.2	05	204.0	20.1	65	263.7	26.0
26	25.9	02.5	86	85.6	08.4	46	145.3	14.3	06	205.0	20.2	66	264.7	26.1
27	26.9	02.6	87	86.6	08.5	47	146.3	14.4	07	206.0	20.2	67	265.7	26.2
28	27.9	02.7	88	87.6	08.6	48	147.3	14.5	08	207.0	20.3	68	266.7	26.3
29	28.9	02.8	89	88.6	08.7	49	148.3	14.6	09	208.0	20.4	69	267.7	26.4
30	29.9	02.9	90	89.6	08.8	50	149.3	14.7	10	209.0	20.5	70	268.7	26.5
31	30.9	03.0	91	90.6	08.9	151	150.3	14.8	211	210.0	20.6	271	269.7	26.6
32	31.8	03.1	92	91.6	09.0	52	151.3	14.9	12	211.0	20.7	72	270.7	26.7
33	32.8	03.2	93	92.6	09.1	53	152.3	15.0	13	212.0	20.8	73	271.7	26.8
34	33.8	03.3	94	93.5	09.2	54	153.3	15.1	14	213.0	20.9	74	272.7	26.9
35	34.8	03.4	95	94.5	09.3	55	154.3	15.2	15	214.0	21.0	75	273.7	27.0
36	35.8	03.5	96	95.5	09.4	56	155.3	15.3	16	215.0	21.1	76	274.7	27.1
37	36.8	03.6	97	96.5	09.5	57	156.2	15.4	17	216.0	21.2	77	275.7	27.2
38	37.8	03.7	98	97.5	09.6	58	157.2	15.5	18	217.0	21.3	78	276.7	27.3
39	38.8	03.8	99	98.5	09.7	59	158.2	15.6	19	217.9	21.4	79	277.7	27.4
40	39.8	03.9	100	99.5	09.8	60	159.2	15.7	20	218.9	21.5	80	278.7	27.5
41	40.8	04.0	101	100.5	09.9	161	160.2	15.7	221	219.9	21.6	281	279.6	27.6
42	41.8	04.1	02	101.5	10.0	62	161.2	15.8	22	220.9	21.7	82	280.6	27.7
43	42.8	04.2	03	102.5	10.1	63	162.2	15.9	23	221.9	21.8	83	281.6	27.8
44	43.8	04.3	04	103.5	10.2	64	163.2	16.0	24	222.9	21.9	84	282.6	27.9
45	44.8	04.4	05	104.5	10.3	65	164.2	16.1	25	223.9	22.0	85	283.6	28.0
46	45.8	04.5	06	105.5	10.4	66	165.2	16.2	26	224.9	22.1	86	284.6	28.1
47	46.8	04.6	07	106.5	10.5	67	166.2	16.3	27	225.9	22.2	87	285.6	28.2
48	47.8	04.7	08	107.5	10.6	68	167.2	16.4	28	226.9	22.3	88	286.6	28.3
49	48.8	04.8	09	108.5	10.7	69	168.2	16.5	29	227.9	22.4	89	287.6	28.4
50	49.8	04.9	10	109.5	10.8	70	169.2	16.6	30	228.9	22.5	90	288.6	28.5
51	50.8	05.0	111	110.5	10.9	171	170.2	16.7	231	229.9	22.6	291	289.6	28.6
52	51.8	05.1	12	111.5	11.0	72	171.2	16.8	32	230.9	22.7	92	290.6	28.7
53	52.7	05.2	13	112.5	11.1	73	172.2	16.9	33	231.9	22.8	93	291.6	28.8
54	53.7	05.3	14	113.5	11.2	74	173.2	17.0	34	232.9	22.9	94	292.6	28.9
55	54.7	05.4	15	114.4	11.2	75	174.2	17.1	35	233.9	23.0	95	293.6	29.0
56	55.7	05.5	16	115.4	11.3	76	175.2	17.2	36	234.9	23.1	96	294.6	29.1
57	56.7	05.6	17	116.4	11.4	77	176.2	17.3	37	235.9	23.2	97	295.6	29.2
58	57.7	05.7	18	117.4	11.5	78	177.1	17.4	38	236.9	23.3	98	296.6	29.3
59	58.7	05.8	19	118.4	11.6	79	178.1	17.5	39	237.9	23.4	99	297.6	29.4
60	59.7	05.9	20	119.4	11.7	80	179.1	17.6	40	238.8	23.5	300	298.6	29.5
Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 7½ Points.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep
1	01.0	00.1	61	60.3	08.9	121	119.7	17.7	181	179.0	26.5	241	238.4	35.3
2	02.0	00.3	62	61.3	09.1	22	120.7	17.8	82	180.0	26.7	42	239.4	35.5
3	03.0	00.4	63	62.3	09.2	23	121.7	18.0	83	181.0	26.8	43	240.4	35.6
4	04.0	00.6	64	63.3	09.4	24	122.7	18.2	84	182.0	27.0	44	241.3	35.8
5	04.9	00.7	65	64.3	09.5	25	123.6	18.3	85	183.0	27.1	45	242.3	35.9
6	05.9	00.9	66	65.3	09.7	26	124.6	18.5	86	184.0	27.3	46	243.3	36.1
7	06.9	01.0	67	66.3	09.8	27	125.6	18.6	87	185.0	27.4	47	244.3	36.2
8	07.9	01.2	68	67.3	10.0	28	126.6	18.8	88	186.0	27.6	48	245.3	36.4
9	08.9	01.3	69	68.2	10.1	29	127.6	18.9	89	186.9	27.7	49	246.3	6.5
10	09.9	01.5	70	69.2	10.3	30	128.6	19.1	90	187.9	27.9	50	247.3	36.7
11	10.9	01.6	71	70.2	10.4	131	129.6	19.2	191	188.9	28.0	251	248.3	36.8
12	11.9	01.8	72	71.2	10.6	32	130.6	19.4	92	189.9	28.2	52	249.3	37.0
13	12.9	01.9	73	72.2	10.7	33	131.6	19.5	93	190.9	28.3	53	250.2	37.1
14	13.8	02.1	74	73.2	10.8	34	132.5	19.6	94	191.9	28.5	54	251.2	37.3
15	14.8	02.2	75	74.2	11.0	35	133.5	19.8	95	192 9	28.6	55	252.2	37 4
16	15.8	02.3	76	75.2	11.1	36	134.5	19.9	96	193.9	28.7	56	253.2	37.5
17	16.8	02.5	77	76.2	11.2	37	135.5	20.1	97	194.9	28.9	57	254.2	37.7
18	17.8	02 6	78	77.1	11.4	38	136.5	20.2	98	195.8	29.0	58	255.2	37.8
19	18.8	02.8	79	78.1	11.6	39	137.5	20.4	99	196.8	29.2	59	256.2	38.0
20	19.8	02.9	80	79.1	11.7	40	138.5	20.5	200	197.8	29.3	60	257.2	38.1
21	20.8	03.1	81	80.1	11.9	141	139.5	20.7	201	198.8	29.5	261	258.2	38.3
22	21.8	03.2	82	81.1	12.0	42	140.5	20.8	02	199.8	29.6	62	259.1	38.4
23	22.7	03.4	83	82.1	12.2	43	141.4	21.0	03	200.8	29.8	63	260.1	38.6
24	23.7	03.5	84	83.1	12.3	44	142.4	21.1	04	201.8	29.9	64	261.1	38.7
25	24.7	03.7	85	84.1	12.5	45	143.4	21.3	05	202.8	30.1	65	262.1	38.9
26	25.7	03.8	86	85.1	12.6	46	144.4	21.4	06	203.8	30.2	66	263.1	39.0
27	26.7	04.0	87	86.1	12.8	47	145.4	21.6	07	204.7	30.4	67	264.1	39.2
28	27.7	04.1	88	87.0	12.9	48	146.4	21.7	08	205.7	30.5	68	265.1	39.3
29	28.7	04.3	89	88.0	13.0	49	147.4	21.8	09	206.7	30.6	69	266.1	39.5
30	29.7	04.4	90	89.0	13.2	50	148.4	22.0	10	207.7	30.8	70	267.1	39.6
31	30.7	04.5	91	90.0	13.3	151	149.4	22.1	211	208.7	30.9	271	268.1	39.7
32	31.7	04.7	92	91.0	13.5	52	150.3	22.3	12	209.7	31.1	72	269.0	39.9
33	32.6	04.8	93	92.0	13.6	53	151.3	22.4	13	210.7	31.2	73	270.0	40.0
34	33.6	05.0	94	93.0	13.8	54	152.3	22.6	14	211.7	31.4	74	271 0	40.2
35	34.6	05.1	95	94.0	13.9	55	153.3	22.7	15	212.7	31.5	75	272.0	40.3
36	35.6	05.3	96	95.0	14.1	56	154.3	22.9	16	213.7	31.7	76	273.0	40.5
37	36.6	05.4	97	95.9	14.7	57	155.3	23.0	17	214.6	31.8	77	274.0	40.6
38	37.6	05.6	98	96.9	14.4	58	156.3	23.2	18	215.6	32.0	78	275.0	40.8
39	38.6	05.7	99	97.9	14.5	59	157.3	23.3	19	216.6	32.1	79	276.0	40.9
40	39.6	05.9	100	98.9	14.7	60	158.3	23.5	20	217.6	32.3	80	277.0	41.1
41	40.6	06.0	101	99.9	14.8	161	159.2	23.6	221	218.6	32.4	281	277.9	41.2
42	41.5	06.2	02	100.9	15.0	62	160.2	23.8	22	219.6	32.6	82	278.9	41.4
43	42.5	06.3	03	101.9	15.1	63	161.2	23.9	23	220.6	32.7	83	279.9	41.5
44	43.5	06.5	04	102.9	15.3	64	162.2	24.0	24	221.6	32.8	84	280.9	41.6
45	44.5	06.6	05	103.9	15.4	65	163.2	24.2	25	222.6	33.0	85	281.9	41.8
46	45.5	06.7	06	104.8	15.5	66	164.2	24.3	26	223.5	33.1	86	282.9	41.9
47	46.5	06.9	07	105.8	15.7	67	165.2	24.5	27	224.5	33.3	87	283.9	42.1
48	47.5	07.0	08	106.8	15.8	68	166.2	24.6	28	225.5	33.4	88	284.9	42.2
49	48.5	07.2	09	107.8	16.0	69	167.2	24.8	29	226.4	33.2	89	285.9	42.4
50	49.5	07.3	10	108.8	16.1	70	168.1	24.9	30	227.5	33.7	90	286.9	42.5
51	50.4	07.5	111	109.8	16.3	171	169.1	25.1	231	228.5	33.9	291	287.8	42.7
52	51.4	07.6	12	110.8	16.4	72	170.1	25.2	32	229.5	34.0	92	288.8	42.8
53	52.4	07.8	13	111.8	16.6	73	171.1	25.4	33	230.5	34.2	93	289.8	43.0
54	53.4	07.9	14	112.8	16.7	74	172.1	25.5	34	231.5	34.3	94	290.8	43.1
55	54.4	08.1	15	113.7	16.9	75	173.1	25.7	35	232.4	34.5	95	291.8	43.3
56	55.4	08.2	16	114.7	17.0	76	174.1	25.8	36	233.4	34.6	96	292.8	43.4
57	56.4	08.4	17	115.7	17.2	77	175.1	26.0	37	234.4	34.8	97	293.8	43.6
58	57.4	08.5	18	116.7	17.3	78	176.1	26.1	38	235.4	34.9	98	294.8	43.7
59	58.4	08.6	19	117.7	17.5	79	177.1	26.3	39	236.4	35.0	99	295.8	43.8
60	59.3	08.8	120	118.7	17.6	180	178.0	26.4	240	237.4	35.2	300	296.8	44.0
Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat	Dist	Dep.	Lat.

Table II. Difference of Latitude and Departure for 1 Point.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep
1	01.0	00.2	61	59.8	11.9	121	118.7	23.6	181	177.5	35.3	241	236.3	47.0
2	02.0	00.4	62	60.8	12.1	22	119.6	23.8	82	178.5	35.5	42	237.3	47.2
3	02.9	00.6	63	61.8	12.3	23	120.6	24.0	83	179.5	35.7	43	238.3	47.4
4	03.9	00.8	64	62.8	12.5	24	121.6	24.2	84	180.4	35.9	44	239.3	47.6
5	04.9	01.0	65	63.7	12.7	25	122.6	24.4	85	181.4	36.1	45	240.3	47.8
6	05.9	01.2	66	64.7	12.9	26	123.6	24.6	86	182.4	36.3	46	241.2	48.0
7	06.9	01.4	67	65.7	13.1	27	124.5	24.8	87	183.4	36.5	47	242.2	48.2
8	07.8	01.6	68	66.7	13.3	28	125.5	25.0	88	184.4	36.7	48	243.2	48.4
9	08.8	01.8	69	67.7	13.5	29	126.5	25.2	89	185.3	36.9	49	244.2	48.6
10	09.8	02.0	70	68.6	13.7	30	127.5	25.4	90	186.3	37.1	50	245.2	48.8
11	10.8	02.1	71	69.6	13.9	131	128.5	25.6	191	187.3	37.3	251	246.1	49.0
12	11.8	02.3	72	70.6	14.0	32	129.5	25.8	92	188.3	37.5	52	247.1	49.2
13	12.7	02.5	73	71.6	14.2	33	130.4	26.0	93	189.3	37.7	53	248.1	49.4
14	13.7	02.7	74	72.6	14.4	34	131.4	26.1	94	190.2	37.9	54	249.1	49.6
15	14.7	02.9	75	73.6	14.6	35	132.4	26.3	95	191.2	38.0	55	250.1	49.8
16	15.7	03.1	76	74.5	14.8	36	133.4	26.5	96	192.2	38.2	56	251.1	50.0
17	16.7	03.3	77	75.5	15.0	37	134.4	26.7	97	193.2	38.4	57	252.1	50.1
18	17.7	03.5	78	76.5	15.2	38	135.3	26.9	98	194.2	38.6	58	253.0	50.3
19	18.6	03.7	79	77.5	15.4	39	136.3	27.1	99	195.2	38.8	59	254.0	50.5
20	19.6	03.9	80	78.5	15.6	40	137.3	27.3	200	196.1	39.0	60	255.0	50.7
21	20.6	04.1	81	79.4	15.8	141	138.3	27.5	201	197.1	39.2	261	256.0	50.9
22	21.6	04.3	82	80.4	16.0	42	139.3	27.7	02	198.1	39.4	62	256.9	51.1
23	22.6	04.5	83	81.4	16.2	43	140.2	27.9	03	199.1	39.6	63	257.9	51.3
24	23.5	04.7	84	82.4	16.4	44	141.2	28.1	04	200.1	39.8	64	258.9	51.5
25	24.5	04.9	85	83.4	16.6	45	142.2	28.3	05	201.0	40.0	65	259.9	51.7
26	25.5	05.1	86	84.3	16.8	46	143.2	28.5	06	202.0	40.2	66	260.9	51.9
27	26.5	05.3	87	85.3	17.0	47	144.2	28.7	07	203.0	40.4	67	261.8	52.1
28	27.5	05.5	88	86.3	17.2	48	145.1	28.9	08	204.0	40.6	68	262.8	52.3
29	28.4	05.7	89	87.3	17.4	49	146.1	29.1	09	205.0	40.8	69	263.8	52.5
30	29.4	05.9	90	88.3	17.6	50	147.1	29.3	10	205.9	41.0	70	264.8	52.7
31	30.4	06.0	91	89.2	17.8	151	148.1	29.5	211	206.9	41.2	271	265.8	52.9
32	31.4	06.2	92	90.2	18.0	52	149.1	29.7	12	207.9	41.4	72	266.7	53.1
33	32.4	06.4	93	91.2	18.1	53	150.0	29.9	13	208.9	41.6	73	267.7	53.3
34	33.3	06.6	94	92.2	18.3	54	151.0	30.0	14	209.9	41.8	74	268.7	53.5
35	34.3	06.8	95	93.2	18.5	55	152.0	30.2	15	210.8	42.0	75	269.7	53.7
36	35.3	07.0	96	94.1	18.7	56	153.0	30.4	16	211.8	42.1	76	270.7	53.9
37	36.3	07.2	97	95.1	18.9	57	154.0	30.6	17	212.8	42.3	77	271.6	54.0
38	37.3	07.4	98	96.1	19.1	58	154.9	30.8	18	213.8	42.5	78	272.6	54.2
39	38.2	07.6	99	97.1	19.3	59	155.9	31.0	19	214.8	42.7	79	273.6	54.4
40	39.2	07.8	100	98.1	19.5	60	156.9	31.2	20	215.7	42.9	80	274.6	54.6
41	40.2	08.0	101	99.1	19.7	161	157.9	31.4	221	216.7	43.1	281	275.6	54.8
42	41.2	08.2	02	100.0	19.9	62	158.9	31.6	22	217.7	43.3	82	276.5	55.0
43	42.2	08.4	03	101.0	20.1	63	159.8	31.8	23	218.7	43.5	83	277.5	55.2
44	43.2	08.6	04	102.0	20.3	64	160.8	32.0	24	219.7	43.7	84	278.5	55.4
45	44.1	08.8	05	103.0	20.5	65	161.8	32.2	25	220.6	43.9	85	279.5	55.6
46	45.1	09.0	06	104.0	20.7	66	162.8	32.4	26	221.6	44.1	86	280.5	55.8
47	46.1	09.2	07	104.9	20.9	67	163.8	32.6	27	222.6	44.3	87	281.5	56.0
48	47.1	09.4	08	105.9	21.1	68	164.7	32.8	28	223.6	44.5	88	282.4	56.2
49	48.1	09.6	09	106.9	21.3	69	165.7	33.0	29	224.6	44.7	89	283.4	56.4
50	49.0	09.8	10	107.9	21.5	70	166.7	33.2	30	225.6	44.9	90	284.4	56.6
51	50.0	10.0	111	108.8	21.7	171	167.7	33.4	231	226.5	45.1	291	285.4	56.8
52	51.0	10.1	12	109.8	21.9	72	168.7	33.6	32	227.5	45.3	92	286.4	57.0
53	52.0	10.3	13	110.8	22.0	73	169.7	33.8	33	228.5	45.5	93	287.3	57.2
54	53.0	10.5	14	111.8	22.2	74	170.6	34.0	34	229.5	45.7	94	288.3	57.4
55	53.9	10.7	15	112.8	22.4	75	171.6	34.1	35	230.5	45.9	95	289.3	57.6
56	54.9	10.9	16	113.8	22.6	76	172.6	34.3	36	231.4	46.0	96	290.3	57.8
57	55.9	11.1	17	114.7	22.8	77	173.6	34.5	37	232.4	46.2	97	291.3	58.0
58	56.9	11.3	18	115.7	23.0	78	174.6	34.7	38	233.4	46.4	98	292.2	58.1
59	57.9	11.5	19	116.7	23.2	79	175.5	34.9	39	234.4	46.6	99	293.2	58.3
60	58.8	11.7	120	117.7	23.4	80	176.5	35.1	40	235.4	46.8	300	294.2	58.5
Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 7 Points.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep
1	01.0	00.2	61	59.2	14.8	121	117.4	29.4	181	175.6	44.0	241	233.8	58.6
2	01.9	00.5	62	60.1	15.1	22	118.3	29.6	82	176.5	44.2	42	234.7	58.8
3	02.9	00.7	63	61.1	15.3	23	119.3	29.9	83	177.5	44.5	43	235.7	59.0
4	03.9	01.0	64	62.1	15.6	24	120.3	30.1	84	178.5	44.7	44	236.7	59.3
5	04.9	01.2	65	63.1	15.8	25	121.3	30.4	85	179.5	45.0	45	237.7	59.5
6	05.8	01.5	66	64.0	16.0	26	122.2	30.6	86	180.4	45.2	46	238.6	59.8
7	06.8	01.7	67	65.0	16.3	27	123.2	30.9	87	181.4	45.4	47	239.6	60.0
8	07.8	01.9	68	66.0	16.5	28	124.2	31.1	88	182.4	45.7	48	240.6	60.3
9	08.7	02.2	69	66.9	16.8	29	125.1	31.3	89	183.3	45.9	49	241.5	60.5
10	09.7	02.4	70	67.9	17.0	30	126.1	31.6	90	184.3	46.2	50	242.5	60.7
11	10.7	02.7	71	68.9	17.3	131	127.1	31.8	191	185.3	46.4	251	243.5	61.0
12	11.6	02.9	72	69.8	17.5	32	128.0	32.1	92	186.2	46.7	52	244.4	61.2
13	12.6	03.4	73	70.8	17.7	33	129.0	32.3	93	187.2	46.9	53	245.4	61.5
14	13.6	03.2	74	71.8	18.0	34	130.0	32.6	94	188.2	47.1	54	246.4	61.7
15	14.6	03.6	75	72.8	18.2	35	131.0	32.8	95	189.2	47.4	55	247.4	62.0
16	15.5	03.9	76	73.7	18.5	36	131.9	33.0	96	190.1	47.6	56	248.3	62.2
17	16.5	04.1	77	74.7	18.7	37	132.9	33.3	97	191.1	47.9	57	249.3	62.5
18	17.5	04.4	78	75.7	19.0	38	133.9	33.5	98	192.1	48.1	58	250.3	62.7
19	18.4	04.6	79	76.6	19.2	39	134.8	33.8	99	193.0	48.4	59	251.2	62.9
20	19.4	04.9	80	77.6	19.4	40	135.8	34.0	200	194.0	48.6	60	252.2	63.2
21	20.4	05.1	81	78.6	19.7	141	136.8	34.3	201	195.0	48.8	261	253.2	63.4
22	21.3	05.3	82	79.5	19.9	42	137.7	34.5	02	195.9	49.1	62	254.1	63.7
23	22.3	05.6	83	80.5	20.2	43	138.7	34.7	03	196.9	49.3	63	255.1	63.9
24	23.3	05.8	84	81.5	20.4	44	139.7	35.0	04	197.9	49.6	64	256.1	64.2
25	24.3	06.1	85	82.5	20.7	45	140.7	35.2	05	198.9	49.8	65	257.1	64.4
26	25.2	06.3	86	83.4	20.9	46	141.6	35.5	06	199.8	50.1	66	258.0	64.6
27	26.2	06.6	87	84.4	21.1	47	142.6	35.7	07	200.8	50.3	67	259.0	64.9
28	27.2	06.8	88	85.4	21.4	48	143.6	36.0	08	201.8	50.5	68	260.0	65.1
29	28.1	07.0	89	86.3	21.6	49	144.5	36.2	09	202.7	50.8	69	260.9	65.4
30	29.1	07.3	90	87.3	21.9	50	145.5	36.5	10	203.7	51.0	70	261.9	65.6
31	30.1	07.5	91	88.3	22.1	151	146.5	36.7	211	204.7	51.3	271	262.9	65.9
32	31.0	07.8	92	89.2	22.4	52	147.4	36.9	12	205.6	51.5	72	263.8	66.1
33	32.0	08.0	93	90.2	22.6	53	148.4	37.2	13	206.6	51.8	73	264.8	66.3
34	33.0	08.3	94	91.2	22.8	54	149.4	37.4	14	207.6	52.0	74	265.8	66.6
35	34.0	08.5	95	92.2	23.1	55	150.4	37.7	15	208.6	52.2	75	266.8	66.8
36	34.9	08.7	96	93.1	23.3	56	151.3	37.9	16	209.5	52.5	76	267.7	67.1
37	35.9	09.0	97	94.1	23.6	57	152.3	38.2	17	210.5	52.7	77	268.7	67.3
38	36.9	09.2	98	95.1	23.8	58	153.3	38.4	18	211.5	53.0	78	269.7	67.6
39	37.8	09.5	99	96.0	24.1	59	154.2	38.6	19	212.4	53.2	79	270.6	67.8
40	38.8	09.7	100	97.0	24.3	60	155.2	38.9	20	213.4	53.5	80	271.6	68.0
41	39.8	10.0	101	98.0	24.5	161	156.2	39.1	221	214.4	53.7	281	272.6	68.3
42	40.7	10.2	02	98.9	24.8	62	157.1	39.4	22	215.3	53.9	82	273.5	68.5
43	41.7	10.4	03	99.9	25.0	63	158.1	39.6	23	216.3	54.2	83	274.5	68.8
44	42.7	10.7	04	100.9	25.3	64	159.1	39.9	24	217.3	54.4	84	275.5	69.0
45	43.7	10.9	05	101.9	25.5	65	160.1	40.1	25	218.3	54.7	85	276.5	69.3
46	44.6	11.2	06	102.8	25.8	66	161.0	40.3	26	219.2	54.9	86	277.4	69.5
47	45.6	11.4	07	103.8	26.0	67	162.0	40.6	27	220.2	55.2	87	278.4	69.7
48	46.6	11.7	08	104.8	26.2	68	163.0	40.8	28	221.2	55.4	88	279.4	70.0
49	47.5	11.9	09	105.7	26.5	69	163.9	41.1	29	222.1	55.6	89	280.3	70.2
50	48.5	12.2	110	106.7	26.7	70	164.9	41.3	30	223.1	55.9	90	281.3	70.5
51	49.5	12.4	111	107.7	27.0	171	165.9	41.6	231	224.1	56.1	291	282.3	70.7
52	50.4	12.6	12	108.6	27.2	72	166.8	41.8	32	225.0	56.4	92	283.2	71.0
53	51.4	12.9	13	109.6	27.5	73	167.8	42.0	33	226.0	56.6	93	284.2	71.2
54	52.4	13.1	14	110.6	27.7	74	168.8	42.3	34	227.0	56.9	94	285.2	71.4
55	53.4	13.4	15	111.6	27.9	75	169.8	42.5	35	228.0	57.1	95	286.2	71.7
56	54.3	13.6	16	112.5	28.2	76	170.7	42.8	36	228.9	57.3	96	287.1	71.9
57	55.3	13.9	17	113.5	28.4	77	171.7	43.0	37	229.9	57.6	97	288.1	72.2
58	56.3	14.1	18	114.5	28.7	78	172.7	43.3	38	230.9	57.8	98	289.1	72.4
59	57.2	14.3	19	115.4	28.9	79	173.6	43.5	39	231.8	58.1	99	290.0	72.7
60	58.2	14.6	120	116.4	29.2	80	174.6	43.7	40	232.8	58.3	300	291.0	72.9
Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 6 ¾ Points.

TABLE II. Difference of Latitude and Departure for 1½ Point.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep
1	01.0	00.3	61	58.4	17.7	121	115.8	35.1	181	173.2	52.5	241	230.6	69.9
2	01.9	00.6	62	59.3	18.0	22	116.8	35.4	82	174.2	52.8	42	231.6	70.2
3	02.9	00.9	63	60.3	18.3	23	117.7	35.7	83	175.1	53.1	43	232.5	70.5
4	03.8	01.2	64	61.2	18.6	24	118.7	36.0	84	176.1	53.4	44	233.5	70.8
5	04.8	01.5	65	62.2	18.9	25	119.6	36.3	85	177.0	53.7	45	234.5	71.0
6	05.7	01.7	66	63.2	19.1	26	120.6	36.5	86	178.0	53.9	46	235.4	71.3
7	06.7	02.0	67	64.1	19.4	27	121.5	36.8	87	179.0	54.2	47	236.4	71.6
8	07.7	02.3	68	65.1	19.7	28	122.5	37.1	88	179.9	54.5	48	237.3	71.9
9	08.6	02.6	69	66.0	20.0	29	123.5	37.4	89	180.9	54.8	49	238.3	72.2
10	09.6	02.9	70	67.0	20.3	30	124.4	37.7	90	181.8	55.1	50	239.2	72.5
11	10.5	03.2	71	67.9	20.6	131	125.4	38.0	191	182.8	55.4	251	240.2	72.8
12	11.5	03.5	72	68.9	20.9	32	126.3	38.3	92	183.7	55.7	52	241.2	73.1
13	12.4	03.8	73	69.9	21.2	33	127.3	38.6	93	184.7	56.0	53	242.1	73.4
14	13.4	04.1	74	70.8	21.5	34	128.2	38.9	94	185.7	56.3	54	243.1	73.7
15	14.4	04.4	75	71.8	21.8	35	129.2	39.2	95	186.6	56.6	55	244.0	74.0
16	15.3	04.6	76	72.7	22.0	36	130.2	39.4	96	187.6	56.8	56	245.0	74.2
17	16.3	04.9	77	73.7	22.3	37	131.1	39.7	97	188.5	57.1	57	245.9	74.5
18	17.2	05.2	78	74.6	22.6	38	132.1	40.0	98	189.5	57.4	58	246.9	74.8
19	18.2	05.5	79	75.6	22.9	39	133.0	40.3	99	190.4	57.7	59	247.9	75.1
20	19.1	05.8	80	76.6	23.2	40	134.0	40.6	200	191.4	58.0	60	248.8	75.4
21	20.1	06.1	81	77.5	23.5	141	134.9	40.9	201	192.4	58.3	261	249.8	75.7
22	21.1	06.4	82	78.5	23.8	42	135.9	41.2	02	193.3	58.6	62	250.7	76.0
23	22.0	06.7	83	79.4	24.1	43	136.9	41.5	03	194.3	58.9	63	251.7	76.3
24	23.0	07.0	84	80.4	24.4	44	137.8	41.8	04	195.2	59.2	64	252.6	76.6
25	23.9	07.3	85	81.3	24.7	45	138.8	42.1	05	196.2	59.5	65	253.6	76.9
26	24.9	07.5	86	82.3	24.9	46	139.7	42.3	06	197.1	59.7	66	254.6	77.1
27	25.8	07.8	87	83.3	25.2	47	140.7	42.6	07	198.1	60.0	67	255.5	77.4
28	26.8	08.1	88	84.2	25.5	48	141.6	42.9	08	199.1	60.3	68	256.5	77.7
29	27.8	08.4	89	85.2	25.8	49	142.6	43.2	09	200.0	60.6	69	257.4	78.0
30	28.7	08.7	90	86.1	26.1	50	143.5	43.5	10	201.0	60.9	70	258.4	78.3
31	29.7	09.0	91	87.1	26.4	151	144.5	43.8	211	201.9	61.2	271	259.3	78.6
32	30.6	09.3	92	88.0	26.7	52	145.5	44.1	12	202.9	61.5	72	260.3	78.9
33	31.6	09.6	93	89.0	27.0	53	146.4	44.4	13	203.8	61.8	73	261.3	79.2
34	32.5	09.9	94	90.0	27.3	54	147.4	44.7	14	204.8	62.1	74	262.2	79.5
35	33.5	10.2	95	90.9	27.6	55	148.3	45.0	15	205.8	62.4	75	263.2	79.8
36	34.5	10.4	96	91.9	27.8	56	149.3	45.2	16	206.7	62.6	76	264.1	80.0
37	35.4	10.7	97	92.8	28.1	57	150.2	45.5	17	207.7	62.9	77	265.1	80.3
38	36.4	11.0	98	93.8	28.4	58	151.2	45.8	18	208.6	63.2	78	266.0	80.6
39	37.3	11.3	99	94.7	28.7	59	152.2	46.1	19	209.6	63.5	79	267.0	80.9
40	38.3	11.6	100	95.7	29.0	60	153.1	46.4	20	210.5	63.8	80	268.0	81.2
41	39.2	11.9	101	96.7	29.3	161	154.1	46.7	221	211.5	64.1	281	268.9	81.5
42	40.2	12.2	02	97.6	29.6	62	155.0	47.0	22	212.5	64.4	82	269.9	81.8
43	41.2	12.5	03	98.6	29.9	63	156.0	47.3	23	213.4	64.7	83	270.8	82.1
44	42.1	12.8	04	99.5	30.2	64	156.9	47.6	24	214.4	65.0	84	271.8	82.4
45	43.1	13.1	05	100.5	30.5	65	157.9	47.9	25	215.3	65.3	85	272.7	82.7
46	44.0	13.3	06	101.4	30.7	66	158.9	48.1	26	216.3	65.5	86	273.7	82.9
47	45.0	13.6	07	102.4	31.0	67	159.8	48.4	27	217.2	65.8	87	274.7	83.2
48	45.9	13.9	08	103.4	31.3	68	160.8	48.7	28	218.2	66.1	88	275.6	83.5
49	46.9	14.2	09	104.3	31.6	69	161.7	49.0	29	219.2	66.4	89	276.7	83.8
50	47.9	14.5	10	105.3	31.9	70	162.7	49.3	30	220.1	66.7	90	277.5	84.1
51	48.8	14.8	111	106.2	32.2	171	163.6	49.6	231	221.1	67.0	291	278.5	84.4
52	49.8	15.1	12	107.2	32.5	72	164.6	49.9	32	222.0	67.3	92	279.4	84.7
53	50.7	15.4	13	108.1	32.8	73	165.6	50.2	33	223.0	67.6	93	280.4	85.0
54	51.7	15.7	14	109.1	33.1	74	166.5	50.5	34	223.9	67.9	94	281.4	85.3
55	52.6	16.0	15	110.1	33.4	75	167.5	50.8	35	224.9	68.2	95	282.3	85.6
56	53.6	16.2	16	111.0	33.6	76	168.4	51.0	36	225.9	68.4	96	283.3	85.8
57	54.5	16.5	17	112.0	33.9	77	169.4	51.3	37	226.8	68.7	97	284.2	86.1
58	55.5	16.8	18	112.9	34.2	78	170.3	51.6	38	227.8	69.0	98	285.2	86.4
59	56.5	17.1	19	113.9	34.5	79	171.3	51.9	39	228.7	69.3	99	286.1	86.7
60	57.4	17.4	20	114.8	34.8	80	172.3	52.2	40	229.7	69.6	300	287.1	87.0
Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 6½ Points.

TABLE II. Difference of Latitude and Departure for 1¼ Point.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep.
1	00.9	00.3	61	57.4	20.5	121	113.9	40.8	181	170.4	61.0	241	226.9	81.2
2	01.9	00.7	62	58.4	20.9	22	114.9	41.1	82	171.4	61.3	42	227.8	81.5
3	02.8	01.0	63	59.3	21.2	23	115.8	41.4	83	172.3	61.6	43	228.8	81.8
4	03.8	01.3	64	60.3	21.6	24	116.7	41.8	84	173.3	62.0	44	229.7	82.2
5	04.7	01.7	65	61.2	21.9	25	117.7	42.1	85	174.2	62.3	45	230.7	82.5
6	05.6	02.0	66	62.1	22.2	26	118.6	42.4	86	175.1	62.6	46	231.6	82.9
7	06.6	02.4	67	63.1	22.6	27	119.6	42.8	87	176.1	63.0	47	232.5	83.2
8	07.5	02.7	68	64.0	22.9	28	120.5	43.1	88	177.0	63.3	48	233.5	83.5
9	08.5	03.0	69	65.0	23.2	29	121.5	43.4	89	177.9	63.7	49	234.4	83.9
10	09.4	03.4	70	65.9	23.6	30	122.4	43.8	90	178.9	64.0	50	235.4	84.2
11	10.4	03.7	71	66.8	23.9	131	123.3	44.1	191	179.8	64.3	251	236.3	84.5
12	11.3	04.0	72	67.8	24.2	32	124.3	44.5	92	180.8	64.7	52	237.3	84.9
13	12.2	04.4	73	68.7	24.6	33	125.2	44.8	93	181.7	65.0	53	238.2	85.2
14	13.2	04.7	74	69.7	24.9	34	126.2	45.1	94	182.6	65.3	54	239.1	85.5
15	14.1	05.1	75	70.6	25.3	35	127.1	45.5	95	183.6	65.7	55	240.1	85.9
16	15.1	05.4	76	71.6	25.6	36	128.0	45.8	96	184.5	66.0	56	241.0	86.2
17	16.0	05.7	77	72.5	25.9	37	129.0	46.1	97	185.5	66.3	57	242.0	86.6
18	17.0	06.1	78	73.4	26.3	38	129.9	46.5	98	186.4	66.7	58	242.9	86.9
19	17.9	06.4	79	74.4	26.6	39	130.9	46.8	99	187.4	67.0	59	243.8	87.2
20	18.8	06.7	80	75.3	26.9	40	131.8	47.2	200	188.3	67.4	60	244.8	87.6
21	19.8	07.1	81	76.3	27.3	141	132.8	47.5	201	189.2	67.7	261	245.7	87.9
22	20.7	07.4	82	77.2	27.6	42	133.7	47.8	02	190.2	68.0	62	246.7	88.2
23	21.7	07.7	83	78.1	28.0	43	134.6	48.2	03	191.1	68.4	63	247.6	88.6
24	22.6	08.1	84	79.1	28.3	44	135.6	48.5	04	192.1	68.7	64	248.6	88.9
25	23.5	08.4	85	80.0	28.6	45	136.5	48.8	05	193.0	69.0	65	249.5	89.2
26	24.5	08.8	86	81.0	29.0	46	137.5	49.2	06	194.0	69.4	66	250.4	89.6
27	25.4	09.1	87	81.9	29.3	47	138.4	49.5	07	194.9	69.7	67	251.4	89.9
28	26.4	09.4	88	82.8	29.6	48	139.3	49.8	08	195.8	70.1	68	252.3	90.3
29	27.3	09.8	89	83.8	30.0	49	140.3	50.2	09	196.8	70.4	69	253.3	90.6
30	28.2	10.1	90	84.7	30.3	50	141.2	50.5	10	197.7	70.7	70	254.2	90.9
31	29.2	10.4	91	85.7	30.6	151	142.2	50.9	211	198.7	71.1	271	255.1	91.3
32	30.1	10.8	92	86.6	31.0	52	143.1	51.2	12	199.6	71.4	72	256.1	91.6
33	31.1	11.1	93	87.6	31.3	53	144.0	51.5	13	200.5	71.7	73	257.0	91.9
34	32.0	11.5	94	88.5	31.7	54	145.0	51.9	14	201.5	72.1	74	258.0	92.3
35	33.0	11.8	95	89.4	32.0	55	145.9	52.2	15	202.4	72.4	75	258.9	92.6
36	33.9	12.1	96	90.4	32.3	56	146.9	52.5	16	203.4	72.7	76	259.9	93.0
37	34.8	12.5	97	91.3	32.7	57	147.8	52.9	17	204.3	73.1	77	260.8	93.3
38	35.8	12.8	98	92.3	33.0	58	148.8	53.2	18	205.2	73.4	78	261.7	93.6
39	36.7	13.1	99	93.2	33.3	59	149.7	53.6	19	206.2	73.8	79	262.7	94.0
40	37.7	13.5	100	94.2	33.7	60	150.6	53.9	20	207.1	74.1	80	263.6	94.3
41	38.6	13.8	101	95.1	34.0	161	151.6	54.2	221	208.1	74.4	281	264.6	94.6
42	39.5	14.1	02	96.0	34.4	62	152.5	54.6	22	209.0	74.8	82	265.5	95.0
43	40.5	14.5	03	97.0	34.7	63	153.5	54.9	23	210.0	75.1	83	266.4	95.3
44	41.4	14.8	04	97.9	35.0	64	154.4	55.2	24	210.9	75.4	84	267.4	95.6
45	42.4	15.2	05	98.9	35.4	65	155.3	55.6	25	211.8	75.8	85	268.3	96.0
46	43.3	15.5	06	99.8	35.7	66	156.3	55.9	26	212.8	76.1	86	269.3	96.3
47	44.3	15.8	07	100.8	36.0	67	156.2	56.2	27	213.7	76.5	87	270.2	96.7
48	45.2	16.2	08	101.7	36.4	68	158.2	56.6	28	214.7	76.8	88	271.2	97.0
49	46.1	16.5	09	102.7	36.7	69	159.1	56.9	29	215.6	77.1	89	272.1	97.3
50	47.1	16.8	10	103.6	37.0	70	160.1	57.3	30	216.5	77.5	90	273.0	97.7
51	48.0	17.2	111	104.5	37.4	171	161.0	57.6	231	217.5	77.8	291	274.0	98.0
52	49.0	17.5	12	105.4	37.7	72	161.9	57.9	32	218.4	78.1	92	274.9	98.3
53	49.9	17.9	13	106.4	38.1	73	162.9	58.3	33	219.4	78.5	93	275.9	98.7
54	50.8	18.2	14	107.3	38.4	74	163.8	58.6	34	220.3	78.8	94	276.8	99.0
55	51.8	18.5	15	108.3	38.7	75	164.8	58.9	35	221.3	79.1	95	277.7	99.4
56	52.7	18.9	16	109.2	39.1	76	165.7	59.3	36	222.2	79.5	96	278.7	99.7
57	53.7	19.2	17	110.2	39.4	77	166.6	59.6	37	223.1	79.8	97	279.6	100.0
58	54.6	19.5	18	111.1	39.7	78	167.6	60.0	38	224.1	80.2	98	280.6	100.4
59	55.5	19.9	19	112.0	40.1	79	168.5	60.3	39	225.0	80.5	99	281.5	100.7
60	56.5	20.2	20	113.0	40.4	80	169.5	60.6	40	226.0	80.8	300	282.5	101.0
Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat	Dist	Dep.	Lat.

for 6¼ Points.

Table II. Difference of Latitude and Departure for 2 Points.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep.
1	00.9	00.4	61	56.4	23.3	121	111.8	46.3	181	167.2	69.3	241	222.7	92.2
2	01.8	00.8	62	57.3	23.7	22	112.7	46.7	82	168.2	69.7	42	223.6	92.6
3	02.8	01.1	63	58.2	24.1	23	113.6	47.1	83	169.1	70.0	43	224.5	93.0
4	03.7	01.5	64	59.1	24.5	24	114.6	47.5	84	170.0	70.4	44	225.5	93.4
5	04.6	01.9	65	60.1	24.9	25	115.5	47.8	85	170.9	70.8	45	226.4	93.8
6	05.5	02.3	66	61.0	25.3	26	116.4	48.2	86	171.9	71.2	46	227.3	94.1
7	06.5	02.7	67	61.9	25.6	27	117.3	48.6	87	172.8	71.6	47	228.2	94.5
8	07.4	03.1	68	62.8	26.0	28	118.3	49.0	88	173.7	72.0	48	229.1	94.9
9	08.3	03.4	69	63.8	26.4	29	119.2	49.4	89	174.6	72.3	49	230.1	95.3
10	09.2	03.8	70	64.7	26.8	30	120.1	49.8	90	175.6	72.7	50	231.0	95.7
11	10.0	04.2	71	65.6	27.2	131	121.0	50.1	191	176.5	73.1	251	231.9	96.1
12	11.1	04.6	72	66.5	27.6	32	122.0	50.5	92	177.4	73.5	52	232.8	96.4
13	12.0	05.0	73	67.5	27.9	33	122.9	50.9	93	178.3	73.9	33	233.8	96.8
14	12.9	05.4	74	68.4	28.3	34	123.8	51.3	94	179.2	74.2	54	234.7	97.2
15	13.9	05.7	75	69.3	28.7	35	124.7	51.7	95	180.2	74.6	55	235.6	97.6
16	14.8	06.1	76	70.2	29.1	36	125.7	52.0	96	181.1	75.0	56	236.5	98.0
17	15.7	06.5	77	71.1	29.5	37	126.6	52.4	97	182.0	75.4	57	237.5	98.4
18	16.6	06.9	78	72.1	29.9	38	127.5	52.8	98	182.9	75.8	58	238.4	98.7
19	17.6	07.3	79	73.0	30.2	39	128.4	53.1	99	183.9	76.2	59	239.3	99.1
20	18.5	07.7	80	73.9	30.6	40	129.4	53.6	200	184.8	76.5	60	240.2	99.5
21	19.4	08.0	81	74.8	31.0	141	130.3	54.0	201	185.7	76.9	261	241.1	99.9
22	20.3	08.4	82	75.8	31.4	42	131.2	54.3	02	186.6	77.3	62	242.1	100.3
23	21.3	08.8	83	76.7	31.8	43	132.1	54.7	03	187.6	77.7	63	243.0	100.7
24	22.2	09.2	84	77.6	32.1	44	133.0	55.1	04	188.5	78.1	64	243.9	101.0
25	23.1	09.6	85	78.5	32.5	45	134.0	55.5	05	189.4	78.5	65	244.8	101.4
26	24.0	10.0	86	79.5	32.9	46	134.9	55.9	06	190.3	78.8	66	245.8	101.8
27	24.9	10.3	87	80.4	33.3	47	135.8	56.3	07	191.3	79.2	67	246.7	102.2
28	25.9	10.7	88	81.3	33.7	48	136.7	56.6	08	192.2	79.6	68	247.6	102.6
29	26.8	11.1	89	82.2	34.1	49	137.7	57.0	09	193.1	80.0	69	248.5	103.0
30	27.7	11.5	90	83.2	34.4	50	138.6	57.4	10	194.0	80.4	70	249.5	103.3
31	28.6	11.9	91	84.1	34.8	151	139.5	57.8	211	194.9	80.8	271	250.4	103.7
32	29.6	12.2	92	85.0	35.2	52	140.4	58.2	12	195.9	81.1	72	251.3	104.1
33	30.5	12.6	93	85.9	35.6	53	141.4	58.6	13	196.8	81.5	73	252.2	104.5
34	31.4	13.0	94	86.9	36.0	54	142.3	58.9	14	197.7	81.9	74	253.2	104.9
35	32.3	13.4	95	87.8	36.4	55	143.2	59.3	15	198.6	82.3	75	254.1	105.2
36	33.3	13.8	96	88.7	36.7	56	144.1	59.7	16	199.6	82.7	76	255.0	105.6
37	34.2	14.2	97	89.6	37.1	57	145.1	60.1	17	200.5	83.0	77	255.9	106.0
38	35.1	14.5	98	90.6	37.5	58	146.0	60.5	18	201.5	83.4	78	256.9	106.4
39	36.0	14.9	99	91.5	37.9	59	146.9	60.9	19	202.3	83.8	79	257.8	106.8
40	37.0	15.3	100	92.4	38.3	60	147.8	61.2	20	203.3	84.2	80	258.7	107.2
41	37.9	15.7	101	93.3	38.7	161	148.8	61.6	221	204.2	84.6	281	259.6	107.5
42	38.8	16.1	02	94.1	39.0	62	149.7	62.0	22	205.1	85.0	82	260.6	107.9
43	39.7	16.5	03	95.1	39.4	63	150.6	62.4	23	206.0	85.3	83	261.5	108.3
44	40.6	16.8	04	96.1	39.8	64	151.5	62.8	24	207.0	85.7	84	262.4	108.7
45	41.6	17.2	05	97.0	40.2	65	152.5	63.1	25	207.9	86.1	85	263.3	109.1
46	42.5	17.6	06	97.9	40.6	66	153.4	63.5	26	208.8	86.5	86	264.2	109.5
47	43.4	18.0	07	98.9	41.0	67	154.3	63.9	27	209.7	86.9	87	265.2	109.8
48	44.4	18.4	08	99.8	41.3	68	155.2	64.3	28	210.7	87.3	88	266.1	110.2
49	45.3	18.8	09	100.7	41.7	69	156.1	64.7	29	211.6	87.6	89	267.0	110.6
50	46.2	19.1	10	101.6	42.1	70	157.1	65.1	30	212.5	88.0	90	267.9	111.0
51	47.1	19.5	111	102.6	42.5	171	158.0	65.4	231	213.4	88.4	291	268.9	111.4
52	48.0	19.9	12	103.5	42.9	72	158.9	65.8	32	214.4	88.8	92	269.8	111.8
53	49.0	20.3	13	104.4	43.2	73	159.8	66.2	33	215.3	89.2	93	270.7	112.1
54	49.9	20.7	14	105.3	43.6	74	160.8	66.6	34	216.2	89.6	94	271.6	112.5
55	50.8	21.0	15	106.3	44.0	75	161.7	67.0	35	217.1	89.9	95	272.6	112.9
56	51.7	21.4	16	107.2	44.4	76	162.6	67.4	36	218.0	90.3	96	273.5	113.3
57	52.7	21.8	17	108.1	44.8	77	163.5	67.7	37	219.0	90.7	97	274.4	113.7
58	53.6	22.2	18	109.0	45.2	78	164.5	68.1	38	219.9	91.1	98	275.3	114.0
59	54.5	22.6	19	109.9	45.5	79	165.4	68.5	39	220.8	91.5	99	276.3	114.4
60	55.4	23.0	20	110.9	45.9	80	166.3	68.9	40	221.7	91.9	300	277.2	114.8
Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 6 Points.

Table II. Difference of Latitude and Departure for 2 ¼ Points.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.9	00.4	61	55.1	26.1	121	109.4	51.7	181	163.6	77.4	241	217.8	103.0
2	01.8	00.9	62	56.0	26.5	22	110.3	52.2	82	164.5	77.8	42	218.7	103.5
3	02.7	01.3	63	57.0	26.9	23	111.2	52.6	83	165.4	78.2	43	219.6	103.9
4	03.6	01.7	64	57.9	27.4	24	112.1	53.0	84	166.3	78.7	44	220.5	104.3
5	04.5	02.1	65	58.8	27.8	25	113.0	53.5	85	167.2	79.1	45	221.4	104.8
6	05.4	02.6	66	59.7	28.2	26	113.9	53.9	86	168.1	79.5	46	222.4	105.2
7	06.3	03.0	67	60.6	28.6	27	114.8	54.3	87	169.0	80.0	47	223.3	105.6
8	07.2	03.4	68	61.5	29.1	28	115.7	54.7	88	169.9	80.4	48	224.2	106.0
9	08.1	03.8	69	62.4	29.5	29	116.6	55.2	89	170.8	80.8	49	225.1	106.5
10	09.0	04.3	70	63.3	29.9	30	117.5	55.6	90	171.7	81.2	50	226.0	106.9
11	09.9	04.7	71	64.2	30.4	131	118.4	56.0	191	172.6	81.7	251	226.9	107.3
12	10.8	05.1	72	65.1	30.8	32	119.3	56.4	92	173.6	82.1	52	227.8	107.8
13	11.8	05.6	73	66.0	31.2	33	120.2	56.9	93	174.5	82.5	53	228.7	108.2
14	12.7	06.0	74	66.9	31.6	34	121.1	57.3	94	175.4	83.0	54	229.6	108.6
15	13.6	06.4	75	67.8	32.1	35	122.0	57.7	95	176.3	83.4	55	230.5	109.0
16	14.5	06.8	76	68.7	32.5	36	122.9	58.2	96	177.2	83.8	56	231.4	109.5
17	15.4	07.3	77	69.6	32.9	37	123.8	58.6	97	178.1	84.2	57	232.3	109.9
18	16.3	07.7	78	70.5	33.4	38	124.7	59.0	98	179.0	84.7	58	233.2	110.3
19	17.2	08.1	79	71.4	33.8	3	125.6	59.4	99	179.9	85.1	59	234.1	110.7
20	18.1	08.6	80	72.3	34.2	40	126.5	59.9	200	180.8	85.5	60	235.0	111.2
21	19.0	09.0	81	73.2	34.6	141	127.4	60.3	201	181.7	85.9	261	235.9	111.6
22	19.9	09.4	82	74.1	35.1	42	128.4	60.7	02	182.6	86.4	62	236.8	112.0
23	20.8	09.8	83	75.0	35.5	43	129.3	61.1	03	183.5	86.8	63	237.7	112.5
24	21.7	10.3	84	75.9	35.9	44	130.2	61.6	04	184.4	87.2	64	238.6	112.9
25	22.6	10.7	85	76.8	36.3	45	131.2	62.0	05	185.3	87.7	65	239.5	113.3
26	23.5	11.1	86	77.7	36.8	46	132.0	62.4	06	186.2	88.1	66	240.4	113.7
27	24.4	11.5	87	78.6	37.2	47	132.9	62.9	07	187.1	88.5	67	241.3	114.2
28	25.3	12.0	88	79.6	37.6	48	133.8	63.3	08	188.0	88.9	68	242.2	114.6
29	26.2	12.4	89	80.5	38.1	49	134.7	63.7	09	188.9	89.4	69	243.1	115.0
30	27.1	12.8	90	81.4	38.5	50	135.6	64.1	10	189.8	89.8	70	244.0	115.5
31	28.0	13.3	91	82.3	38.9	151	136.5	64.6	211	190.7	90.2	271	245.0	115.9
32	28.9	13.7	92	83.2	39.3	52	137.4	65.0	12	191.6	90.6	72	45.9	116.3
33	29.8	14.1	93	84.1	39.8	53	138.3	65.4	13	192.5	91.1	73	246.8	116.7
34	30.7	14.5	94	85.0	40.2	54	139.2	65.8	14	193.4	91.5	74	247.7	117.2
35	31.6	15.0	95	85.9	40.6	55	140.1	66.3	15	194.3	91.9	75	248.6	117.6
36	32.5	15.4	96	86.8	41.0	56	141.0	66.7	16	195.2	92.4	76	249.5	118.0
37	33.4	15.8	97	87.7	41.5	57	141.9	67.1	17	196.1	92.8	77	250.4	118.4
38	34.4	16.2	98	88.6	41.9	58	142.8	67.6	18	197.0	93.2	78	51.3	118.9
39	35.3	16.7	99	89.5	42.3	59	143.7	68.0	19	197.9	93.6	79	252.2	119.3
40	36.2	17.1	100	90.4	42.8	60	144.6	68.4	20	198.8	94.1	80	253.1	119.7
41	37.1	17.5	101	91.3	43.2	161	145.5	68.8	221	199.8	94.5	281	254.0	120.2
42	38.0	18.0	02	92.2	43.6	62	146.4	69.3	22	200.7	94.9	82	254.9	120.6
43	38.9	18.4	03	93.1	44.0	63	147.3	69.7	23	201.6	95.4	83	255.8	121.0
44	39.8	18.8	04	94.0	44.5	64	148.2	70.1	24	202.5	95.8	84	256.7	121.4
45	40.7	19.2	05	94.9	44.9	65	149.1	70.6	25	203.4	96.2	85	257.6	121.9
46	41.6	19.7	06	95.8	45.3	66	150.0	71.0	26	204.3	96.6	86	258.5	122.3
47	42.5	20.1	07	96.7	45.8	67	151.0	71.4	27	205.2	97.1	87	259.4	122.7
48	43.4	20.5	08	97.6	46.2	68	151.9	71.8	28	206.1	97.5	88	260.3	123.1
49	44.3	21.0	09	98.5	46.6	69	152.8	72.3	29	207.0	97.9	89	261.2	123.6
50	45.2	21.4	10	99.4	47.0	70	153.7	72.7	30	207.9	98.3	90	262.1	124.0
51	46.1	21.8	111	100.3	47.5	171	154.6	73.1	231	208.8	98.8	291	263.0	124.4
52	47.0	22.2	12	101.2	47.9	72	155.5	73.5	32	209.7	99.2	92	263.9	124.9
53	47.9	22.7	13	102.1	48.3	73	156.4	74.0	33	210.6	99.6	93	264.8	125.3
54	48.8	23.1	14	103.0	48.7	74	157.3	74.4	34	211.5	100.1	94	265.7	125.7
55	49.7	23.5	15	103.9	49.2	75	158.2	74.8	35	212.4	100.5	95	266.6	126.1
56	50.6	23.9	16	104.8	49.6	76	159.1	75.3	36	213.3	100.9	96	267.6	126.6
57	51.5	24.4	17	105.8	50.0	77	160.0	75.7	37	214.2	101.3	97	268.5	127.0
58	52.4	24.8	18	106.7	50.5	78	160.9	76.1	38	215.1	101.8	98	269.4	127.4
59	53.3	25.2	19	107.6	50.9	79	161.8	76.5	39	216.0	102.2	99	270.3	127.8
60	54.2	25.7	20	108.5	51.3	80	162.7	77.0	40	216.9	102.6	300	271.2	128.3
Dist	Dep.	Lat.	Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 5 ¼ Points.

Table II. Difference of Latitude and Departure for 2 ½ Points.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.9	00.5	61	53.8	28.7	121	106.7	57.0	181	159.6	85.3	241	212.6	113.5
2	01.8	00.9	62	54.7	29.2	22	107.6	57.5	82	160.5	85.8	42	213.4	114.0
3	02.6	01.4	63	55.6	29.7	23	108.5	58.0	83	161.4	86.2	43	214.3	114.5
4	03.5	01.9	64	56.4	30.2	24	109.4	58.4	84	162.3	86.7	44	215.2	115.0
5	04.4	02.4	65	57.3	30.6	25	110.3	58.9	85	163.2	87.2	45	216.1	115.4
6	05.3	02.8	66	58.2	31.1	26	111.2	59.4	86	164.1	87.6	46	217.0	115.9
7	06.2	03.3	67	59.1	31.6	17	112.1	59.8	87	164.9	88.1	47	217.9	116.4
8	07.1	03.8	68	60.0	32.0	28	112.9	60.3	88	165.8	88.6	48	218.7	116.8
9	07.9	04.2	69	60.9	32.5	29	113.8	60.8	89	166.7	89.1	49	219.6	117.3
10	08.8	04.7	70	61.7	33.0	30	114.7	61.3	90	167.6	89.5	50	220.5	117.8
11	09.7	05.2	71	62.6	33.5	13	115.5	61.7	191	168.5	90.0	251	221.4	118.3
12	10.6	05.7	72	63.5	33.9	32	116.4	62.2	92	169 3	90.5	52	222.3	118.7
13	11.5	06.1	73	64.4	34.4	33	117.3	62.7	93	170.2	90.9	53	223.1	119.2
14	12.3	06.6	74	65.3	34.9	34	118.2	63.1	94	171.1	91.4	54	224.0	119.7
15	13.2	07.1	75	66.2	35.3	35	119.1	63.6	95	172.0	91.9	55	224.9	120.1
16	14.1	07.5	76	67.0	35.8	36	120.0	64.5	96	172.9	92.4	56	225.8	120.6
17	15.0	08.0	77	67 9	36.3	37	120.8	64.6	97	173.8	92.8	57	226 7	121.1
18	15.9	08.5	78	68.8	36.8	38	121.7	65.0	98	174.6	93.3	58	227 6	121.6
19	16.8	09.	79	69.7	37.2	39	122.6	65.5	99	175.5	93.8	59	228.4	122.0
20	17.6	09.4	80	70.6	37.7	4	123.5	66.0	200	176.4	94.2	60	229.3	122.5
21	18.5	09.9	81	71.4	38.2	141	124.4	66.4	201	177.3	94 7	261	230.2	123.0
22	19.4	10.4	82	72.3	38.6	42	125.2	66.9	02	178.2	95.2	62	231.1	123.4
23	20.3	10.8	83	73.2	39.1	43	126.1	67.4	03	179.0	95.6	63	232.0	123.9
24	21.2	11.3	84	74.1	39.6	44	127.0	67.8	04	179.9	96.1	64	232.8	124.4
25	22.1	11.8	85	75.0	40.1	45	127.9	68.3	05	180.0	96.6	65	233.7	124.9
26	22.9	12.3	86	75.9	40.5	46	128.8	68.8	06	181.7	97.1	66	234.6	125.3
17	23.8	12.7	87	76.7	41.0	47	129.6	69.3	07	182.6	97.5	67	235.5	125.8
28	24.7	13.2	88	77.6	41.5	48	130.5	69.7	08	183.5	98.0	68	236.4	126.3
29	25.6	13.7	89	78.5	41.9	49	131.4	70.2	09	184.3	98.5	69	237.3	126.7
30	26.5	14.1	90	79.4	42.4	50	132.3	70.7	10	185.2	98.6	70	238.1	127.2
31	27.3	14.6	91	80.3	42.9	151	133.2	71.1	211	186.1	99.4	271	239.0	127.7
32	28.2	15.1	92	81.1	43.4	52	134.1	71.6	12	187.0	99.9	72	239.9	128.2
38	29.1	15.5	93	82.0	43.8	53	134.9	72.1	13	187 9	100.4	73	240.8	128.6
34	30.0	16.0	94	82 9	44.3	54	135.8	72.6	14	188.7	100.8	74	241.7	129.1
35	30.9	16.5	95	83.8	44.8	55	136.7	73.0	15	189.6	101.3	75	242.5	129.6
36	31.8	17.0	96	84.7	45.2	56	137.6	73.5	16	190.5	101.8	76	243.4	130.0
37	32.6	17.4	97	85.6	45.7	57	138.5	74.0	17	191.4	102.2	77	244.3	130.5
38	33.5	17.9	98	86.4	46.2	58	139.4	74.4	18	192.3	102.7	78	245.2	131.0
39	34.4	18.4	99	87.3	46.6	59	140.2	74.9	19	193.2	103.2	79	246.1	131.5
40	35.3	18.8	100	88.2	47.1	60	141.1	75.4	20	194.0	103.7	80	247.0	131.9
41	36.2	19.3	101	89.1	47.6	161	142.0	75.9	221	194.9	104.1	281	247.8	132.4
42	37.0	19.8	02	90.0	48.1	62	142.9	76.3	22	195.8	104.6	82	248.7	132.9
43	37.9	20.3	03	90.8	48.5	63	143.8	76.8	23	196.7	105.1	83	249.6	133.3
44	38.8	20.7	04	91.7	49.0	64	144.6	77.3	24	197.6	105.5	84	250.5	133.8
45	39.7	21.2	05	92.6	49.5	65	145.5	77.7	25	198.4	106.0	85	251.4	134.3
46	40.6	21.7	06	93.5	49.9	66	146.4	78.2	26	199.3	106.5	86	252.3	134.8
47	41.5	22.1	07	94.4	50.4	67	147.3	78.7	27	200.2	107.0	87	253.1	135.2
48	42.3	22.6	08	95.3	50.9	68	148.2	79.2	28	201.1	107.4	88	254.0	135.7
49	43.2	23.1	09	96.1	51.4	69	149.1	79.6	29	202.0	107.9	89	254.9	136.2
50	44.1	23.6	10	97.0	51.8	70	149.9	80.1	30	202.9	108.4	90	255.8	136.6
51	45.0	24.0	111	97.9	52.3	171	150.8	80.6	231	203.7	108.8	291	256.7	137.1
52	45.9	24.5	12	98.8	52.8	72	151.7	81.0	32	204.6	109.3	92	257.5	137.6
53	46.7	25.0	13	99.7	53.2	73	152.6	81.5	33	205.5	109.8	93	258.4	138.1
54	47.6	25.4	14	100.5	53.7	74	153.5	82.0	34	206.4	110.3	94	259.3	138.5
55	48.5	25.9	15	101.4	54.2	75	154.3	82.5	35	207.3	110.7	95	260.2	139.0
56	49.4	26.4	16	102.3	54.7	76	155.2	82.9	36	208.2	111.2	96	261.1	139.5
57	50.3	26.9	17	103.2	55.1	77	156.1	83.4	37	209.0	111.7	97	262.0	139.9
58	51.2	27.3	18	104.1	55.6	78	157.0	83.9	38	210.9	112.1	98	262.8	140.4
59	52.0	27.8	19	105.1	56.1	79	157.9	84.3	39	210.8	112.6	99	263.7	140.9
60	52.9	28.3	20	105.8	56.5	80	158.8	84.8	40	211.7	113.1	300	264.6	141.4
Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 5 ½ Points.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.9	00.6	61	52.3	31.4	121	103.8	62.2	181	155.2	93 0	241	206.7	123.9
2	01.7	01.0	62	53.2	31.9	22	104.6	62.7	82	156.1	93.5	42	207.6	124.4
3	02.6	01.5	63	54.0	32.4	23	105.5	63.2	83	157.0	94.0	43	208.4	124.9
4	03.4	02.1	64	54.9	32.9	24	106.4	63.7	84	157.8	94.6	44	209.3	125.4
5	04.3	02.6	65	55.8	33.4	25	107.2	64.2	85	158.7	95.1	45	210.1	125.9
6	05.1	03.1	66	56.6	33.9	26	108.1	64.8	86	159.5	95.6	46	211.0	126.4
7	06.0	03.6	67	57.5	34.4	27	108.9	65.3	87	160.4	96.1	47	211.9	126.9
8	06.9	04.1	68	58.3	35.0	28	109.8	65.8	88	161.2	96.6	48	212.7	127.4
9	07.7	04.6	69	59.2	35.5	29	110.6	66.3	89	162.1	97.2	49	213.6	128.0
10	08.6	05.1	70	60.0	36.0	30	111.5	66.8	90	163.0	97.7	50	214.4	128.5
11	09.4	05.7	71	60.9	36.5	131	112.4	67.3	191	163.8	98.2	251	215.3	129.0
12	10.3	06.2	72	61.8	37.0	32	113.2	67.8	92	164.7	98.7	52	216.1	129.5
13	11.2	06.7	73	62.6	37.6	33	114.1	68.4	93	165.5	99.2	53	217.0	130 0
14	12.0	07.2	74	63.5	38.1	34	114.9	68.9	94	166.4	99.7	54	217.9	130.5
15	12.9	07.7	75	64.3	38.6	35	115.8	69.4	95	167.3	100.2	55	218.7	131.0
16	13.7	08.2	76	65.2	39.1	36	116.6	69.9	96	168.1	100.7	56	219.6	131.5
17	14.6	08.7	77	66.0	39.6	37	117.5	70.4	97	169.0	101.2	57	220.4	132.1
18	15.4	09.3	78	66.9	40.1	38	118.4	70.9	98	169.8	101.8	58	221.3	132.6
19	16.3	09.8	79	67.8	40.6	39	119.2	71.4	99	170.7	102.3	59	222.1	133.1
20	17.2	10.3	80	68.6	41.1	40	120.1	72.0	200	171.5	102.8	60	223.0	133 6
21	18.0	10.8	81	69.5	41.6	141	120.9	72.5	201	172.4	103.3	261	223.9	134.1
22	18.9	11.3	82	70.3	42.2	42	121.8	73.0	02	173.3	103.8	62	224.7	134.6
23	19.7	11.8	83	71.2	42.7	43	122.7	73.5	03	174.1	104.3	63	225.6	135.7
24	20.6	12.3	84	72.0	43.2	44	123.5	74.0	04	175.0	104.8	64	226.4	135.7
25	21.4	12.9	85	72.9	43.7	45	124.4	74.6	05	175.8	105.4	65	227.3	136.2
26	22.3	13.4	86	73.8	44.2	46	125.2	75.1	06	176.7	105.9	66	228.1	136.7
27	23.2	13.9	87	74.6	44.7	47	126.1	75.6	07	177.5	106.4	67	229.0	137.2
28	24.0	14.4	88	75.5	45.2	48	126.9	76.1	08	178.4	106.9	68	229.9	137.7
29	24.9	14.9	89	76.3	45.7	49	127.8	76.6	09	179.3	107.4	69	230.7	138.2
30	25.7	15.4	90	77.2	46.3	50	128.7	77.1	10	180.1	107.9	70	231.6	138.8
31	26.6	15.9	91	78.1	46.8	151	129.5	77.6	211	181.0	108.4	271	232.4	139.3
32	27.4	16.4	92	78.9	47.3	52	130.4	78.1	12	181.8	109.0	72	233.3	139.8
33	28.3	17.0	93	79.8	47.8	53	131.2	78.6	13	182.7	109.5	73	234.2	140.3
34	29.2	17.5	94	80.6	48.3	54	132.1	79.1	14	183.5	110.0	74	235.0	140.8
35	30.0	18.0	95	81.5	48.8	55	132.9	79.7	15	184.4	110.5	75	235.9	141.3
36	30.9	18.5	96	82.3	49.3	56	133.8	80.2	16	185.3	111.0	76	236.7	141.8
37	31.7	19.0	97	83.2	49.9	57	134.7	80.7	17	186.1	111.5	77	237.6	142.4
38	32.6	19.5	98	84.1	50.4	58	135.5	81.2	18	187.0	112.0	78	238.4	142.9
39	33.5	20.0	99	84.9	50.9	59	136.4	81.7	19	187.8	112.6	79	239.3	143.4
40	34.3	20.6	100	85.8	51.4	60	137.2	82.2	20	188.7	113.1	80	240.2	143.9
41	35.2	21.1	101	86.6	51.9	161	138.1	82.7	221	189.6	113.6	281	241.0	144.4
42	36.0	21.6	02	87.5	52.4	62	138.9	83.3	22	190.4	114.1	82	241.9	144.9
43	36.9	22.1	03	88.3	52.9	63	139.8	83.8	23	191.3	114.6	83	242.7	145.4
44	37.7	22.6	04	89.2	53.4	64	140.7	84.3	24	192.1	115.1	84	243.6	146.0
45	38.6	23.1	05	90.1	54.0	65	141.5	84.8	25	193.0	115.6	85	244.4	146.5
46	39.5	23.6	06	90.9	54.5	66	142.4	85.3	26	193.8	116.1	86	245.3	147.0
47	40.3	24.2	07	91.8	55.0	67	143.2	85.8	27	194.7	116.7	87	246.2	147.5
48	41.2	24.7	08	92.6	55.5	68	144.1	86.3	28	195.6	117.2	88	247.0	148.0
49	42.0	25.2	09	93.5	56.0	69	145.0	86.9	29	196.4	117.7	89	247.9	148.5
50	42.9	25.7	10	94.3	56.5	70	145.8	87.4	30	197.3	118.2	90	248.7	149.0
51	43.7	26.2	111	95.2	57.0	171	146.7	87.9	231	198.1	118.7	291	249.6	149.6
52	44.6	26.7	12	96.1	57.6	72	147.5	88.4	32	199.0	119.2	92	250.4	150.1
53	45.5	27.2	13	96.9	58.1	73	148.4	88.9	33	199.8	119.7	93	251.3	150.6
54	46.3	27.8	14	97.8	58.6	74	149.2	89.4	34	200 7	120.3	94	252.2	151.1
55	47.2	28.3	15	98.6	59.1	75	150.1	89.9	35	201.6	120.8	95	253.0	151.2
56	48.0	28.8	16	99.5	59.6	76	151.0	90.4	36	202.4	121.3	96	253.9	152.1
57	48.9	29.3	17	100.4	60.1	77	151.6	91.0	37	203.3	121.8	97	254.7	152.6
58	49.7	29.8	18	101.2	60.6	78	152.7	91.5	38	204.1	122.3	98	255.6	153.1
59	50.6	30.3	19	102.1	61.2	79	153.5	92.0	39	205.0	122.8	99	256.5	153.7
60	51.5	30.8	20	102.9	61.7	180	154.4	92.5	140	205.8	123.3	300	257.3	154.2
Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

Table II. Difference of Latitude and Departure for 3 Points.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.8	00.6	61	50.7	33.9	121	100.6	67.2	181	150.5	100.5	241	200.4	133.9
2	01.7	01.1	62	51.5	34.4	22	101.4	67.8	82	151.3	101.1	42	201.2	134.4
3	02.5	01.7	63	52.4	35.0	23	102.3	68.3	83	152.1	101.7	43	202.0	135.0
4	03.3	02.2	64	53.2	35.6	24	103.1	68.9	84	153.0	102.2	44	202.8	135.5
5	04.2	02.8	65	54.0	36.1	25	103.9	69.4	85	153.8	102.8	45	203.7	136.1
6	05.0	03.3	66	54.9	36.7	26	104.8	70.0	86	154.6	103.3	46	204.5	136.7
7	05.8	03.9	67	55.7	37.2	27	105.6	70.5	87	155.5	103.9	47	205.3	137.2
8	06.7	04.4	68	56.5	37.8	28	106.4	71.1	88	156.3	104.4	48	206.2	137.8
9	07.5	05.0	69	57.4	38.3	29	107.2	71.7	89	157.1	105.0	49	207.0	138.3
10	08.3	05.6	70	58.2	38.9	30	108.1	72.2	90	158.0	105.5	50	207.8	138.9
11	09.1	06.1	71	59.0	39.4	131	108.9	72.8	191	158.8	106.1	251	208.7	139.4
12	10.0	06.7	72	59.9	40.0	32	109.7	73.3	92	159.6	106.7	52	209.5	140.0
13	10.8	07.2	73	60.7	40.6	33	110.6	73.9	93	160.4	107.2	53	210.3	140.5
14	11.6	07.8	74	61.5	41.1	34	111.4	74.4	94	161.3	107.8	54	211.2	141.1
15	12.5	08.3	75	62.4	41.7	35	112.2	75.0	95	162.1	108.3	55	212.0	141.7
16	13.3	08.9	76	63.2	42.2	36	113.1	75.5	96	162.9	108.9	56	212.8	142.2
17	14.1	09.4	77	64.0	42.8	37	113.9	76.1	97	163.8	109 4	57	213.7	142.8
18	15.0	10.0	78	64.8	43.3	38	114.7	76.7	98	164.6	110.0	58	214.5	143.3
19	15.8	10.6	79	65.7	43.9	39	115.6	77.2	99	165.4	110.5	59	215.3	143.9
20	16.6	11.1	80	66.5	44.4	40	116.4	77.8	200	166.3	111.1	60	216.1	144.4
21	17.5	11.7	81	67.3	45.0	141	117.2	78.3	201	167.1	111.7	261	217.0	145.0
22	18.3	12.2	82	68.2	45.6	42	118.1	78.9	02	167.9	112.2	62	217.8	145.5
23	19.1	12.8	83	69.0	46.1	43	118.9	79.4	03	168.8	112.8	63	218.6	146.1
24	20.0	13.3	84	69.8	46.7	44	119.7	80.0	04	169.6	113.3	64	219.5	146.7
25	20.8	13.9	85	70.7	47.2	45	120.5	80.5	05	170.4	113.9	65	220.3	147.2
26	21.6	14.4	86	71.5	47.8	46	121.4	81.1	06	171.3	114.4	66	221.1	147.8
27	22.4	15.0	87	72.3	48.3	47	122.2	81.7	07	172.1	115.0	67	222.0	148.3
28	23.3	15.6	88	73.2	48.9	48	123.0	82.2	08	172.9	115.5	68	222.8	148.9
29	24.1	16.1	89	74.0	49.4	49	123.9	82.8	09	173.8	116.1	69	223.6	149.4
30	24.9	16.7	90	74.8	50.0	50	124.7	83.3	10	174.6	116.7	70	224.5	150.0
31	25.8	17.2	91	75.7	50.6	151	125.5	83.9	211	175.4	117.2	271	225.3	150.5
32	26.6	17.8	92	76.5	51.1	52	126.4	84.4	12	176.2	117.8	72	226.1	151.1
33	27.4	18.3	93	77.3	51.7	53	127.2	85.0	13	177.1	118.3	73	227.0	151.7
34	28.3	18.9	94	78.1	52.2	54	128.0	85.5	14	177.9	118.9	74	227.8	152.2
35	29.1	19.4	95	79.0	52.8	55	128.9	86.1	15	178.7	119.4	75	228.6	152.8
36	29.9	20.0	96	79.8	53.3	56	129.7	86.7	16	179.6	120.0	76	229.4	153.3
37	30.8	20.6	97	80.6	53.9	57	130.5	87.2	17	180.4	120.5	77	230.3	153.9
38	31.6	21.1	98	81.5	54.4	58	131.4	87.8	18	181.2	122.1	78	231.1	154.4
39	32.4	21.7	99	82.3	55.0	59	132.2	88.3	19	182.1	121.7	79	231.9	155.0
40	33.3	22.2	100	83.1	55.6	60	133.0	88.9	20	182.9	122.2	80	232.8	155.5
41	34.1	22.8	101	84.0	56.1	161	133.8	89.4	221	183.7	122.8	281	233.6	156.1
42	34.9	23.3	02	84.8	56.7	62	134.7	90.0	22	184.6	123.3	82	234.4	156.7
43	35.8	23.9	03	85.6	57.2	63	135.5	90.5	23	185.4	123.9	83	235.3	157.2
44	36.6	24.4	04	86.5	57.8	64	136.3	91.1	24	186.2	124.4	84	236.1	157.8
45	37.4	25.0	05	87.3	58.3	65	137.2	91.7	25	187.1	125.0	85	236.9	158.3
46	38.2	25.6	06	88.1	58.9	66	138.0	92.2	26	187.9	125.5	86	237.8	158.9
47	39.1	26.1	07	89.0	59.4	67	138.8	92.8	27	188.7	126.1	87	238.6	159.4
48	39.9	26.7	08	89.8	60.0	68	139.7	93.3	28	189.5	126.7	88	239.4	160.0
49	40.7	27.2	09	90.6	60.5	69	140.5	93.9	29	190.4	127.2	89	240.3	160.5
50	41.6	27.8	10	91.4	61.1	70	141.3	94.4	30	191.2	127.8	90	241.1	161.1
51	42.4	28.3	111	92.3	61.7	171	142.2	95 0	231	192.0	128.3	291	241.9	161.7
52	43.2	28.9	12	93.1	62.2	72	143.0	95.5	32	192.9	128.9	92	242.8	162.2
53	44.1	29.4	13	93.9	62.8	73	143.8	96.1	33	193.7	129.4	93	243.6	162.8
54	44.9	30.0	14	94.9	63.3	74	144.7	96.7	34	194.5	130.0	94	244.4	163.3
55	45.7	30.6	15	95.6	63.9	75	145.5	97.2	35	195.4	130.5	95	245.2	163.9
56	46.6	31.1	16	96.4	64.4	76	146.3	97.8	36	196.2	131.1	96	246.1	164.4
57	47.4	31.7	17	97.3	65.0	77	147.1	98.3	37	197.0	131.7	97	246.9	165.0
58	48.2	32.2	18	98.1	65.5	78	148.0	98.9	38	197.9	132.2	98	247.7	165.5
59	49.1	32.8	19	98.9	66.1	79	148.8	99.4	39	198.7	132.8	99	248.5	166.1
60	49.9	33.3	120	99.8	66.7	180	149.6	100.0	140	199.5	133.3	300	249.4	166.7
Dist	Dep	Lat.	Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 5 Points.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.8	00.6	61	49.0	36 3	121	97.2	72.1	181	145.4	107.8	241	193.5	143.6
2	01.6	01.2	62	49.8	36.9	22	98.0	72.7	82	146.2	108.4	42	194.3	144.2
3	02.4	01.8	63	50.6	37.5	23	98.8	73.3	83	147.0	109 0	43	195.1	144.8
4	03.2	02.4	64	51.4	38.1	24	99.6	73.9	84	147.8	109.6	44	195.9	145.4
5	04.0	03.0	65	52.2	38 7	25	100.4	74.5	85	148.6	110.2	45	196.7	146.0
6	04.8	03.6	66	53.0	39.3	26	101.2	75.1	86	149.4	110.8	46	197.5	146.6
7	05.6	04.2	67	53.8	39.9	27	102.0	75.7	87	150.2	111.4	47	198.4	147.1
8	06.4	04.8	68	54.6	40.5	28	102.8	76.3	88	151.0	112.0	48	199.2	147.7
9	07.2	05.4	69	55.4	41.1	29	103.6	76.9	89	151.8	112.6	49	200.0	148.3
10	08.0	06.0	70	56.2	41.7	30	104.4	77.4	90	152.6	113.2	50	200.8	148.9
11	08.8	06.6	71	57.0	42.3	131	105.2	78.0	191	153.4	113.8	251	201.6	149.5
12	09.6	07.1	72	57.8	42.9	32	106.0	78.6	92	154.2	114.4	52	202.4	150.1
13	10.4	07.7	73	58.6	43.5	33	106.8	79.2	93	155.0	115.0	53	203.2	150.7
14	11.2	08.3	74	59.4	44.1	34	107.6	79 8	94	155.8	115.6	54	204.0	151.3
15	12.0	08.9	75	60.2	44.7	35	108.4	80.4	95	156.6	116.2	55	204.8	151.9
16	12.8	09.5	76	61.0	45.3	36	109.2	81.0	96	157.4	116.8	56	205.6	152.5
17	13.7	10.1	77	61.8	45.9	37	110.0	81.6	97	158.2	117.4	57	206.4	153.1
18	14.5	10.7	78	62.6	46.5	38	110.8	82.2	98	159.0	118 0	58	207.2	153.7
19	15.3	11.3	79	63.4	47.1	39	111.6	82.8	99	159.8	118.6	59	208.0	154.3
20	16.1	11.9	80	64.2	47.7	40	112.4	83.4	200	160.6	119.1	60	208.8	154.9
21	16.9	12.5	81	65.0	48.3	141	113.2	84.0	201	161.4	119.7	261	209.6	155.5
22	17.7	13.1	82	65.8	48.9	42	114.0	84.6	02	162.2	120.3	62	210.4	156.1
23	18.5	13.7	83	66.7	49.4	43	114.8	85.2	03	163.0	120.9	63	211.2	156.7
24	19.3	14.3	84	67.5	50.0	44	115.6	85.8	04	163.8	121.5	64	212.0	157.3
25	20.1	14.9	85	68.3	50.6	45	116.4	86.4	05	164.6	122.1	65	212.8	157.9
26	20.9	15.5	86	69.1	51.2	46	117 2	87.0	06	165.4	122.7	66	213.6	158.5
27	21.7	16.1	87	69.9	51.8	47	118.0	87.6	07	166.2	123.3	67	214.4	159.1
28	22.5	16.7	88	70.7	52.4	48	118.8	88.2	08	167.0	123.9	68	215.2	159.7
29	23.3	17.3	89	71.5	53.0	49	119.7	88.8	09	167.8	124.5	69	216.0	160.3
30	24.1	17 9	90	72.3	53.6	50	120.5	89.4	10	168.6	125.1	70	216.8	160.9
31	24.9	18.5	91	73.1	54.2	151	121.3	90.0	211	169.4	125.7	271	217 6	161.4
32	25.7	19.1	92	73.9	54.8	52	122 1	90.6	12	170.2	126.3	72	218.4	162.0
33	26.5	19.7	93	74.7	55.4	53	122.9	91.1	13	171.0	126.9	73	219.2	162.6
34	27.3	20.3	94	75.5	56.0	54	123.7	91.7	14	171.8	127.5	74	220.0	163.2
35	28.1	20.9	95	76.3	56.6	55	124 5	92.3	15	172.7	128.1	75	220.8	163.8
36	28.9	21.4	96	77.1	57.2	56	125.3	92.9	16	173.5	128.7	76	221.6	164.4
37	29.7	22.0	97	77.9	57.8	57	126 1	93.5	17	174.3	129.3	77	222.4	165.0
38	30.5	22.6	98	78.7	58.4	58	126.9	94.1	18	175.1	129 9	78	223.2	165.6
39	31.3	23.2	99	79.5	59.0	59	127.7	94.7	19	175.9	130.5	79	224.0	166.2
40	32.1	23.8	100	80.3	59.6	60	128.5	95.3	20	176.7	131.1	80	224.8	166.8
41	32.9	24.4	101	81.1	60.2	161	129.3	95.9	221	177.5	131.7	281	225.7	167.4
42	33.7	25.0	02	81.9	60.8	62	130.1	96.5	22	178.3	132.3	82	226.5	168.0
43	34.5	25.6	03	82.7	61.4	63	130.9	97.1	23	179.1	132.9	83	227.3	168.6
44	35.3	26.2	04	83.5	62.0	64	131.7	97.7	24	179.9	133.5	84	228.1	169.2
45	36.1	26.8	05	84.3	62.6	65	132.5	98.3	25	180.7	134.0	85	228.9	169.8
46	36.9	27.4	06	85.1	63.1	66	133.3	98.9	26	181.5	134.6	86	229.7	170.4
47	37.7	28.0	07	85.9	63.7	67	134.1	99.5	27	182.3	135.2	87	230.5	171.0
48	38.5	28.6	08	86.7	64.3	68	134.9	100.1	28	183.1	135.8	88	231.3	171.6
49	39.3	29.2	09	87.5	64.9	69	135.7	100.7	29	183.9	136.4	89	232.1	172.2
50	40.2	29.8	10	88.3	65.5	70	136.5	101.3	30	184.7	137.0	90	232.9	172.8
51	41.0	30.4	111	89.1	66.1	171	137.3	101.9	231	185.5	137.6	291	233.7	173.4
52	41.8	31.0	12	89.9	66.7	72	138.1	102.5	32	186.3	138.2	92	234.5	174.0
53	42.6	31.6	13	90.7	67.3	73	138.9	103.1	33	187.1	138.8	93	235.3	174.6
54	43.4	32.2	14	91.5	67.9	74	139.7	103.7	34	187.9	139.4	94	236.1	175.1
55	44.2	32.8	15	92.4	68.5	75	140.5	104.3	35	188.7	140.0	95	236.9	175.7
56	45.0	33.4	16	93.2	69.1	76	141.3	104.9	36	189.5	140.6	96	237.7	176.3
57	45 8	34.0	17	94.0	69.7	77	142.1	105.4	37	190.3	141.2	97	238.5	176.9
58	46.6	34.6	18	94.8	70.3	78	142.9	106.0	38	191.1	141.8	98	239.3	177.5
59	47.4	35.1	19	95.6	70.9	79	143.7	106.6	39	192.1	142.4	99	240.1	178.1
60	48.2	35.7	120	96.4	71.5	180	144.3	107.2	40	192.7	143.0	300	240.9	178.7
Dist	Dep	Lat.	Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

TABLE II. Difference of Latitude and Departure for $3\frac{1}{2}$ Points.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.8	00.6	61	47.1	38.7	121	93.5	76.7	181	139.9	114.8	241	186.2	152.8
2	01.5	01.3	62	47.9	39.3	22	94.3	77.4	82	140.6	115.4	42	187.0	153.5
3	02.3	01.9	63	48.7	40.0	23	95.1	78.0	83	141.4	116.0	43	187.8	154.1
4	03.1	02.5	64	49.5	40.6	24	95.8	78.6	84	142.2	116.6	44	188.6	154.7
5	03.9	03.2	65	50.2	41.2	25	96.6	79.3	85	143.0	117.3	45	189.3	155.4
6	04.6	03.8	66	51.0	41.9	26	97.4	79.9	86	143.7	118.0	46	190.1	156.0
7	05.4	04.4	67	51.8	42.5	27	98.1	80.5	87	144.5	118.6	47	190.9	156.6
8	06.2	05.1	68	52.6	43.1	28	98.9	81.2	88	145.3	119.2	48	191.6	157.3
9	07.0	05.7	69	53.3	43.8	29	99.7	81.8	89	146.1	119.9	49	192.4	157.9
10	07.7	06.3	70	54.1	44.4	30	100.5	82.4	90	146.8	120.5	50	193.2	158.5
11	08.5	07.0	71	54.9	45.0	131	101.2	83.1	191	147.6	121.1	251	194.0	159.2
12	09.3	07.6	72	55.6	45.7	32	102.0	83.7	92	148.4	121.8	52	194.7	159.8
13	10.1	08.2	73	56.4	46.3	33	102.8	84.3	93	149.1	122.4	53	195.5	160.4
14	10.8	08.9	74	57.2	46.9	34	103.6	85.0	54	149.9	123.0	54	196.3	161.1
15	11.6	09.5	75	58.0	47.6	35	104.3	85.6	95	150.7	123.7	55	197.1	161.7
16	12.4	10.1	76	58.7	48.2	36	105.1	86.2	96	151.4	124.3	56	197.8	162.3
17	13.1	10.8	77	59.5	48.8	37	105.9	86.9	97	152.2	124.9	57	198.6	163.0
18	13.9	11.4	78	60.3	49.5	38	106.6	87.5	98	153.0	125.6	58	199.4	163.6
19	14.7	12.0	79	61.1	50.1	39	107.4	88.1	99	153.8	126.2	59	200.1	164.2
20	15.5	12.7	80	61.8	50.7	40	108.2	88.8	200	154.6	126.8	60	200.9	164.9
21	16.2	13.3	81	62.6	51.4	141	109.0	89.4	201	155.3	127.5	261	201.7	165.5
22	17.0	14.0	82	63.4	52.0	42	109.7	90.0	02	156.1	128.1	62	202.4	166.1
23	17.8	14.6	83	64.1	52.6	43	110.5	90.7	03	156.9	128.7	63	203.2	166.8
24	18.5	15.2	84	64.9	53.3	44	111.3	91.3	04	157.6	129.4	64	204.0	167.4
25	19.3	15.9	85	65.7	53.9	45	112.1	92.0	05	158.4	130.0	65	204.8	168.0
26	20.1	16.5	86	66.5	54.5	46	112.8	92.6	06	159.2	130.6	66	205.6	168.7
27	20.9	17.1	87	67.2	55.2	47	113.6	93.2	07	160.0	131.3	67	206.3	169.3
28	21.6	17.8	88	68.0	55.8	48	114.4	93.9	08	160.7	131.9	68	207.1	170.0
29	22.4	18.4	89	68.8	56.4	49	115.1	94.5	09	161.5	132.5	69	207.9	170.6
30	23.2	19.0	90	69.6	57.1	50	115.9	95.1	10	162.3	133.2	70	208.6	171.2
31	24.0	19.7	91	70.3	57.7	151	116.7	95.8	211	163.1	133.8	271	209.4	171.9
32	24.7	20.3	92	71.1	58.3	52	117.5	96.4	12	163.8	134.4	72	210.2	172.5
33	25.5	20.9	93	71.9	59.0	53	118.2	97.0	13	164.6	135.1	73	211.0	173.1
34	26.3	21.6	94	72.6	59.6	54	119.0	97.7	14	165.4	135.7	74	211.7	173.8
35	27.1	22.2	95	73.4	60.2	55	119.8	98.3	15	166.1	136.3	75	212.5	174.4
36	27.8	22.8	96	74.2	60.9	56	120.6	98.9	16	166.9	137.0	76	213.3	175.0
37	28.6	23.5	97	75.0	61.5	57	121.3	99.6	17	167.7	137.6	77	214.1	175.7
38	29.4	24.1	98	75.7	62.1	58	122.1	100.2	18	168.5	138.2	78	214.8	176.3
39	30.1	24.7	99	76.5	62.8	59	122.9	100.8	19	169.2	138.9	79	215.6	176.9
40	30.9	25.4	100	77.2	63.4	60	123.6	101.5	20	170.0	139.5	80	216.4	177.6
41	31.7	26.0	101	78.0	64.0	161	124.4	102.1	221	170.8	140.1	281	217.1	178.2
42	32.5	26.6	02	78.8	64.7	62	125.2	102.7	22	171.6	140.8	82	217.9	178.8
43	33.2	27.3	03	79.6	65.3	63	126.0	103.4	23	172.3	141.4	83	218.7	179.5
44	34.0	27.9	04	80.4	66.0	64	126.7	104.0	24	173.1	142.0	84	219.5	180.1
45	34.8	28.5	05	81.1	66.6	65	127.5	104.6	25	173.9	142.7	85	220.2	180.7
46	35.6	29.2	06	81.9	67.2	66	128.3	105.3	26	174.6	143.3	86	221.0	181.4
47	36.3	29.8	07	82.7	67.9	67	129.1	105.9	27	175.4	144.0	87	221.8	182.0
48	37.1	30.4	08	83.5	68.5	68	129.8	106.5	28	176.2	144.6	88	222.6	182.6
49	37.9	31.1	09	84.2	69.1	69	130.6	107.2	29	177.0	145.2	89	223.3	183.3
50	38.6	31.7	110	85.0	69.8	70	131.4	107.8	30	177.7	145.9	90	224.1	183.9
51	39.4	32.3	111	85.8	70.4	171	132.1	108.4	231	178.5	146.5	291	224.9	184.5
52	40.2	33.0	12	86.6	71.0	72	132.9	109.1	32	179.3	147.2	92	225.6	185.2
53	41.0	33.6	13	87.3	71.7	73	133.7	109.7	33	180.1	147.8	93	226.4	185.8
54	41.7	34.2	14	88.1	72.3	74	134.5	110.3	34	180.8	148.4	94	227.2	186.4
55	42.5	34.9	15	88.9	72.9	75	135.2	111.0	35	181.6	149.0	95	228.0	187.1
56	43.3	35.5	16	89.6	73.6	76	136.0	111.6	36	182.4	149.7	96	228.7	187.7
57	44.1	36.1	17	90.4	74.2	77	136.8	112.2	37	183.1	150.3	97	229.5	188.3
58	44.8	36.8	18	91.2	74.8	78	137.6	112.9	38	183.9	150.9	98	230.3	189.0
59	45.6	37.4	19	92.0	75.5	79	138.3	113.5	39	184.7	151.6	99	231.1	189.6
60	46.4	38.0	120	92.7	76.1	80	139.1	114.1	240	185.5	152.2	300	231.8	190.2
Dist	Dep.	Lat.	Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for $4\frac{1}{2}$ Points.

Table II. Difference of Latitude and Departure for 3 3/4 Points.

Dist	Lat	Dep	Dist	Lat	Dep	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.7	00.7	61	45.2	41.0	121	89.6	81.2	181	134.1	121.5	241	178.5	161.8
2	01.5	01.3	62	45.9	41.6	22	90.4	81.9	82	134.8	122.2	42	179.3	162.5
3	02.2	02.0	63	46.7	42.3	23	91.1	82.6	83	135.6	122.9	43	180.0	163.2
4	03.0	02.7	64	47.4	43.0	24	91.9	83.3	84	136.3	123.5	44	180.7	163.8
5	03.7	03.4	65	48.2	43.6	25	92.6	83.9	85	137.0	124.2	45	181.5	164.5
6	04.4	04.0	66	48.9	44.3	26	93.3	84.6	86	137.8	124.9	46	182.2	165.2
7	05.2	04.7	67	49.6	45.0	27	94.1	85.3	87	138.5	125.6	47	183.0	165.8
8	05.9	05.4	68	50.4	45.7	28	94.8	85.9	88	139.3	126.2	48	183.7	166.5
9	06.7	06.0	69	51.1	46.3	29	95.6	86.6	89	140.0	126.9	49	184.4	167.2
10	07.4	06.7	70	51.9	47.0	30	96.3	87.3	90	140.7	127.6	50	185.2	167.9
11	08.2	07.4	71	52.6	47.7	131	97.0	88.0	191	141.5	128.2	251	185.9	168 5
12	08.9	08.1	72	53.3	48.3	32	97.8	88.6	92	142.2	128.9	52	186.7	169.2
13	09.6	08.7	73	54.1	49.0	33	98.5	89.3	93	143.0	129.6	53	187.4	169.9
14	10.4	09.4	74	54.8	49.7	34	99.3	90.0	94	143.7	130.3	54	188.2	170.5
15	11.1	10.1	75	55.6	50.4	35	100.0	90.6	95	144.4	130.9	55	188.9	171.2
16	11.9	10.7	76	56.3	51.0	36	100.7	91.3	96	145.2	131.6	56	189.6	171.9
17	12.6	11.4	77	57.0	51.7	37	101.5	92.0	97	145.9	132.3	57	190.4	172.6
18	13.3	12.1	78	57.8	52.4	38	102.2	92.7	98	146.7	132.9	58	191.1	173.2
19	14.1	12.8	79	58.5	53.0	39	103.0	93.3	99	147.4	133.6	59	191.9	173.9
20	14.8	13.4	80	59.3	53.7	40	103.7	94.0	200	148.2	134.3	60	192.6	174.6
21	15.6	14.1	81	60.0	54.4	141	104.4	94.7	201	148.9	135.0	261	193.3	175.2
22	16.3	14.8	82	60.7	55.1	42	105.2	95.3	02	149.6	135.6	62	194.1	175.9
23	17.0	15.4	83	61.5	55.8	43	105.9	96.0	03	150.4	136.3	63	194.8	176.6
24	17.8	16.1	84	62.2	56.4	44	106.7	96.7	04	151.1	137.0	64	195.6	177.3
25	18.5	16.8	85	63.0	57.1	45	107.4	97.4	05	151.9	137.6	65	196.3	177.9
26	19.3	17.5	86	63.7	57.7	46	108.2	98.0	06	152.6	138.3	66	197.0	178.6
27	20.0	18.1	87	64.4	58.4	47	108.9	98.7	07	153.3	139.0	67	197.8	179.3
28	20.7	18.8	88	65.2	59.1	48	109.6	99.4	08	154.1	139.7	68	198.5	179.9
29	21.5	19.5	89	65.9	59.8	49	110.4	100.0	09	154.8	140.3	69	199.3	180.6
30	22.2	20.1	90	66.7	60.4	50	111.1	100.7	10	155.6	141.0	70	200.0	181.3
31	23.0	20.8	91	67.4	61.1	151	111.9	101.4	211	156.3	141.7	271	200.7	182.0
32	23.7	21.5	92	68.2	61.8	52	112.6	102.1	12	157.0	142.3	72	201.5	182.6
33	24.4	22.2	93	68.9	62.4	53	113.3	102.7	13	157.8	143.0	73	202.2	183.3
34	25.2	22.8	94	69.6	63.1	54	114.1	103.4	14	158.5	143.7	74	203.0	184.0
35	25.9	23.5	95	70.4	63.8	55	114.8	104.1	15	159.3	144.4	75	203.7	184.6
36	26.7	24.2	96	71.1	64.5	56	115.6	104.7	16	160.0	145.0	76	204.4	185.3
37	27.4	24.8	97	71.9	65.1	57	116.3	105.4	17	160.7	145.7	77	205.2	186.0
38	28.2	25.5	98	72.6	65.8	58	117.0	106.1	18	161.5	146.4	78	205.9	186.7
39	28.9	26.2	99	73.3	66.5	59	117.8	106.8	19	162.2	147.0	79	206.7	187.3
40	29.6	26.9	100	74.1	67.1	60	118.5	107.4	20	163.0	147.7	80	207.4	188.0
41	30.4	27.5	101	74.8	67.8	161	119.3	108.1	221	163.7	148.4	281	208.2	188.7
42	31.1	28.2	02	75.6	68.5	62	120.0	108.8	22	164.4	149.1	82	208.9	189.3
43	31.9	28.9	03	76.3	69.2	63	120.7	109.4	23	165.2	149.7	83	209.6	190.0
44	32.6	29.5	04	77.0	69.8	64	121.5	110.1	24	165.9	150.4	84	210.4	190.7
45	33.3	30.2	05	77.8	70.5	65	122.2	110.8	25	166.7	151.1	85	211.1	191.4
46	34.1	30.9	06	78.5	71.2	66	123.0	111.5	26	167.4	151.7	86	211.9	192.0
47	34.8	31.6	07	79.3	71.8	67	123.7	112.1	27	168.2	152.4	87	212.6	192.7
48	35.6	32.2	08	80.0	72.5	68	124.4	112.8	28	168.9	153.1	88	213.3	193.4
49	36.3	32.9	09	80.7	73.2	69	125.2	113.5	29	169.6	153.8	89	214.1	194.0
50	37.0	33.6	10	81.5	73.9	70	125.9	114.1	30	170.4	154.5	90	214.8	194.7
51	37.8	34.2	111	82.2	74.5	171	126.7	114.8	231	171.1	155.1	291	215.6	195.4
52	38.5	34.9	12	83.0	75.2	72	127.4	115.5	32	171.9	155.8	92	216.3	196.1
53	39.3	35.6	13	83.7	75.9	73	128.2	116.2	33	172 6	156.4	93	217.0	196.7
54	40.0	36.3	14	84.4	76.5	74	128.9	116.8	34	173.3	157.1	94	217.8	197.4
55	40.7	36.9	15	85.2	77.2	75	129.6	117.5	35	174.1	157.8	95	218.5	198.1
56	41.5	37.6	16	85.9	77.9	76	130.4	118.2	36	174.8	158.5	96	219.3	198.7
57	42.2	38.3	17	86.7	78.6	77	131.1	118.8	37	175.6	159.1	97	220.0	199.9
58	43.0	38.9	18	87.5	79.2	78	131.9	119.5	38	176.3	159.8	98	220.7	200.1
59	43.7	39.6	19	88.2	79.9	79	132.6	120.2	39	177.0	160.5	99	221.5	200.8
60	44.5	40.3	120	88.9	80.6	180	133.3	120.9	140	177.8	161.1	300	222.2	201.4
Dist	Dep	Lat	Dist	Dep	Lat	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 4 1/4 Points.

Table II. Difference of Latitude and Departure for 4 Points.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.7	00.7	61	43.1	43.1	121	85.6	85.6	181	128.0	128.0	241	170.4	170.4
2	01.4	01.4	62	43.8	43.8	22	86.3	86.3	82	128.7	128.7	42	171.1	171.1
3	02.1	02.1	63	44.5	44.5	23	87.0	87.0	83	129.4	129.4	43	171.8	171.8
4	02.8	02.8	64	45.3	45.3	24	87.7	87.7	84	130.1	130.1	44	172.5	172.5
5	03.5	03.5	65	46.0	46.0	25	88.4	88.4	85	130.8	130.8	45	173.2	173.2
6	04.2	04.2	66	46.7	46.7	26	89.1	89.1	86	131.5	131.5	46	173.9	173.9
7	04.9	04.9	67	47.4	47.4	27	89.8	89.8	87	132.2	132.2	47	174.6	174.6
8	05.7	05.7	68	48.1	48.1	28	90.5	90.5	88	132.9	132.9	48	175.4	175.4
9	06.4	06.4	69	48.8	48.8	29	91.2	91.2	89	133.6	133.6	49	176.1	176.1
10	07.1	07.1	70	49.5	49.5	30	91.9	91.9	90	134.3	134.3	50	176.8	176.8
11	07.8	07.8	71	50.2	50.2	131	92.6	92.6	91	135.1	135.1	251	177.5	177.5
12	08.5	08.5	72	50.9	50.9	32	93.3	93.3	92	135.8	135.8	52	178.2	178.2
13	09.2	09.2	73	51.6	51.6	33	94.0	94.0	93	136.5	136.5	53	178.9	178.9
14	09.9	09.9	74	52.3	52.3	34	94.7	94.7	94	137.2	137.2	54	179.6	179.6
15	10.6	10.6	75	53.0	53.0	35	95.5	95.5	95	137.9	137.9	55	180.3	180.3
16	11.3	11.3	76	53.7	53.7	36	96.2	96.2	96	138.6	138.6	56	181.0	181.0
17	12.0	12.0	77	54.4	54.4	37	96.9	96.9	97	139.3	139.3	57	181.7	181.7
18	12.7	12.7	78	55.2	55.2	38	97.6	97.6	98	140.0	140.0	58	182.4	182.4
19	13.4	13.4	79	55.9	55.9	39	98.3	98.3	99	140.7	140.7	59	183.1	183.1
20	14.1	14.1	80	56.6	56.6	40	99.0	99.0	200	141.4	141.4	60	183.8	183.8
21	14.8	14.8	81	57.3	57.3	141	99.7	99.7	201	142.1	142.1	261	184.5	184.5
22	15.6	15.6	82	58.0	58.0	42	100.4	100.4	02	142.8	142.8	62	185.3	185.3
23	16.3	16.3	83	58.7	58.7	43	101.1	101.1	03	143.5	143.5	63	186.0	186.0
24	17.0	17.0	84	59.4	59.4	44	101.8	101.8	04	144.2	144.2	64	186.7	186.7
25	17.7	17.7	85	60.1	60.1	45	102.5	102.5	05	144.9	144.9	65	187.4	187.4
26	18.4	18.4	86	60.8	60.8	46	103.2	103.2	06	145.7	145.7	66	188.1	188.1
27	19.1	19.1	87	61.5	61.5	47	103.9	103.9	07	146.4	146.4	67	188.8	188.8
28	19.8	19.8	88	62.2	62.2	48	104.6	104.6	08	147.1	147.1	68	189.5	189.5
29	20.5	20.5	89	62.9	62.9	49	105.4	105.4	09	147.8	147.8	69	190.2	190.2
30	21.2	21.2	90	63.6	63.6	50	106.1	106.1	10	148.5	148.5	70	190.9	190.9
31	21.9	21.9	91	64.3	64.3	151	106.8	106.8	211	149.2	149.2	271	191.6	191.6
32	22.6	22.6	92	65.1	65.1	52	107.5	107.5	12	149.9	149.9	72	192.3	192.3
33	23.3	23.3	93	65.8	65.8	53	108.2	108.2	13	150.6	150.6	73	193.0	193.0
34	24.0	24.0	94	66.5	66.5	54	108.9	108.9	14	151.3	151.3	74	193.7	193.7
35	24.7	24.7	95	67.2	67.2	55	109.6	109.6	15	152.0	152.0	75	194.4	194.4
36	25.5	25.5	96	67.9	67.9	56	110.3	110.3	16	152.7	152.7	76	195.2	195.2
37	26.2	26.2	97	68.6	68.6	57	111.0	111.0	17	153.4	153.4	77	195.9	195.9
38	26.9	26.9	98	69.3	69.3	58	111.7	111.7	18	154.1	154.1	78	196.6	196.6
39	27.6	27.6	99	70.0	70.0	59	112.4	112.4	19	154.8	154.8	79	197.3	197.3
40	28.3	28.3	100	70.7	70.7	60	113.1	113.1	20	155.6	155.6	80	198.0	198.0
41	29.0	29.0	101	71.4	71.4	161	113.8	113.8	221	156.3	156.3	281	198.7	198.7
42	29.7	29.7	02	72.1	72.1	62	114.5	114.5	22	157.0	157.0	82	199.4	199.4
43	30.4	30.4	03	72.8	72.8	63	115.3	115.3	23	157.7	157.7	83	200.1	200.1
44	31.1	31.1	04	73.5	73.5	64	116.0	116.0	24	158.4	158.4	84	200.8	200.8
45	31.8	31.8	05	74.2	74.2	65	116.7	116.7	25	159.1	159.1	85	201.5	201.5
46	32.5	32.5	06	74.9	74.9	66	117.4	117.4	26	159.8	159.8	86	202.2	202.2
47	33.2	33.2	07	75.7	75.7	67	118.1	118.1	27	160.5	160.5	87	202.9	202.9
48	33.9	33.9	08	76.4	76.4	68	118.8	118.8	28	161.2	161.2	88	203.6	203.6
49	34.6	34.6	09	77.1	77.1	69	119.5	119.5	29	161.9	161.9	89	204.3	204.3
50	35.4	35.4	10	77.8	77.8	70	120.2	120.2	30	162.6	162.6	90	205.1	205.1
51	36.1	36.1	111	78.5	78.5	171	120.9	120.9	231	163.3	163.3	291	205.8	205.8
52	36.8	36.8	12	79.2	79.2	72	121.6	121.6	32	164.0	164.0	92	206.5	206.5
53	37.5	37.5	13	79.9	79.9	73	122.3	122.3	33	164.7	164.7	93	207.2	207.2
54	38.2	38.2	14	80.6	80.6	74	123.0	123.0	34	165.5	165.5	94	207.9	207.9
55	38.9	38.9	15	81.3	81.3	75	123.7	123.7	35	166.2	166.2	95	208.6	208.6
56	39.6	39.6	16	82.0	82.0	76	124.4	124.4	36	166.9	166.9	96	209.3	209.3
57	40.3	40.3	17	82.7	82.7	77	125.2	125.2	37	167.6	167.6	97	210.0	210.0
58	41.0	41.0	18	83.4	83.4	78	125.9	125.9	38	168.3	168.3	98	210.7	210.7
59	41.7	41.7	19	84.1	84.1	79	126.6	126.6	39	169.0	169.0	99	211.4	211.4
60	42.4	42.4	120	84.8	84.8	180	127.3	127.3	40	169.7	169.7	300	212.1	212.1
Dist	Dep	Lat.	Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 4 Points

TABLE III. Difference of Latitude and Departure for 1 Degree.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep
1	01.0	00.0	61	61.0	01.1	121	121.0	02.1	181	181.0	03.1	241	241.0	04.1
2	02.0	00.0	62	62.0	01.1	22	122.0	02.1	82	182.0	03.1	42	242.0	04.2
3	03.0	00.1	63	63.0	01.1	23	123.0	02.1	83	183.0	03.2	43	243.0	04.2
4	04.0	00.1	64	64.0	01.1	24	124.0	02.2	84	184.0	03.2	44	244.0	04.2
5	05.0	00.1	65	65.0	01.1	25	125.0	02.2	85	185.0	03.2	45	245.0	04.2
6	06.0	00.1	66	66.0	01.2	26	126.0	02.2	86	186.0	03.2	46	246.0	04.2
7	07.0	00.1	67	67.0	01.2	27	127.0	02.2	87	187.0	03.2	47	247.0	04.2
8	08.0	00.1	68	68.0	01.2	28	128.0	02.2	88	188.0	03.2	48	248.0	04.3
9	09.0	00.2	69	69.0	01.2	29	129.0	02.2	89	189.0	03.3	49	249.0	04.3
10	10.0	00.2	70	70.0	01.2	30	130.0	02.3	90	190.0	03.3	50	250.0	04.3
11	11.0	00.2	71	71.0	01.2	131	131.0	02.3	191	191.0	03.3	251	251.0	04.3
12	12.0	00.2	72	72.0	01.3	32	132.0	02.3	92	192.	03.3	52	252.0	04.3
13	13.0	00.2	73	73.0	01.3	33	133.0	02.3	93	193.0	03.3	53	253.0	04.3
14	14.0	00.2	74	74.0	01.3	34	134.0	02.3	94	194.0	03.3	54	254.0	04.4
15	15.0	00.3	75	75.0	01.3	35	135.0	02.3	95	195.0	03.4	55	255.0	04.4
16	16.0	00.3	76	76.0	01.3	36	136.0	02.4	96	196.0	03.4	56	256.0	04.4
17	17.0	00.3	77	77.0	01.3	37	137.0	02.4	97	197.0	03.4	57	257.0	04.4
18	18.0	00.3	78	78.0	01.4	38	138.0	02.4	98	198.0	03.4	58	258.0	04.4
19	19.0	00.3	79	79.0	01.4	39	139.0	02.4	99	199.0	03.4	59	259.0	04.4
20	20.0	00.4	80	80.0	01.4	40	140.0	02.4	200	200.0	03.4	60	260.0	04.5
21	21.0	00.4	81	81.0	01.4	141	141.0	02.4	201	201.0	03.5	261	261.0	04.5
22	22.0	00.4	82	82.0	01.4	42	142.0	02.5	02	202.0	03.5	62	262.0	04.5
23	23.0	00.4	83	83.0	01.5	43	143.0	02.5	03	203.0	03.5	63	263.0	04.5
24	24.0	00.4	84	84.0	01.5	44	144.0	02.5	04	204.0	03.5	64	264.0	04.5
25	25.0	00.4	85	85.0	01.5	45	145.0	02.5	05	205.0	03.5	65	265.0	04.6
26	26.0	00.5	86	86.0	01.5	46	146.0	02.5	06	206.0	03.5	66	266.0	04.6
27	27.0	00.5	87	87.0	01.5	47	147.0	02.5	07	207.0	03.6	67	267.0	04.6
28	28.0	00.5	88	88.0	01.5	48	148.0	02.6	08	208.0	03.6	68	268.0	04.6
29	29.0	00.5	89	89.0	01.6	49	149.0	02.6	09	209.0	03.6	69	269.0	04.6
30	30.0	00.5	90	90.0	01.6	50	150.0	02.6	10	210.0	03.6	70	270.0	04.6
31	31.0	00.5	91	91.0	01.6	151	151.0	02.6	211	211.0	03.6	271	271.0	04.7
32	32.0	00.6	92	92.0	01.6	52	152.0	02.6	12	212.0	03.6	72	272.0	04.7
33	33.0	00.6	93	93.0	01.6	53	153.0	02.6	13	213.0	03.7	73	273.0	04.7
34	34.0	00.6	94	94.0	01.6	54	154.0	02.7	14	214.0	03.7	74	274.0	04.7
35	35.0	00.6	95	95.0	01.7	55	155.0	02.7	15	215.0	03.7	75	275.0	04.7
36	36.0	00.6	96	96.0	01.7	56	156.0	02.7	16	216.0	03.7	76	276.0	04.7
37	37.0	00.6	97	97.0	01.7	57	157.0	02.7	17	217.0	03.7	77	277.0	04.8
38	38.0	00.7	98	98.0	01.7	58	158.0	02.7	18	218.0	03.8	78	278.0	04.8
39	39.0	00.7	99	99.0	01.7	59	159.0	02.7	19	219.0	03.8	79	179.0	04.8
40	40.0	00.7	100	100.0	01.7	60	160.0	02.8	20	220.0	03.8	80	280.0	04.8
41	41.0	00.7	101	101.0	01.8	161	161.0	02.8	221	221.0	03.8	281	281.0	04.8
42	42.0	00.7	02	102.0	01.8	62	162.0	02.8	22	222.0	03.8	82	282.0	04.8
43	43.0	00.8	03	103.0	01.8	63	163.0	02.8	23	223.0	03.8	83	283.0	04.9
44	44.0	00.8	04	104.0	01.8	64	164.0	02.8	24	224.0	03.9	84	284.0	04.9
45	45.0	00.8	05	105.0	01.8	65	165.0	02.9	25	225.0	03.9	85	285.0	04.9
46	46.0	00.8	06	106.0	01.8	66	166.0	02.9	26	226.0	03.9	86	286.0	04.9
47	47.0	00.8	07	107.0	01.9	67	167.0	02.9	27	227.0	03.9	87	287.0	04.9
48	48.0	00.8	08	108.0	01.9	68	168.0	02.9	28	228.0	03.9	88	288.0	04.9
49	49.0	00.9	09	109.0	01.9	69	169.0	02.9	29	229.0	03.9	89	289.0	05.0
50	50.0	00.9	10	110.0	01.9	70	170.0	02.9	30	230.0	04.0	90	290.0	05.0
51	51.0	00.9	111	111.0	01.9	171	171.0	03.0	231	231.0	04.0	291	291.0	05.0
52	52.0	00.9	12	112.0	01.9	72	172.0	03.0	32	232.0	04.0	92	292.0	05.0
53	53.0	00.9	13	113.0	02.0	73	173.0	03.0	33	233.0	04.0	93	293.0	05.0
54	54.0	00.9	14	114.0	02.0	74	174.0	03.0	34	234.0	04.0	94	294.0	05.0
55	55.0	01.0	15	115.0	02.0	75	175.0	03.0	35	235.0	04.0	95	295.0	05.1
56	56.0	01.0	16	116.0	02.0	76	176.0	03.0	36	236.0	04.1	96	296.0	05.1
57	57.0	01.0	17	117.0	02.0	77	177.0	03.1	37	237.0	04.1	97	297.0	05.1
58	58.0	01.0	18	118.0	02.1	78	178.0	03.1	38	238.0	04.1	98	298.0	05.1
59	59.0	01.0	19	119.0	02.1	79	179.0	03.1	39	239.0	04.1	99	299.0	05.1
60	60.0	01.1	120	120.0	02.1	180	180.0	03.1	240	240.0	04.1	300	300.0	05.1
Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 89 Degrees.

Table III. Difference of Latitude and Departure for 2 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep
1	01.0	00.0	61	61.0	02.1	121	120.9	04.2	181	180.9	06.3	241	240.9	08.4
2	02.0	00.1	62	62.0	02.2	22	121.9	04.3	82	181.9	06.4	42	241.9	08.5
3	03.0	00.1	63	63.0	02.2	23	122.9	04.3	83	182.9	06.4	43	242.9	08.5
4	04.0	00.1	64	64.0	02.2	24	123.9	04.3	84	183.9	06.4	44	243.9	08.5
5	05.0	00.2	65	65.0	02.3	25	124.9	04.4	85	184.9	06.5	45	244.9	08.6
6	06.0	00.2	66	66.0	02.3	26	125.9	04.4	86	185.9	06.5	46	245.9	08.6
7	07.0	00.2	67	67.0	02.3	27	126.9	04.4	87	186.9	06.5	47	246.9	08.6
8	08.0	00.3	68	68.0	02.4	28	127.9	04.5	88	187.9	06.6	48	247.9	08.7
9	09.0	00.3	69	69.0	02.4	29	128.9	04.5	89	188.9	06.6	49	248.9	08.7
10	10.0	00.3	70	70.0	02.4	30	129.9	04.6	90	189.9	06.7	50	249.9	08.8
11	11.0	00.4	71	71.0	02.5	131	130.9	04.6	191	190.9	06.7	251	250.8	08.8
12	12.0	00.4	72	72.0	02.5	32	131.9	04.6	92	191.9	06.7	52	251.8	08.8
13	13.0	00.5	73	73.0	02.5	33	132.9	04.7	93	192.9	06.8	53	252.8	08.9
14	14.0	00.5	74	74.0	02.6	34	133.9	04.7	94	193.9	06.8	54	253.8	08.9
15	15.0	00.5	75	75.0	02.6	35	134.9	04.7	95	194.9	06.8	55	254.8	08.9
16	16.0	00.6	76	76.0	02.7	36	135.9	04.8	96	195.9	06.9	56	255.8	09.0
17	17.0	00.6	77	77.0	02.7	37	136.9	04.8	97	196.9	06.9	57	256.8	09.0
18	18.0	00.6	78	78.0	02.7	38	137.9	04.8	98	197.9	06.9	58	257.8	09.0
19	19.0	00.7	79	79.0	02.8	39	138.9	04.9	99	198.9	07.0	59	258.8	09.1
20	20.0	00.7	80	80.0	02.8	40	139.9	04.9	200	199.9	07.0	60	259.8	09.1
21	21.0	00.7	81	81.0	02.8	141	140.9	04.9	201	200.9	07.0	261	260.8	09.1
22	22.0	00.8	82	81.9	02.9	42	141.9	05.0	02	201.9	07.1	62	261.8	09.2
23	23.0	00.8	83	82.9	02.9	43	142.9	05.0	03	202.9	07.1	63	262.8	09.2
24	24.0	00.8	84	83.9	02.9	44	143.9	05.0	04	203.9	07.1	64	263.8	09.2
25	25.0	00.9	85	84.9	03.0	45	144.9	05.1	05	204.9	07.2	65	264.8	09.3
26	26.0	00.9	86	85.9	03.0	46	145.9	05.1	06	205.9	07.2	66	265.8	09.3
27	27.0	00.9	87	86.9	03.0	47	146.9	05.1	07	206.9	07.2	67	266.8	09.3
28	28.0	01.0	88	87.9	03.1	48	147.9	05.2	08	207.9	07.3	68	267.8	09.4
29	29.0	01.0	89	88.9	03.1	49	148.9	05.2	09	208.9	07.3	69	268.8	09.4
30	30.0	01.1	90	89.9	03.1	50	149.9	05.3	10	209.9	07.4	70	269.8	09.5
31	31.0	01.1	91	90.9	03.2	151	150.9	05.3	211	210.9	07.4	271	270.8	09.5
32	32.0	01.1	92	91.9	03.2	52	151.9	05.3	12	211.9	07.4	72	271.8	09.5
33	33.0	01.2	93	92.9	03.2	53	152.9	05.4	13	212.9	07.5	73	272.8	09.6
34	34.0	01.2	94	93.9	03.3	54	153.9	05.4	14	213.9	07.5	74	273.8	09.6
35	35.0	01.2	95	94.9	03.3	55	154.9	05.4	15	214.9	07.5	75	274.8	09.6
36	36.0	01.3	96	95.9	03.4	56	155.9	05.5	16	215.9	07.6	76	275.8	09.7
37	37.0	01.3	97	96.9	03.4	57	156.9	05.5	17	216.9	07.6	77	276.8	09.7
38	38.0	01.3	98	97.9	03.4	58	157.9	05.5	18	217.9	07.6	78	277.8	09.7
39	39.0	01.4	99	98.9	03.5	59	158.9	05.6	19	218.9	07.7	79	278.8	09.8
40	40.0	01.4	100	99.9	03.5	60	159.9	05.6	20	219.9	07.7	80	279.8	09.8
41	41.0	01.4	101	100.9	03.5	161	160.9	05.6	221	220.9	07.7	281	280.8	09.8
42	42.0	01.5	02	101.9	03.6	62	161.9	05.7	22	221.9	07.8	82	281.8	09.9
43	43.0	01.5	03	102.9	03.6	63	162.9	05.7	23	222.9	07.8	83	282.8	09.9
44	44.0	01.5	04	103.9	03.6	64	163.9	05.7	24	223.9	07.8	84	283.8	09.9
45	45.0	01.6	05	104.9	03.7	65	164.9	05.8	25	224.9	07.9	85	284.8	10.0
46	46.0	01.6	06	105.9	03.7	66	165.9	05.8	26	225.9	07.9	86	285.8	10.0
47	47.0	01.6	07	106.9	03.7	67	166.9	05.8	27	226.9	07.9	87	286.8	10.0
48	48.0	01.7	08	107.9	03.8	68	167.9	05.9	28	227.9	08.0	88	287.8	10.1
49	49.0	01.7	09	108.9	03.8	69	168.9	05.9	29	228.9	08.0	89	288.8	10.1
50	50.0	01.7	10	109.9	03.8	70	169.9	06.0	30	229.9	08.1	90	289.8	10.2
51	51.0	01.8	111	110.9	03.9	171	170.9	06.0	231	230.9	08.1	291	290.8	10.2
52	52.0	01.8	12	111.9	03.9	72	171.9	06.0	32	231.9	08.1	92	291.8	10.2
53	53.0	01.8	13	112.9	04.0	73	172.9	06.1	33	232.9	08.2	93	292.8	10.3
54	54.0	01.9	14	113.9	04.0	74	173.9	06.1	34	233.9	08.2	94	293.8	10.3
55	55.0	01.9	15	114.9	04.0	75	174.9	06.1	35	234.9	08.2	95	294.8	10.3
56	56.0	02.0	16	115.9	04.1	76	175.9	06.2	36	235.9	08.3	96	295.8	10.4
57	57.0	02.0	17	116.9	04.1	77	176.9	06.2	37	236.9	08.3	97	296.8	10.4
58	58.0	02.0	18	117.9	04.1	78	177.9	06.2	38	237.9	08.3	98	297.8	10.4
59	59.0	02.1	19	118.9	04.2	79	178.9	06.3	39	238.9	08.4	99	298.8	10.5
60	60.0	02.1	120	119.9	04.2	180	179.9	06.3	40	239.9	08.4	300	299.8	10.5
Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 88 Degrees.

Table III. Difference of Latitude and Departure for 3 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep
1	01.0	00.1	61	60.9	03.2	121	120.8	06.3	181	180.7	09.5	241	240.7	12.6
2	02.0	00.1	62	61.9	03.2	22	121.8	06.4	82	181.7	09.5	42	241.7	12.7
3	03.0	00.2	63	62.9	03.3	23	122.8	06.4	83	182.7	09.6	43	242.7	12.7
4	04.0	00.2	64	63.9	03.3	24	123.8	06.5	84	183.7	09.6	44	243.7	12.8
5	05.0	00.3	65	64.9	03.4	25	124.8	06.5	85	184.7	09.7	45	244.7	12.8
6	06.0	00.3	66	65.9	03.5	26	125.8	06.6	86	185.7	09.7	46	245.7	12.9
7	07.0	00.4	67	66.9	03.5	27	126.8	06.6	87	186.7	09.8	47	246.7	12.9
8	08.0	00.4	68	67.9	03.6	28	127.8	06.7	88	187.7	09.8	48	247.7	13.0
9	09.0	00.5	69	68.9	03.6	29	128.8	06.8	89	188.7	09.9	49	248.7	13.0
10	10.1	00.5	70	69.9	03.7	30	129.8	06.8	90	189.7	09.9	50	249.7	13.1
11	11.0	00.6	71	70.9	03.7	131	130.8	06.9	191	190.7	10.0	251	250.6	13.1
12	12.0	00.6	72	71.9	03.8	32	131.8	06.9	92	191.7	10.0	52	251.6	13.2
13	13.0	00.7	73	72.9	03.8	33	132.8	07.0	93	192.7	10.1	53	252.6	13.2
14	14.0	00.7	74	73.9	03.9	34	133.8	07.0	94	193.7	10.1	54	253.6	13.3
15	15.0	00.8	75	74.9	03.9	35	134.8	07.1	95	194.7	10.2	55	254.6	13.3
16	16.0	00.8	76	75.9	04.0	36	135.8	07.1	96	195.7	10.3	56	255.6	13.4
17	17.0	00.9	77	76.9	04.0	37	136.8	07.2	97	196.7	10.3	57	256.6	13.4
18	18.0	00.9	78	77.9	04.1	38	137.8	07.2	98	197.7	10.4	58	257.6	13.5
19	19.0	01.0	79	78.9	04.1	39	138.8	07.3	99	198.7	10.4	59	258.6	13.6
20	20.0	01.0	80	79.9	04.2	40	139.8	07.3	200	199.7	10.5	60	259.6	13.6
21	21.0	01.1	81	80.9	04.2	141	140.8	07.4	201	200.7	10.5	261	260.6	13.7
22	22.0	01.1	82	81.9	04.3	42	141.8	07.4	02	201.7	10.6	62	261.6	13.7
23	23.0	01.2	83	82.9	04.3	43	142.8	07.5	03	202.7	10.6	63	262.6	13.8
24	24.0	01.3	84	83.9	04.4	44	143.8	07.5	04	203.7	10.7	64	263.6	13.8
25	25.0	01.3	85	84.9	04.4	45	144.8	07.6	05	204.7	10.7	65	264.6	13.9
26	26.0	01.4	86	85.9	04.5	46	145.8	07.6	06	205.7	10.8	66	265.6	13.9
27	27.0	01.4	87	86.9	04.6	47	146.8	07.7	07	206.7	10.8	67	266.6	14.0
28	28.0	01.5	88	87.9	04.6	48	147.8	07.7	08	207.7	10.9	68	267.6	14.0
29	29.0	01.5	89	88.9	04.7	49	148.8	07.8	09	208.7	10.9	69	268.6	14.1
30	30.0	01.6	90	89.9	04.7	50	149.8	07.9	10	209.7	11.0	70	269.6	14.1
31	31.0	01.6	91	90.9	04.8	151	150.8	07.9	211	210.7	11.0	271	270.6	14.2
32	32.0	01.7	92	91.9	04.8	52	151.8	08.0	12	211.7	11.1	72	271.6	14.2
33	33.0	01.7	93	92.9	04.9	53	152.8	08.0	13	212.7	11.1	73	272.6	14.3
34	34.0	01.8	94	93.9	04.9	54	153.8	08.1	14	213.7	11.2	74	273.6	14.3
35	35.0	01.8	95	94.9	05.0	55	154.8	08.1	15	214.7	11.2	75	274.6	14.4
36	35.9	01.9	96	95.9	05.0	56	155.8	08.2	16	215.7	11.3	76	275.6	14.4
37	36.9	01.9	97	96.9	05.1	57	156.8	08.2	17	216.7	11.4	77	276.6	14.5
38	37.9	02.0	98	97.9	05.1	58	157.8	08.3	18	217.7	11.4	78	277.6	14.5
39	38.9	02.0	99	98.9	05.2	59	158.8	08.3	19	218.7	11.5	79	278.6	14.6
40	39.9	02.1	100	99.9	05.2	60	159.8	08.4	20	219.7	11.5	80	279.6	14.7
41	40.9	02.1	101	100.9	05.3	161	160.8	08.4	221	220.7	11.6	281	280.6	14.7
42	41.9	02.2	02	101.9	05.3	62	161.8	08.5	22	221.7	11.6	82	281.6	14.8
43	42.9	02.2	03	102.9	05.4	63	162.8	08.5	23	222.7	11.7	83	282.6	14.8
44	43.9	02.3	04	103.9	05.4	64	163.8	08.6	24	223.7	11.7	84	283.6	14.9
45	44.9	02.4	05	104.9	05.5	65	164.8	08.6	25	224.7	11.8	85	284.6	14.9
46	45.9	02.4	06	105.9	05.5	66	165.8	08.7	26	225.7	11.8	86	285.6	15.0
47	46.9	02.5	07	106.9	05.6	67	166.8	08.7	27	226.7	11.9	87	286.6	15.0
48	47.9	02.5	08	107.8	05.7	68	167.8	08.8	28	227.7	11.9	88	287.6	15.1
49	48.9	02.6	09	108.8	05.7	69	168.8	08.8	29	228.7	12.0	89	288.6	15.1
50	49.9	02.6	10	109.8	05.8	70	169.8	08.9	30	229.7	12.0	90	289.6	15.2
51	50.9	02.7	111	110.8	05.8	171	170.8	09.0	231	230.7	12.1	291	290.6	15.2
52	51.9	02.7	12	111.8	05.9	72	171.8	09.0	32	231.7	12.1	92	291.6	15.3
53	52.9	02.8	13	112.8	05.9	73	172.8	09.1	33	232.7	12.2	93	292.6	15.3
54	53.9	02.8	14	113.8	06.0	74	173.8	09.1	34	233.7	12.2	94	293.6	15.4
55	54.9	02.9	15	114.8	06.0	75	174.8	09.2	35	234.7	12.3	95	294.6	15.4
56	55.9	02.9	16	115.8	06.1	76	175.8	09.2	36	235.7	12.3	96	295.6	15.5
57	56.9	03.0	17	116.8	06.1	77	176.8	09.3	37	236.7	12.4	97	296.6	15.5
58	57.9	03.0	18	117.8	06.2	78	177.8	09.3	38	237.7	12.5	98	297.6	15.6
59	58.9	03.1	19	118.8	06.2	79	178.8	09.4	39	238.7	12.5	99	298.6	15.6
60	59.9	03.1	120	119.8	06.3	180	179.8	09.4	240	239.7	12.6	300	299.6	15.7
Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

Table III. Difference of Latitude and Departure for 4 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep
1	01.0	00.1	61	60.9	04.3	121	120.7	08.4	181	180.6	12.6	241	240.4	16.8
2	02.0	00.1	62	61.9	04.3	22	121.7	08.5	82	181.6	12.7	42	241.4	16.9
3	03.0	00.2	63	62.8	04.4	23	122.7	08.6	83	182.6	12.8	43	242.4	16.9
4	04.0	00.3	64	63.8	04.5	24	123.7	08.6	84	183.6	12.8	44	243.4	17.0
5	05.0	00.3	65	64.8	04.5	25	124.7	08.7	85	184.6	12.9	45	244.4	17.1
6	06.0	00.4	66	65.8	04.6	26	125.7	08.8	86	185.6	13.0	46	245.4	17.1
7	07.0	00.5	67	66.8	04.7	27	126.7	08.9	87	186.6	13.0	47	246.4	17.2
8	08.0	00.6	68	67.8	04.7	28	127.7	08.9	88	187.5	13.1	48	247.4	17.3
9	09.0	00.6	69	68.8	04.8	29	128.7	09.0	89	188.5	13.2	49	248.4	17.4
10	10.0	00.7	70	69.8	04.9	30	129.7	09.1	90	189.5	13.2	50	249.4	17.4
11	11.0	00.8	71	70.8	05.0	131	130.7	09.1	191	190.5	13.3	251	250.4	17.5
12	12.0	00.8	72	71.8	05.0	32	131.7	09.2	92	191.5	13.4	52	251.4	17.6
13	13.0	00.9	73	72.8	05.1	33	132.7	09.3	93	192.5	13.5	53	252.4	17.6
14	14.0	01.0	74	73.8	05.2	34	133.7	09.3	94	193.5	13.5	54	253.4	17.7
15	15.0	01.0	75	74.8	05.2	35	134.7	09.4	95	194.5	13.6	55	254.4	17.8
16	16.0	01.1	76	75.8	05.3	36	135.7	09.5	96	195.5	13.7	56	255.4	17.8
17	17.0	01.2	77	76.8	05.4	37	136.7	09.5	97	196.5	13.7	57	256.4	17.9
18	18.0	01.3	78	77.8	05.4	38	137.7	09.6	98	197.5	13.8	58	257.4	18.0
19	19.0	01.3	79	78.8	05.5	39	138.7	09.7	99	198.5	13.9	59	258.4	18.1
20	20.0	01.4	80	79.8	05.6	40	139.7	09.8	200	199.5	13.9	60	259.4	18.1
21	20.9	01.5	81	80.8	05.7	141	140.7	09.8	201	200.5	14.0	261	260.4	18.2
22	21.9	01.5	82	81.8	05.7	42	141.7	09.9	02	201.5	14.1	62	261.4	18.3
23	22.9	01.6	83	82.8	05.8	43	142.7	10.0	03	202.5	14.1	63	262.4	18.3
24	23.9	01.7	84	83.8	05.9	44	143.7	10.0	04	203.5	14.2	64	263.4	18.4
25	24.9	01.7	85	84.8	05.9	45	144.7	10.1	05	204.5	14.3	65	264.4	18.5
26	25.9	01.8	86	85.8	06.0	46	145.6	10.2	06	205.5	14.4	66	265.4	18.5
27	26.9	01.9	87	86.8	06.1	47	146.6	10.2	07	206.5	14.4	67	266.4	18.6
28	27.9	02.0	88	87.8	06.1	48	147.6	10.3	08	207.5	14.5	68	267.4	18.7
29	28.9	02.0	89	88.8	06.2	49	148.6	10.4	09	208.5	14.6	69	268.4	18.7
30	29.9	02.1	90	89.8	06.3	50	149.6	10.5	10	209.5	14.6	70	269.4	18.8
31	30.9	02.2	91	90.8	06.4	151	150.6	10.5	211	210.5	14.7	271	270.3	18.9
32	31.9	02.2	92	91.8	06.4	52	151.6	10.6	12	211.5	14.8	72	271.3	19.0
33	32.9	02.3	93	92.8	06.5	53	152.6	10.7	13	212.5	14.8	73	272.3	19.0
34	33.9	02.4	94	93.8	06.6	54	153.6	10.7	14	213.5	14.9	74	273.3	19.1
35	34.9	02.4	95	94.8	06.6	55	154.6	10.8	15	214.5	15.0	75	274.3	19.2
36	35.9	02.5	96	95.8	06.7	56	155.6	10.9	16	215.5	15.1	76	275.3	19.2
37	36.9	02.6	97	96.8	06.8	57	156.6	10.9	17	216.5	15.1	77	276.3	19.3
38	37.9	02.7	98	97.8	06.8	58	157.6	11.0	18	217.5	15.2	78	277.3	19.4
39	38.9	02.7	99	98.8	06.9	59	158.6	11.1	19	218.5	15.3	79	278.3	19.4
40	39.9	02.8	100	99.8	07.0	60	159.6	11.2	20	219.5	15.3	80	279.3	19.5
41	40.9	02.9	101	100.8	07.0	161	160.6	11.2	221	220.5	15.4	281	280.3	19.6
42	41.9	02.9	02	101.8	07.1	62	161.6	11.3	22	221.5	15.5	82	281.3	19.7
43	42.9	03.0	03	102.8	07.2	63	162.6	11.4	23	222.5	15.5	83	282.3	19.7
44	43.9	03.1	04	103.8	07.2	64	163.6	11.4	24	223.5	15.6	84	283.3	19.8
45	44.9	03.1	05	104.7	07.3	65	164.6	11.5	25	224.5	15.7	85	284.3	19.9
46	45.9	03.2	06	105.7	07.4	66	165.6	11.6	26	225.5	15.8	86	285.3	19.9
47	46.9	03.3	07	106.7	07.5	67	166.6	11.6	27	226.5	15.8	87	286.3	20.0
48	47.9	03.4	08	107.7	07.5	68	167.6	11.7	28	227.5	15.9	88	287.3	20.1
49	48.9	03.4	09	108.7	07.6	69	168.6	11.8	29	228.5	16.0	89	288.3	20.1
50	49.9	03.5	10	109.7	07.7	70	169.6	11.8	30	229.4	16.0	90	289.3	20.2
51	50.9	03.6	111	110.7	07.7	171	170.6	11.9	231	230.4	16.1	291	290.3	20.3
52	51.9	03.6	12	111.7	07.8	72	171.6	12.0	32	231.4	16.2	92	291.3	20.4
53	52.9	03.7	13	112.7	07.9	73	172.6	12.1	33	232.4	16.2	93	292.3	20.4
54	53.9	03.8	14	113.7	07.9	74	173.6	12.1	34	233.4	16.3	94	293.3	20.5
55	54.9	03.8	15	114.7	08.0	75	174.6	12.2	35	234.4	16.4	95	294.3	20.6
56	55.9	03.9	16	115.7	08.1	76	175.6	12.3	36	235.4	16.4	96	295.3	20.6
57	56.9	04.0	17	116.7	08.2	77	176.6	12.3	37	236.4	16.5	97	296.3	20.7
58	57.9	04.0	18	117.7	08.2	78	177.6	12.4	38	237.4	16.6	98	297.3	20.8
59	58.9	04.1	19	118.7	08.3	79	178.6	12.5	39	238.4	16.7	99	298.3	20.8
60	59.9	04.2	120	119.7	08.4	180	179.6	12.5	240	239.4	16.7	300	299.3	20.9
Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 86 Degrees.

Table III. Difference of Latitude and Departure for 5 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep
1	01.0	00.1	61	60.8	05.3	121	120.5	10.5	181	180.3	15.7	241	240.1	21.0
2	02.0	00.2	62	61.8	05.4	22	121.5	10.6	82	181.3	15.8	42	241.1	21.1
3	03.0	00.3	63	62.8	05.5	23	122.5	10.7	83	182.3	15.9	43	242.1	21.1
4	04.0	00.3	64	63.8	05.6	24	123.5	10.8	84	183.3	16.0	44	243.1	21.2
5	05.0	00.4	65	64.8	05.7	25	124.5	10.9	85	184.3	16.1	45	244.1	21.3
6	06.0	00.5	66	65.7	05.8	26	125.5	11.0	86	185.3	16.2	46	245.1	21.4
7	07.0	00.6	67	66.7	05.8	27	126.5	11.1	87	186.3	16.3	47	246.1	21.5
8	08.0	00.7	68	67.7	05.9	28	127.5	11.2	88	187.3	16.4	48	247.1	21.6
9	09.0	00.8	69	68.7	06.0	29	128.5	11.3	89	188.3	16.4	49	248.1	21.7
10	10.0	00.9	70	69.7	06.1	30	129.5	11.4	90	189.3	16.5	50	249.1	21.8
11	11.0	01.0	71	70.7	06.2	131	130.5	11.4	191	190.3	16.6	251	250.0	21.8
12	12.0	01.0	72	71.7	06.3	32	131.5	11.5	92	191.3	16.7	52	251.0	21.9
13	12.9	01.1	73	72.7	06.4	33	132.5	11.6	93	192.3	16.8	53	252.0	22.0
14	13.9	01.2	74	73.7	06.5	34	133.5	11.7	94	193.3	16.9	54	253.0	22.1
15	14.9	01.3	75	74.7	06.5	35	134.5	11.7	95	194.3	17.0	55	254.0	22.2
16	15.9	01.4	76	75.7	06.6	36	135.5	11.8	96	195.3	17.1	56	255.0	22.3
17	16.9	01.5	77	76.7	06.7	37	136.5	11.9	97	196.3	17.2	57	256.0	22.4
18	17.9	01.6	78	77.7	06.8	38	137.5	12.0	98	197.2	17.3	58	257.0	22.4
19	18.9	01.7	79	78.7	06.9	39	138.5	12.1	99	198.2	17.3	59	258.0	22.5
20	19.9	01.7	80	79.7	07.0	40	139.5	12.2	200	199.2	17.4	60	259.0	22.6
21	20.9	01.8	81	80.7	07.1	141	140.5	12.3	201	200.2	17.5	261	260.0	22.7
22	21.9	01.9	82	81.7	07.2	42	141.5	12.4	02	201.2	17.6	62	261.0	22.8
23	22.9	02.0	83	82.7	07.2	43	142.5	12.4	03	202.2	17.7	63	262.0	22.9
24	23.9	02.1	84	83.7	07.3	44	143.5	12.5	04	203.2	17.7	64	263.0	23.0
25	24.9	02.2	85	84.7	07.4	45	144.4	12.6	05	204.2	17.8	65	264.0	23.1
26	25.9	02.3	86	85.7	07.5	46	145.4	12.7	06	205.2	17.9	66	265.0	23.1
27	26.9	02.4	87	86.7	07.6	47	146.4	12.8	07	206.2	18.0	67	266.0	23.2
28	27.9	02.4	88	87.7	07.7	48	147.4	12.9	08	207.2	18.1	68	267.0	23.3
29	28.9	02.5	89	88.7	07.8	49	148.4	13.0	09	208.2	18.2	69	268.0	23.4
30	29.9	02.6	90	89.7	07.8	50	149.4	13.1	10	209.2	18.3	70	269.0	23.5
31	30.9	02.7	91	90.7	07.9	151	150.4	13.1	211	210.2	18.4	271	270.0	23.6
32	31.9	02.8	92	91.6	08.0	52	151.4	13.2	12	211.2	18.4	72	271.0	23.7
33	32.9	02.9	93	92.6	08.1	53	152.4	13.3	13	212.2	18.5	73	272.0	23.8
34	33.9	03.0	94	93.6	08.2	54	153.4	13.4	14	213.2	18.6	74	273.0	23.8
35	34.9	03.1	95	94.6	08.3	55	154.4	13.5	15	214.2	18.7	75	274.0	23.9
36	35.9	03.1	96	95.6	08.4	56	155.4	13.6	16	215.2	18.8	76	275.0	24.0
37	36.9	03.2	97	96.6	08.5	57	156.4	13.7	17	216.2	18.9	77	275.9	24.1
38	37.9	03.3	98	97.6	08.5	58	157.4	13.7	18	217.2	19.0	78	276.9	24.2
39	38.9	03.4	99	98.6	08.6	59	158.4	13.8	19	218.2	19.1	79	277.9	24.3
40	39.8	03.5	100	99.6	08.7	60	159.4	13.9	20	219.2	19.1	80	278.9	24.4
41	40.8	03.6	101	100.6	08.8	161	160.4	14.0	221	220.2	19.2	281	279.9	24.4
42	41.8	03.7	02	101.6	08.9	62	161.4	14.1	22	221.2	19.3	82	280.9	24.5
43	42.8	03.8	03	102.6	09.0	63	162.4	14.2	23	222.2	19.4	83	281.9	24.6
44	43.8	03.8	04	103.6	09.0	64	163.4	14.3	24	223.1	19.5	84	282.9	24.7
45	44.8	03.9	05	104.6	09.1	65	164.4	14.4	25	224.1	19.6	85	283.9	24.8
46	45.8	04.0	06	105.6	09.2	66	165.4	14.4	26	225.1	19.7	86	284.9	24.9
47	46.8	04.1	07	106.6	09.3	67	166.4	14.5	27	226.1	19.7	87	285.9	25.0
48	47.8	04.2	08	107.6	09.4	68	167.4	14.6	28	227.1	19.8	88	286.9	25.1
49	48.8	04.3	09	108.6	09.5	69	168.4	14.7	29	228.1	19.9	89	287.9	25.1
50	49.8	04.4	10	109.6	09.6	70	169.4	14.8	30	229.1	20.0	90	288.9	25.2
51	50.8	04.4	111	110.6	09.7	171	170.4	14.9	231	230.1	20.1	291	289.9	25.3
52	51.8	04.5	12	111.6	09.7	72	171.3	15.0	32	231.1	20.2	92	290.9	25.4
53	52.8	04.6	13	112.6	09.8	73	172.3	15.1	33	232.1	20.3	93	291.9	25.5
54	53.8	04.7	14	113.6	09.9	74	173.3	15.1	34	233.1	20.4	94	292.9	25.6
55	54.8	04.8	15	114.6	10.0	75	174.3	15.2	35	234.1	20.4	95	293.9	25.7
56	55.8	04.9	16	115.6	10.1	76	175.3	15.3	36	235.1	20.5	96	294.9	25.8
57	56.8	05.0	17	116.6	10.2	77	176.3	15.4	37	236.1	20.6	97	295.9	25.8
58	57.8	05.1	18	117.6	10.3	78	177.3	15.5	38	237.1	20.7	98	296.9	25.9
59	58.8	05.1	19	118.5	10.4	79	178.3	15.6	39	238.1	20.8	99	297.9	26.0
60	59.8	05.2	120	119.5	10.4	180	179.3	15.7	240	239.1	20.9	300	298.9	26.1
Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 85 Degrees:

Table III. Difference of Latitude and Departure for 6 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep
1	01.0	00.1	61	60.7	06.4	121	120.3	12.6	181	180.0	18.9	241	239.7	25.2
2	02.0	00.2	62	61.7	06.5	22	121.3	12.7	82	181.0	19.0	42	240.7	25.3
3	03.0	00.3	63	62.7	06.6	23	122.3	12.9	83	182.0	19.1	43	241.7	25.4
4	04.0	00.4	64	63.6	06.7	24	123.3	13.0	84	183.0	19.2	44	242.7	25.5
5	05.0	00.5	65	64.6	06.8	25	124.3	13.1	85	184.0	19.3	45	243.7	25.6
6	06.0	00.6	66	65.6	06.9	26	125.3	13.2	86	185.0	19.4	46	244.6	25.7
7	07.0	00.7	67	66.6	07.0	27	126.3	13.3	87	186.0	19.5	47	245.6	25.8
8	08.0	00.8	68	67.6	07.1	28	127.3	13.4	88	187.0	19.6	48	246.6	25.9
9	08.9	00.9	69	68.6	07.2	29	128.3	13.5	89	188.0	19.8	49	247.6	26.0
10	09.9	01.0	70	69.6	07.3	30	129.3	13.6	90	189.0	19.9	50	248.6	26.1
11	10.9	01.1	71	70.6	07.4	131	130.3	13.7	191	189.9	20.0	251	249.6	26.2
12	11.9	01.3	72	71.6	07.5	32	131.3	13.8	92	190.9	20.1	52	250.6	26.3
13	12.9	01.4	73	72.6	07.6	33	132.3	13.9	93	191.9	20.2	53	251.6	26.4
14	13.9	01.5	74	73.6	07.7	34	133.3	14.0	94	192.9	20.3	54	252.6	26.5
15	14.9	01.6	75	74.6	07.8	35	134.3	14.1	95	193.9	20.4	55	253.6	26.6
16	15.9	01.7	76	75.6	07.9	36	135.3	14.2	96	194.9	20.5	56	254.6	26.8
17	16.9	01.8	77	76.6	08.0	37	136.2	14.3	97	195.9	20.6	57	255.6	26.9
18	17.9	01.9	78	77.6	08.1	38	137.2	14.4	98	196.9	20.7	58	256.6	27.0
19	18.9	02.0	79	78.6	08.3	39	138.2	14.5	99	197.9	20.8	59	257.6	27.1
20	19.9	02.1	80	79.6	08.4	40	139.2	14.6	200	198.9	20.9	60	258.6	27.2
21	20.9	02.2	81	80.6	08.5	141	140.2	14.7	201	199.9	21.0	261	259.6	27.3
22	21.9	02.3	82	81.5	08.6	42	141.2	14.8	02	200.9	21.1	62	260.6	27.4
23	22.9	02.4	83	82.5	08.7	43	142.2	14.9	03	201.9	21.2	63	261.6	27.5
24	23.9	02.5	84	83.5	08.8	44	143.2	15.0	04	202.9	21.3	64	262.5	27.6
25	24.9	02.6	85	84.5	08.9	45	144.2	15.2	05	203.9	21.4	65	263.5	27.7
26	25.9	02.7	86	85.5	09.0	46	145.2	15.3	06	204.9	21.5	66	264.5	27.8
27	26.9	02.8	87	86.5	09.1	47	146.2	15.4	07	205.9	21.6	67	265.5	27.9
28	27.8	02.9	88	87.5	09.2	48	147.2	15.5	08	206.9	21.7	68	266.5	28.0
29	28.8	03.0	89	88.5	09.3	49	148.2	15.6	09	207.9	21.8	69	267.5	28.1
30	29.8	03.1	90	89.5	09.4	50	149.2	15.7	10	208.8	21.9	70	268.5	28.2
31	30.8	03.2	91	90.5	09.5	151	150.2	15.8	211	209.8	22.0	271	269.5	28.3
32	31.8	03.3	92	91.5	09.6	52	151.2	15.9	12	210.8	22.2	72	270.5	28.4
33	32.8	03.4	93	92.5	09.7	53	152.2	16.0	13	211.8	22.3	73	271.5	28.5
34	33.8	03.6	94	93.5	09.8	54	153.2	16.1	14	212.8	22.4	74	272.5	28.6
35	34.8	03.7	95	94.5	09.9	55	154.1	16.2	15	213.8	22.5	75	273.5	28.7
36	35.8	03.8	96	95.5	10.0	56	155.1	16.3	16	214.8	22.6	76	274.5	28.8
37	36.8	03.9	97	96.5	10.1	57	156.1	16.4	17	215.8	22.7	77	275.5	28.9
38	37.8	04.0	98	97.5	10.2	58	157.1	16.5	18	216.8	22.8	78	276.5	29.1
39	38.8	04.1	99	98.5	10.3	59	158.1	16.6	19	217.8	22.9	79	277.5	29.2
40	39.8	04.2	100	99.5	10.5	60	159.1	16.7	20	218.8	23.0	80	278.5	29.3
41	40.8	04.3	101	100.4	10.6	161	160.1	16.8	221	219.8	23.1	281	279.5	29.3
42	41.8	04.4	02	101.4	10.7	62	161.1	16.9	22	220.8	23.2	82	280.4	29.4
43	42.8	04.5	03	102.4	10.8	63	162.1	17.0	23	221.8	23.3	83	281.4	29.5
44	43.8	04.6	04	103.4	10.9	64	163.1	17.1	24	222.8	23.4	84	282.4	29.6
45	44.8	04.7	05	104.4	11.0	65	164.1	17.2	25	223.8	23.5	85	283.4	29.7
46	45.7	04.8	06	105.4	11.1	66	165.1	17.3	26	224.8	23.6	86	284.4	29.8
47	46.7	04.9	07	106.4	11.2	67	166.1	17.5	27	225.8	23.7	87	285.4	30.0
48	47.7	05.0	08	107.4	11.3	68	167.1	17.6	28	226.7	23.8	88	286.4	30.1
49	48.7	05.1	09	108.4	11.4	69	168.1	17.7	29	227.7	23.9	89	287.4	30.2
50	49.7	05.2	110	109.4	11.5	70	169.1	17.8	30	228.7	24.0	90	288.4	30.3
51	50.7	05.3	111	110.4	11.6	171	170.1	17.9	231	229.7	24.1	291	289.4	30.4
52	51.7	05.4	12	111.4	11.7	72	171.1	18.0	32	230.7	24.2	92	290.4	30.5
53	52.7	05.5	13	112.4	11.8	73	172.0	18.1	33	231.7	24.3	93	291.4	30.6
54	53.7	05.6	14	113.4	11.9	74	173.0	18.2	34	232.7	24.5	94	292.4	30.7
55	54.7	05.7	15	114.4	12.0	75	174.0	18.3	35	233.7	24.6	95	293.4	30.8
56	55.7	05.8	16	115.4	12.1	76	175.0	18.4	36	234.7	24.7	96	294.4	30.9
57	56.7	06.0	17	116.4	12.2	77	176.0	18.5	37	235.7	24.8	97	295.4	31.0
58	57.7	06.1	18	117.4	12.3	78	177.0	18.6	38	236.7	24.9	98	296.4	31.1
59	58.7	06.2	19	118.3	12.4	79	178.0	18.7	39	237.7	25.0	99	297.4	31.2
60	59.7	06.3	120	119.3	12.5	80	179.0	18.8	240	238.7	25.1	300	298.4	31.4
Dist	Dep	Lat.	Dist	Dep	Lat.	Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

Table III. Difference of Latitude and Departure for 7 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep
1	01.0	00.1	61	60.5	07.4	121	120.1	14.7	181	179.6	22.0	241	239.2	29.3
2	02.0	00.2	62	61.5	07.5	22	121.1	14.9	82	180.6	22.2	42	240.2	29.5
3	03.0	00.4	63	62.5	07.7	23	122.1	15.0	83	181.6	22.3	43	241.2	29.6
4	04.0	00.5	64	63.5	07.8	24	123.1	15.1	84	182 6	22.4	44	242.2	29.7
5	05.0	00.6	65	64.5	07.9	25	124.1	15.2	85	183.6	22.5	45	243.2	29.8
6	06.0	00.7	66	65.5	08.0	26	125.1	15.3	86	184.6	22.7	46	244.1	29.9
7	06.9	00.9	67	66.5	08.2	27	126.0	15.5	87	185.6	22.8	47	245.1	30.1
8	07.9	01.0	68	67.5	08.3	28	127.0	15.6	88	186.6	22.9	48	246.1	30.2
9	08.9	01.1	69	68.5	08.4	29	128.0	15.7	89	187.6	23.0	49	247.1	30.3
10	09.9	01 2	70	69.5	08.5	30	129.0	15.8	90	188.6	23.1	50	248.1	30.4
11	10.9	01.3	71	70.5	08.6	131	130.0	16.0	191	189.6	23.3	251	249.1	30.6
12	11.9	01.5	72	71.5	08.8	32	131.0	16.1	92	190.6	23.4	52	250.1	30.7
13	12.9	01.6	73	72.5	08.9	33	132.0	16.2	93	191.6	23.5	53	251.1	30.8
14	13.9	01.7	74	73.4	09.0	34	133.0	16.3	94	192.5	23.6	54	252.1	30.9
15	14.9	01.8	75	74.4	09.1	35	134.0	16.4	95	193.5	23.7	55	253.1	31.0
16	15.9	01.9	76	75.4	09.3	36	135.0	16.6	96	194.5	23.9	56	254.1	31.2
17	16.9	02.1	77	76.4	09.4	37	136.0	16.7	97	195.5	24.0	57	255.1	31.3
18	17.9	02.2	78	77.4	09.5	38	137.0	16.8	98	196.5	24.1	58	256.1	51.4
19	18.9	02.3	79	78.4	09.6	39	138.0	16.9	99	197.5	24.2	59	257.1	31.5
20	19.9	02.4	80	79.4	09.7	40	139.0	17.1	200	198.5	24.4	60	258.1	31.7
21	20.8	02.6	81	80.4	09 9	141	139.9	17.2	201	199.5	24.5	261	259.0	31.8
22	21.8	02.7	82	81.4	10.0	42	140.9	17.3	02	200.5	24.6	62	260.0	31.9
23	22.8	02.8	83	82.4	10.1	43	141.9	17.4	03	201.5	24.7	63	261.0	32.0
24	23.8	02.9	84	83.4	10.2	44	142.9	17.5	04	202.5	24.8	64	262.0	32.1
25	24.8	03.0	85	84.4	10.4	45	143.9	17.7	05	203.5	25.0	65	263.0	32.3
26	25.8	03.2	86	85.4	10.5	46	144.9	17.8	06	204.5	25.1	66	264.0	32.4
27	26.8	03.3	87	86.3	10 6	47	145.9	17.9	07	205.4	25.2	67	265.0	32.5
28	27.8	03.4	88	87.3	10.7	48	146.9	18.0	08	206.4	25.3	68	266.0	32.6
29	28.8	03.5	89	88.3	10.8	49	147.9	18.1	09	207.4	25.4	69	267.0	32.8
30	29.8	03.7	90	89.3	11.0	50	148.9	18.3	10	208.4	25.6	70	268.0	32.9
31	30.8	03.8	91	90.3	11.1	151	149.9	18.4	211	209.4	25.7	271	269.0	33.0
32	31 8	03.9	92	91.3	11.2	52	150.9	18.5	12	210.4	25.8	72	270.0	33.1
33	32.8	04.0	93	92.3	11.3	53	151.9	18.6	13	211.4	25.9	73	271.0	33.2
34	33.7	04.1	94	93.3	11.5	54	152.8	18.7	14	212.4	26.1	74	271.9	33.4
35	34.7	04.3	95	94.3	11.6	55	153.8	18.9	15	213.4	26.2	75	272.9	33.5
36	35.7	04.4	96	95.3	11.7	56	154.8	19 0	16	214.4	26.3	76	273.9	33.6
37	36.7	04.5	97	96.3	11.8	57	155 8	19.1	17	215.4	26.4	77	274.9	33.7
38	37.7	04.6	98	97.3	11.9	58	156.8	19.2	18	216.4	26.5	78	275.9	33.9
39	38.7	04.8	99	98.3	12.1	59	157.8	19.4	19	217.4	26.7	79	276.9	34.0
40	39.7	04.9	100	99.3	12.2	60	158.8	19.5	20	218.4	26.8	80	277.9	34.1
41	40.7	05.0	101	100.2	12.3	161	159.8	19.6	221	219.3	26.9	281	278.9	34.2
42	41.7	05.1	02	101.2	12.4	62	160.8	19.7	22	220.3	27.0	82	279.9	34.3
43	42.7	05.2	03	102.2	12.5	63	161.8	19 8	23	221.3	27 2	83	280.9	34.5
44	43.7	05.4	04	103.2	12.7	64	162.8	20.0	24	222.3	27.3	84	281.9	34.6
45	44.7	05.5	05	104.2	12.8	65	163.8	20.1	25	223.3	27.4	85	282.9	34.7
46	45.7	05.6	06	105.2	12.9	66	164.8	20.2	26	224.3	27.5	86	283.9	34.8
47	46.6	05.7	07	106.2	13.0	67	165.7	20.3	27	225.3	27.6	87	284.8	34.9
48	47.6	05.8	08	107.2	13 1	68	166.7	20.5	28	226.3	27.7	88	285.8	35.1
49	48.6	06.0	09	108.2	13.3	69	167.7	20.6	29	227.3	27.9	89	286.8	35.2
50	49.6	06.1	10	109.2	13.4	70	168.7	20.7	30	228.3	28.0	90	287.8	35.3
51	50.6	06.2	111	110.2	13.5	171	169.7	20.2	231	229.3	28.1	291	288.8	35.4
52	51.6	06.3	12	111.2	13.6	72	170.7	20.9	32	230.3	28.3	92	289.8	35.5
53	52.6	06.5	13	112.2	13.8	73	171.7	21.1	33	231.3	28.4	93	290.8	35.7
54	53.6	06.6	14	113.1	13.9	74	172.7	21.2	34	232.2	28.5	94	201.8	35.8
55	54.6	06.7	15	114.1	14.0	75	173.7	21.3	35	233.2	28.6	95	292.8	35.9
56	55.6	06.8	16	115.1	14.1	76	174.7	21.4	36	234.2	28.7	96	293.8	36.0
57	56 6	06.9	17	116.1	14.2	77	175.7	21.6	37	235.2	28.9	97	294.8	36.2
58	57.6	07.1	18	117.1	14.4	78	176.7	21.7	38	236.2	29.0	98	295.8	36.3
59	58.6	07.2	19	118 1	14.5	79	177.7	21.8	39	237.2	29.1	99	296.8	36.4
60	59.6	07.3	120	119.1	14.6	180	178.7	21.9	140	238.2	29.2	300	297.8	36.5
Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 83 Degrees.

TABLE III. Difference of Latitude and Departure for 8 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep
1	01.0	00.1	61	60.4	08.5	121	119.8	16.8	181	179.2	25.2	241	238.7	33.5
2	02.0	00.3	62	61.4	08.6	22	120.8	17.0	82	180.2	25.3	42	239.7	33.7
3	03.0	00.4	63	62.4	08.8	23	121.8	17.1	83	181.2	25.5	43	240.6	33.8
4	04.0	00.6	64	63.4	08.9	24	122.8	17.3	84	182.2	25.6	44	241.6	34.0
5	05.0	00.7	65	64.4	09.0	25	123.8	17.4	85	183.2	25.8	45	242.6	34.1
6	05.9	00.8	66	65.4	09.2	26	124.8	17.5	86	184.2	25.9	46	243.6	34.2
7	06.9	01.0	67	66.4	09.3	27	125.8	17.7	87	185.2	26.0	47	244.6	34.4
8	07.9	01.1	68	67.3	09.5	28	126.8	17.8	88	186.2	26.2	48	245.6	34.5
9	08.9	01.3	69	68.3	09.6	29	127.7	18.0	89	187.2	26.3	49	246.6	34.7
10	09.9	01.4	70	69.3	09.7	30	128.7	18.1	90	188.2	26.4	50	247.6	34.8
11	10.9	01.5	71	70.3	09.9	131	129.7	18.2	191	189.1	26.6	251	248.6	34.9
12	11.9	01.7	72	71.3	10.0	32	130.7	18.4	92	190.1	26.7	52	249.6	35.1
13	12.9	01.8	73	72.3	10.2	33	131.7	18.5	93	191.01	26.9	53	250.5	35.2
14	13.9	01.9	74	73.3	10.3	34	132.7	18.7	49	192.1	27.0	54	251.5	35.4
15	14.9	02.1	75	74.3	10.4	35	133.7	18.8	95	193.1	27.1	55	252.5	35.5
16	15.8	02.2	76	75.3	10.6	36	134.7	18.9	96	194.1	27.3	56	253.5	35.6
17	16.8	02.4	77	76.3	10.7	37	135.7	19.1	97	195.1	27.4	57	254.5	35.8
18	17.8	02.5	78	77.2	10.9	38	136.7	19.2	98	196.1	27.6	58	255.5	35.9
19	18.8	02.6	79	78.2	11.0	39	137.7	19.3	99	197.1	27.7	59	256.5	36.1
20	19.8	02.8	80	79.2	11.1	40	138.6	19.5	200	198.1	27.8	60	257.5	36.2
21	20.8	02.9	81	80.2	11.3	141	139.6	19.6	201	199.0	28.0	261	258.5	36.3
22	21.8	03.1	82	81.2	11.4	42	140.6	19.8	02	200.0	28.1	62	259.5	36.5
23	22.8	03.2	83	82.2	11.6	43	141.6	19.9	03	201.0	28.3	63	260.4	36.6
24	23.8	03.3	84	83.2	11.7	44	142.6	20.0	04	202.0	28.4	64	261.4	36.7
25	24.8	03.5	85	84.2	11.8	45	143.6	20.2	05	203.0	28.5	65	262.4	36.9
26	25.7	03.6	86	85.2	12.0	46	144.6	20.3	06	204.0	28.7	66	263.4	37.0
27	26.7	03.8	87	86.2	12.1	47	145.6	20.5	07	205.0	28.8	67	264.4	37.2
28	27.7	03.9	88	87.1	12.2	48	146.6	20.6	08	206.0	29.0	68	265.4	37.3
29	28.7	04.0	89	88.1	12.4	49	147.6	20.7	09	207.0	29.1	69	266.4	37.4
30	29.7	04.2	90	89.1	12.5	50	148.5	20.9	10	208.0	29.2	70	267.4	37.6
31	30.7	04.3	91	90.1	12.7	151	149.5	21.0	211	209.0	29.4	271	268.4	37.7
32	31.7	04.5	92	91.1	12.8	52	150.5	21.2	12	209.9	29.5	72	269.4	37.9
33	32.7	04.6	93	92.1	12.9	53	151.5	21.3	13	210.9	29.6	73	270.4	38.0
34	33.7	04.7	94	93.1	13.1	54	152.5	21.4	14	211.9	29.8	74	271.3	38.1
35	34.7	04.9	95	94.1	13.2	55	153.5	21.6	15	212.9	29.9	75	272.3	38.3
36	35.7	05.0	96	95.1	13.4	56	154.5	21.7	16	213.9	30.1	76	273.3	38.4
37	36.6	05.2	97	96.1	13.5	57	155.5	21.9	17	214.9	30.2	77	274.3	38.6
38	37.6	05.4	98	97.0	13.6	58	156.5	22.0	18	215.9	30.3	78	275.3	38.7
39	38.6	05.5	99	98.0	13.8	59	157.5	22.1	19	216.9	30.5	79	276.3	38.8
40	39.6	05.6	100	99.0	13.9	60	158.4	22.3	20	217.9	30.6	80	277.3	39.0
41	40.6	05.7	101	100.0	14.1	161	159.4	22.4	221	218.9	30.8	281	278.3	39.1
42	41.6	05.8	02	101.0	14.2	62	160.4	22.6	22	219.8	30.9	82	279.3	39.3
43	42.6	06.0	03	102.0	14.3	63	161.4	22.7	23	220.8	31.0	83	280.3	39.4
44	43.6	06.1	04	103.0	14.5	64	162.4	22.8	24	221.8	31.2	84	281.2	39.5
45	44.6	06.3	05	104.0	14.6	65	163.4	23.0	25	222.8	31.3	85	282.2	39.7
46	45.6	06.4	06	105.0	14.8	66	164.4	23.1	26	223.8	31.5	86	283.2	39.8
47	46.5	06.5	07	106.0	14.9	67	165.4	23.2	27	224.8	31.6	87	284.2	40.0
48	47.5	06.7	08	107.0	15.0	68	166.4	23.4	28	225.8	31.7	88	285.2	40.1
49	48.5	06.8	09	107.9	15.2	69	167.4	23.5	29	226.8	31.9	89	286.2	40.2
50	49.5	07.0	10	108.9	15.3	70	168.4	23.7	30	227.8	32.0	90	287.2	40.4
51	50.5	07.1	111	109.9	15.5	171	129.3	23.8	231	228.8	32.2	291	288.2	40.5
52	51.5	07.2	12	110.9	15.6	72	170.3	23.9	32	229.7	32.3	92	289.2	40.6
53	52.5	07.4	13	111.9	15.7	73	171.3	24.1	33	230.7	32.4	93	290.2	40.8
54	53.5	07.5	14	112.9	15.9	74	172.3	24.2	34	231.7	32.6	94	291.1	40.9
55	54.5	07.7	15	113.9	16.0	75	173.3	24.3	35	232.7	32.7	95	292.1	41.1
56	55.5	07.8	16	114.9	16.1	76	174.3	24.5	36	233.7	32.9	96	293.1	41.2
57	56.4	07.9	17	115.9	16.3	77	175.3	24.6	37	234.7	33.0	97	294.1	41.3
58	57.4	08.1	18	116.9	16.4	78	176.3	24.7	38	235.7	33.1	98	295.1	41.5
59	58.4	08.2	19	117.8	16.6	79	177.3	24.9	39	236.7	33.3	99	296.1	41.6
60	59.4	08.4	120	118.8	16.7	180	178.3	25.1	140	237.7	33.4	300	297.1	41.8
Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 82 Degrees.

Table III. Difference of Latitude and Departure for 9 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep
1	01.0	00.2	61	60.2	09.5	121	119.5	18.9	181	178.8	28.3	241	238.0	37.7
2	02.0	00.3	62	61.2	09.7	22	120.5	19.1	82	179.8	28.5	42	239.0	37.8
3	03.0	00.5	63	62.2	09.9	23	121.5	19.2	83	180.7	28.6	43	240.0	38.0
4	04.0	00.6	64	63.2	10.0	24	122.5	19.4	84	181.7	28.8	44	241.0	38.2
5	04.9	00.8	65	64.2	10.2	25	123.5	19.6	85	182.7	28.9	45	242.0	38.3
6	05.9	00.9	66	65.2	10.3	26	124.5	19.7	86	183.7	29.1	46	243.0	38.5
7	06.9	01.1	67	66.2	10.5	27	125.4	19.9	87	184.7	29.2	47	244.0	38.6
8	07.9	01.3	68	67.2	10.6	28	126.4	20.0	88	185.7	29.4	48	244.9	38.8
9	08.9	01.4	69	68.2	10.8	29	127.4	20.2	89	186.7	29.6	49	245.9	38.9
10	09.9	01.6	70	69.1	10.9	30	128.4	20.3	90	187.7	29.7	50	246.9	39.1
11	10.9	01.7	71	70.1	11.1	131	129.4	20.5	191	188.7	29.9	251	247.9	39.3
12	11.9	01.9	72	71.1	11.3	32	130.4	20.6	92	189.6	30.0	52	248.9	39.4
13	12.9	02.0	73	72.1	11.4	33	131.4	20.8	93	190.6	30.2	53	249.9	39.6
14	13.8	02.2	74	73.1	11.6	34	132.4	21.0	94	191.6	30.3	54	250.9	39.7
15	14.8	02.3	75	74.1	11.7	35	133.3	21.1	95	192.6	30.5	55	251.9	39.9
16	15.8	02.5	76	75.1	11.9	36	134.3	21.3	96	193.6	30.7	56	252.9	40.0
17	16.8	02.7	77	76.1	12.0	37	135.3	21.4	97	194.6	30.8	57	253.8	40.2
18	17.8	02.8	78	77.0	12.2	38	136.3	21.6	98	195.6	31.0	58	254.8	40.4
19	18.8	03.0	79	78.0	12.4	39	137.3	21.7	99	196.6	31.1	59	255.8	40.5
20	19.8	03.1	80	79.0	12.5	40	138.3	21.9	200	197.5	31.3	60	256.8	40.7
21	20.7	03.3	81	80.0	12.7	141	139.3	22.1	201	198.5	31.4	261	257.8	40.8
22	21.7	03.4	82	81.0	12.8	42	140.3	22.2	02	199.5	31.6	62	258.8	41.0
23	22.7	03.6	83	82.0	13.0	43	141.2	22.4	03	200.5	31.7	63	259.8	41.1
24	23.7	03.8	84	83.0	13.1	44	142.2	22.5	04	201.5	31.9	64	260.8	41.3
25	24.7	03.9	85	84.0	13.3	45	143.2	22.7	05	202.5	32.1	65	261.7	41.4
26	25.7	04.1	86	84.9	13.5	46	144.2	22.8	06	203.5	32.2	66	262.7	41.6
27	26.7	04.2	87	85.9	13.6	47	145.2	23.0	07	204.5	32.4	67	263.7	41.8
28	27.7	04.4	88	86.9	13.8	48	146.2	23.1	08	205.4	32.5	68	264.7	41.9
29	28.6	04.5	89	87.9	13.9	49	147.2	23.3	09	206.4	32.7	69	265.7	42.1
30	29.6	04.7	90	88.9	14.1	50	148.2	23.5	10	207.4	32.8	70	266.7	42.2
31	30.6	04.8	91	89.9	14.2	151	149.1	23.6	211	208.4	33.0	271	267.7	42.4
32	31.6	05.0	92	90.9	14.4	52	150.1	23.8	12	209.4	33.2	72	268.7	42.5
33	32.6	05.2	93	91.9	14.5	53	151.1	23.9	13	210.4	33.3	73	269.6	42.7
34	33.6	05.3	94	92.8	14.7	54	152.1	24.1	14	211.4	33.5	74	270.6	42.9
35	34.6	05.5	95	93.8	14.9	55	153.1	24.2	15	212.4	33.6	75	271.6	43.0
36	35.6	05.6	96	94.8	15.0	56	154.1	24.4	16	213.3	33.8	76	272.6	43.2
37	36.5	05.8	97	95.8	15.2	57	155.1	24.6	17	214.3	33.9	77	273.5	43.3
38	37.5	05.9	98	96.8	15.3	58	156.1	24.7	18	215.3	34.1	78	274.6	43.5
39	38.5	06.1	99	97.8	15.5	59	157.0	24.9	19	216.3	34.3	79	275.6	43.6
40	39.5	06.3	100	98.8	15.6	60	158.0	25.0	20	217.3	34.4	80	276.6	43.8
41	40.5	06.4	101	99.8	15.8	161	159.0	25.2	221	218.3	34.6	281	277.5	43.9
42	41.5	06.6	02	100.7	16.0	62	160.0	25.3	22	219.3	34.7	82	278.5	44.1
43	42.5	06.7	03	101.7	16.1	63	161.0	25.5	23	220.3	34.9	83	279.5	44.3
44	43.5	06.9	04	102.7	16.3	64	162.0	25.6	24	221.2	35.0	84	280.5	44.4
45	44.4	07.0	05	103.7	16.4	65	163.0	25.8	25	222.2	35.2	85	281.5	44.6
46	45.4	07.2	06	104.7	16.6	66	164.0	26.0	26	223.2	35.3	86	282.5	44.7
47	46.4	07.4	07	105.7	16.7	67	164.9	26.1	27	224.2	35.5	87	283.5	44.9
48	47.4	07.5	08	106.7	16.9	68	165.9	26.3	28	225.2	35.7	88	284.5	45.0
49	48.4	07.7	09	107.7	17.0	69	166.9	26.4	29	226.2	35.8	89	285.4	45.2
50	49.4	07.8	10	108.6	17.2	70	167.9	26.6	30	227.2	36.0	90	286.4	45.4
51	50.4	08.0	111	109.6	17.4	171	168.9	26.7	231	228.2	36.1	291	287.4	45.5
52	51.4	08.1	12	110.6	17.5	72	169.9	26.9	32	229.1	36.3	92	288.4	45.7
53	52.3	08.3	13	111.6	17.7	73	170.9	27.1	33	230.1	36.4	93	289.4	45.8
54	53.3	08.4	14	112.6	17.8	74	171.9	27.2	34	231.1	36.6	94	290.4	46.0
55	54.3	08.6	15	113.6	18.0	75	172.8	27.4	35	232.1	36.8	95	291.4	46.1
56	55.3	08.8	16	114.6	18.1	76	173.8	27.5	36	233.1	36.9	96	292.4	46.3
57	56.3	08.9	17	115.6	18.3	77	174.8	27.7	37	234.1	37.1	97	293.3	46.5
58	57.3	09.1	18	116.5	18.5	78	175.8	27.8	38	235.1	37.2	98	294.3	46.6
59	58.3	09.2	19	117.5	18.6	79	176.8	28.0	39	236.1	37.4	99	295.3	46.8
60	59.3	09.4	20	118.5	18.8	180	177.8	28.2	240	237.0	37.5	300	296.3	46.9
Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 81 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep
1	01.0	00.2	61	60.1	10.6	121	119.2	21.0	181	178.2	31.4	241	237.3	41.8
2	02.0	00.3	62	61.1	10.8	22	120.1	21.2	82	179.2	31.6	42	238.3	42.0
3	03.0	00.5	63	62.0	10.9	23	121.1	21.3	83	180.2	31.7	43	239.3	42.1
4	03.9	00.7	64	63.0	11.1	24	122.1	21.5	84	181.2	31.9	44	240.3	42.3
5	04.9	00.9	65	64.0	11.2	25	123.1	21.7	85	182.2	32.1	45	241.3	42.5
6	05.9	01.0	66	65.0	11.4	26	124.1	21.8	86	183.2	32.3	46	242.3	42.7
7	06.9	01.2	67	66.0	11.6	27	125.1	22.0	87	184.2	32.4	47	243.2	42.8
8	07.9	01.4	68	67.0	11.8	28	126.1	22.2	88	185.1	32.6	48	244.2	43.0
9	08.9	01.6	69	68.0	12.0	29	127.0	22.4	89	186.1	32.8	49	245.2	43.2
10	09.8	01.7	70	68.9	12.1	30	128.0	22.5	90	187.1	32.9	50	246.2	43.4
11	10.8	01.9	71	69.9	12.3	131	129.0	22.7	191	188.1	33.1	251	247.2	43.5
12	11.8	02.1	72	70.9	12.5	32	130.0	22.9	92	189.1	33.3	52	248.2	43.7
13	12.8	02.3	73	71.9	12.7	33	131.0	23.1	93	190.1	33.5	53	249.2	43.9
14	13.8	02.4	74	72.9	12.8	34	132.0	23.2	94	191.0	33.6	54	250.1	44.0
15	14.8	02.6	75	73.9	13.0	35	132.9	23.4	95	192.0	33.8	55	251.1	44.2
16	15.8	02.8	76	74.8	13.2	36	133.9	23.6	96	193.0	34.0	56	252.1	44.4
17	16.7	02.9	77	75.8	13.4	37	134.9	23.8	97	194.0	34.2	57	253.1	44.6
18	17.7	03.1	78	76.8	13.5	38	135.9	23.9	98	195.0	34.3	58	254.1	44.7
19	18.7	03.3	79	77.8	13.7	39	136.9	24.1	99	196.0	34.5	59	255.1	44.9
20	19.7	03.5	80	78.8	13.9	40	137.9	24.3	200	197.0	34.7	60	256.0	45.1
21	20.7	03.6	81	79.8	14.0	141	138.9	24.4	201	197.9	34.9	261	257.0	45.3
22	21.7	03.8	82	80.8	14.2	42	139.8	24.6	02	198.9	35.0	62	258.0	45.4
23	22.7	04.0	83	81.7	14.4	43	140.8	24.8	03	199.9	35.2	63	259.0	45.6
24	23.6	04.2	84	82.7	14.6	44	141.8	25.0	04	200.9	35.4	64	260.0	45.8
25	24.6	04.3	85	83.7	14.7	45	142.8	25.1	05	201.9	35.5	65	261.0	46.0
26	25.6	04.5	86	84.7	14.9	46	143.8	25.3	06	202.9	35.7	66	262.0	46.1
27	26.6	04.7	87	85.7	15.1	47	144.8	25.5	07	203.9	35.9	67	262.9	46.3
28	27.6	04.9	88	86.7	15.3	48	145.7	25.7	08	204.8	36.1	68	263.9	46.5
29	28.6	05.0	89	87.6	15.4	49	146.7	25.8	09	205.8	36.2	69	264.9	46.6
30	29.5	05.2	90	88.6	15.6	50	147.7	26.0	10	206.8	36.4	70	265.9	46.8
31	30.5	05.4	91	89.6	15.8	151	148.7	26.2	211	207.8	36.6	271	266.9	47.0
32	31.5	05.5	92	90.6	16.0	52	149.7	26.4	12	208.8	36.8	72	267.9	47.2
33	32.5	05.7	93	91.6	16.1	53	150.7	26.5	13	209.8	36.9	73	268.9	47.3
34	33.5	05.9	94	92.6	16.3	54	151.7	26.7	14	210.7	37.1	74	269.8	47.5
35	34.5	06.1	95	93.6	16.5	55	152.6	26.9	15	211.7	37.3	75	270.8	47.7
36	35.5	06.2	96	94.5	16.6	56	153.6	27.1	16	212.7	37.5	76	271.8	47.9
37	36.4	06.4	97	95.5	16.8	57	154.6	27.2	17	213.7	37.6	77	272.8	48.0
38	37.4	06.6	98	96.5	17.0	58	155.6	27.4	18	214.7	37.8	78	273.8	48.2
39	38.4	06.8	99	97.5	17.2	59	156.6	27.6	19	215.7	38.0	79	274.8	48.4
40	39.4	06.9	100	98.5	17.3	60	157.6	27.7	20	216.7	38.1	80	275.7	48.6
41	40.4	07.1	101	99.5	17.5	161	158.6	27.9	221	217.6	38.3	281	276.7	48.7
42	41.4	07.3	02	100.4	17.7	62	159.5	28.1	22	218.6	38.5	82	277.7	48.9
43	42.3	07.5	03	101.4	17.9	63	160.5	28.3	23	219.6	38.7	83	278.7	49.1
44	43.3	07.6	04	102.4	18.0	64	161.5	28.4	24	220.6	38.8	84	279.7	49.2
45	44.3	07.8	05	103.4	18.2	65	162.5	28.6	25	221.6	39.0	85	280.7	49.4
46	45.3	08.0	06	104.4	18.4	66	163.5	28.8	26	222.6	39.2	86	281.6	49.6
47	46.3	08.1	07	105.4	18.6	67	164.5	29.0	27	223.5	39.4	87	282.6	49.8
48	47.3	08.3	08	106.4	18.7	68	165.4	29.1	28	224.5	39.5	88	283.6	49.9
49	48.[illegible]	08.5	09	107.3	18.9	69	166.4	29.3	29	225.5	39.7	89	284.6	50.1
50	49.2	08.7	10	108.3	19.1	70	167.4	29.5	30	226.5	39.9	90	285.6	50.3
51	50.2	08.8	111	109.3	19.2	171	168.4	29.7	231	227.5	40.1	291	286.6	50.5
52	51.2	09.0	12	110.3	19.4	72	169.4	29.8	32	228.5	40.2	92	287.6	50.6
53	52.2	09.2	13	111.3	19.6	73	170.4	30.0	33	229.5	40.4	93	288.5	50.8
54	53.2	09.4	14	112.3	19.8	74	171.4	30.2	34	230.4	40.6	94	289.5	51.0
55	54.2	09.5	15	113.3	19.9	75	172.3	30.3	35	231.4	40.7	95	290.5	51.2
56	55.1	09.7	16	114.2	20.1	76	173.3	30.5	36	232.4	40.9	96	291.5	51.3
57	56.1	09.9	17	115.2	20.3	77	174.3	30.7	37	233.4	41.1	97	292.5	51.5
58	57.1	10.1	18	116.2	20.5	78	175.3	30.9	38	234.4	41.3	98	293.5	51.7
59	58.1	10.2	19	117.2	20.6	79	176.3	31.0	39	235.4	41.4	99	294.5	51.8
60	59.1	10.4	120	118.2	20.8	180	177.3	31.2	240	236.4	41.6	300	295.4	52.0
Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep
1	01.0	00.2	61	59.9	11.6	121	118.8	23.1	181	177.7	34.5	241	236.6	46.0
2	02.0	00.4	62	60.9	11.8	22	119.8	23.3	82	178.6	34.7	42	237.5	46.2
3	02.9	00.6	63	61.8	12.0	23	120.7	23.5	83	179.6	34.9	43	238.5	46.4
4	03.9	00.8	64	62.8	12.2	24	121.7	23.7	84	180.6	35.1	44	239.5	46.6
5	04.9	01.0	65	63.8	12.4	25	123.7	23.9	85	181.6	35.3	45	240.5	46.8
6	05.9	01.1	66	64.8	12.6	26	123.7	24.0	86	182.6	35.5	46	241.5	47.0
7	06.9	01.3	67	65.8	12.8	27	124.7	24.2	87	183.6	35.7	47	242.5	47.1
8	07.9	01.5	68	66.7	13.0	28	125.6	24.4	88	184.5	35.9	48	243.4	47.3
9	08.8	01.7	69	67.7	13.2	29	126.6	24.6	89	185.5	36.1	49	244.4	47.5
10	09.8	01.9	70	68.7	13.4	30	127.6	24.8	90	186.5	36.3	50	245.4	47.7
11	10.8	02.1	71	69.7	13.5	131	128.6	25.0	191	187.5	36.4	251	246.4	47.9
12	11.8	02.3	72	70.7	13.7	32	129.6	25.2	92	188.5	36.6	52	247.4	48.1
13	12.8	02.5	73	71.7	13.9	33	130.6	25.4	93	189.4	36.8	53	248.3	48.3
14	13.7	02.7	74	72.6	14.1	34	131.5	25.6	94	190.4	37.0	54	249.3	48.5
15	14.7	02.9	75	73.6	14.3	35	132.5	25.8	95	191.4	37.2	55	250.3	48.7
16	15.7	03.1	76	74.6	14.5	36	133.5	25.9	96	192.4	37.4	56	251.3	48.8
17	16.7	03.2	77	75.6	14.7	37	134.5	26.1	97	193.4	37.2	57	252.3	49.0
18	17.7	03.4	78	76.6	14.9	38	135.5	26.3	98	194.4	37.8	58	253.2	49.2
19	18.7	03.6	79	77.5	15.1	39	136.4	26.5	99	195.3	38.0	59	254.2	49.4
20	19.6	03.8	80	78.5	15.3	40	137.4	26.7	200	196.3	38.2	60	255.2	49.6
21	20.6	04.0	81	79.5	15.5	141	138.4	26.9	201	197.3	38.4	261	256.2	49.8
22	21.6	04.2	82	80.5	15.6	42	139.4	27.1	02	198.3	38.5	62	257.2	50.0
23	22.6	04.4	83	81.5	15.8	43	140.4	27.3	03	199.3	38.7	63	258.2	50.2
24	23.6	04.6	84	82.5	16.0	44	141.3	27.5	04	200.2	38.9	64	259.1	50.4
25	24.5	04.8	85	83.4	16.2	45	142.3	27.7	05	201.2	39.1	65	260.1	50.6
26	25.5	05.0	86	84.4	16.4	46	143.3	27.9	06	202.2	39.3	66	261.1	50.8
27	26.5	05.2	87	85.4	16.6	47	144.3	28.0	07	203.2	39.5	67	262.1	50.9
28	27.5	05.3	88	86.4	16.8	48	145.3	28.2	08	204.2	39.7	68	263.1	51.1
29	28.5	05.5	89	87.4	17.0	49	146.3	28.4	09	205.2	39.9	69	264.0	51.3
30	29.4	05.7	90	88.3	17.2	50	147.2	28.6	10	206.1	40.1	70	265.0	51.5
31	30.4	05.9	91	89.3	17.4	151	148.2	28.8	211	207.1	40.3	271	266.0	51.7
32	31.4	06.1	92	90.3	17.6	52	149.2	29.0	12	208.1	40.4	72	267.0	51.9
33	32.4	06.3	93	91.3	17.7	53	150.2	29.2	13	209.1	40.6	73	268.0	52.1
34	33.4	06.5	94	92.3	17.9	54	151.2	29.4	14	210.1	40.8	74	269.0	52.3
35	34.4	06.7	95	93.3	18.1	55	152.1	29.6	15	211.0	41.0	75	269.9	52.5
36	35.3	06.9	96	94.2	18.3	56	153.1	29.8	16	212.0	41.2	76	270.9	52.7
37	36.3	07.1	97	95.2	18.5	57	154.1	30.0	17	213.0	41.4	77	271.9	52.9
38	37.3	07.3	98	96.2	18.7	58	155.1	30.1	18	214.0	41.6	78	272.9	53.0
39	38.3	07.4	99	97.2	18.9	59	156.1	30.3	19	215.0	41.8	79	273.9	53.2
40	39.3	07.6	100	98.2	19.1	60	157.1	30.5	20	215.9	42.0	80	274.8	53.4
41	40.2	07.8	101	99.1	19.3	161	158.0	30.7	221	216.9	42.2	281	275.8	53.6
42	41.2	08.0	02	100.1	19.5	62	159.0	30.9	22	217.9	42.4	82	276.8	53.8
43	42.2	08.2	03	101.1	19.7	63	160.0	31.1	23	218.9	42.5	83	277.8	54.0
44	43.2	08.4	04	102.1	19.8	64	161.0	31.3	24	219.9	42.7	84	278.8	54.2
45	44.2	08.6	05	103.1	20.0	65	162.0	31.5	25	220.9	42.9	85	279.8	54.4
46	45.2	08.8	06	104.0	20.2	66	162.9	31.7	26	221.8	43.1	86	280.7	54.6
47	46.1	09.0	07	105.0	20.4	67	163.9	31.9	27	222.8	43.3	87	281.7	54.8
48	47.1	09.2	08	106.0	20.6	68	164.9	32.1	28	223.8	43.5	88	282.7	55.0
49	48.1	09.3	09	107.0	20.8	69	165.9	32.2	29	224.8	43.7	89	283.7	55.1
50	49.1	09.5	10	108.0	21.0	70	166.9	32.4	30	225.8	43.9	90	284.7	55.3
51	50.1	09.7	111	109.0	21.2	171	167.9	32.6	231	226.7	44.1	291	285.6	55.5
52	51.0	09.9	12	109.9	21.4	72	168.8	32.8	32	227.7	44.3	92	286.6	55.7
53	52.0	10.1	13	110.9	21.6	73	169.8	33.0	33	228.7	44.5	93	287.6	55.9
54	53.0	10.3	14	111.9	21.8	74	170.8	33.2	34	229.7	44.6	94	288.6	56.0
55	54.0	10.5	15	112.9	21.9	75	171.8	33.4	35	230.7	44.8	95	289.6	56.3
56	55.0	10.7	16	113.9	22.1	76	172.8	33.6	36	231.7	45.0	96	290.5	56.5
57	56.0	10.9	17	114.8	22.3	77	173.7	33.8	37	232.6	45.2	97	291.5	56.7
58	56.9	11.1	18	115.8	22.5	78	174.7	34.0	38	233.6	45.4	98	292.5	56.9
59	57.9	11.3	19	116.8	22.7	79	175.7	34.2	39	234.6	45.6	99	293.5	57.0
60	58.9	11.4	120	117.8	22.9	180	176.7	34.3	240	235.6	45.8	300	294.5	57.2
Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat	Dist	Dep.	Lat.	Dist	Dep	Lat.

TABLE III. Difference of Latitude and Departure for 78 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep
1	01.0	00.2	61	59.7	12.7	121	118.3	25.2	181	177.0	37.6	241	235.7	50.1
2	02.0	00.4	62	60.6	12.9	22	119.3	25.4	82	178.0	37.9	42	236.7	50.3
3	02.9	00.6	63	61.6	13.1	23	120.3	25.6	83	179.0	38.1	43	237.7	50.5
4	03.9	00.8	64	62.6	13.3	24	121.3	25.8	84	180.0	38.3	44	238.6	50.8
5	04.9	01.0	65	63.6	13.5	25	122.3	26.0	85	180.9	38.5	45	239.6	51.0
6	05.9	01.2	66	64.5	13.9	26	123.2	26.2	86	181.9	38.7	46	240.6	51.2
7	06.8	01.5	67	65.5	13.9	27	124.2	26.4	87	182.9	38.9	47	241.6	51.4
8	07.8	01.7	68	66.5	14.1	28	125.2	26.6	88	183.9	39.1	48	242.5	51.6
9	08.8	01.9	69	67.5	14.4	29	126.2	26.8	89	184.8	39.3	49	243.5	51.8
10	09.8	02.1	70	68.5	14.6	30	127.2	27.0	90	185.8	39.5	50	244.5	52.0
11	10.8	02.3	71	69.4	14.8	131	128.1	27.2	191	186.8	39.7	251	245.5	52.2
12	11.7	02.5	72	70.4	15.0	32	129.1	27.5	92	187.8	39.9	52	246.5	52.4
13	12.7	02.7	73	71.4	15.2	33	130.1	27.7	93	188.8	40.1	53	247.4	52.6
14	13.7	02.9	74	72.4	15.4	34	131.1	27.9	94	189.7	40.4	54	248.4	52.8
15	14.7	03.1	75	73.4	15.6	35	132.0	28.1	95	190.7	40.6	55	249.4	53.0
16	15.6	03.3	76	74.3	15.8	36	133.0	28.3	96	191.7	40.8	56	250.4	53.2
17	16.6	03.5	77	75.3	16.0	37	134.0	28.5	97	192.7	41.0	57	251.3	53.5
18	17.6	03.7	78	76.3	16.2	38	135.0	28.7	98	193.6	41.2	58	252.3	53.7
19	18.6	04.0	79	77.3	16.4	39	135.9	28.9	99	194.6	41.4	59	253.3	53.9
20	19.6	04.2	80	78.2	16.6	40	136.9	29.1	200	195.6	41.6	60	254.3	54.1
21	20.5	04.4	81	79.2	16.8	141	137.9	29.3	201	196.6	41.8	261	255.3	54.3
22	21.5	04.6	82	80.2	17.1	42	138.9	29.5	02	197.6	42.0	62	256.2	54.5
23	22.5	04.8	83	81.2	17.3	43	139.9	29.7	03	198.5	42.2	63	257.2	54.7
24	23.5	05.0	84	82.2	17.5	44	140.8	30.0	04	199.5	42.4	64	258.2	54.9
25	24.5	05.2	85	83.1	17.7	45	141.8	30.2	05	200.5	42.6	65	259.2	55.1
26	25.4	05.3	86	84.1	17.9	46	142.8	30.4	06	201.5	42.8	66	260.1	55.3
27	26.4	05.6	87	85.1	18.1	47	143.8	30.6	07	202.4	43.1	67	261.1	55.5
28	27.4	05.8	88	86.1	18.3	48	144.7	30.8	08	203.4	43.3	68	262.1	55.7
29	28.4	06.0	89	87.0	18.5	49	145.7	31.0	09	204.4	43.5	69	263.1	56.0
30	29.3	06.2	90	88.0	18.7	50	146.7	31.2	10	205.4	43.7	70	264.1	56.2
31	30.3	06.4	91	89.0	18.9	151	147.7	31.4	211	206.4	43.9	271	265.0	56.4
32	31.3	06.7	92	90.0	19.1	52	148.7	31.6	12	207.3	44.1	72	266.0	56.6
33	32.3	06.9	93	91.0	19.3	53	149.6	31.8	13	208.3	44.3	73	267.0	56.8
34	33.3	07.1	94	91.9	19.6	54	150.6	32.0	14	209.3	44.5	74	268.0	57.0
35	34.2	07.3	95	92.9	19.8	55	151.6	32.2	15	210.3	44.7	75	269.0	57.2
36	35.2	07.5	96	93.9	20.0	56	152.6	32.4	16	211.2	44.9	76	269.9	57.4
37	36.2	07.7	97	94.9	20.2	57	153.5	32.7	17	212.2	45.1	77	270.9	57.6
38	37.2	07.9	98	95.8	20.4	58	154.5	32.9	18	213.2	45.3	78	271.9	57.8
39	38.1	08.1	99	96.8	20.6	59	155.5	33.1	19	214.2	45.6	79	272.9	58.0
40	39.1	08.3	100	97.8	20.8	60	156.5	33.3	20	215.2	45.8	80	273.8	58.2
41	40.1	08.5	101	98.8	21.0	161	157.5	33.5	221	216.1	46.0	281	274.8	58.4
42	41.1	08.7	02	99.8	21.2	62	158.4	33.7	22	217.1	46.2	82	275.8	58.7
43	42.1	08.9	03	100.7	21.4	63	159.4	33.9	23	218.1	46.4	83	276.8	58.9
44	43.0	09.2	04	101.7	21.6	64	160.4	34.1	24	219.1	46.6	84	277.8	59.1
45	44.0	09.4	05	102.7	21.8	65	161.4	34.3	25	220.1	46.8	85	278.7	59.3
46	45.0	09.6	06	103.7	22.0	66	162.3	34.5	26	221.0	47.0	86	279.7	59.5
47	46.0	09.8	07	104.6	22.3	67	163.3	34.7	27	222.0	47.2	87	280.7	59.7
48	46.9	10.0	08	105.6	22.5	68	164.3	34.9	28	223.0	47.4	88	281.7	59.9
49	47.9	10.2	09	106.6	22.7	69	165.2	35.2	29	224.0	47.6	89	282.6	60.1
50	48.9	10.4	10	107.6	22.9	70	166.2	35.4	30	225.0	47.8	90	283.6	60.3
51	49.9	10.6	111	108.6	23.1	171	167.2	35.6	231	225.9	48.0	291	284.6	60.5
52	50.9	10.8	12	109.5	23.3	72	168.2	35.8	32	226.9	48.3	92	285.6	60.7
53	51.8	11.0	13	110.5	23.5	73	169.2	36.0	33	227.9	48.5	93	286.6	60.9
54	52.8	11.2	14	111.5	23.7	74	170.2	36.2	34	228.9	48.7	94	287.5	61.2
55	53.8	11.4	15	112.5	23.9	75	171.2	36.4	35	229.8	48.9	95	288.5	61.4
56	54.8	11.6	16	113.4	24.1	76	172.1	36.6	36	230.8	49.1	96	289.5	61.6
57	55.7	11.9	17	114.4	24.3	77	173.1	36.8	37	231.8	49.3	97	290.5	61.8
58	56.7	12.1	18	115.4	24.5	78	174.1	37.0	38	232.8	49.5	98	291.4	62.0
59	57.7	12.3	19	116.4	24.8	79	175.1	37.2	39	233.7	49.7	99	292.4	62.2
60	58.7	12.5	120	117.4	25.0	180	176.0	37.4	240	234.7	49.9	300	293.4	62.4
Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 78 Degrees.

Table III. Difference of Latitude and Departure for 13 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep
1	01.0	00.2	61	59.4	13.7	121	117.9	27.2	181	176.4	40.7	241	234.8	54.2
2	01.9	00.4	62	60.4	13.9	22	118.9	27.4	82	177.3	40.9	42	235.8	54.4
3	02.9	00.7	63	61.4	14.2	23	119.8	27.7	83	178.3	41.2	43	236.8	54.7
4	03.9	00.9	64	62.4	14.4	24	120.8	27.9	84	179.3	41.4	44	237.8	54.9
5	04.9	01.1	65	63.3	14.6	25	121.8	28.1	85	180.3	41.6	45	238.7	55.1
6	05.8	01.3	66	64.3	14.8	26	122.8	28.3	86	181.2	41.8	46	239.7	55.3
7	06.8	01.6	67	65.3	15.1	27	123.7	28.6	87	182.2	42.1	47	240.7	55.6
8	07.8	01.8	68	66.3	15.3	28	124.7	28.8	88	183.2	42.3	48	241.6	55.8
9	08.8	02.0	69	67.2	15.5	29	125.7	29.0	89	184.2	42.5	49	242.6	56.0
10	09.7	02.2	70	68.2	15.7	30	126.7	29.2	90	185.1	42.7	50	243.6	56.2
11	10.7	02.5	71	69.2	16.0	131	127.6	29.5	191	186.1	43.0	251	244.6	56.5
12	11.7	02.7	72	70.2	16.2	32	128.6	29.7	92	187.1	43.2	52	245.5	56.7
13	12.7	02.9	73	71.1	16.4	33	129.6	29.9	93	188.1	43.4	53	246.5	56.9
14	13.6	03.1	74	72.1	16.6	34	130.6	30.1	94	189.0	43.6	54	247.5	57.1
15	14.6	03.4	75	73.1	16.9	35	131.5	30.4	95	190.0	43.9	55	248.5	57.4
16	15.6	03.6	76	74.1	17.1	36	132.5	30.6	96	191.0	44.1	56	249.4	57.6
17	16.6	03.8	77	75.0	17.3	37	133.5	30.8	97	192.0	44.3	57	250.4	57.8
18	17.5	04.0	78	76.0	17.5	38	134.5	31.0	98	192.9	44.5	58	251.4	58.0
19	18.5	04.3	79	77.0	17.8	39	135.4	31.3	99	193.9	45.8	59	252.4	58.3
20	19.5	04.5	80	78.0	18.0	40	136.4	31.5	200	194.9	45.0	60	253.3	58.5
21	20.5	04.7	81	78.9	18.2	141	137.4	31.7	201	195.9	45.2	261	254.3	58.7
22	21.4	04.9	82	79.9	18.4	42	138.4	31.9	02	196.8	45.4	62	255.3	58.9
23	22.4	05.2	83	80.9	18.7	43	139.3	32.2	03	197.8	45.7	63	256.3	59.1
24	23.4	05.4	84	81.8	18.9	44	140.3	32.4	04	198.8	46.9	64	257.2	59.4
25	24.4	05.6	85	82.8	19.1	45	141.5	32.6	05	199.7	46.1	65	258.2	59.6
26	25.3	05.8	86	83.8	19.3	46	142.3	32.8	06	200.7	46.3	66	259.2	59.8
27	26.3	06.1	87	84.8	19.6	47	143.2	33.1	07	201.7	46.5	67	260.2	60.0
28	27.3	06.3	88	85.7	19.8	48	144.2	33.3	08	202.7	46.8	68	261.1	60.3
29	28.3	06.5	89	86.7	20.0	49	145.2	33.5	09	203.6	47.0	69	262.1	60.5
30	29.2	06.7	90	87.7	20.2	50	146.2	33.7	10	204.6	47.2	70	263.1	60.7
31	30.2	07.0	91	88.7	20.5	151	147.1	34.0	211	205.6	47.9	271	264.1	61.0
32	31.2	07.2	92	89.6	20.7	52	148.1	34.2	12	206.6	47.7	72	265.0	61.2
33	32.2	07.4	93	90.6	20.9	53	149.1	34.4	13	207.5	47.9	73	266.0	61.4
34	33.1	07.6	94	91.6	21.1	54	150.1	34.6	14	208.5	48.1	74	267.0	61.6
35	34.1	07.9	95	92.6	21.4	55	151.0	34.9	15	209.5	48.4	75	268.0	61.9
36	35.1	08.1	96	93.5	21.6	56	152.0	35.1	16	210.5	48.6	76	268.9	62.1
37	36.1	08.3	97	94.5	21.8	57	153.0	35.3	17	211.4	48.8	77	269.9	62.3
38	37.0	08.5	98	95.5	22.0	58	154.0	35.5	18	212.4	49.0	78	270.9	62.5
39	38.0	08.8	99	96.5	22.3	59	154.9	35.8	19	213.4	49.3	79	271.9	62.8
40	39.0	08.0	100	97.4	22.5	60	155.9	36.0	20	214.4	49.5	80	272.8	63.0
41	39.9	09.2	101	98.4	22.7	161	156.9	36.2	221	215.3	49.7	281	273.8	63.2
42	40.9	09.4	02	99.4	22.9	62	157.9	36.4	22	216.3	49.9	82	274.8	63.4
43	41.9	09.7	03	100.4	23.2	63	158.8	36.7	23	217.3	50.2	83	275.8	63.7
44	42.9	09.9	04	101.3	23.4	64	159.8	36.9	24	218.3	50.4	84	276.7	63.9
45	43.8	10.1	05	102.3	23.6	65	160.8	37.1	25	219.2	50.6	85	277.7	64.1
46	44.8	10.3	06	103.3	23.8	66	161.7	37.3	26	220.2	50.8	86	278.7	64.3
47	45.8	10.6	07	104.3	24.1	67	162.7	37.6	27	221.2	51.1	87	279.6	64.6
48	46.8	10.8	08	105.2	24.3	68	163.7	37.8	28	222.2	51.3	88	280.6	64.8
49	47.7	11.0	09	106.2	24.5	69	164.7	38.0	29	223.1	51.5	89	281.6	65.0
50	48.7	11.2	10	107.2	24.7	70	165.6	38.2	30	224.1	51.7	90	282.6	65.2
51	49.7	11.5	111	108.2	25.0	171	166.6	38.5	231	225.1	52.0	291	283.5	65.5
52	50.7	11.7	12	109.1	25.2	72	167.6	38.7	32	226.1	52.2	92	284.5	65.7
53	51.6	11.9	13	110.1	25.4	73	168.6	38.9	33	227.0	52.4	93	285.5	65.9
54	52.6	12.1	14	111.1	25.6	74	169.5	39.1	34	228.0	52.6	94	286.5	66.1
55	53.6	12.4	15	112.1	25.9	75	170.5	39.4	35	229.0	52.9	95	287.4	66.4
56	54.6	12.6	16	113.0	26.1	76	171.5	39.6	36	230.0	53.1	96	288.4	66.6
57	55.5	12.8	17	114.0	26.3	77	172.5	39.8	37	230.9	53.3	97	289.4	66.8
58	56.5	13.0	18	115.0	26.5	7	173.4	40.0	38	231.9	53.5	98	290.4	67.0
59	57.5	13.3	19	116.0	26.8	79	174.4	40.2	39	232.9	53.8	99	291.3	67.3
60	58.5	13.5	120	116.9	27.0	180	175.4	40.5	240	233.9	54.0	300	292.3	67.5
Dist	Dep	Lat.	Dist	Dep.	Lat	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 77 Degrees.

Table III. Difference of Latitude and Departure for 14 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep
1	01.0	00.2	61	59.2	14.8	121	117.4	29.3	181	175.6	43.8	241	233.8	58.3
2	01.9	00.5	62	60.2	15.0	22	118.4	29.5	82	176.6	44.0	42	234.8	58.6
3	02.9	00.7	63	61.1	15.2	23	119.3	29.8	83	177.6	44.3	43	235.8	58.8
4	03.9	01.0	64	62.1	15.5	24	120.3	30.0	84	178.5	44.5	44	236.7	59.0
5	04.9	01.2	65	63.1	15.7	25	121.3	30.2	85	179.5	44.8	45	237.7	59.3
6	05.8	01.5	66	64.0	16.0	26	122.3	30.5	86	180.5	45.0	46	238.7	59.5
7	06.8	01.7	67	65.0	16.2	27	123.2	30.7	87	181.4	45.3	47	239.7	59.8
8	07.8	01.9	68	66.0	16.5	28	124.2	31.0	88	182.4	45.5	48	240.6	60.0
9	08.7	02.2	69	66.9	16.7	29	125.2	31.2	89	183.4	45.7	49	241.6	60.3
10	09.7	02.4	70	67.9	16.9	30	126.1	31.5	90	184.4	46.0	50	242.6	60.5
11	10.7	02.7	71	68.9	17.2	131	127.1	31.7	191	185.3	46.2	251	243.5	60.7
12	11.6	02.9	72	69.8	17.4	32	128.1	31.9	92	186.3	46.5	52	244.5	61.0
13	12.6	03.1	73	70.8	17.7	33	129.0	32.2	93	187.3	46.7	53	245.5	61.2
14	13.6	03.4	74	71.8	17.9	34	130.0	32.4	94	188.2	46.9	54	246.4	61.5
15	14.6	03.6	75	72.8	18.1	35	131.0	32.7	95	189.2	47.2	55	247.4	61.7
16	15.5	03.9	76	73.7	18.4	36	132.0	32.9	96	190.2	47.4	56	248.4	62.0
17	16.5	04.1	77	74.7	18.6	37	132.9	33.2	97	191.1	47.7	57	249.4	62.2
18	17.5	04.4	78	75.7	18.9	38	133.9	33.4	98	192.1	47.9	58	250.3	62.4
19	18.4	04.6	79	76.7	19.1	39	134.9	33.6	99	193.1	48.2	59	251.3	62.7
20	19.4	04.8	80	77.6	19.4	40	135.8	33.9	200	194.1	48.4	60	252.3	62.9
21	20.4	05.1	81	78.6	19.6	141	136.8	34.1	201	195.0	48.6	261	253.2	63.2
22	21.3	05.3	82	79.6	19.8	42	137.8	34.4	02	196.0	48.9	62	254.2	63.4
23	22.3	05.6	83	80.5	20.1	43	138.7	34.6	03	197.0	49.1	63	255.2	63.6
24	23.3	05.8	84	81.5	20.3	44	139.7	34.8	04	197.9	49.4	64	256.2	63.9
25	24.3	06.0	85	82.5	20.6	45	140.7	35.1	05	198.9	49.6	65	257.1	64.1
26	25.2	06.3	86	83.4	20.8	46	141.7	35.3	06	199.9	49.9	66	258.1	64.4
27	26.2	06.5	87	84.4	21.1	47	142.6	35.6	07	200.8	50.1	67	259.1	64.6
28	27.2	06.8	88	85.4	21.3	48	143.6	35.8	08	201.8	50.3	68	260.0	64.9
29	28.1	07.0	89	86.4	21.5	49	144.6	36.1	09	202.8	50.6	69	261.0	65.1
30	29.1	07.3	90	87.3	21.8	50	145.5	36.3	10	203.8	50.8	70	262.0	65.3
31	30.1	07.5	91	88.3	22.0	151	146.5	36.5	211	204.7	51.1	271	262.9	65.6
32	31.0	07.7	92	89.3	22.3	52	147.5	36.8	12	205.7	51.3	72	263.9	65.8
33	32.0	08.0	93	90.2	22.5	53	148.5	37.0	13	206.7	51.5	73	264.9	66.1
34	33.0	08.2	94	91.2	22.7	54	149.4	37.3	14	207.6	51.8	74	265.9	66.3
35	34.0	08.5	95	92.2	23.0	55	150.4	37.5	15	208.6	52.0	75	266.8	66.5
36	34.9	08.7	96	93.1	23.2	56	151.4	37.7	16	209.6	52.3	76	267.8	66.8
37	35.9	09.0	97	94.1	23.5	57	152.3	38.0	17	210.5	52.5	77	268.8	67.0
38	36.9	09.2	98	95.1	23.7	58	153.3	38.2	18	211.5	52.8	78	269.7	67.2
39	37.8	09.4	99	96.1	24.0	59	154.3	38.5	19	212.5	53.0	79	270.7	67.5
40	38.8	09.7	100	97.0	24.2	60	155.2	38.7	20	213.5	53.2	80	271.7	67.8
41	39.8	09.9	101	98.0	24.4	161	156.2	39.0	221	214.4	53.5	281	272.6	68.0
42	40.8	10.2	02	99.0	24.7	62	157.2	39.2	22	215.4	53.7	82	273.6	68.2
43	41.7	10.4	03	99.9	24.9	63	158.2	39.4	23	216.4	54.0	83	274.6	68.5
44	42.7	10.6	04	100.9	25.2	64	159.1	39.7	24	217.3	54.2	84	275.6	68.7
45	43.7	10.9	05	101.9	25.4	65	160.1	39.9	25	218.3	54.4	85	276.5	69.0
46	44.6	11.1	06	102.8	25.7	66	161.1	40.2	26	219.3	54.7	86	277.5	69.2
47	45.6	11.4	07	103.8	25.9	67	162.0	40.4	27	220.3	54.9	87	278.5	69.5
48	46.6	11.6	08	104.8	26.1	68	163.0	40.7	28	221.2	55.2	88	279.4	69.7
49	47.5	11.9	09	105.8	26.4	69	164.0	40.9	29	222.2	55.4	89	280.4	69.9
50	48.5	12.1	10	106.7	26.6	70	164.9	41.1	30	223.2	55.7	90	281.4	70.2
51	49.5	12.3	111	107.7	26.9	171	165.9	41.4	231	224.1	55.9	291	282.3	70.4
52	50.5	12.6	12	108.7	27.1	72	166.9	41.6	32	225.1	56.1	92	283.3	70.7
53	51.4	12.8	13	109.6	27.3	73	167.9	41.9	33	226.1	56.4	93	284.3	70.9
54	52.4	13.1	14	110.6	27.6	74	168.8	42.1	34	227.0	56.6	94	285.3	71.1
55	53.4	13.3	15	111.6	27.8	75	169.8	42.3	35	228.0	56.9	95	286.2	71.4
56	54.3	13.6	16	112.6	28.1	76	170.8	42.6	36	229.0	57.1	96	287.2	71.6
57	55.3	13.8	17	113.5	28.3	77	171.7	42.8	37	230.0	57.4	97	288.2	71.9
58	56.3	14.0	18	114.5	28.6	78	172.7	43.1	38	230.9	57.6	98	289.1	72.1
59	57.2	14.3	19	115.5	28.8	79	173.7	43.3	39	231.9	57.8	99	290.1	72.4
60	58.2	14.5	120	116.4	29.0	180	174.6	43.6	140	232.9	58.1	300	291.1	72.6
Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 76 Degrees.

Table III. Difference of Latitude and Departure for 15 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep
1	01.0	00.3	61	58.9	15.8	121	116.9	31.3	181	174.8	46.8	241	232.8	62.4
2	01.9	00.5	62	59.9	16.0	22	117.8	31.6	82	175.8	47.1	42	233.7	62.6
3	02.9	00.8	63	60.9	16.3	23	118.8	31.8	83	176.8	47.4	43	234.7	62.9
4	03.9	01.0	64	61.8	16.6	24	119.8	32.1	84	177.7	47.6	44	235.7	63.1
5	04.8	01.3	65	62.8	16.8	25	120.7	32.4	85	178.7	47.9	45	236.6	63.4
6	05.8	01.6	66	63.7	17.1	26	121.7	32.6	86	179.7	48.1	46	237.6	63.7
7	06.8	01.8	67	64.7	17.3	27	122.7	32.9	87	180.6	48.4	47	238.6	63.9
8	07.7	02.1	68	65.7	17.6	28	123.6	33.1	88	181.6	48.7	48	239.5	64.2
9	08.7	02.3	69	66.6	17.9	29	124.6	33.4	89	182.6	48.9	49	240.5	64.4
10	09.7	02.6	70	67.6	18.2	30	125.6	33.6	90	183.5	49.2	50	241.5	64.7
11	10.6	02.8	71	68.6	18.4	131	126.5	33.9	191	184.5	49.4	251	242.4	65.0
12	11.6	03.1	72	69.5	18.6	32	127.5	34.2	92	185.5	49.7	52	243.4	65.2
13	12.6	03.4	73	70.5	18.9	33	128.5	34.4	93	186.4	49.9	53	244.4	65.5
14	13.5	03.6	74	71.5	19.2	34	129.4	34.7	49	187.4	50.2	54	245.3	65.7
15	14.5	03.9	75	72.4	19.4	35	130.4	34.9	95	188.4	50.5	55	246.3	66.0
16	15.5	04.1	76	73.4	19.7	36	131.4	35.2	96	189.3	50.7	56	247.3	66.3
17	16.4	04.4	77	74.4	19.9	37	132.3	35.5	97	190.3	51.0	57	248.2	66.5
18	17.4	04.7	78	75.3	20.2	38	133.3	35.7	98	191.2	51.2	58	249.2	66.8
19	18.4	04.9	79	76.3	20.4	39	134.3	36.0	99	192.2	51.5	59	250.2	67.0
20	19.3	05.1	80	77.3	20.7	40	135.2	36.2	200	193.2	51.8	60	251.1	67.3
21	20.3	05.4	81	78.2	21.0	141	136.2	36.5	201	194.1	52.0	261	252.1	67.5
22	21.2	05.7	82	79.2	21.2	42	137.2	36.7	02	195.1	52.3	62	253.1	67.8
23	22.2	06.0	83	80.2	21.5	43	138.1	37.0	03	196.1	52.5	63	254.0	68.1
24	23.2	06.2	84	81.1	21.7	44	139.1	37.3	04	197.0	52.8	64	255.0	68.3
25	24.1	06.5	85	82.1	22.0	45	140.1	37.5	05	198.0	53.1	65	256.0	68.6
26	25.1	06.7	86	83.1	22.3	46	141.0	37.8	06	199.0	53.3	66	256.9	68.8
27	26.1	07.0	87	84.0	22.5	47	142.0	38.0	07	199.9	53.6	67	257.9	69.1
28	27.0	07.2	88	85.0	22.8	48	143.0	38.3	08	200.9	53.8	68	258.9	69.4
29	28.0	07.5	89	86.0	23.0	49	143.9	38.6	09	201.9	54.1	69	259.8	69.6
30	29.0	07.8	90	86.9	23.3	50	144.9	38.8	10	202.8	54.3	70	260.8	69.9
31	29.9	08.0	91	87.9	23.6	151	145.8	39.1	211	203.8	54.6	271	261.8	70.1
32	30.9	08.3	92	88.8	23.8	52	146.8	39.3	12	204.8	54.9	72	262.7	70.4
33	31.9	08.5	93	89.8	24.1	53	147.8	39.6	13	205.7	55.1	73	263.7	70.7
34	32.8	08.8	94	90.8	24.3	54	148.7	39.9	14	206.7	55.4	74	264.7	70.9
35	33.8	09.1	95	91.8	24.6	55	149.7	40.1	15	207.7	55.6	75	265.6	71.2
36	34.8	09.3	96	92.7	24.8	56	150.7	40.4	16	208.6	55.9	76	266.6	71.4
37	35.7	09.6	97	93.7	25.1	57	151.6	40.6	17	209.6	56.1	77	267.6	71.7
38	36.7	09.8	98	94.7	25.4	58	152.6	40.9	18	210.6	56.4	78	268.5	71.9
39	37.7	10.1	99	95.6	25.6	59	153.6	41.1	19	211.5	56.7	79	269.5	72.2
40	38.6	10.4	100	96.6	25.9	60	154.5	41.4	20	212.5	56.9	80	270.5	72.5
41	39.6	10.6	101	97.6	26.1	161	155.5	41.7	221	213.5	57.2	281	271.4	72.7
42	40.6	10.9	02	98.5	26.4	62	156.5	41.9	22	214.4	57.5	82	272.4	73.0
43	41.5	11.1	03	99.5	26.7	63	157.4	42.2	23	215.4	57.7	83	273.4	73.2
44	42.5	11.4	04	100.5	26.9	64	158.4	42.4	24	216.4	58.0	84	274.3	73.5
45	43.5	11.6	05	101.4	27.2	65	159.4	42.7	25	217.3	58.2	85	275.3	73.8
46	44.4	11.9	06	102.4	27.4	66	160.3	43.0	26	218.3	58.5	86	276.2	74.0
47	45.4	12.2	07	103.4	27.7	67	161.3	43.2	27	219.3	58.7	87	277.2	74.3
48	46.4	12.4	08	104.3	28.0	68	162.3	43.5	28	220.2	59.0	88	278.2	74.5
49	47.3	12.7	09	105.3	28.2	69	163.2	43.7	29	221.2	59.3	89	279.1	74.8
50	48.3	12.9	10	106.2	28.5	70	164.2	44.0	30	222.2	59.5	90	280.1	75.0
51	49.3	13.2	111	107.2	28.7	171	165.2	44.3	231	223.1	59.8	291	281.1	75.3
52	50.2	13.5	12	108.2	29.0	72	166.1	44.5	32	224.1	60.0	92	282.0	75.6
53	51.2	13.7	13	109.1	29.2	73	167.1	44.8	33	225.1	60.3	93	283.0	75.8
54	52.2	14.0	14	110.1	29.5	74	168.1	45.0	34	226.0	60.6	94	284.0	76.1
55	53.1	14.2	15	111.1	29.8	75	169.0	45.3	35	227.0	60.8	95	284.9	76.3
56	54.1	14.5	16	112.0	30.0	76	170.0	45.5	36	228.0	61.1	96	285.9	76.6
57	55.1	14.8	17	113.0	30.3	77	171.0	45.8	37	228.9	61.3	97	286.9	76.9
58	56.0	15.0	18	114.0	30.5	78	171.9	46.1	38	229.9	61.6	98	287.8	77.1
59	57.0	15.3	19	114.9	30.8	79	172.9	46.3	39	230.9	61.9	99	288.8	77.4
60	58.0	15.5	120	115.9	31.1	180	173.9	46.6	240	231.8	62.1	300	289.8	77.6
Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat

for 75 Degrees.

Table III. Difference of Latitude and Departure for 16 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep
1	01.0	00.3	61	58.6	16.8	121	116.3	33.3	181	174.0	49.9	241	231.6	66.4
2	01.9	00.6	62	59.6	17.1	22	117.3	33.6	82	174.9	50.2	42	232.6	66.7
3	02.9	00.8	63	60.6	17.4	23	118.2	33.9	83	175.9	50.4	43	233.6	67.0
4	03.8	01.1	64	61.5	17.6	24	119.2	34.2	84	176.8	50.7	44	234.5	67.2
5	04.8	01.4	65	62.5	17.9	25	120.1	34.4	85	177.8	51.0	45	235.5	67.5
6	05.8	01.7	66	63.4	18.2	26	121.1	34.7	86	178.8	51.3	46	236.4	67.8
7	06.7	01.9	67	64.4	18.5	27	122.1	35.0	87	179.7	51.5	47	237.4	68.1
8	07.7	02.2	68	65.4	18.7	28	123.0	35.3	88	180.7	51.8	48	238.4	68.3
9	08.7	02.5	69	66.3	19.0	29	124.0	35.6	89	181.7	52.1	49	239.3	68.6
10	09.6	02.8	70	67.3	19.3	30	124.9	35.8	90	182.6	52.4	50	240.3	68.9
11	10.6	03.0	71	68.2	19.6	131	125.9	36.1	191	183.6	52.6	251	241.2	69.2
12	11.5	03.3	72	69.2	19.8	32	126.9	36.4	92	184.5	52.9	52	242.2	69.5
13	12.5	03.6	73	70.2	20.1	33	127.8	36.7	93	185.5	53.2	53	243.2	69.7
14	13.5	03.9	74	71.1	20.4	34	128.8	36.9	94	186.5	53.5	54	244.1	70.0
15	14.4	04.1	75	72.1	20.7	35	129.8	37.2	95	187.4	53.7	55	245.1	70.3
16	15.4	04.4	76	73.0	20.9	36	130.7	37.5	96	188.4	54.0	56	246.0	70.6
17	16.3	04.7	77	74.0	21.2	37	131.7	37.8	97	189.3	54.3	57	247.0	70.8
18	17.3	05.0	78	75.0	21.5	38	132.6	38.0	98	190.3	54.6	58	248.0	71.1
19	18.3	05.2	79	75.9	21.8	39	133.6	38.3	99	191.3	54.8	59	248.9	71.4
20	19.2	05.5	80	76.9	22.0	40	134.6	38.6	200	192.2	55.1	60	249.9	71.7
21	20.2	05.8	81	77.9	22.3	141	135.5	38.9	201	193.2	55.4	261	250.9	71.9
22	21.1	06.1	82	78.8	22.6	42	136.5	39.1	02	194.1	55.7	62	251.8	72.2
23	22.1	06.3	83	79.8	22.9	43	137.4	39.4	03	195.1	55.9	63	252.8	72.5
24	23.1	06.6	84	80.7	23.1	44	138.4	39.7	04	196.1	56.2	64	253.7	72.8
25	24.0	06.9	85	81.7	23.4	45	139.4	40.0	05	197.0	56.5	65	254.7	73.0
26	25.0	07.2	86	82.7	23.7	46	140.3	40.2	06	198.0	56.8	66	255.7	73.3
27	26.0	07.4	87	83.6	24.0	47	141.3	40.5	07	199.0	57.0	67	256.6	73.6
28	26.9	07.7	88	84.6	24.3	48	142.2	40.8	08	199.9	57.3	68	257.6	73.9
29	27.9	08.0	89	85.5	24.5	49	143.2	41.1	09	200.9	57.6	69	258.5	74.1
30	28.8	08.3	90	86.5	24.8	50	144.2	41.3	10	201.8	57.9	70	259.5	74.4
31	29.8	08.5	91	87.5	25.1	151	145.1	41.6	211	202.8	58.2	271	260.5	74.7
32	30.8	08.8	92	88.4	25.4	52	146.1	41.9	12	203.8	58.4	72	261.4	75.0
33	31.7	09.1	93	89.4	25.6	53	147.1	42.2	13	204.7	58.7	73	262.4	75.2
34	32.7	09.4	94	90.3	25.9	54	148.0	42.4	14	205.7	59.0	74	263.3	75.5
35	33.6	09.6	95	91.3	26.2	55	149.0	42.7	15	206.6	59.3	75	264.3	75.8
36	34.6	09.9	96	92.3	26.5	56	149.9	43.0	16	207.6	59.5	76	265.3	76.1
37	35.6	10.2	97	93.2	26.7	57	150.9	43.3	17	208.6	59.8	77	266.2	76.3
38	36.5	10.5	98	94.2	27.0	58	151.9	43.5	18	209.5	60.1	78	267.2	76.6
39	37.5	10.7	99	95.2	27.3	59	152.8	43.8	19	210.5	60.4	79	268.2	76.9
40	38.4	11.0	100	96.1	27.6	60	153.8	44.1	20	211.4	60.6	80	269.1	77.2
41	39.4	11.3	101	97.1	27.8	161	154.7	44.4	221	212.4	60.9	281	270.1	77.4
42	40.4	11.6	02	98.0	28.1	62	155.7	44.6	22	213.4	61.2	82	271.0	77.7
43	41.3	11.9	03	99.0	28.4	63	156.7	44.9	23	214.3	61.5	83	272.0	78.0
44	42.3	12.1	04	100.0	28.7	64	157.6	45.2	24	215.3	61.7	84	273.0	78.3
45	43.3	12.4	05	100.9	28.9	65	158.6	45.5	25	216.3	62.0	85	274.9	78.5
46	44.2	12.7	06	101.9	29.2	66	159.5	45.7	26	217.2	62.3	86	274.9	78.8
47	45.2	13.0	07	102.8	29.5	67	160.5	46.0	27	218.2	62.6	87	275.8	79.1
48	46.1	13.2	08	103.8	29.8	68	161.5	46.3	28	219.1	62.8	88	276.8	79.4
49	47.1	13.5	09	104.8	30.0	69	162.4	46.6	29	220.1	63.1	89	277.8	79.6
50	48.1	13.8	10	105.7	30.3	70	163.4	46.9	30	221.1	63.4	90	278.7	79.9
51	49.0	14.1	111	106.7	30.6	171	164.4	47.1	231	222.0	63.7	291	279.7	80.2
52	50.0	14.3	12	107.6	30.9	72	165.3	47.4	32	223.0	63.9	92	280.6	80.5
53	50.9	14.6	13	108.6	31.1	73	166.3	47.7	33	223.9	64.2	93	281.6	80.8
54	51.9	14.9	14	109.6	31.4	74	167.2	48.0	34	224.9	64.5	94	282.6	81.0
55	52.9	15.2	15	110.5	31.7	75	168.2	48.2	35	225.9	64.8	95	283.5	81.3
56	53.8	15.4	16	111.5	32.0	76	169.2	48.5	36	226.8	65.0	96	284.5	81.6
57	54.8	15.7	17	112.5	32.2	77	170.1	48.8	37	227.8	65.3	97	285.5	81.9
58	55.7	16.0	18	113.4	32.5	78	171.1	49.1	38	228.7	65.6	98	286.4	82.1
59	56.7	16.3	19	114.4	32.8	79	172.0	49.3	39	229.7	65.9	99	287.4	82.4
60	57.7	16.5	120	115.3	33.1	180	173.0	49.6	240	230.7	66.1	300	288.3	82.7
Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep
1	01.0	00.3	61	58.3	17.8	121	115.7	35.4	181	173.1	52.9	241	230.5	70.4
2	01.9	00.6	62	59.3	18.1	22	116.7	35.7	82	174.0	53.2	42	231.4	70.7
3	02.9	00.9	63	60.2	18.4	23	117.6	36.0	83	175.0	53.5	43	232.4	71.0
4	03.8	01.2	64	61.2	18.7	24	118.6	36.2	84	175.9	53.8	44	233.3	71.3
5	04.8	01.5	65	62.2	19.0	25	119.5	36.5	85	176.9	54.1	45	234.3	71.6
6	05.7	01.8	66	63.1	19.3	26	120.5	36.8	86	177.9	54.4	46	235.2	71.9
7	06.7	02.0	67	64.1	19.6	27	121.4	37.1	87	178.8	54.7	47	236.2	72.1
8	07.6	02.3	68	65.9	19.9	28	122.4	37.4	88	179.8	55.0	48	237.1	72.4
9	08.6	02.6	69	66.0	20.2	29	123.4	37.7	89	180.7	55.2	49	238.1	72.7
10	09.6	02.9	70	66.9	20.5	30	124.3	38.0	90	181.7	55.5	50	239.1	73.0
11	10.5	03.2	71	67.9	20.8	131	125.3	38.3	191	182.6	55.8	251	240.0	73.3
12	11.5	03.5	72	68.8	21.0	32	126.2	38.6	92	183.6	56.1	52	241.0	73.6
13	12.4	03.8	73	69.8	21.3	33	127.2	38.9	93	184.6	56.4	53	241.9	73.9
14	13.4	04.1	74	70.8	21.6	34	128.1	39.2	94	185.5	56.7	54	242.9	74.1
15	14.3	04.4	75	71.7	21.9	35	129.1	39.5	95	186.5	57.0	55	243.8	74.4
16	15.3	04.7	76	72.7	22.2	36	130.0	39.8	96	187.4	57.3	56	244.8	74.7
17	16.3	05.0	77	73.6	22.5	37	131.0	40.0	97	188.4	57.6	57	245.8	75.0
18	17.2	05.3	78	74.6	22.8	38	132.0	40.3	98	189.3	57.9	58	246.7	75.3
19	18.2	05.6	79	75.5	23.1	39	132.9	40.6	99	190.3	58.2	59	247.7	75.6
20	19.1	05.8	80	76.5	23.4	40	133.9	40.9	200	191.2	58.5	60	248.6	75.9
21	20.1	06.1	81	77.5	23.7	141	134.8	41.2	201	192.2	58.8	261	249.6	76.2
22	21.0	06.4	82	78.4	24.0	42	135.8	41.5	02	193.2	59.0	62	250.5	76.5
23	22.0	06.7	83	79.4	24.3	43	136.7	41.8	03	194.1	59.3	63	251.5	76.8
24	22.9	07.0	84	80.3	24.6	44	137.7	42.1	04	195.1	59.6	64	252.4	77.1
25	23.9	07.3	85	81.3	24.8	45	138.7	42.4	05	196.0	59.9	65	253.4	77.4
26	24.9	07.6	86	82.2	25.1	46	139.6	42.7	06	197.0	60.2	66	254.4	77.7
27	25.8	07.9	87	83.2	25.4	47	140.6	43.0	07	197.9	60.5	67	255.3	77.9
28	26.8	08.2	88	84.1	25.7	48	141.5	43.3	08	198.9	60.8	68	256.3	78.2
29	27.7	08.5	89	85.1	26.0	49	142.5	43.6	09	199.8	61.1	69	257.2	78.5
30	28.7	08.8	90	86.1	26.3	50	143.4	43.8	10	200.8	61.4	70	258.2	78.8
31	29.6	09.1	91	87.0	26.6	151	144.4	44.1	211	201.8	61.7	271	259.1	79.1
32	30.6	09.4	92	88.0	26.9	52	145.3	44.4	12	202.7	62.0	72	260.1	79.4
33	31.6	09.6	93	88.9	27.2	53	146.3	44.7	13	203.7	62.3	73	261.1	79.7
34	32.5	09.9	94	89.9	27.5	54	147.3	45.0	14	204.6	62.6	74	262.0	80.0
35	33.5	10.2	95	90.8	27.8	55	148.2	45.3	15	205.6	62.8	75	263.0	80.3
36	34.4	10.5	96	91.8	28.1	56	149.2	45.6	16	206.5	63.1	76	263.9	80.6
37	35.4	10.8	97	92.8	28.4	57	150.1	45.9	17	207.5	63.4	77	264.9	80.9
38	36.3	11.1	98	93.7	28.6	58	151.1	46.2	18	208.5	63.7	78	265.8	81.2
39	37.3	11.4	99	94.7	28.9	59	152.0	46.5	19	209.4	64.0	79	266.8	81.4
40	38.2	11.7	100	95.6	29.2	60	153.0	46.8	20	210.4	64.3	80	267.7	81.7
41	39.2	12.0	101	96.6	29.5	161	154.0	47.1	221	211.3	64.6	281	268.7	82.0
42	40.2	12.3	02	97.5	29.8	62	154.9	47.4	22	212.3	64.9	82	269.7	82.3
43	41.1	12.6	03	98.5	30.1	63	155.9	47.6	23	213.2	65.2	83	270.6	82.6
44	42.1	12.9	04	99.4	30.4	64	156.8	47.9	24	214.2	65.5	84	271.6	82.9
45	43.0	13.2	05	100.4	30.7	65	157.8	48.2	25	215.2	65.8	85	272.5	83.2
46	44.0	13.4	06	101.4	31.0	66	158.7	48.5	26	216.1	66.1	86	273.5	83.5
47	44.9	13.7	07	102.3	31.3	67	159.7	48.8	27	217.1	66.4	87	274.4	83.8
48	45.9	14.0	08	103.3	31.6	68	160.6	49.1	28	218.0	66.6	88	275.4	84.1
49	46.9	14.3	09	104.2	31.9	69	161.6	49.4	29	219.0	66.9	89	276.4	84.4
50	47.8	14.6	10	105.2	32.2	70	162.6	49.7	30	219.9	67.2	90	277.3	84.7
51	48.8	14.9	111	106.1	32.4	171	163.5	50.0	231	220.9	67.5	291	278.3	85.0
52	49.7	15.2	12	107.1	32.7	72	164.5	50.3	32	221.8	67.8	92	279.2	85.3
53	50.7	15.5	13	108.1	33.0	73	165.4	50.6	33	222.8	68.1	93	280.2	85.5
54	51.6	15.8	14	109.0	33.3	74	166.4	50.9	34	223.8	68.4	94	281.1	85.8
55	52.6	16.1	15	110.0	33.6	75	167.3	51.2	35	224.7	68.7	95	282.1	86.1
56	53.5	16.4	16	110.9	33.9	76	168.3	51.4	36	225.7	69.0	96	283.0	86.4
57	54.5	16.7	17	111.9	34.2	77	169.3	51.7	37	226.6	69.3	97	284.0	86.7
58	55.5	17.0	18	112.8	34.5	78	170.2	52.0	38	227.6	69.6	98	285.0	87.0
59	56.4	17.2	19	113.8	34.8	79	171.2	52.3	39	228.5	69.9	99	285.9	87.3
60	57.4	17.5	120	114.7	35.1	180	172.1	52.6	240	229.5	70.2	300	286.9	87.6
Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 73 Degrees.

Dist	Lat.	Dep.	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep
1	01.0	00.3	61	58.0	18.8	121	115.1	37.4	181	172.1	55.9	241	229.2	74.5
2	01.9	00.6	62	59.0	19.2	22	116.0	37.7	82	173.1	56.2	42	230.1	74.8
3	02.9	00.9	63	59.9	19.5	23	117.0	38.0	83	174.0	56.5	43	231.1	75.1
4	03.8	01.2	64	60.9	19.8	24	117.9	38.3	84	175.0	56.9	44	232.0	75.4
5	04.8	01.5	65	61.8	20.1	25	118.9	38.6	85	175.9	57.2	45	233.0	75.7
6	05.7	01.9	66	62.8	20.4	26	119.8	38.9	86	176.9	57.5	46	233.9	76.0
7	06.7	02.2	67	63.7	20.7	27	120.8	39.2	87	177.8	57.8	47	234.9	76.3
8	07.6	02.5	68	64.7	21.0	28	121.7	39.6	88	178.8	58.1	48	235.8	76.6
9	08.6	02.8	69	65.6	21.3	29	122.7	39.9	89	179.7	58.4	49	236.8	76.9
10	09.5	03.1	70	66.6	21.6	30	123.6	40.2	90	180.7	58.7	50	237.8	77.3
11	10.5	03.4	71	67.5	21.9	131	124.6	40.5	191	181.6	59.0	251	238.7	77.6
12	11.4	03.7	72	68.5	22.2	32	125.5	40.8	92	182.6	59.3	52	239.7	77.9
13	12.4	04.0	73	69.4	22.6	33	126.5	41.1	93	183.5	59.6	53	240.6	78.2
14	13.3	04.3	74	70.4	22.9	34	127.4	41.4	94	184.5	59.9	54	241.6	78.5
15	14.3	04.6	75	71.3	23.2	35	128.4	41.7	95	185.4	60.3	55	242.5	78.8
16	15.2	04.9	76	72.3	23.5	36	129.3	42.0	96	186.4	60.6	56	243.5	79.1
17	16.2	05.3	77	73.2	23.8	37	130.3	42.3	97	187.3	60.9	57	244.4	79.4
18	17.1	05.6	78	74.2	24.1	38	131.2	42.6	98	188.3	61.2	58	245.4	79.7
19	18.1	05.9	79	75.1	24.4	39	132.2	43.0	99	189.2	61.5	59	246.3	80.0
20	19.0	06.2	80	76.1	24.7	40	133.1	43.3	200	190.2	61.8	60	247.3	80.3
21	20.0	06.5	81	77.0	25.0	141	134.1	43.6	201	191.2	62.1	261	248.2	80.6
22	20.9	06.8	82	78.0	25.3	42	135.0	43.9	02	192.1	62.4	62	249.2	81.0
23	21.9	07.1	83	78.9	25.6	43	136.0	44.2	03	193.1	62.7	63	250.1	81.3
24	22.8	07.4	84	79.9	26.0	44	136.9	44.5	04	194.0	63.0	64	251.1	81.6
25	23.8	07.7	85	80.8	26.3	45	137.9	44.8	05	195.0	63.3	65	252.0	81.9
26	24.7	08.0	86	81.8	26.6	46	138.8	45.1	06	195.9	63.7	66	253.0	82.2
27	25.7	08.3	87	82.7	26.9	47	139.8	45.4	07	196.9	64.0	67	253.9	82.5
28	26.6	08.7	88	83.7	27.2	48	140.7	45.7	08	197.8	64.3	68	254.9	82.8
29	27.6	09.0	89	84.6	27.5	49	141.7	46.0	09	198.8	64.6	69	255.8	83.1
30	28.5	09.3	90	85.6	27.8	50	142.7	46.3	10	199.7	64.9	70	256.8	83.4
31	29.5	09.6	91	86.5	28.1	151	143.6	46.7	211	200.7	65.2	271	257.7	83.7
32	30.4	09.9	92	87.5	28.4	52	144.6	47.0	12	201.6	65.5	72	258.7	84.0
33	31.4	10.2	93	88.4	28.7	53	145.5	47.3	13	202.6	65.8	73	259.6	84.4
34	32.3	10.5	94	89.4	29.0	54	146.5	47.6	14	203.5	66.1	74	260.6	84.7
35	33.3	10.8	95	90.3	29.4	55	147.4	47.9	15	204.5	66.4	75	261.5	85.0
36	34.2	11.1	96	91.3	29.7	56	148.4	48.2	16	205.4	66.7	76	262.5	85.3
37	35.2	11.4	97	92.2	30.0	57	149.3	48.5	17	206.4	67.1	77	263.4	85.6
38	36.1	11.7	98	93.2	30.3	58	150.3	48.8	18	207.3	67.4	78	264.4	85.9
39	37.1	12.1	99	94.1	30.6	59	151.2	49.1	19	208.3	67.7	79	265.3	86.2
40	38.0	12.4	100	95.1	30.9	60	152.2	49.4	20	209.2	68.0	80	266.3	86.5
41	39.0	12.7	101	96.1	31.2	161	153.1	49.7	221	210.2	68.3	281	267.2	86.8
42	39.9	13.0	02	97.0	31.5	62	154.1	50.1	22	211.1	68.6	82	268.2	87.1
43	40.9	13.3	03	98.0	31.8	63	155.0	50.4	23	212.1	68.9	83	269.1	87.4
44	41.8	13.6	04	98.9	32.1	64	156.0	50.7	24	213.0	69.2	84	270.1	87.8
45	42.8	13.9	05	99.9	32.4	65	156.9	51.0	25	214.0	69.5	85	271.0	88.1
46	43.7	14.2	06	100.8	32.8	66	157.9	51.3	26	214.9	69.8	86	272.0	88.4
47	44.7	14.5	07	101.8	33.1	67	158.8	51.6	27	215.9	70.1	87	272.9	88.7
48	45.6	14.8	08	102.7	33.4	68	159.8	51.9	28	216.8	70.5	88	273.9	89.0
49	46.6	15.1	09	103.7	33.7	69	160.7	52.2	29	217.8	70.8	89	274.8	89.3
50	47.6	15.5	10	104.6	34.0	70	161.7	52.5	30	218.7	71.1	90	275.8	89.6
51	48.5	15.8	111	105.6	34.3	171	162.6	52.8	231	219.7	71.4	291	276.7	89.9
52	49.5	16.1	12	106.5	34.6	72	163.6	53.1	32	220.6	71.7	92	277.7	90.2
53	50.4	16.4	13	107.5	34.9	73	164.5	53.5	33	221.6	72.0	93	278.6	90.5
54	51.4	16.7	14	108.4	35.2	74	165.5	53.8	34	222.5	72.3	94	279.6	90.8
55	52.3	17.0	15	109.4	35.5	75	166.4	54.1	35	223.5	72.6	95	280.5	91.2
56	53.3	17.3	16	110.3	35.8	76	167.4	54.4	36	224.4	72.9	96	281.5	91.5
57	54.2	17.6	17	111.3	36.2	77	168.3	54.7	37	225.4	73.2	97	282.4	91.8
58	55.2	17.9	18	112.2	36.5	78	169.3	55.0	38	226.3	73.5	98	283.4	92.1
59	56.1	18.2	19	113.2	36.8	79	170.2	55.3	39	227.3	73.9	99	284.3	92.4
60	57.1	18.5	120	114.1	37.1	180	171.2	55.6	240	228.2	74.2	300	285.3	92.7
Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 72 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep
1	00.9	00.3	61	57.7	19.9	121	114.0	39.4	181	171.1	58.9	241	227.9	78.5
2	01.9	00.7	62	58.6	20.2	22	115.3	39.7	82	172.1	59.3	42	228.8	78.8
3	02.8	01.0	63	59.6	20.5	23	116.3	40.0	83	173.0	59.6	43	229.7	79.1
4	03.8	01.3	64	60.5	20.8	24	117.2	40.4	84	174.0	59.9	44	230.7	79.4
5	04.7	01.6	65	61.5	21.2	25	118.2	40.7	85	174.9	60.2	45	231.6	79.8
6	05.7	02.0	66	62.4	21.5	26	119.1	41.0	86	175.9	60.6	46	232.6	80.1
7	06.6	02.3	67	63.3	21.8	27	120.1	41.4	87	176.8	60.9	47	233.5	80.4
8	07.6	02.6	68	64.3	22.1	28	121.0	41.7	88	177.7	61.2	48	234.5	80.7
9	08.5	02.9	69	65.2	22.5	29	122.0	42.0	89	178.7	61.5	49	235.4	81.1
10	09.5	03.3	70	66.2	22.8	30	122.9	42.3	90	179.6	61.9	50	236.4	81.4
11	10.4	03.6	71	67.1	23.1	131	123.9	42.7	191	180.6	62.2	251	237.3	81.7
12	11.3	03.9	72	68.1	23.4	32	124.8	43.0	92	181.5	62.5	52	238.3	82.1
13	12.3	04.2	73	69.0	23.8	33	125.7	43.3	93	182.5	62.8	53	239.2	82.4
14	13.2	04.6	74	70.0	24.1	34	126.7	43.6	94	183.4	63.2	54	240.1	82.7
15	14.2	04.9	75	70.9	24.4	35	127.6	44.0	95	184.4	63.5	55	241.1	83.0
16	15.1	05.2	76	71.9	24.7	36	128.6	44.3	96	185.3	63.8	56	242.0	83.4
17	16.1	05.5	77	72.8	25.1	37	129.5	44.6	97	186.3	64.1	57	243.0	83.7
18	17.0	05.9	78	73.7	25.4	38	130.5	44.9	98	187.2	64.5	58	243.9	84.0
19	18.0	06.2	79	74.7	25.7	39	131.4	45.3	99	188.1	64.8	59	244.9	84.3
20	18.9	06.5	80	75.6	26.0	40	132.4	45.6	200	189.1	65.1	60	245.8	84.7
21	19.9	06.8	81	76.6	26.4	141	133.3	45.9	201	190.0	65.4	261	246.8	85.0
22	20.8	07.2	82	77.5	26.7	42	134.3	46.2	02	191.0	65.8	62	247.7	85.3
23	21.7	07.5	83	78.5	27.0	43	135.2	46.6	03	191.9	66.1	63	248.7	85.6
24	22.7	07.8	84	79.4	27.4	44	136.1	46.9	04	192.9	66.4	64	249.6	86.0
25	23.6	08.1	85	80.4	27.7	45	137.1	47.2	05	193.8	66.7	65	250.5	86.3
26	24.6	08.5	86	81.3	28.0	46	138.0	47.5	06	194.8	67.1	66	251.5	86.6
27	25.5	08.8	87	82.3	28.3	47	139.0	47.9	07	195.7	67.4	67	252.4	86.9
28	26.5	09.1	88	83.2	28.7	48	139.9	48.2	08	196.7	67.7	68	253.4	87.3
29	27.4	09.4	89	84.1	29.0	49	140.9	48.5	09	197.6	68.1	69	254.3	87.6
30	28.4	09.8	90	85.1	29.3	50	141.8	48.8	10	198.5	68.4	70	255.3	87.9
31	29.3	10.1	91	86.0	29.6	151	142.8	49.2	211	199.5	68.7	271	256.2	88.2
32	30.3	10.4	92	87.0	30.0	52	143.7	49.5	12	200.4	69.0	72	257.2	88.6
33	31.2	10.7	93	87.9	30.3	53	144.7	49.8	13	201.4	69.4	73	258.1	88.9
34	32.1	11.1	94	88.9	30.6	54	145.6	50.1	14	202.3	69.7	74	259.1	89.2
35	33.1	11.4	95	89.8	30.9	55	146.6	50.5	15	203.3	70.0	75	260.0	89.5
36	34.0	11.7	96	90.8	31.3	56	147.5	50.8	16	204.2	70.3	76	260.9	89.9
37	35.0	12.0	97	91.7	31.6	57	148.4	51.1	17	205.2	70.7	77	261.9	90.2
38	35.9	12.4	98	92.7	31.9	58	149.4	51.4	18	206.1	71.0	78	262.8	90.5
39	36.9	12.7	99	93.6	32.2	59	150.3	51.8	19	207.1	71.3	79	263.8	90.8
40	37.8	13.0	100	94.5	32.6	60	151.3	52.1	20	208.0	71.6	80	264.7	91.2
41	38.8	13.3	101	95.5	32.9	161	152.2	52.4	221	208.9	72.0	281	265.7	91.5
42	39.7	13.7	02	96.4	33.2	62	153.2	52.7	22	209.9	72.3	82	266.6	91.8
43	40.7	14.0	03	97.4	33.5	63	154.1	53.1	23	210.8	72.6	83	267.6	92.1
44	41.6	14.3	04	98.3	33.9	64	155.1	53.4	24	211.8	72.9	84	268.5	92.5
45	42.5	14.7	05	99.3	34.2	65	156.0	53.7	25	212.7	73.3	85	269.5	92.8
46	43.5	15.0	06	100.2	34.5	66	156.9	54.0	26	213.7	73.6	86	270.4	93.1
47	44.4	15.3	07	101.2	34.8	67	157.9	54.4	27	214.6	73.9	87	271.3	93.4
48	45.4	15.6	08	102.1	35.2	68	158.8	54.7	28	215.6	74.2	88	272.3	93.8
49	46.3	16.0	09	103.1	35.5	69	159.8	55.0	29	216.5	74.6	89	273.2	94.1
50	47.3	16.3	10	104.0	35.8	70	160.7	55.4	30	217.5	74.9	90	274.2	94.4
51	48.2	16.6	111	104.9	36.1	171	161.7	55.7	231	218.4	75.2	291	275.1	94.7
52	49.2	16.9	12	105.9	36.5	72	162.6	56.0	32	219.3	75.5	92	276.1	95.1
53	50.1	17.3	13	106.8	36.8	73	163.6	56.3	33	220.3	75.9	93	277.0	95.4
54	51.1	17.6	14	107.8	37.1	74	164.5	56.7	34	221.2	76.2	94	278.0	95.7
55	52.0	17.9	15	108.7	37.4	75	165.5	57.0	35	222.2	76.5	95	278.9	96.1
56	52.9	18.2	16	109.7	37.8	76	166.4	57.3	36	223.1	76.8	96	279.9	96.4
57	53.9	18.6	17	110.6	38.1	77	167.3	57.6	37	224.1	77.2	97	280.8	96.7
58	54.8	18.9	18	111.6	38.4	78	168.3	58.0	38	225.0	77.5	98	281.7	97.0
59	55.8	19.2	19	112.5	38.7	79	169.3	58.3	39	226.0	77.8	99	282.7	97.4
60	56.7	19.5	120	113.5	39.1	180	170.2	58.6	240	226.9	78.1	300	283.6	97.7
Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

Table III. Difference of Latitude and Departure for 20 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep.
1	00.9	00.3	61	57.3	20.9	121	113.7	41.4	181	170.1	61.9	241	226.5	82.4
2	01.9	00.7	62	58.3	21.2	22	114.6	41.7	82	171.0	62.2	42	227.4	82.8
3	02.8	01.0	63	59.2	21.5	23	115.6	42.1	83	172.0	62.6	43	228.3	83.1
4	03.8	01.4	64	60.1	21.9	24	116.5	42.4	84	172.9	62.9	44	229.3	83.4
5	04.7	01.7	65	61.1	22.2	25	117.5	42.8	85	173.8	63.3	45	230.2	83.8
6	05.6	02.1	66	62 0	22.6	26	118.4	43.1	86	174.8	63.6	46	231.2	84.1
7	06.6	02.4	67	63.0	22.9	27	119.3	43.4	87	175.7	64.0	47	232.1	84.5
8	07.5	02.7	68	63.9	23.3	28	120.3	43.8	88	176.7	64.3	48	233.0	84.8
9	08.5	03.1	69	64.8	23.6	29	121.2	44.1	89	177.6	64.6	49	234.0	85.2
10	09.4	03.4	70	65.8	23.9	30	122.2	44.5	90	178.5	65.0	50	234.9	85.5
11	10.3	03.8	71	66.7	24.3	131	123.1	44.8	191	179.5	65.3	251	235.9	85.8
12	11.3	04.1	72	67.7	24.6	32	124.0	45.1	92	180.4	65.7	52	236.8	86.2
13	12.2	04.4	73	68.6	25.0	33	125.0	45.5	93	181.4	66.0	53	237.7	86.5
14	13.2	04.8	74	69.5	25.3	34	125.9	45.8	49	182.3	66.3	54	238.7	86 9
15	14.1	05.1	75	70.5	25.7	35	126.9	46.2	95	183.2	66.7	55	239.6	87.2
16	15.0	05.5	76	71.4	26.0	36	127.8	46.5	96	184.2	67.0	56	240.6	87.6
17	16 0	05.8	77	72.4	26.3	37	128.7	46.9	97	185.1	67.4	57	241.5	87.9
18	16.9	06.2	78	73.3	26.7	38	129.7	47.2	98	186.1	67.7	58	242.4	88 2
19	17.9	06.5	79	74.2	27.0	39	130.6	47.5	99	187.0	68.1	59	243.4	88.6
20	18.8	06.8	80	75.2	27.4	40	131.6	47.9	200	187.9	68.4	60	244.3	88.9
21	19.7	07.2	81	76.1	27.7	141	132.5	48.2	201	188.9	68.7	261	245.3	89.3
22	20.7	07.5	82	77.1	28.0	42	133.4	48.6	02	189.8	69.1	62	246.2	89.6
23	21.6	07.9	83	78.0	28.4	43	134.4	48.9	03	190.8	69.4	63	247.1	89.9
24	22.6	08.2	84	78.9	28.7	44	135.3	49.2	04	191.7	69.8	64	248.1	90.3
25	23.5	08.6	85	79.9	29.1	45	136.3	49.6	05	192.6	70.1	65	249.0	90.6
26	24.4	08.9	86	80.8	29.4	46	137.2	49.9	06	193.6	70.5	66	250.0	91.0
27	25.4	09.2	87	81.8	29.8	47	138.1	50.3	07	194.5	70.8	67	250.9	91.3
28	26.3	09.6	88	82.7	30.1	48	139.1	50.6	08	195.5	71.1	68	251.8	91.7
29	27.3	09.9	89	83.6	30.4	49	140.0	51.0	09	196.4	71.5	69	252.8	92.0
30	28.2	10.3	90	84.6	30.8	50	141.0	51 3	10	197.3	71.8	70	253.7	92.3
31	29.1	10.6	91	85.5	31.1	151	141.9	51.6	211	198.3	72.2	271	254 7	92 7
32	30.1	10.9	92	86.5	31.5	52	142.8	52.0	12	199.2	72.5	72	255.6	93.0
33	31.0	11.3	93	87.4	31.8	53	143.8	52.3	13	200.2	72.8	73	256.5	93.4
34	31.9	11.6	94	88.3	32.1	54	144.7	52.7	14	201.1	73.2	74	257.5	93.7
35	32.9	12.0	95	89.3	32.5	55	145.7	53.0	15	202.0	73.5	75	258.4	94.1
36	33.8	12.3	96	90.2	32.8	56	146.6	53.4	16	203.0	73.9	76	259.4	94.4
37	34.8	12.7	97	91.2	33.2	57	147.5	53.7	17	203.9	74 2	77	260.3	94.7
38	35.7	13.0	98	92.1	33.5	58	148.5	54.0	18	204.9	74.6	78	261.2	95.1
39	36.6	13.3	99	93.0	33.9	59	149.4	54.4	19	205.8	74.9	79	262.2	95.4
40	37.6	13.7	100	94.0	34.2	60	150.4	54.7	20	206.7	75.2	80	263.1	95.8
41	38.5	14.0	101	94.9	34.5	161	151.3	55.1	221	207.7	75.6	281	264.1	96.1
42	39.5	14.4	02	95.8	34.9	62	152.2	55.4	22	208.6	75.9	82	265.0	96.4
43	40.4	14.7	03	96.8	35.2	63	153.2	55.7	23	209.6	76.3	83	265.9	96.8
44	41.3	15.0	04	97.7	35.6	64	154.1	56.1	24	210.5	76.6	84	266.9	97.1
45	42.3	15.4	05	98.7	35.9	65	155.1	56.4	25	211.4	77.0	85	267.8	97.5
46	43.2	15.7	06	99.6	36.3	66	156.0	56.8	26	212.4	77.3	86	268.8	97.8
47	44.2	16 1	07	100.5	36.6	67	156.9	57.1	27	213.3	77.6	87	269.7	98.2
48	45.1	16.4	08	101.5	36.9	68	157.9	57.5	28	214.3	78.0	88	270.6	98.5
49	46.0	16.8	09	102.4	37.3	69	158.8	57.8	29	215.2	78.3	89	271.6	98.8
50	47.0	17.1	10	103.4	37.6	70	159.7	58.1	30	216.1	78.7	90	272.5	99.2
51	47.9	17.4	111	104.3	38.0	171	160.7	58.5	231	217.1	79.0	291	273.5	99.5
52	48.9	17.8	12	105.2	38.3	72	161.6	58.8	32	218.0	79.3	92	274.4	99.9
53	49.8	18.1	13	106.2	38.6	73	162.6	59.2	33	219.0	79.7	93	275.3	100.2
54	50.7	18.5	14	107.1	39.0	74	163.5	59.5	34	219.9	80.0	94	276.3	100.5
55	51.7	18.8	15	108.1	39.3	75	164.4	59.9	35	220.8	80.4	95	277.2	100 9
56	52.6	19.2	16	109.0	39.7	76	165.4	60.2	36	221.8	80.7	96	278.2	101.2
57	53.6	19.5	17	109.9	40.0	77	166.3	60.5	37	222.7	81.1	97	279.1	101.6
58	54.5	19.8	18	110.9	40 4	78	167.3	60.9	38	223.6	81.4	98	280 0	101.9
59	55.4	20.2	19	111.8	40.7	79	168 2	61.2	39	224.6	81.7	99	281.0	102.3
60	56.4	20.5	120	112.8	41.0	180	169.1	61.6	240	225.5	82.1	300	281.9	102.6
Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 70 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep.
1	00.9	00.4	61	56.9	21.9	121	113.0	43.4	181	169.0	64.9	241	225.0	86.4
2	01.9	00.7	62	57.9	22.2	22	113.9	43.7	82	169.9	65.2	42	225.9	86.7
3	02.8	01.1	63	58.8	22.6	23	114.9	44.1	83	170.9	65.6	43	226.9	87.1
4	03.7	01.4	64	59.7	22.9	24	115.8	44.4	84	171.8	65.9	44	227.8	87.4
5	04.7	01.8	65	60.7	23.3	25	116.7	44.8	85	172.7	66.3	45	228.7	87.8
6	05.6	02.2	66	61.6	23.7	26	117.7	45.2	86	173.7	66.7	46	229.7	88.2
7	06.5	02.5	67	62.5	24.0	27	118.6	45.5	87	174.6	67.0	47	230.6	88.5
8	07.5	02.9	68	63.5	24.4	28	119.5	45.9	88	175.5	67.4	48	231.5	88.9
9	08.4	03.2	69	64.4	24.7	29	120.5	46.2	89	176.5	67.7	49	232.5	89.2
10	09.3	03.6	70	65.3	25.1	30	121.4	46.6	90	177.4	68.1	50	233.4	89.6
11	10.3	03.9	71	66.3	25.4	131	122.3	47.0	191	178.3	68.5	251	234.3	90.0
12	11.2	04.3	72	67.2	25.8	32	123.3	47.3	92	179.3	68.8	52	235.3	90.3
13	12.1	04.6	73	68.1	26.2	33	124.2	47.7	93	180.2	69.2	53	236.2	90.7
14	13.1	05.0	74	69.1	26.5	34	125.1	48.0	94	181.1	69.5	54	237.1	91.0
15	14.0	05.4	75	70.0	26.9	35	126.1	48.4	95	182.1	69.9	55	238.1	91.4
16	14.9	05.7	76	70.9	27.2	36	127.0	48.7	96	183.0	70.2	56	239.0	91.8
17	15.9	06.1	77	71.9	27.6	37	127.9	49.1	97	183.9	70.6	57	239.9	92.1
18	16.8	06.5	78	72.8	28.0	38	128.9	49.5	98	184.9	71.0	58	240.9	91.5
19	17.7	06.8	79	73.7	28.3	39	129.8	49.8	99	185.8	71.3	59	241.8	92.8
20	18.7	07.2	80	74.7	28.7	40	130.7	50.2	200	186.7	71.7	60	242.7	93.2
21	19.6	07.5	81	75.6	29.0	141	131.7	50.5	201	187.6	72.0	261	243.7	93.5
22	20.5	07.9	82	76.5	29.4	42	132.6	50.9	02	188.6	72.4	62	244.6	93.9
23	21.5	08.2	83	77.5	29.7	43	133.5	51.3	03	189.5	72.8	63	245.5	94.3
24	22.4	08.6	84	78.4	30.1	44	134.5	51.6	04	190.4	73.1	64	246.5	94.6
25	23.3	09.0	85	79.3	30.5	45	135.4	52.0	05	191.4	73.5	65	247.4	95.0
26	24.3	09.3	86	80.3	30.8	46	136.3	52.3	06	192.3	73.8	66	248.3	95.3
27	25.2	09.7	87	81.2	31.2	47	137.3	52.7	07	193.2	74.2	67	249.3	95.7
28	26.1	10.0	88	82.1	31.5	48	138.2	53.0	08	194.2	74.5	68	250.2	96.1
29	27.1	10.4	89	83.1	31.9	49	139.1	53.4	09	195.1	74.9	69	251.1	96.4
30	28.0	10.8	90	84.0	32.3	50	140.1	53.8	10	196.0	75.3	70	252.1	96.8
31	28.9	11.1	91	84.9	32.6	151	141.0	54.1	211	197.0	75.6	271	253.0	97.1
32	29.9	11.5	92	85.9	33.0	52	141.9	54.5	12	197.9	76.0	72	253.9	97.5
33	30.8	11.8	93	86.8	33.3	53	142.9	54.8	13	198.8	76.3	73	254.9	97.8
34	31.7	12.2	94	87.7	33.7	54	143.8	55.2	14	199.8	76.7	74	255.8	98.2
35	32.7	12.5	95	88.7	34.0	55	144.7	55.6	15	200.7	77.1	75	256.7	98.6
36	33.6	12.9	96	89.6	34.4	56	145.7	55.9	16	201.6	77.4	76	257.7	98.9
37	34.5	13.3	97	90.5	34.8	57	146.6	56.3	17	202.6	77.8	77	258.6	99.3
38	35.5	13.6	98	91.5	35.1	58	147.5	56.6	18	203.5	78.1	78	259.5	99.6
39	36.4	14.0	99	92.4	35.5	59	148.5	57.0	19	204.4	78.5	79	260.5	100.0
40	37.3	14.3	100	93.4	35.8	60	149.4	57.3	20	205.4	78.8	80	261.4	100.4
41	38.3	14.7	101	94.3	36.2	161	150.3	57.7	221	206.3	79.2	281	262.3	100.9
42	39.2	15.1	02	95.3	36.6	62	151.3	58.1	22	207.3	79.6	82	263.3	101.1
43	40.1	15.4	03	96.2	36.9	63	152.2	58.4	23	208.2	79.9	83	264.2	101.4
44	41.1	15.8	04	97.1	37.3	64	153.1	58.8	24	209.1	80.3	84	265.1	101.8
45	42.0	16.1	05	98.1	37.6	65	154.1	59.1	25	210.0	80.6	85	266.1	102.1
46	42.9	16.5	06	99.0	38.0	66	155.0	59.5	26	211.0	81.0	86	267.0	102.5
47	43.9	16.8	07	99.9	38.3	67	155.9	59.9	27	211.9	81.4	87	267.9	102.9
48	44.8	17.2	08	100.9	38.7	68	156.9	60.2	28	212.8	81.7	88	268.9	103.2
49	45.7	17.6	09	101.8	39.1	69	157.8	60.6	29	213.8	82.1	89	269.8	103.6
50	46.7	17.9	10	102.7	39.4	70	158.7	60.9	30	214.7	82.4	90	270.7	103.9
51	47.6	18.3	111	103.7	39.8	171	159.7	61.3	231	215.6	82.8	291	271.7	104.3
52	48.5	18.6	12	104.6	40.1	72	160.6	61.6	32	216.6	83.1	92	272.6	104.7
53	49.5	19.0	13	105.5	40.5	73	161.5	62.0	33	217.5	83.5	93	273.5	105.0
54	50.4	19.4	14	106.5	40.9	74	162.5	62.4	34	218.4	83.9	94	274.5	105.4
55	51.3	19.7	15	107.4	41.2	75	163.4	62.7	35	219.4	84.2	95	275.4	105.7
56	52.3	20.1	16	108.3	41.6	76	164.3	63.1	36	220.3	84.6	96	276.3	106.1
57	53.2	20.4	17	109.3	41.9	77	165.3	63.4	37	221.2	84.9	97	277.3	106.4
58	54.1	20.8	18	110.2	42.3	78	166.2	63.8	38	222.2	85.3	98	278.2	106.8
59	55.1	21.1	19	111.1	42.6	79	167.1	64.2	39	223.1	85.7	99	279.1	107.2
60	56.0	21.5	120	112.1	43.0	180	168.1	64.5	240	224.1	86.0	300	280.1	107.5
Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

Table III. Difference of Latitude and Departure for 22 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep.
1	00.9	00.4	61	56.6	22.9	121	112.2	45.3	181	167.8	67.8	241	223.5	90.3
2	01.9	00.7	62	57.5	23.2	22	113.1	45.7	82	168.8	68.2	42	224.4	90.7
3	02.8	01.1	63	58.4	23.6	23	114.0	46.1	83	169.7	68.6	43	225.3	91.0
4	03.7	01.5	64	59.3	24.0	24	115.0	46.5	84	170.6	68.9	44	226.2	91.4
5	04.6	01.9	65	60.3	24.3	25	115.9	46.8	85	171.5	69.3	45	227.2	91.8
6	05.6	02.2	66	61.2	24.7	26	116.8	47.2	86	172.5	69.7	46	228.1	92.2
7	06.5	02.6	67	62.1	25.1	27	117.8	47.6	87	173.4	70.1	47	229.0	92.5
8	07.4	03.0	68	63.0	25.5	28	118.7	47.9	88	174.3	70.4	48	229.9	92.9
9	08.3	03.4	69	64.0	25.8	29	119.6	48.3	89	175.2	70.8	49	230.9	93.3
10	09.3	03.7	70	64.9	26.2	30	120.5	48.7	90	176.2	71.2	50	231.8	93.7
11	10.2	04.1	71	65.8	26.6	131	121.5	49.1	191	177.1	71.5	251	232.7	94.0
12	11.1	04.5	72	66.8	27.0	32	122.4	49.4	92	178.0	71.9	52	233.7	94.4
13	12.1	04.9	73	67.7	27.3	33	123.3	49.8	93	178.9	72.[illegible]	53	234.6	94.8
14	13.0	05.2	74	68.6	27.7	34	124.2	50.2	94	179.8	72.7	54	235.5	95.2
15	13.9	05.6	75	69.5	28.1	35	125.[illegible]	50.6	95	180.[illegible]	73.0	55	236.4	95.5
16	14.9	06.0	76	70.5	28.5	36	126.1	50.9	96	181.7	73.4	56	237.4	95.9
17	15.8	06.4	77	71.4	28.8	37	127.0	51.3	97	182.7	73.8	57	238.3	96.3
18	16.7	06.7	78	72.3	29.2	38	128.0	51.7	98	183.6	74.2	58	239.2	96.6
19	17.6	07.1	79	73.2	29.6	39	128.9	51.1	99	184.5	74.5	59	240.1	97.0
20	18.5	07.5	80	74.2	30.0	40	129.8	52.4	200	185.4	74.9	60	241.1	97.4
21	19.5	07.9	81	75.1	30.3	141	130.7	52.8	201	186.4	75.3	261	242.0	97.8
22	20.4	08.2	82	76.0	30.7	42	131.7	53.2	02	187.3	75.7	62	242.9	98.1
23	21.3	08.6	83	77.0	31.1	43	132.6	53.6	03	188.2	76.0	63	243.	98.5
24	22.3	09.0	84	77.9	31.5	44	133.5	53.9	04	189.1	76.4	64	244.8	98.9
25	23.2	09.4	85	78.8	31.8	45	134.4	54.3	05	190.1	76.8	65	245.7	99.3
26	24.1	09.7	86	79.7	32.2	46	135.4	54.7	06	191.0	77.2	66	246.6	99.6
27	25.0	10.1	87	80.7	32.6	47	136.3	55.1	07	191.9	77.5	67	247.6	100.0
28	26.0	10.5	88	81.6	33.0	48	137.2	55.4	08	192.8	77.9	68	248.5	100.4
29	26.9	10.9	89	82.5	33.3	49	138.2	55.8	09	193.8	78.3	69	249.4	100.8
30	27.8	11.2	90	83.4	33.7	50	139.1	56.2	10	194.7	78.7	70	250.3	101.1
31	28.7	11.6	91	84.4	34.1	151	140.0	56.6	211	195.6	79.0	271	251.3	101.5
32	29.7	12.0	92	85.3	34.5	52	140.9	56.9	12	196.6	79.4	72	252.2	101.9
33	30.6	12.4	93	86.2	34.8	53	141.9	57.3	13	197.5	79.8	73	253.1	102.3
34	31.5	12.7	94	87.2	35.2	54	142.8	57.7	14	198.4	80.2	74	254.1	102.6
35	32.5	13.1	95	88.1	35.6	55	143.7	58.1	15	199.3	80.5	75	255.0	103.0
36	33.4	13.5	96	89.0	36.0	56	144.6	58.4	16	200.3	80.9	76	255.9	113.4
37	34.3	13.9	97	89.9	36.3	57	145.6	58.8	17	201.2	81.3	77	256.8	103.8
38	35.2	14.2	98	90.9	36.7	58	146.5	59.2	18	202.1	81.7	78	257.8	104.1
39	36.2	14.6	99	91.8	37.1	59	147.4	59.6	19	203.1	82.0	79	258.7	104.5
40	37.1	15.0	100	92.7	37.5	60	148.4	59.9	20	204.0	82.4	80	259.6	104.9
41	38.0	15.4	101	93.6	37.8	161	149.3	60.3	221	204.9	82.8	281	260.5	105.3
42	38.9	15.7	02	94.6	38.2	62	150.2	60.7	22	205.8	83.2	82	261.5	105.6
43	39.9	16.1	03	95.5	38.6	63	151.1	61.1	23	206.7	83.5	83	262.4	106.0
44	40.8	16.5	04	96.4	39.0	64	152.1	61.4	24	207.7	83.9	84	263.3	106.4
45	41.7	16.9	05	97.[illegible]	39.3	65	153.0	61.8	25	208.6	84.3	85	264.3	106.8
46	42.7	17.2	06	98.3	39.7	66	153.9	62.2	26	209.5	84.7	86	265.2	107.1
47	43.6	17.6	07	99.2	40.1	67	154.8	62.6	27	210.5	85.0	87	266.1	107.5
48	44.5	18.0	08	100.1	40.5	68	155.8	62.9	28	211.4	85.4	88	267.0	107.9
49	45.4	18.4	09	101.1	40.8	69	156.7	63.3	29	212.3	85.8	89	268.0	108.3
50	46.4	18.7	10	102.0	41.2	70	157.6	63.7	30	213.3	86.2	90	268.9	108.6
51	47.3	19.1	111	102.9	41.6	171	158.6	64.1	231	214.2	86.5	291	269.8	109.0
52	48.2	19.5	12	103.8	42.0	72	159.5	64.4	32	215.1	86.9	92	270.7	109.4
53	49.1	19.9	13	104.8	42.3	73	160.4	64.8	33	216.0	87.3	93	271.7	109.8
54	50.1	20.2	14	105.7	42.7	74	161.3	65.2	34	217.0	87.7	94	272.6	110.1
55	51.0	20.6	15	106.6	43.1	75	162.3	65.6	35	117.9	88.0	95	273.5	110.5
56	51.9	21.0	16	107.6	43.5	76	163.2	65.9	36	218.8	88.4	96	274.5	110.9
57	52.9	21.4	17	108.5	43.8	77	164.1	66.3	37	219.7	88.8	97	275.4	111.3
58	53.8	21.7	18	109.4	44.2	78	165.0	66.7	38	220.7	89.2	98	276.3	111.6
59	54.7	22.1	19	110.3	44.6	79	166.0	67.1	39	221.6	89.5	99	277.2	112.0
60	55.6	22.5	120	111.3	45.0	180	166.9	67.4	240	222.5	89.9	300	278.2	112.4
Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 68 Degrees.

TABLE III. Difference of Latitude and Departure for 23 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.9	00.4	61	56.1	23.8	121	111.4	47.3	181	166.5	70.7	241	221.8	94.1
2	01.8	00.8	62	57.1	24.2	22	112.3	47.7	82	167.5	71.1	42	222.8	94.5
3	02.8	01.2	63	58.0	24.6	23	113.2	48.1	83	168.5	71.5	43	223.7	94.9
4	03.7	01.6	64	58.9	25.0	24	114.1	48.4	84	169.4	71.9	44	224.6	95.3
5	04.6	02.0	65	59.8	25.4	25	115.1	48.8	85	170.3	72.3	45	225.5	95.7
6	05.5	02.3	66	60.8	25.8	26	116.0	49.2	86	171.2	72.7	46	226.4	96.1
7	06.4	02.7	67	61.7	26.2	27	116.9	49.6	87	172.2	73.1	47	227.4	96.5
8	07.4	03.1	68	62.6	26.6	28	117.8	50.0	88	173.1	73.5	48	228.3	96.9
9	08.3	03.5	69	63.5	27.0	29	118.7	50.4	89	174.0	73.8	49	229.2	97.3
10	09.2	03.9	70	64.4	27.3	30	119.7	50.8	90	174.9	74.2	50	230.1	97.7
11	10.1	04.3	71	65.4	27.7	131	120.6	51.2	191	175.8	74.6	251	231.0	98.1
12	11.0	04.7	72	66.3	28.1	32	121.5	51.6	92	176.7	75.0	52	232.0	98.5
13	12.0	05.1	73	67.2	28.5	33	122.4	52.0	93	177.7	75.4	53	232.9	98.8
14	12.9	05.5	74	68.1	28.9	34	123.3	52.4	94	178.6	75.8	54	233.8	99.2
15	13.8	05.9	75	69.0	29.3	35	124.3	52.7	95	179.5	76.2	55	234.7	99.6
16	14.7	06.3	76	70.0	29.7	36	125.2	53.1	96	180.4	76.6	56	235.6	100.0
17	15.6	06.6	77	70.9	30.1	37	126.1	53.5	97	181.3	77.0	57	236.6	100.4
18	16.6	07.0	78	71.8	30.5	38	127.0	53.9	98	182.3	77.4	58	237.5	100.8
19	17.5	07.4	79	72.7	30.9	39	127.9	54.3	99	183.2	77.7	59	238.4	101.2
20	18.4	07.8	80	73.6	31.3	40	128.9	54.7	200	184.1	78.1	60	239.3	101.6
21	19.3	08.2	81	74.6	31.6	141	129.8	55.1	201	185.0	78.5	261	240.2	102.0
22	20.3	08.6	82	75.5	32.0	42	130.7	55.5	02	185.9	78.9	62	241.2	102.4
23	21.2	09.0	83	76.4	32.4	43	131.6	55.9	03	186.9	79.3	63	242.1	102.8
24	22.1	09.4	84	77.3	32.8	44	132.6	56.3	04	187.8	79.7	64	243.0	103.1
25	23.0	09.8	85	78.2	33.2	45	133.5	56.7	05	188.7	70.1	65	243.9	103.5
26	23.9	10.2	86	79.2	33.6	46	134.4	57.0	06	189.6	80.5	66	244.9	103.9
27	24.9	10.5	87	80.1	34.0	47	135.3	57.4	07	190.5	80.9	67	245.8	194.3
28	25.8	10.9	88	81.0	34.4	48	136.2	57.8	08	191.5	81.3	68	246.7	104.7
29	26.7	11.3	89	81.9	34.8	49	137.2	58.2	09	192.4	81.7	69	247.6	105.1
30	27.6	11.7	90	82.8	35.2	50	138.1	58.6	10	193.3	82.0	70	248.5	105.5
31	28.5	12.1	91	83.8	35.6	151	139.0	59.0	211	194.2	82.4	271	249.5	105.9
32	29.5	12.5	92	84.7	35.9	52	139.9	59.4	12	195.1	82.8	72	250.4	106.3
33	30.4	12.9	93	85.6	36.3	53	140.8	59.8	13	196.1	83.2	73	251.3	106.7
34	31.3	13.3	94	86.5	36.7	54	141.8	60.2	14	197.0	83.6	74	252.2	107.1
35	32.2	13.7	95	87.4	37.1	55	142.7	60.6	15	197.9	84.0	75	253.1	107.4
36	33.1	14.1	96	88.4	37.5	56	143.6	60.9	16	198.8	84.4	76	254.1	107.8
37	34.1	14.5	97	89.3	37.9	57	144.5	61.3	17	199.7	84.8	77	255.0	108.2
38	35.0	14.8	98	90.2	38.3	58	145.4	61.7	18	200.7	85.2	78	255.9	108.6
39	35.9	15.2	99	91.1	38.7	59	146.4	62.1	19	201.6	85.6	79	256.8	109.0
40	36.8	15.6	100	92.0	39.1	60	147.3	62.5	20	202.5	86.0	80	257.7	109.4
41	37.7	16.0	101	93.0	39.5	161	148.2	62.9	221	203.4	86.3	281	258.7	109.8
42	38.7	16.4	02	93.9	39.9	62	149.1	63.3	22	204.4	86.7	82	259.6	110.2
43	39.6	16.8	03	94.8	40.2	63	150.0	63.7	23	205.3	87.1	83	260.5	110.6
44	40.5	17.2	04	95.7	40.6	64	151.0	64.1	24	206.2	87.5	84	261.4	111.0
45	41.4	17.6	05	96.7	41.0	65	251.9	64.5	25	207.1	87.9	85	262.3	111.3
46	42.3	18.0	06	97.6	41.4	66	152.8	64.9	26	208.0	88.3	86	263.3	111.7
47	43.3	18.4	07	98.5	41.8	67	153.7	65.2	27	209.0	88.7	87	264.2	112.1
48	44.2	18.8	08	99.4	42.2	68	154.6	65.6	28	209.9	89.1	88	265.1	112.5
49	45.1	19.1	09	100.3	42.6	69	155.6	66.0	29	210.8	89.5	89	266.0	112.9
50	46.0	19.5	10	101.3	43.0	70	156.5	66.4	30	211.7	89.9	90	266.9	113.3
51	46.9	19.9	111	102.2	43.4	171	157.4	66.8	231	212.6	90.3	291	267.9	113.7
52	47.9	20.3	12	103.1	43.8	72	158.3	67.2	32	213.6	90.6	92	268.8	114.1
53	48.8	20.7	13	104.0	44.1	73	159.2	67.6	33	214.5	91.0	93	269.7	114.5
54	49.7	21.1	14	104.9	44.5	74	160.2	68.0	34	215.4	91.4	94	270.6	114.9
55	50.6	21.5	15	105.9	44.9	75	161.1	68.4	35	216.3	91.8	95	271.5	115.3
56	51.5	21.9	16	106.8	45.3	76	162.0	68.8	36	217.2	92.2	96	272.5	115.6
57	52.5	22.3	17	107.7	45.7	77	162.9	69.2	37	218.2	92.6	97	273.4	116.0
58	53.4	22.7	18	108.6	46.1	78	163.8	69.5	38	219.1	93.0	98	274.3	116.4
59	54.3	23.1	19	109.5	46.5	79	164.8	69.9	39	220.0	93.4	99	275.2	116.8
60	55.2	23.4	120	110.5	46.9	180	165.7	70.3	240	220.9	93.8	300	276.2	117.2
Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 67 Degrees.

TABLE III. Difference of Latitude and Departure for 24 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep.
1	00.9	00.4	61	55.7	24.8	121	110.5	49.2	181	165.3	73.6	241	220.2	98.0
2	01.8	00.8	62	56.6	25.2	22	111.4	49.6	82	166.3	74.0	42	221.1	98.4
3	02.7	01.2	63	57.6	25.6	23	112.4	50.0	83	167.2	74.4	43	222.0	98.8
4	03.7	01.6	64	58.5	26.0	24	113.3	50.4	84	168.1	74.8	44	222.9	99.2
5	04.6	02.0	65	59.4	26.4	25	114.2	50.8	85	169.0	75.2	45	223.8	99.6
6	05.5	02.4	66	60.3	26.8	26	115.1	51.2	86	169.9	75.6	46	224.7	100.0
7	06.4	02.8	67	61.2	27.2	27	116.0	51.7	87	170.8	76.1	47	225.6	100.5
8	07.3	03.3	68	62.1	27.7	28	116.9	52.1	88	171.7	76.5	48	226.5	100.9
9	08.2	03.7	69	63.0	28.1	29	117.8	52.5	89	172.7	76.9	49	227.5	101.3
10	09.1	04.1	70	63.9	28.5	30	118.8	52.9	90	173.6	77.3	50	228.4	101.7
11	10.0	04.5	71	64.9	28.9	131	119.7	53.3	191	174.5	77.7	251	229.3	102.1
12	11.0	04.9	72	65.8	29.3	32	120.6	53.7	92	175.4	78.1	52	230.2	102.5
13	11.9	05.3	73	66.7	29.7	33	121.5	54.1	93	176.3	78.5	53	231.1	102.9
14	12.8	05.7	74	67.6	30.1	34	122.4	54.5	94	177.2	78.9	54	232.0	103.3
15	13.7	06.1	75	68.5	30.5	35	123.3	54.9	95	178.1	79.3	55	232.9	103.7
16	14.6	06.5	76	69.4	30.9	36	124.2	55.3	96	179.0	79.7	56	233.9	104.1
17	15.5	06.9	77	70.3	31.3	37	125.1	55.7	97	180.0	80.1	57	234.8	104.5
18	16.4	07.3	78	71.3	31.7	38	126.1	56.1	98	180.9	80.5	58	235.7	104.9
19	17.4	07.7	79	72.2	32.1	39	127.0	56.5	99	181.8	80.9	59	236.6	105.3
20	18.3	08.1	80	73.1	32.5	40	127.9	56.9	200	182.7	81.3	60	237.5	105.7
21	19.2	08.5	81	74.0	32.9	141	128.8	57.3	201	183.6	81.7	261	238.4	106.1
22	20.1	08.9	82	74.9	33.3	42	129.7	57.8	02	184.5	82.1	62	239.3	106.6
23	21.0	09.4	83	75.8	33.8	43	130.6	58.2	03	185.4	82.6	63	240.3	107.0
24	21.9	09.8	84	76.7	34.2	44	131.5	58.6	04	186.4	83.0	64	241.2	107.4
25	22.8	10.2	85	77.6	34.6	45	132.5	59.0	05	187.3	83.4	65	242.1	107.8
26	23.8	10.6	86	78.6	35.0	46	133.4	59.4	06	188.2	83.8	66	243.0	108.2
27	24.7	11.0	87	79.5	35.4	47	134.3	59.8	07	189.1	84.2	67	243.9	108.6
28	25.6	11.4	88	80.4	35.8	48	135.2	60.2	08	190.0	84.6	68	244.8	109.0
29	26.5	11.8	89	81.3	36.2	49	136.1	60.6	09	190.9	85.0	69	245.7	109.4
30	27.4	12.2	90	82.2	36.6	50	137.0	61.0	10	191.8	85.4	70	246.6	109.8
31	28.3	12.6	91	83.1	37.0	151	137.9	61.4	211	192.7	85.8	271	247.6	110.2
32	29.2	13.0	92	84.0	37.4	52	138.9	61.8	12	193.7	86.2	72	248.5	110.6
33	30.1	13.4	93	85.0	37.8	53	139.8	62.2	13	194.6	86.6	73	249.4	111.0
34	31.1	13.8	94	85.9	38.2	54	140.7	62.6	14	195.5	87.0	74	250.3	111.4
35	32.0	14.2	95	86.8	38.6	55	141.6	63.0	15	196.4	87.4	75	251.2	111.8
36	32.9	14.6	96	87.7	39.0	56	142.5	63.4	16	197.3	87.8	76	252.1	112.2
37	33.8	15.0	97	88.6	39.4	57	143.4	63.9	17	198.2	88.3	77	253.0	112.7
38	34.7	15.5	98	89.5	39.9	58	144.3	64.3	18	199.1	88.7	78	254.0	113.1
39	35.6	15.9	99	90.4	40.3	59	145.2	64.7	19	200.1	89.1	79	254.9	113.5
40	36.5	16.3	100	91.4	40.7	60	146.2	65.1	20	201.0	89.5	80	255.8	113.9
41	37.5	16.7	101	92.3	41.1	161	147.1	65.5	221	201.9	89.9	281	256.7	114.3
42	38.4	17.1	02	93.2	41.5	62	148.0	65.9	22	202.8	90.3	82	257.6	114.7
43	39.3	17.5	03	94.1	41.9	63	148.9	66.3	23	203.7	90.7	83	258.5	115.1
44	40.2	17.9	04	95.0	42.3	64	149.8	66.7	24	204.6	91.1	84	259.4	115.5
45	41.1	18.3	05	95.9	42.7	65	150.7	67.1	25	205.5	91.5	85	260.3	115.9
46	42.0	18.7	06	96.8	43.1	66	151.6	67.5	26	206.5	91.9	86	261.3	116.3
47	42.9	19.1	07	97.7	43.5	67	152.6	67.9	27	207.4	92.3	87	262.2	116.7
48	43.8	19.5	08	98.7	43.9	68	153.5	68.3	28	208.3	92.7	88	263.1	117.1
49	44.8	19.9	09	99.6	44.3	69	154.4	68.7	29	209.2	93.1	89	264.0	117.5
50	45.7	20.3	10	100.5	44.7	70	155.3	69.1	30	210.1	93.5	90	264.9	117.9
51	46.6	20.7	111	101.4	45.1	171	156.2	69.5	231	211.0	93.9	291	265.8	118.3
52	47.5	21.1	12	102.3	45.6	72	157.1	70.0	32	211.9	94.4	92	266.7	118.8
53	48.4	21.6	13	103.2	46.0	73	158.0	70.4	33	212.8	94.8	93	267.7	119.2
54	49.3	22.0	14	104.1	46.4	74	158.9	70.8	34	213.8	95.2	94	268.6	119.6
55	50.2	22.4	15	105.1	46.8	75	159.9	71.2	35	214.7	95.6	95	269.5	120.0
56	51.0	22.8	16	106.0	47.2	76	160.8	71.6	36	215.6	96.0	96	270.4	120.4
57	52.1	23.2	17	106.9	47.6	77	161.7	72.0	37	216.5	96.4	97	271.3	120.8
58	53.0	23.6	18	107.8	48.0	78	162.6	72.4	38	217.4	96.8	98	272.2	121.2
59	53.9	24.0	19	108.7	48.4	79	163.5	72.8	39	218.3	97.2	99	273.1	121.6
60	54.8	24.4	120	109.6	48.8	180	164.4	73.2	240	219.2	97.6	300	274.1	212.0
Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep	Lat

for 66 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.4	61	55.3	25.8	121	109.7	51.1	181	164.[illegible]	76.5	241	218.4	101.8
2	01.8	00.8	62	56.2	26.2	22	110.6	51.6	82	164.9	76.9	42	219.3	102.3
3	02.7	01.3	63	57.1	26.6	23	111.5	52.0	83	165.9	77.3	43	220.2	[illegible]
4	03.6	01.7	64	58.0	27.0	24	112.4	52.4	84	166.8	77.8	44	221.1	103.1
5	04.5	02.1	65	58.9	27.5	25	113.3	52.8	85	167.7	78.2	45	222.0	103.5
6	05.4	02.5	66	59.8	27.9	26	114.2	53.2	86	168.6	78.6	46	222.9	104.0
7	06.3	03.0	67	60.7	28.3	27	115.1	53.7	87	169.5	79.0	47	223.9	104.4
8	07.3	03.4	68	61.6	28.7	28	116.0	54.1	88	170.4	79.4	48	224.8	104.8
9	08.2	03.8	69	62.5	29.2	29	116.9	54.5	89	171.3	79.9	49	225.7	105.2
10	09.1	04.2	70	63.4	29.6	30	117.8	54.9	90	172.2	80.3	50	226.6	105.7
11	10.0	04.6	71	64.3	30.0	131	118.7	55.4	191	173.1	80.7	251	227.5	106.1
12	10.9	05.0	72	65.3	30.4	32	119.6	55.8	92	174.0	81.1	52	228.4	106.5
13	11.8	05.5	73	66.2	30.8	33	120.5	56.2	93	174.9	81.6	53	229.3	106.9
14	12.7	05.9	74	67.1	31.3	34	121.4	56.6	94	175.8	82.0	54	230.2	107.3
15	13.6	06.3	75	68.0	31.7	35	122.4	57.1	95	176.7	82.4	55	231.1	107.8
16	14.5	06.8	76	68.9	32.1	36	123.3	57.5	96	177.6	82.8	56	232.0	108.2
17	15.4	07.2	77	69.8	32.5	37	124.2	57.9	97	178.5	83.3	57	232.9	108.6
18	16.3	07.6	78	70.7	33.0	38	125.1	58.3	98	179.4	83.7	58	233.8	109.0
19	17.2	08.0	79	71.6	33.4	39	126.0	58.7	99	180.4	84.1	59	234.7	109.5
20	18.1	08.5	80	72.5	33.8	40	126.9	59.2	200	181.3	84.5	60	235.6	109.9
21	19.0	08.9	81	73.4	34.2	141	127.8	59.6	201	182.2	84.9	261	236.5	110.3
22	19.9	09.3	82	74.3	34.7	42	128.7	60.0	02	183.1	85.4	62	237.5	110.7
23	20.8	09.7	83	75.2	35.1	43	129.6	60.4	03	184.0	85.8	63	238.4	111.1
24	21.8	10.1	84	76.1	35.5	44	130.5	60.9	04	184.9	86.2	64	239.3	111.6
25	22.7	10.6	85	77.0	35.9	45	131.4	61.3	05	185.8	86.6	65	240.2	112.0
26	23.6	11.0	86	77.9	36.3	46	132.3	61.7	06	186.7	87.1	66	241.1	112.4
27	24.5	11.4	87	78.8	36.8	47	133.2	62.1	07	187.6	87.5	67	242.0	112.8
28	25.4	11.8	88	79.8	37.2	48	134.1	62.5	08	188.5	87.9	68	242.9	113.3
29	26.3	12.3	89	80.7	37.6	49	135.0	63.0	09	189.4	88.3	69	243.8	113.7
30	27.2	12.7	90	81.6	38.0	50	135.9	63.4	10	190.3	88.7	70	244.7	114.1
31	28.1	13.1	91	82.5	38.5	151	136.9	63.8	211	191.2	89.2	271	245.6	114.5
32	29.0	13.5	92	83.4	38.9	52	137.8	64.2	12	192.1	89.6	72	246.5	114.9
33	29.9	13.9	93	84.3	39.3	53	138.7	64.7	13	193.0	90.0	73	247.4	115.4
34	30.8	14.4	94	85.2	39.7	54	139.6	65.1	14	193.9	90.4	74	248.3	115.8
35	31.7	14.8	95	86.1	40.1	55	140.5	65.5	15	194.9	90.9	75	249.2	116.2
36	32.6	15.2	96	87.0	40.6	56	141.4	65.9	16	195.8	91.3	76	250.1	116.6
37	33.5	15.6	97	87.9	41.0	57	142.3	66.3	17	196.7	91.7	77	251.0	117.1
38	34.4	16.1	98	88.8	41.4	58	143.2	66.8	18	197.6	92.1	78	252.0	117.5
39	35.3	16.5	99	89.7	41.8	59	144.1	67.2	19	198.5	92.5	79	252.9	117.9
40	36.3	16.9	100	90.6	42.3	60	145.0	67.6	20	199.4	93.0	80	253.8	118.3
41	37.2	17.3	101	91.5	42.7	161	145.9	68.0	221	200.3	93.4	281	254.7	118.8
42	38.1	17.7	02	92.4	43.1	62	146.8	68.5	22	201.2	93.8	82	255.6	119.2
43	39.0	18.2	03	93.3	43.5	63	147.7	68.9	23	202.1	94.2	83	256.5	119.6
44	39.9	18.6	04	94.3	44.0	64	148.6	69.3	24	203.0	94.7	84	257.4	120.0
45	40.8	19.0	05	95.2	44.4	65	149.5	69.7	25	203.9	95.1	85	258.3	120.4
46	41.7	19.4	06	96.1	44.8	66	150.4	70.2	26	204.8	95.5	86	259.2	120.9
47	42.6	19.9	07	97.0	45.2	67	151.4	70.6	27	205.7	95.9	87	260.1	121.3
48	43.5	20.3	08	97.9	45.6	68	152.3	71.0	28	206.6	96.4	88	261.0	121.7
49	44.4	20.7	09	98.8	46.1	69	153.2	71.4	29	207.5	96.8	89	261.9	122.1
50	45.3	21.1	10	99.7	46.5	70	154.1	71.8	30	208.4	97.2	90	262.8	122.6
51	46.2	21.6	111	100.6	46.9	171	155.0	72.3	231	209.4	97.6	291	263.7	123.0
52	47.1	22.0	12	101.5	47.3	72	155.9	72.7	32	210.3	98.0	92	264.6	123.4
53	48.0	22.4	13	102.4	47.8	73	156.8	73.1	33	211.2	98.5	93	265.5	123.8
54	48.9	22.8	14	103.3	48.2	74	157.7	73.5	34	212.1	98.9	94	266.5	124.2
55	49.8	23.2	15	104.2	48.6	75	158.6	73.0	35	213.0	99.3	95	267.4	124.7
56	50.8	23.7	16	105.1	49.0	76	159.5	74.4	36	213.9	99.7	96	268.3	125.1
57	51.7	24.1	17	106.0	49.4	77	160.4	74.8	37	214.8	100.2	97	269.2	125.5
58	52.6	24.5	18	106.9	49.9	78	161.3	75.2	38	215.7	100.6	98	270.1	125.9
59	53.5	24.9	19	107.8	50.3	79	162.2	75.6	39	216.6	101.0	99	271.0	126.4
60	54.4	25.4	120	108.8	50.7	180	163.1	76.1	240	217.5	101.4	300	271.9	126.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

TABLE III. Difference of Latitude and Departure for 26 Degrees.

Diff	Lat.	Dep	Diff	Lat.	Dep	Diff	Lat.	Dep	Diff	Lat.	Dep.	Diff	Lat.	Dep.
1	00.9	00.4	61	54.8	26.7	121	108.8	53.0	181	162.7	79.4	241	216.6	105.7
2	01.8	00.9	62	55.7	27.2	22	109.7	53.5	82	163.6	79.8	42	217.5	106.1
3	02.7	01.3	63	56.6	27.6	23	110.6	53.9	83	164.5	80.2	43	218.4	106.5
4	03.6	01.8	64	57.5	28.1	24	111.5	54.4	84	165.4	80.7	44	219.3	107.0
5	04.5	02.2	65	58.4	28.5	25	112.4	54.8	85	166.3	81.1	45	220.2	107.4
6	05.4	02.6	66	59.3	28.9	26	113.2	55.2	86	167.2	81.5	46	221.1	107.8
7	06.3	03.1	67	60.2	29.4	27	114.1	55.7	87	168.1	82.0	47	222.0	108.3
8	07.2	03.5	68	61.1	29.8	28	115.0	56.1	88	169.0	82.4	48	222.9	108.7
9	08.1	03.9	69	62.0	30.2	29	115.9	56.6	89	169.9	82.9	49	223.8	109.2
10	09.0	04.4	70	62.9	30.7	30	116.8	57.0	90	170.8	83.3	50	224.7	109.6
11	09.9	04.8	71	63.8	31.1	131	117.7	57.4	191	171.7	83.7	251	225.6	110.0
12	10.8	5.3	72	64.7	31.6	32	118.6	57.9	92	172.6	84.2	52	226.5	110.5
13	11.7	05.7	73	65.6	32.0	33	119.5	58.3	93	173.5	84.6	53	227.4	110.9
14	12.6	06.1	74	66.5	32.4	34	120.4	58.7	94	174.4	85.0	54	228.3	111.4
15	13.5	06.6	75	67.4	32.9	35	121.3	59.2	95	175.3	85.5	55	229.2	111.8
16	14.4	07.0	76	68.3	33.3	36	122.2	59.6	96	176.2	85.9	56	230.1	112.2
17	15.3	07.5	77	69.2	33.8	37	123.1	60.1	97	177.1	86.4	57	231.0	112.7
18	16.2	07.9	78	70.1	34.2	38	124.0	60.5	98	178.0	86.8	58	231.9	113.1
19	17.1	08.3	79	71.0	34.6	39	124.9	60.9	99	178.9	87.2	59	232.8	113.5
20	18.0	08.7	80	71.9	35.1	40	125.8	61.4	200	179.8	87.7	60	233.7	114.0
21	18.9	09.2	81	72.8	35.5	141	126.7	61.8	201	180.7	88.1	261	234.6	114.4
22	19.8	09.6	82	73.7	35.9	42	127.6	62.3	02	181.6	88.6	62	235.5	114.9
23	20.7	10.1	83	74.6	36.4	43	128.5	62.7	03	182.5	89.0	63	236.4	115.3
24	21.6	10.5	84	75.5	36.8	44	129.4	63.1	04	183.4	89.4	64	237.3	115.7
25	22.5	11.0	85	76.4	37.3	45	130.3	63.6	05	184.3	89.9	65	238.2	116.2
26	23.4	11.4	86	77.3	37.7	46	131.2	64.0	06	185.2	90.3	66	239.1	116.6
27	24.3	11.8	87	78.2	38.1	47	132.1	64.4	07	186.1	90.7	67	240.0	117.1
28	25.2	12.3	88	79.1	38.6	48	133.0	64.9	08	187.0	91.2	68	240.9	117.5
29	26.1	12.7	89	80.0	39.0	49	133.9	65.3	09	187.8	91.6	69	241.8	117.9
30	27.0	13.2	90	80.9	39.5	50	134.8	65.8	10	188.7	92.1	70	242.7	118.4
31	27.9	13.6	91	81.8	39.9	151	135.7	66.2	211	189.6	92.5	271	243.6	118.8
32	28.8	14.0	92	82.7	40.3	52	136.6	66.6	12	190.5	92.9	72	244.5	119.2
33	29.7	14.5	93	83.6	40.8	53	137.5	67.1	13	191.4	93.4	73	245.4	119.7
34	30.6	14.9	94	84.5	41.2	54	138.4	67.5	14	192.3	93.8	74	246.3	120.1
35	31.5	15.3	95	85.4	41.6	55	139.3	68.0	15	193.2	94.3	75	247.2	120.6
36	32.4	15.8	96	86.3	42.1	56	140.2	68.4	16	194.1	94.7	76	248.1	121.0
37	33.3	16.2	97	87.2	42.5	57	141.1	68.8	17	195.0	95.1	77	249.0	121.4
38	34.2	16.7	98	88.1	43.0	58	142.0	69.3	18	195.9	95.6	78	249.9	121.9
39	35.1	17.1	99	89.0	43.4	59	142.9	69.7	19	196.8	96.0	79	250.8	122.3
40	36.0	17.5	100	89.9	43.8	60	143.8	70.1	20	197.7	96.4	80	251.7	122.8
41	36.9	18.0	101	90.8	44.3	161	144.7	70.6	221	198.6	96.9	281	252.6	123.2
42	37.7	18.4	02	91.7	44.7	62	145.6	71.0	22	199.5	97.3	82	253.5	123.6
43	38.6	18.9	03	92.6	45.2	63	146.5	71.5	23	200.4	97.8	83	254.4	123.1
44	39.5	19.3	04	93.5	45.6	64	147.4	71.9	24	201.3	98.2	84	255.3	124.5
45	40.4	19.7	05	94.4	46.0	65	148.3	72.3	25	202.2	98.6	85	256.2	124.9
46	41.3	20.2	06	95.3	46.5	66	149.2	72.8	26	203.1	99.1	86	257.1	125.4
47	42.2	20.6	07	96.2	46.9	67	150.1	73.2	27	204.0	99.5	87	258.0	125.8
48	43.1	21.0	08	97.1	47.3	68	151.0	73.7	28	204.9	100.0	88	258.9	126.3
49	44.0	21.5	09	98.0	47.8	69	151.9	74.1	29	205.8	100.4	89	259.8	126.7
50	44.9	21.9	10	98.9	48.2	70	152.8	74.5	30	206.7	100.8	90	260.7	127.1
51	45.8	22.4	111	99.8	48.7	171	153.7	75.0	231	207.6	101.3	291	261.6	127.6
52	46.7	22.8	12	100.7	49.1	72	154.6	75.4	32	208.5	101.7	92	262.4	128.0
53	47.6	23.2	13	101.6	49.5	73	155.5	75.8	33	209.4	102.1	93	263.3	128.5
54	48.5	23.7	14	102.5	50.0	74	156.4	76.3	34	210.3	102.6	94	264.2	128.9
55	49.4	24.1	15	103.4	50.4	75	157.3	76.7	35	211.2	103.0	95	265.1	129.3
56	50.3	24.6	16	104.3	50.9	76	158.2	77.2	36	212.1	103.5	96	266.0	129.8
57	51.2	25.0	17	105.2	51.3	77	159.1	77.6	37	213.0	103.9	97	266.9	130.2
58	52.1	25.4	18	106.1	51.7	78	160.0	78.0	38	213.9	104.3	98	267.8	130.6
59	53.0	2579	19	107.0	52.2	79	160.9	78.5	39	214.8	104.8	99	268.7	131.1
60	53.9	26.3	20	107.9	52.6	180	161.8	78.9	240	215.7	105.2	300	269.6	131.5
Diff	Dep	Lat.	Diff	Dep.	Lat.	Diff	Dep.	Lat.	Diff	Dep.	Lat.	Diff	Dep.	Lat.

for 64 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	90.9	00.5	61	54.4	27.7	121	107.8	54.9	181	161.3	82.2	241	214.7	109.4
2	01.8	00.9	62	55.2	28.1	22	108.7	55.4	82	162.2	82.6	42	215.6	109.9
3	02.7	01.4	63	56.1	28.6	23	109.6	55.8	83	163.1	83.1	43	216.5	110.3
4	03.6	01.8	64	57.0	29.1	24	110.5	56.3	84	164.0	83.5	44	217.4	110.8
5	04.5	02.3	65	57.9	29.5	25	111.4	56.8	85	164.8	84.0	45	218.3	111.2
6	05.3	02.7	66	58.8	30.0	26	112.3	57.2	86	165.7	84.4	46	219.2	111.7
7	06.2	03.2	67	59.7	30.4	27	113.2	57.7	87	166.6	84.9	47	220.1	112.1
8	07.1	03.6	68	60.6	30.9	28	114.0	58.1	88	167.5	85.4	48	221.0	112.6
9	08.0	04.1	69	61.5	31.3	29	114.9	58.6	89	168.4	85.8	49	221.9	113.0
10	08.9	04.5	70	62.4	31.8	30	115.8	59.0	90	169.3	86.3	50	222.8	113.5
11	09.8	05.0	71	63.3	32.2	131	116.7	59.5	191	170.2	86.7	251	223.6	114.0
12	10.7	05.4	72	64.2	32.7	32	117.6	59.9	92	171.1	87.2	52	224.5	114.4
13	11.6	05.9	73	65.0	33.1	33	118.5	60.4	93	172.0	87.6	53	225.4	114.9
14	12.5	06.4	74	65.9	33.6	34	119.4	60.8	94	172.9	88.1	54	226.3	115.3
15	13.4	06.8	75	66.8	34.1	35	120.3	61.3	95	173.7	88.5	55	227.2	115.8
16	14.3	07.3	76	67.7	34.5	36	121.2	61.7	96	174.6	89.0	56	228.1	116.2
17	15.1	07.7	77	68.6	35.0	37	122.1	62.2	97	175.5	89.4	57	229.0	116.7
18	16.0	08.2	78	69.5	35.4	38	123.0	62.7	98	176.4	89.9	58	229.9	117.1
19	16.9	08.6	79	70.4	35.9	39	123.8	63.1	99	177.3	90.3	59	230.8	117.6
20	17.8	09.1	80	71.3	36.3	40	124.7	63.6	200	178.2	90.8	60	231.7	118.0
21	18.7	09.5	81	72.2	36.8	141	125.6	64.0	201	179.1	91.3	261	232.6	118.5
22	19.6	10.0	82	73.1	37.2	42	126.5	64.5	02	180.0	91.7	62	233.4	118.9
23	20.5	10.4	83	74.0	37.7	43	127.4	64.9	03	180.9	92.2	63	234.3	119.4
24	21.4	10.9	84	74.8	38.1	44	128.3	65.4	04	181.8	92.6	64	235.2	119.9
25	22.3	11.4	85	75.7	38.6	45	129.2	65.8	05	182.7	93.1	65	236.1	120.3
26	23.2	11.8	86	76.6	39.0	46	130.1	66.3	06	183.5	93.5	66	237.0	120.8
27	24.1	12.3	87	77.5	39.5	47	131.0	66.7	07	184.4	94.0	67	237.9	121.2
28	24.9	12.7	88	78.4	40.0	48	131.9	67.2	08	185.3	94.4	68	238.8	121.7
29	25.8	13.2	89	79.3	40.4	49	132.8	67.6	09	186.2	94.9	69	239.7	122.1
30	26.7	13.6	90	80.2	40.9	50	133.7	68.1	10	187.1	95.3	70	240.6	122.6
31	27.6	14.1	91	81.1	41.3	151	134.5	68.6	211	188.0	95.8	271	241.5	123.1
32	28.5	14.5	92	82.0	41.8	52	135.4	69.0	12	188.9	96.2	72	242.4	123.5
33	29.4	15.0	93	82.9	42.2	53	136.3	69.5	13	189.8	96.7	73	243.2	123.9
34	30.3	15.4	94	83.8	42.7	54	137.2	69.9	14	190.7	97.2	74	244.1	124.4
35	31.2	15.9	95	84.6	43.1	55	138.1	70.4	15	191.6	97.6	75	245.0	124.9
36	32.1	16.3	96	85.5	43.6	56	139.0	70.8	16	192.5	98.1	76	245.9	125.3
37	33.0	16.8	97	86.4	44.0	57	139.9	71.3	17	193.3	98.5	77	246.8	125.8
38	33.9	17.3	98	87.3	44.5	58	140.8	71.7	18	194.2	99.0	78	247.7	126.2
39	34.7	17.7	99	88.2	44.9	59	141.7	72.2	19	195.1	99.4	79	248.6	126.7
40	35.6	18.2	100	89.1	45.4	60	142.6	72.6	20	196.0	99.9	80	249.5	127.1
41	36.5	18.6	101	90.0	45.9	161	143.5	73.1	221	196.9	100.3	281	250.4	127.6
42	37.4	19.1	02	90.9	46.3	62	144.3	73.5	22	197.8	100.8	82	251.3	128.0
43	38.3	19.5	03	91.8	46.8	63	145.2	74.0	23	198.7	101.2	83	252.2	128.5
44	39.2	20.0	04	92.7	47.2	64	146.1	74.5	24	199.6	101.7	84	253.0	128.9
45	40.1	20.4	05	93.6	47.7	65	147.0	74.9	25	200.5	102.2	85	253.9	129.4
46	41.0	20.9	06	94.4	48.1	66	147.9	75.4	26	201.4	102.6	86	254.8	129.8
47	42.9	21.3	07	95.3	48.6	67	148.8	75.8	27	202.3	103.1	87	255.7	130.3
48	42.8	21.8	08	96.2	49.0	68	149.7	76.3	28	203.1	103.5	88	256.6	130.8
49	43.7	22.2	09	97.1	49.5	69	150.6	76.7	29	204.0	104.0	89	257.5	131.2
50	44.6	22.7	10	98.0	49.9	70	151.5	77.2	30	204.9	104.4	90	258.4	131.7
51	45.4	23.2	111	98.9	50.4	171	152.4	77.6	231	205.8	104.9	291	259.3	132.1
52	46.3	23.6	12	99.8	50.8	72	153.3	78.1	32	206.7	105.3	92	260.2	132.6
53	47.2	24.1	13	100.7	51.3	73	154.1	78.5	33	207.6	105.8	93	261.1	133.0
54	48.1	24.5	14	101.6	51.8	74	155.0	79.0	34	208.5	106.2	94	262.0	133.5
55	49.0	25.0	15	102.5	52.2	75	155.9	79.5	35	209.4	106.7	95	262.8	133.9
56	49.9	25.4	16	103.4	52.7	76	156.8	79.9	36	210.3	107.1	96	263.7	134.4
57	50.8	25.9	17	104.2	53.1	77	157.7	80.4	37	211.2	107.6	97	264.6	134.8
58	51.7	26.3	18	105.1	53.6	78	158.6	80.8	38	212.1	108.1	98	265.5	135.3
59	52.6	26.8	19	106.0	54.0	79	159.5	81.3	39	212.9	108.5	99	266.4	135.7
60	53.5	27.2	120	106.9	54.5	180	160.4	81.7	240	213.8	109.0	300	267.3	136.2
Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

TABLE III. Difference of Latitude and Departure for 28 Degrees.

Dist	Lat.	Dep.	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.9	00.5	61	53.9	28.6	121	106.8	56.8	181	159.8	85.0	241	212.8	113.1
2	01.8	00.9	62	54.7	29.1	22	107.7	57.3	82	160.7	85.4	42	213.7	113.6
3	02.6	01.4	63	55.6	29.6	23	108.6	57.7	83	161.6	85.9	43	214.6	114.1
4	03.5	01.9	64	56.5	30.0	24	109.5	58.2	84	162.5	86.4	44	215.5	114.6
5	04.4	02.3	65	57.4	30.5	25	110.4	58.7	85	163.4	86.9	45	216.3	115.0
6	05.3	02.8	66	58.3	31.0	26	111.3	59.2	86	164.2	87.3	46	217.2	115.5
7	06.2	03.3	67	59.2	31.5	27	112.1	59.6	87	165.1	87.8	47	218.1	115.9
8	07.1	03.8	68	60.0	31.9	28	113.0	60.1	88	166.0	88.3	48	219.0	116.4
9	07.9	04.3	69	60.9	32.4	29	113.9	60.6	89	166.9	88.7	49	219.9	116.9
10	08.8	04.7	70	61.8	32.9	30	114.8	61.0	90	167.8	89.2	50	220.8	117.4
11	09.7	05.2	71	62.7	33.3	131	115.7	61.5	191	168.7	89.7	251	221.6	117.8
12	10.6	05.6	72	63.6	33.8	32	116.6	62.0	92	169.5	90.1	52	222.5	118.3
13	11.5	06.1	73	64.5	34.3	33	117.4	62.4	93	170.4	90.6	53	223.4	118.8
14	12.4	06.6	74	65.3	34.7	34	118.3	62.9	94	171.3	91.1	54	224.3	119.2
15	13.2	07.0	75	66.2	35.2	35	119.2	63.4	95	172.2	91.6	55	225.2	119.7
16	14.1	07.5	76	67.1	35.7	36	120.1	63.9	96	173.1	92.0	56	226.0	120.2
17	15.0	08.0	77	68.0	36.2	37	121.0	64.3	97	174.0	92.5	57	226.9	120.7
18	16.9	08.5	78	68.9	36.6	38	121.9	64.8	98	174.8	93.0	58	227.8	121.1
19	16.8	08.9	79	69.8	37.1	39	122.7	65.3	99	175.7	93.4	59	228.7	121.6
20	17.7	09.4	80	70.6	37.6	40	123.6	65.7	200	176.6	93.9	60	229.6	122.1
21	18.5	09.9	81	71.5	38.0	141	124.5	66.2	201	177.5	94.4	261	230.5	122.5
22	19.4	10.3	82	72.4	38.5	42	125.4	66.7	02	178.4	94.8	62	231.3	123.0
23	20.3	10.8	83	73.3	39.0	43	126.3	67.1	03	179.2	95.3	63	232.2	123.5
24	21.2	11.3	84	74.2	39.4	44	127.2	67.6	04	180.1	95.8	64	233.1	123.9
25	22.1	11.7	85	75.1	39.9	45	128.0	68.1	05	181.0	96.2	65	234.0	124.4
26	23.0	12.2	86	75.9	40.4	46	128.9	68.5	06	181.9	96.7	66	234.9	124.9
27	23.8	12.7	87	76.8	40.8	47	129.8	69.0	07	182.8	97.2	67	235.8	125.4
28	24.7	13.1	88	77.7	41.3	48	130.7	69.5	08	183.7	97.7	68	236.6	125.9
29	25.6	13.6	89	78.6	41.8	49	131.6	70.0	09	184.5	98.1	69	237.5	126.3
30	26.5	14.1	90	79.5	42.3	50	132.5	70.4	10	185.4	98.6	70	238.4	126.8
31	27.4	14.6	91	80.4	42.7	151	133.3	70.9	211	186.3	99.1	271	239.3	127.2
32	28.3	15.0	92	81.2	43.2	52	134.2	71.4	12	187.2	99.5	72	240.2	127.7
33	29.1	15.5	93	82.1	43.7	53	135.1	71.8	13	188.1	100.0	73	241.1	128.2
34	30.0	16.0	94	83.0	44.1	54	136.0	72.3	14	189.0	100.5	74	241.9	128.6
35	30.9	16.4	95	83.9	44.6	55	136.9	72.8	15	189.8	100.9	75	242.8	129.1
36	31.8	16.9	96	84.8	45.1	56	137.7	73.2	16	190.7	101.4	76	243.7	129.6
37	32.7	17.4	97	85.7	45.5	57	138.6	73.7	17	191.6	101.9	77	244.6	130.1
38	33.6	17.8	98	86.5	46.0	58	139.5	74.2	18	192.5	102.4	78	245.5	130.5
39	34.5	18.3	99	87.4	46.5	59	140.4	74.6	19	193.4	102.8	79	246.4	131.0
40	35.3	18.8	100	88.3	47.0	60	141.3	75.1	20	194.3	103.3	80	247.2	131.5
41	36.2	19.2	101	89.2	47.4	161	142.2	75.6	221	195.1	103.8	281	248.1	131.9
42	37.1	19.7	02	90.1	47.9	62	143.0	76.1	22	196.0	104.2	82	249.0	132.4
43	38.0	20.2	03	90.9	48.4	63	143.9	76.5	23	196.9	104.7	83	249.9	132.9
44	38.9	20.7	04	91.8	48.8	64	144.8	77.0	24	197.8	105.2	84	250.8	133.3
45	39.7	21.1	05	92.7	49.3	65	145.7	77.5	25	198.7	105.6	85	251.7	133.8
46	40.6	21.6	06	93.6	49.8	66	146.6	77.9	26	199.6	106.1	86	252.5	134.3
47	41.5	22.1	07	94.5	50.2	67	147.5	78.4	27	200.4	106.6	87	253.4	134.7
48	42.4	22.5	08	95.4	50.7	68	148.3	78.9	28	201.3	107.0	88	254.3	135.2
49	43.3	23.0	09	96.2	51.2	69	149.2	79.3	29	202.2	107.5	89	255.2	135.7
50	44.2	23.5	10	97.1	51.6	70	150.1	79.8	30	203.1	108.0	90	256.1	136.1
51	45.0	23.9	111	98.0	52.1	171	151.0	80.3	231	204.0	108.5	291	257.0	136.6
52	45.9	24.4	12	98.9	52.6	72	151.9	80.8	32	204.9	108.9	92	257.8	137.1
53	46.8	24.9	13	99.8	53.1	73	152.8	81.2	33	205.7	109.4	93	258.7	137.6
54	47.7	25.4	14	100.7	53.5	74	153.6	81.7	34	206.6	109.9	94	259.6	138.0
55	48.6	25.8	15	101.5	54.0	75	154.5	82.2	35	207.5	110.3	95	260.5	138.5
56	49.4	26.3	16	102.4	54.5	76	155.4	82.6	36	208.4	110.8	96	260.4	139.0
57	50.3	26.8	17	103.3	54.9	77	156.3	83.1	37	209.3	111.3	97	261.3	139.4
58	51.2	27.2	18	104.2	55.4	78	157.2	83.6	38	210.2	111.7	98	262.1	139.9
59	52.1	27.7	19	105.1	55.9	79	158.1	84.0	39	211.0	112.2	99	263.0	140.4
60	53.0	28.2	120	106.0	56.3	180	158.9	84.5	240	211.9	112.7	300	264.1	140.9
Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 62 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.9	00.5	61	53.4	29.6	121	105.8	58.7	181	158.3	[illegible]	[illegible]	170.8	176.8
2	01.7	01.0	62	54.2	30.1	22	106.7	59.1	82	159.2	88.2	[illegible]	211.7	117.3
3	02.6	01.5	63	55.1	30.5	23	107.6	59.6	83	160.1	88.7	43	212.5	117.8
4	03.5	01.9	64	56.0	31.0	24	108.5	60.1	84	160.9	89.2	44	213.4	118.3
5	04.4	02.4	65	56.8	31.5	25	109.3	60.6	85	161.8	89.7	45	214.3	118.8
6	05.2	02.9	66	57.7	32.0	26	110.2	61.1	86	162.7	90.2	46	215.2	119.3
7	06.1	03.4	67	58.6	32.5	27	111.1	61.6	87	163.6	90.7	47	216.0	119.7
8	07.0	03.9	68	59.5	33.0	28	111.9	62.1	88	164.4	91.1	48	216.9	120.2
9	07.9	04.4	69	60.3	33.5	29	112.8	62.5	89	165.3	91.6	49	217.8	120.7
10	08.7	04.8	70	61.2	33.9	30	113.7	63.0	90	166.2	92.1	50	218.7	121.2
11	09.6	05.3	71	62.1	34.4	131	114.6	63.5	191	167.0	92.6	251	219.5	121.7
12	10.5	05.8	72	63.0	34.9	32	115.4	64.0	92	167.9	93.1	52	220.4	122.2
13	11.4	06.3	73	63.8	35.4	33	116.3	64.5	93	168.8	93.6	53	221.3	122.7
14	12.2	06.8	74	64.7	35.9	34	117.2	65.0	94	169.7	94.1	54	222.2	123.1
15	13.1	07.3	75	65.6	36.4	35	118.1	65.4	95	170.5	94.5	55	223.0	123.6
16	14.0	07.8	76	66.5	36.8	36	118.9	65.9	96	171.4	95.0	56	223.9	124.1
17	14.9	08.2	77	67.3	37.3	37	119.8	66.4	97	172.3	95.5	57	224.8	124.6
18	15.7	08.7	78	68.2	37.8	38	120.7	66.9	98	173.2	96.0	58	225.6	125.1
19	16.6	09.2	79	69.1	38.3	39	121.6	67.4	99	174.0	96.5	59	226.5	125.6
20	17.5	09.7	80	70.0	38.8	40	122.4	67.9	200	174.9	97.0	60	227.4	126.0
21	18.4	10.2	81	70.8	39.3	141	123.3	68.4	201	175.8	97.4	261	228.3	126.5
22	19.2	10.7	82	71.7	39.8	42	124.2	68.9	02	176.7	97.9	62	229.1	127.0
23	20.1	11.2	83	72.6	40.2	43	125.1	69.3	03	177.5	98.4	63	230.0	127.5
24	21.0	11.6	84	73.5	40.7	44	125.9	69.8	04	178.4	98.9	64	230.9	128.0
25	21.9	12.1	85	74.3	41.2	45	126.8	70.3	05	179.3	99.4	65	231.8	128.5
26	22.7	12.6	86	75.2	41.7	46	127.7	70.8	06	180.2	99.9	66	232.6	129.0
27	23.6	13.1	87	76.1	42.2	47	128.6	71.3	07	181.0	100.4	67	233.5	129.4
28	24.5	13.6	88	77.0	42.7	48	129.4	71.8	08	181.9	100.8	68	234.4	129.9
29	25.4	14.0	89	77.8	43.1	49	130.3	72.2	09	182.8	101.3	69	235.3	130.4
30	26.2	14.5	90	78.7	43.6	50	131.2	72.7	10	183.7	101.8	70	236.1	130.9
31	27.1	15.0	91	79.6	44.1	151	132.1	73.2	211	184.5	102.3	271	237.0	131.4
32	28.0	15.5	92	80.5	44.6	52	132.9	73.7	12	185.4	102.8	72	237.9	131.9
33	28.9	16.0	93	81.3	45.1	53	133.8	74.2	13	186.3	103.3	73	238.8	132.4
34	29.7	16.5	94	82.2	45.6	54	134.7	74.7	14	187.2	103.7	74	239.6	132.8
35	30.6	17.0	95	83.1	46.1	55	135.6	75.1	15	188.0	104.2	75	240.5	133.3
36	31.5	17.5	96	84.0	46.5	56	136.4	75.6	16	188.9	104.7	76	241.4	133.8
37	32.4	17.9	97	84.8	47.0	57	137.3	76.1	17	189.8	105.2	77	242.3	134.3
38	33.2	18.4	98	85.7	47.5	58	138.2	76.6	18	190.7	105.7	78	243.1	134.8
39	34.1	18.9	99	86.6	48.0	59	139.1	77.1	19	191.5	106.2	79	244.0	135.3
40	35.0	19.4	100	87.5	48.5	60	139.9	77.6	20	192.4	106.7	80	244.9	135.7
41	35.9	19.9	101	88.3	49.0	161	140.8	78.1	221	193.3	107.1	281	245.8	136.2
42	36.7	20.4	02	89.2	49.4	62	141.7	78.5	22	194.2	107.6	82	246.6	136.7
43	37.6	20.8	03	90.1	49.9	63	142.6	79.0	23	195.0	108.1	83	247.5	137.2
44	38.5	21.3	04	91.0	50.4	64	143.4	79.5	24	195.9	108.6	84	248.4	137.7
45	39.4	21.8	05	91.8	50.9	65	144.3	80.0	25	196.8	109.1	85	249.3	138.2
46	40.2	22.3	06	92.7	51.4	66	145.2	80.5	26	197.7	109.6	86	250.1	138.7
47	41.1	22.8	07	93.6	51.9	67	146.1	81.0	27	198.5	110.0	87	251.0	139.1
48	42.0	23.3	08	94.5	52.4	68	146.9	81.4	28	199.4	110.5	88	251.9	139.6
49	42.9	23.8	09	95.3	52.8	69	147.8	81.9	29	200.3	111.0	89	252.8	140.1
50	43.7	24.2	10	96.2	53.3	170	148.7	82.4	30	201.2	111.5	90	253.6	140.6
51	44.6	24.7	111	97.1	53.8	171	149.6	82.9	231	202.0	112.0	291	254.5	141.1
52	45.5	25.2	12	98.0	54.3	72	150.4	83.4	32	202.9	112.5	92	255.4	141.6
53	46.4	25.7	13	98.8	54.8	73	151.3	83.9	33	203.8	113.0	93	256.3	142.0
54	47.2	26.2	14	99.7	55.3	74	152.2	84.4	34	204.7	113.4	94	257.1	142.5
55	48.1	26.7	15	100.6	55.8	75	153.1	84.8	35	205.5	113.9	95	258.0	143.0
56	49.0	27.1	16	101.5	56.2	76	153.9	85.3	36	206.4	114.4	96	258.9	143.5
57	49.9	27.6	17	102.3	56.7	77	154.8	85.8	37	207.3	114.9	97	259.8	144.0
58	50.7	28.1	18	103.2	57.2	78	155.7	86.3	38	208.2	115.4	98	260.6	144.5
59	51.6	28.6	19	104.1	57.7	79	156.6	86.8	39	209.0	115.9	99	261.5	145.0
60	52.5	29.1	120	105.0	58.2	180	157.4	87.3	240	209.9	116.4	300	262.4	145.4
Dist	Dep	Lat.	Dist	Dep	Lat	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 61 Degrees.

Table III. Differences of Latitude and Departure for 30 Degrees.

Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.9	00.5	61	[illegible]	30.5	121	104.8	60.5	181	156.7	90.5	241	208.7	120.5
2	01.7	01.0	62	[illegible]	31.0	22	105.7	61.0	82	157.6	91.0	42	209.6	121.0
3	02.6	01.5	63	[illegible]	31.5	23	106.5	61.5	83	158.5	91.5	43	210.4	121.5
4	03.5	02.0	64	[illegible]	32.0	24	107.4	62.0	84	159.3	92.0	44	211.3	122.0
5	04.3	02.5	65	56.3	32.5	25	108.3	62.5	85	160.2	92.5	45	212.2	122.5
6	05.2	03.0	66	57.2	33.0	26	109.1	63.0	86	161.1	93.0	46	213.0	123.0
7	06.1	03.5	67	58.0	33.5	27	110.0	63.5	87	161.9	93.5	47	213.9	123.5
8	06.9	04.0	68	58.9	34.0	28	110.8	64.0	88	162.8	94.0	48	214.8	124.0
9	07.8	04.5	69	59.8	34.5	29	111.7	64.5	89	163.7	94.5	49	215.6	124.5
10	08.7	05.0	70	60.6	35.0	30	112.6	65.0	90	164.5	95.0	50	216.5	125.0
11	09.5	05.5	71	61.5	35.5	131	113.4	65.5	191	165.4	95.5	251	217.4	125.5
12	10.4	06.0	72	62.4	36.0	32	114.3	66.0	92	166.3	96.0	52	218.2	126.0
13	11.3	06.5	73	63.2	36.5	33	115.2	66.5	93	167.1	96.5	53	219.1	126.5
14	12.1	07.0	74	64.1	37.0	34	116.0	67.0	94	168.0	97.0	54	220.0	127.0
15	13.0	07.5	75	65.0	37.5	35	116.9	67.5	95	168.9	97.5	55	220.8	127.5
16	13.9	08.0	76	65.8	38.0	36	117.8	68.0	96	169.7	98.0	56	221.7	128.0
17	14.7	08.5	77	66.7	38.5	37	118.6	68.5	97	170.6	98.5	57	222.6	128.5
18	15.6	09.0	78	67.5	39.0	38	119.5	69.0	98	171.5	99.0	58	223.4	129.0
19	16.5	09.5	79	68.4	39.5	39	120.4	69.5	99	172.3	99.5	59	224.3	129.5
20	17.3	10.0	80	69.3	40.0	40	121.2	70.0	200	173.2	100.0	60	225.2	130.0
21	18.2	10.5	81	70.1	40.5	141	122.1	70.5	201	174.1	100.5	261	226.0	130.5
22	19.1	11.0	82	71.0	41.0	42	123.0	71.0	02	174.9	101.0	62	226.9	131.0
23	19.9	11.5	83	71.9	41.5	43	123.8	71.5	03	175.8	101.5	63	227.8	131.5
24	20.8	12.0	84	72.7	42.0	44	124.7	72.0	04	176.7	102.0	64	228.6	132.0
25	21.7	12.5	85	73.6	42.5	45	125.6	72.5	05	177.5	102.5	65	229.5	132.5
26	22.5	13.0	86	74.5	43.0	46	126.4	73.0	06	178.4	103.0	66	230.4	133.0
27	23.4	13.5	87	75.3	43.5	47	127.3	73.5	07	179.3	103.5	67	231.2	133.5
28	24.2	14.0	88	76.2	44.0	48	128.2	74.0	08	180.1	104.0	68	232.1	134.0
29	25.1	14.5	89	77.1	44.5	49	129.0	74.5	09	181.0	104.5	69	233.0	134.5
30	26.0	15.0	90	77.9	45.0	50	129.9	75.0	10	181.9	105.0	70	233.8	135.0
31	26.8	15.5	91	78.8	45.5	151	130.8	75.5	211	182.7	105.5	271	234.7	135.5
32	27.7	16.0	92	79.7	46.0	52	131.7	76.0	12	183.6	106.0	72	235.6	136.0
33	28.6	16.5	93	80.5	46.5	53	132.5	76.5	13	184.5	106.5	73	236.4	136.5
34	29.4	17.0	94	81.4	47.0	54	133.4	77.0	14	185.3	107.0	74	237.3	137.0
35	30.3	17.5	95	82.3	47.5	55	134.2	77.5	15	186.2	107.5	75	238.2	137.5
36	31.2	18.0	96	83.1	48.0	56	135.1	78.0	16	187.1	108.0	76	239.0	138.0
37	32.0	18.5	97	84.0	48.5	57	136.0	78.5	17	187.9	108.5	77	239.9	138.5
38	32.9	19.0	98	84.9	49.0	58	136.8	79.0	18	188.8	109.0	78	240.7	139.0
39	33.8	19.5	99	85.7	49.5	59	137.7	79.5	19	189.7	109.5	79	241.6	139.5
40	34.6	20.0	100	86.6	50.0	60	138.6	80.0	20	190.5	110.0	80	242.5	140.0
41	35.5	20.5	101	87.5	50.5	161	139.4	80.5	221	191.4	110.5	281	243.3	140.5
42	36.4	21.0	02	88.3	51.0	62	140.3	81.0	22	192.3	111.0	82	244.2	141.0
43	37.2	21.5	03	89.2	51.5	63	141.2	81.5	23	193.1	111.5	83	245.1	141.5
44	38.1	22.0	04	90.1	52.0	64	142.0	82.0	24	194.0	112.0	84	245.9	142.0
45	39.0	22.5	05	90.9	52.5	65	142.9	82.5	25	194.9	112.5	85	246.8	142.5
46	39.8	23.0	06	91.8	53.0	66	143.8	83.0	26	195.7	113.0	86	247.7	143.0
47	40.7	23.5	07	92.7	53.5	67	144.6	83.5	27	196.6	113.5	87	248.5	143.5
48	41.5	24.0	08	93.5	54.0	68	145.5	84.0	28	197.4	114.0	88	249.4	144.0
49	42.4	24.5	09	94.4	54.5	69	146.4	84.5	29	198.3	114.5	89	250.3	144.5
50	43.3	25.0	10	95.3	55.0	70	147.2	85.0	30	199.2	115.0	90	251.1	145.0
51	44.2	25.5	111	96.1	55.5	171	148.1	85.5	231	200.0	115.5	291	252.0	145.5
52	45.0	26.0	12	97.0	56.0	72	149.0	86.0	32	200.9	116.0	92	252.9	146.0
53	45.9	26.5	13	97.9	56.5	73	149.8	86.5	33	201.8	116.5	93	253.7	146.5
54	46.8	27.0	14	98.7	57.0	74	150.7	87.0	34	202.6	117.0	94	254.6	147.0
55	47.6	27.5	15	99.6	57.5	75	151.6	87.5	35	203.5	117.5	95	255.5	147.5
56	48.5	28.0	16	100.5	58.0	76	152.4	88.0	36	204.4	118.0	96	256.3	148.0
57	49.4	28.5	17	101.3	58.5	77	153.3	88.5	37	205.2	118.5	97	257.2	148.5
58	50.2	29.0	18	102.2	59.0	78	154.1	89.0	38	206.1	119.0	98	258.1	149.0
59	51.1	29.5	19	103.1	59.5	79	155.0	89.5	39	207.0	119.5	99	258.9	149.5
60	52.0	30.0	120	103.9	60.0	180	155.9	90.0	240	207.8	120.0	300	259.8	150.0
Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 60 Degrees.

Table III. Difference of Latitude and Departure for 31 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.9	00.5	61	52.3	31.4	121	103.7	62.3	181	155.1	93.2	241	206.5	124.1
2	01.7	01.0	62	53.1	31.9	22	104.6	62.8	82	156.6	93.7	42	207.4	124.6
3	02.6	01.5	63	54.0	32.4	23	105.4	63.3	83	156.8	94.2	43	208.3	125.1
4	03.4	02.1	64	54.8	33.6	24	106.3	63.9	84	157.7	94.8	44	209.1	125.6
5	04.3	02.6	65	55.7	33.5	25	107.1	64.4	85	158.5	95.3	45	210.0	126.2
6	05.1	03.1	66	56.6	34.0	26	108.0	64.9	86	159.4	95.8	46	210.8	126.7
7	06.0	03.6	67	57.4	34.5	27	108.8	65.4	87	160.3	96.3	47	211.7	127.2
8	06.9	04.1	68	58.3	35.0	28	109.7	65.9	88	161.1	96.8	48	212.5	127.7
9	07.7	04.6	69	59.1	35.5	29	110.6	66.4	89	162.0	97.3	49	213.4	128.2
10	08.6	05.2	70	60.0	36.1	30	111.4	67.0	90	162.8	97.9	50	214.3	128.8
11	09.4	05.7	71	60.8	36.6	131	112.3	67.5	191	163.7	98.4	251	215.1	129.3
12	10.3	06.2	72	61.7	37.1	32	113.1	68.0	92	164.5	98.9	52	216.0	129.8
13	11.1	06.7	73	62.6	37.6	33	114.0	68.5	93	165.4	99.4	53	216.8	130.3
14	12.0	07.2	74	63.4	38.1	34	114.8	69.0	49	166.3	99.9	54	217.7	130.8
15	12.9	07.7	75	64.3	38.6	35	115.7	69.5	95	167.1	100.4	55	218.5	131.3
16	13.7	08.2	76	65.1	39.1	36	116.6	70.0	96	168.0	100.9	56	219.4	131.8
17	14.6	08.8	77	66.0	39.7	37	117.4	70.6	97	168.8	101.5	57	220.2	132.4
18	15.4	09.3	78	66.8	40.2	38	118.3	71.1	98	169.7	102.0	58	221.1	132.9
19	16.3	09.8	79	67.7	40.7	39	119.1	71.6	99	170.5	102.5	59	222.1	133.4
20	17.1	10.3	80	68.6	41.2	40	120.0	72.1	200	171.4	103.0	60	222.8	133.9
21	18.0	10.8	81	69.4	41.7	141	120.8	72.6	201	172.3	103.5	261	223.7	134.4
22	18.9	11.3	82	70.3	42.2	42	121.7	73.1	02	173.1	104.0	62	224.5	134.9
23	19.7	11.8	83	71.1	42.7	43	122.6	73.6	03	174.0	104.5	63	225.4	135.4
24	20.6	12.4	84	72.0	43.3	44	123.4	74.2	04	174.8	105.0	64	226.2	136.0
25	21.4	12.9	85	72.8	43.8	45	124.3	74.7	05	175.7	105.6	65	227.1	136.5
26	22.3	13.4	86	73.7	44.3	46	125.1	75.2	06	176.5	106.1	66	228.0	137.0
27	23.1	13.9	87	74.6	44.8	47	126.0	75.7	07	177.4	106.6	67	228.8	137.5
28	24.0	14.4	88	75.4	45.3	48	126.8	76.2	08	178.3	107.1	68	229.7	138.0
29	24.9	14.9	89	76.3	45.8	49	127.7	76.7	09	179.1	107.6	69	230.5	138.5
30	25.7	15.4	90	77.1	46.4	50	128.6	77.3	10	180.0	108.2	70	231.4	139.1
31	26.6	16.0	91	78.0	46.9	151	129.4	77.8	211	180.8	108.7	271	232.2	139.6
32	27.4	16.5	92	78.8	47.4	52	130.3	78.3	12	181.7	109.2	72	233.1	140.1
33	28.3	17.0	93	79.7	47.9	53	131.1	78.8	13	182.5	109.7	73	234.0	140.6
34	29.1	17.5	94	80.6	48.4	54	132.0	79.3	14	183.4	110.2	74	234.8	141.1
35	30.0	18.0	95	81.4	48.9	55	132.8	79.8	15	184.3	110.7	75	235.7	141.6
36	30.9	18.5	96	82.3	49.4	56	133.7	80.3	16	185.1	111.2	76	236.5	142.2
37	31.7	19.1	97	83.1	50.0	57	134.5	80.9	17	186.0	111.8	77	237.4	142.7
38	32.6	19.6	98	84.0	50.5	58	135.4	81.4	18	186.8	112.3	78	238.2	143.2
39	33.4	20.1	99	84.8	51.0	59	136.3	81.9	19	187.7	112.8	79	239.1	143.7
40	34.3	20.6	100	85.7	51.5	60	137.1	82.4	20	188.5	113.3	80	240.0	144.2
41	35.1	21.1	101	86.6	52.0	161	138.0	82.9	221	189.4	113.8	281	240.8	144.7
42	36.0	21.6	02	87.4	52.5	62	138.8	83.4	22	190.3	114.3	82	241.7	145.2
43	36.9	22.1	03	88.3	53.0	63	139.7	83.9	23	191.1	114.8	83	242.5	145.7
44	37.9	22.6	04	89.1	53.6	64	140.5	84.5	24	192.0	115.4	84	243.4	146.3
45	38.6	23.2	05	90.0	54.1	65	141.4	85.0	25	192.8	115.9	85	244.2	146.8
46	39.4	23.7	06	90.8	54.6	66	142.3	85.5	26	193.7	116.4	86	245.1	147.3
47	40.3	24.2	07	91.7	55.1	67	143.1	86.0	27	194.5	116.9	87	246.0	147.8
48	41.1	24.7	08	92.6	55.6	68	144.0	86.5	28	195.4	117.4	88	246.8	148.3
49	42.0	25.2	09	93.4	56.1	69	144.8	87.0	29	196.3	117.9	89	247.7	148.8
50	42.9	25.8	10	94.3	56.7	70	145.7	87.6	30	197.1	118.5	90	248.5	149.4
51	43.7	26.3	111	95.1	57.2	171	146.5	88.1	231	198.0	119.0	291	249.4	149.8
52	44.6	26.8	12	96.0	57.7	72	147.4	88.6	32	198.8	119.5	92	250.2	150.4
53	45.4	27.3	13	96.8	58.2	73	148.3	89.1	33	199.7	120.0	93	251.1	150.9
54	46.3	27.8	14	97.7	58.7	74	149.1	89.6	34	200.5	120.5	94	252.0	151.4
55	47.1	28.3	15	98.6	59.2	75	150.0	90.1	35	201.4	121.0	95	252.8	151.9
56	48.0	28.8	16	99.4	59.7	76	150.8	90.6	36	202.3	121.5	96	253.7	152.4
57	48.8	29.4	17	100.3	60.3	77	151.7	91.2	37	203.1	122.1	97	254.5	153.0
58	49.7	29.9	18	101.1	60.8	78	152.5	91.7	38	204.0	122.6	98	255.4	153.5
59	50.6	30.4	19	102.0	61.3	79	153.4	92.2	39	204.8	123.1	99	256.2	154.0
60	51.4	30.9	120	102.8	61.8	180	154.3	92.7	240	205.7	123.6	300	257.1	154.5
Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 59 Degrees.

TABLE III. Difference of Latitude and Departure for 32 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.8	00.5	61	52.7	32.3	121	102.6	64.1	181	153.5	95.9	241	204.4	127.7
2	01.7	01.1	62	52.6	32.9	22	103.5	64.7	82	154.4	96.5	42	205.2	128.3
3	02.5	01.6	63	53.4	33.4	23	104.3	65.2	83	155.2	97.0	43	206.1	128.8
4	03.2	02.1	64	54.3	33.9	24	105.2	65.7	84	156.0	97.5	44	206.9	129.3
5	04.4	02.6	65	55.1	34.5	25	106.0	66.3	85	156.9	98.1	45	207.8	129.5
6	05.1	03.2	66	56.0	35.0	26	106.8	66.8	86	157.7	98.6	46	208.6	130.4
7	05.9	03.7	67	56.8	35.5	27	107.7	67.3	87	158.6	99.1	47	209.5	130.9
8	06.8	04.2	68	57.7	36.0	28	108.5	67.8	88	159.4	99.6	48	210.3	131.4
9	07.6	04.8	69	58.5	36.6	29	109.4	68.4	89	160.3	100.2	49	211.2	132.0
10	08.5	05.3	70	59.4	37.1	30	110.2	68.9	90	161.1	100.7	50	212.0	132.5
11	09.3	05.8	71	60.2	37.6	131	111.1	69.4	191	162.0	101.2	251	212.8	133.0
12	10.2	06.4	72	61.1	38.2	32	111.9	70.0	92	162.8	101.8	52	213.7	133.6
13	11.0	06.9	73	61.9	38.7	33	112.8	70.5	93	163.7	102.3	53	214.5	134.1
14	11.9	07.4	74	62.8	39.2	34	113.6	71.0	94	164.5	102.8	54	215.4	134.6
15	12.7	08.0	75	63.6	39.8	35	114.5	71.6	95	165.4	103.4	55	216.2	135.2
16	13.6	08.5	76	64.4	40.3	36	115.3	72.1	96	166.2	103.9	56	217.1	135.7
17	14.4	09.0	77	65.3	40.8	37	116.2	72.6	97	167.1	104.4	57	117.9	136.2
18	15.3	09.5	78	66.1	41.3	38	117.0	73.1	98	167.9	104.9	58	218.8	136.7
19	16.1	10.1	79	67.0	41.9	39	117.9	73.7	99	168.8	105.5	59	219.6	137.3
20	17.0	10.6	80	67.8	42.4	40	118.8	74.2	200	169.6	106.0	60	220.3	137.8
21	17.8	11.1	81	68.7	42.9	141	119.6	74.7	201	170.4	106.5	261	221.3	138.3
22	18.7	11.7	82	69.5	43.5	42	120.4	75.3	02	171.3	107.1	62	222.2	138.9
23	19.5	12.2	83	70.4	44.0	43	121.3	75.8	03	172.1	107.6	63	223.0	139.4
24	20.4	12.7	84	71.2	44.5	44	122.1	76.3	04	173.0	108.1	64	223.9	139.9
25	21.3	13.3	85	72.1	45.1	45	123.0	76.9	05	173.8	108.7	65	224.7	140.5
26	22.0	13.8	86	72.9	45.6	46	123.8	77.4	06	174.7	109.2	66	225.6	141.0
27	22.9	14.3	87	73.8	46.1	47	124.7	77.	07	175.5	109.7	67	226.4	141.5
28	23.7	14.8	88	74.6	46.6	48	125.5	78.4	08	176.6	110.2	68	227.3	142.0
29	24.6	15.4	89	75.4	47.2	49	126.4	79.0	09	177.2	110.8	69	228.1	142.6
30	25.4	15.9	90	76.3	47.7	50	127.2	79.5	10	178.1	111.3	70	229.0	143.1
31	26.3	16.4	91	77.2	48.2	151	128.0	80.0	211	178.9	111.8	271	229.8	143.6
32	27.1	17.0	92	78.0	48.8	52	128.9	80.6	12	179.8	112.4	72	230.7	144.2
33	28.0	17.5	93	78.9	49.3	53	129.7	81.1	13	180.5	112.9	73	231.5	144.7
34	28.8	18.0	94	79.7	49.8	54	130.6	81.6	14	181.4	113.4	74	231.4	145.2
35	29.7	18.6	95	80.6	50.4	55	131.4	82.2	15	182.3	114.0	75	233.2	145.8
36	30.5	19.1	96	81.4	50.9	56	132.3	82.7	16	183.2	114.5	76	234.0	146.3
37	31.4	19.6	97	82.3	51.4	57	133.1	83.2	17	184.0	115.0	77	234.9	146.8
38	32.2	20.1	98	83.1	51.9	58	134.0	83.7	18	184.9	115.5	78	235.7	147.3
39	33.1	20.7	99	84.0	52.5	59	134.8	84.3	19	185.7	116.1	79	236.6	147.9
40	33.9	21.2	100	84.8	53.0	60	135.7	84.8	20	186.6	116.6	80	237.4	148.4
41	34.8	21.7	101	85.6	53.5	161	136.5	85.3	221	187.4	117.1	281	238.3	148.9
42	35.6	22.3	02	86.5	54.1	62	137.4	85.9	22	188.3	117.7	82	239.1	149.5
43	36.5	22.8	03	87.3	54.6	63	138.2	86.4	23	189.1	118.2	83	240.0	150.0
44	37.3	23.3	04	88.2	55.1	64	139.1	86.9	24	190.0	118.7	84	240.8	150.5
45	38.2	23.9	05	89.0	55.7	65	139.9	87.5	25	190.8	119.3	85	241.7	151.1
46	39.0	24.4	06	89.9	56.2	66	140.8	88.0	26	191.6	119.8	86	242.5	151.6
47	39.9	24.9	07	90.7	56.7	67	141.6	88.5	27	192.5	120.3	87	243.4	152.1
48	40.7	25.4	08	91.6	57.2	68	142.5	89.0	28	193.3	120.8	88	244.2	152.6
49	41.6	26.0	09	92.4	57.8	69	143.3	89.6	29	194.2	121.4	89	245.1	153.2
50	42.4	26.5	10	93.3	58.3	70	144.2	90.1	30	195.0	121.9	90	245.9	153.7
51	43.2	27.0	111	94.1	58.8	171	145.0	90.6	231	195.9	122.4	291	246.8	154.2
52	44.1	27.6	12	95.0	59.4	72	145.9	91.2	32	196.7	123.0	92	247.6	154.8
53	44.9	28.1	13	95.8	59.9	73	146.7	91.7	33	197.6	123.5	93	248.5	155.3
54	45.8	28.6	14	96.7	60.4	74	147.6	92.2	34	198.4	124.0	94	249.3	155.8
55	46.6	29.2	15	97.5	61.0	75	148.4	92.8	35	199.3	124.6	95	250.2	156.4
56	47.5	29.7	16	98.4	61.5	76	149.2	93.3	36	200.1	125.1	96	251.0	156.9
57	48.3	30.2	17	99.2	62.0	77	150.1	93.8	37	201.0	125.6	97	251.9	157.4
58	49.2	30.7	18	100.1	62.5	78	150.9	94.3	38	201.8	126.1	98	252.7	157.9
59	50.0	31.3	19	100.9	63.1	79	151.8	94.9	39	202.7	126.7	99	253.6	158.5
60	50.9	31.8	120	101.8	63.6	180	152.6	95.4	240	203.5	127.2	300	254.4	159.0
Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 58 Degrees.

Table III. Difference of Latitude and Departure for 33 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.8	00.5	61	51.2	33.2	121	101.5	65.9	181	151.8	98.6	241	202.1	131.2
2	01.7	01.1	62	52.0	33.8	22	102.3	66.4	82	152.6	99.1	42	202.9	131.8
3	02.5	01.6	63	52.8	34.3	23	103.1	67.0	83	153.5	99.7	43	203.8	132.3
4	03.4	02.2	64	53.7	34.9	24	104.0	67.5	84	154.3	100.2	44	204.6	132.9
5	04.2	02.7	65	54.5	35.4	25	104.8	68.1	85	155.1	100.8	45	205.5	133.4
6	05.0	03.3	66	55.3	35.9	26	105.7	68.6	86	156.0	101.3	46	206.3	134.0
7	05.9	03.8	67	56.2	36.5	27	106.5	69.2	87	156.8	101.8	47	207.1	134.5
8	06.7	04.4	68	57.0	37.0	28	107.3	69.7	88	157.7	102.4	48	208.0	135.1
9	07.5	04.9	69	57.9	37.6	29	108.2	70.3	89	158.5	102.9	49	208.8	135.6
10	08.4	05.4	70	58.7	38.1	30	109.0	70.8	90	159.3	103.5	50	209.7	136.2
11	09.2	06.0	71	59.5	38.7	131	109.9	71.3	191	160.2	104.0	251	210.5	136.7
12	10.1	06.5	72	60.4	39.2	32	110.7	71.9	92	161.0	104.6	52	211.3	137.2
13	10.9	07.1	73	61.2	39.8	33	111.5	72.4	93	161.8	105.1	53	212.2	137.8
14	11.7	07.6	74	62.1	40.3	34	112.4	73.0	94	162.7	105.7	54	213.0	138.3
15	12.6	08.2	75	62.9	40.8	35	113.2	73.5	95	163.5	106.2	55	213.8	138.9
16	13.4	08.7	76	63.7	41.4	36	114.0	74.1	96	164.4	106.7	56	214.7	139.4
17	14.3	09.3	77	64.6	41.9	37	114.9	74.6	97	165.2	107.3	57	215.5	140.0
18	15.1	09.8	78	65.4	42.5	38	115.7	75.2	98	166.0	107.8	58	216.4	140.5
19	15.9	10.3	79	66.2	43.0	39	116.6	75.7	99	166.9	108.4	59	217.2	141.1
20	16.8	10.9	80	67.1	43.6	40	117.4	76.2	200	167.7	108.9	60	218.0	141.6
21	17.6	11.4	81	67.9	44.1	141	118.2	76.8	201	168.6	109.5	261	218.9	142.1
22	18.4	12.0	82	68.8	44.7	42	119.1	77.3	02	169.4	110.0	62	219.7	142.7
23	19.3	12.5	83	69.6	45.2	43	119.9	77.9	03	170.2	110.6	63	220.6	143.2
24	20.1	13.1	84	70.4	45.7	44	120.8	78.4	04	171.1	111.1	64	221.4	143.8
25	21.0	13.6	85	71.3	46.3	45	121.6	79.0	05	171.9	111.6	65	222.2	144.3
26	21.8	14.2	86	72.1	46.8	46	122.4	79.5	06	172.8	112.2	66	223.1	144.9
27	22.6	14.7	87	73.0	47.4	47	123.3	80.1	07	173.6	112.7	67	223.9	145.4
28	23.5	15.2	88	73.8	47.9	48	124.1	80.6	08	174.4	113.3	68	224.7	146.0
29	24.3	15.8	89	74.6	48.5	49	125.0	81.1	09	175.3	113.8	69	225.6	146.5
30	25.2	16.3	90	75.5	49.0	50	125.8	81.7	10	176.1	114.4	70	226.4	147.1
31	26.0	16.9	91	76.3	49.6	151	126.6	82.2	211	176.9	114.9	271	227.3	147.6
32	26.8	17.4	92	77.2	50.1	52	127.5	82.8	12	177.8	115.5	72	228.1	148.2
33	27.7	18.0	93	78.0	50.6	53	128.3	83.3	13	178.6	116.0	73	228.9	148.7
34	28.5	18.5	94	78.8	51.2	54	129.1	83.9	14	179.5	116.5	74	229.8	149.2
35	29.4	19.1	95	79.7	51.7	55	130.0	84.4	15	180.3	117.1	75	230.6	149.8
36	30.2	19.6	96	80.5	52.3	56	130.8	85.0	16	181.1	117.6	76	231.5	150.3
37	31.0	20.2	97	81.3	52.8	57	131.7	85.5	17	182.0	118.2	77	232.3	150.9
38	31.9	20.7	98	82.2	53.4	58	132.5	86.0	18	182.8	118.7	78	233.1	151.4
39	32.7	21.2	99	83.0	53.9	59	133.3	86.6	19	183.7	119.3	79	234.0	151.9
40	33.5	21.8	100	83.9	54.5	60	134.2	87.1	20	184.5	119.8	80	234.8	152.3
41	34.4	22.3	101	84.7	55.0	161	135.0	87.7	221	185.3	120.4	281	235.6	153.0
42	35.2	22.9	02	85.5	55.5	62	135.9	88.2	22	186.2	120.9	82	236.5	153.6
43	36.1	23.4	03	86.4	56.1	63	136.7	88.8	23	187.0	121.4	83	237.3	154.1
44	36.9	24.0	04	87.2	56.6	64	137.5	89.3	24	187.8	122.0	84	238.2	154.7
45	37.7	24.5	05	88.1	57.2	65	138.4	89.9	25	188.7	122.5	85	239.0	155.2
46	38.6	25.1	06	88.9	57.7	66	139.2	90.4	26	189.5	123.1	86	239.8	155.8
47	39.4	25.6	07	89.7	58.3	67	140.0	90.9	27	190.4	123.6	87	240.7	156.3
48	40.3	26.1	08	90.6	58.8	68	140.9	91.5	28	191.2	124.2	88	241.5	156.8
49	41.1	26.7	09	91.4	59.4	69	141.7	92.0	29	192.0	124.7	89	242.4	157.4
50	41.9	27.2	10	92.2	59.9	70	142.6	92.6	30	192.9	125.3	90	243.2	157.9
51	42.8	27.8	111	93.1	60.5	171	143.4	93.1	231	193.7	125.8	291	244.0	158.5
52	43.6	28.3	12	93.9	61.0	72	144.2	93.7	32	194.6	126.3	92	244.9	159.0
53	44.4	28.9	13	94.8	61.5	73	145.1	94.2	33	195.4	126.9	93	245.7	159.6
54	45.3	29.4	14	95.6	62.1	74	145.9	94.8	34	196.2	127.4	94	246.5	160.1
55	46.1	30.0	15	96.4	62.6	75	146.8	95.3	35	197.1	128.0	95	247.4	160.7
56	47.0	30.5	16	97.3	63.2	76	147.6	95.8	36	197.9	128.5	96	248.2	161.2
57	47.8	31.0	17	98.1	63.7	77	148.4	96.4	37	198.7	129.1	97	249.1	161.7
58	48.6	31.6	18	99.0	64.3	78	149.3	96.9	38	199.6	129.6	98	249.9	162.3
59	49.5	32.1	19	99.8	64.8	79	150.1	97.5	39	200.4	130.2	99	250.7	162.8
60	50.4	32.7	120	100.6	65.4	180	150.9	98.0	240	201.3	130.7	300	251.6	163.4
Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 57 Degrees.

Table III. Difference of Latitude and Departure for 34 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.8	00.6	61	50.6	34.1	121	100.3	67.7	181	150.0	101.2	241	199.8	134.8
2	01.7	01.1	62	51.4	34.7	22	101.1	68.2	82	150.9	101.8	42	200.6	135.3
3	02.5	01.7	63	52.2	35.2	23	102.0	68.8	83	151.7	102.3	43	201.4	135.9
4	03.3	02.2	64	53.1	35.8	24	102.8	69.3	84	152.5	102.9	44	202.3	136.4
5	04.1	02.8	65	53.9	36.3	25	103.6	69.9	85	153.4	103.5	45	203.1	137.0
6	05.0	03.4	66	54.7	36.9	26	104.5	70.5	86	154.2	104.0	46	203.9	137.6
7	05.8	03.9	67	55.5	37.5	27	105.3	71.0	87	155.0	104.6	47	204.8	138.1
8	06.6	04.5	68	56.4	38.0	28	106.1	71.6	88	155.9	105.1	48	205.6	138.7
9	07.5	05.0	69	57.2	38.6	29	106.9	72.1	89	156.7	105.7	49	206.4	139.2
10	08.3	05.6	70	58.0	39.1	30	107.8	72.7	90	157.5	106.2	50	207.3	139.8
11	09.1	06.2	71	58.9	39.7	131	108.6	73.3	191	158.3	106.8	251	208.1	140.4
12	09.9	06.7	72	59.7	40.3	32	109.4	73.8	92	159.2	107.4	52	208.9	140.9
13	10.8	07.3	73	60.5	40.8	33	110.3	74.4	93	160.0	107.9	53	209.7	141.5
14	11.6	07.8	74	61.3	41.4	34	111.1	74.9	94	160.8	108.5	54	210.6	142.0
15	12.4	08.4	75	62.2	41.9	35	111.9	75.5	95	161.7	109.0	55	211.4	142.6
16	13.3	08.9	76	63.0	42.5	36	112.7	76.1	96	162.5	109.6	56	212.2	143.2
17	14.1	09.5	77	63.8	43.1	37	113.6	76.6	97	163.3	110.2	57	213.1	143.7
18	14.9	10.1	78	64.7	43.6	38	114.4	77.2	98	164.1	110.7	58	213.9	144.3
19	15.8	10.6	79	65.5	44.2	39	115.2	77.7	99	165.0	111.3	59	214.7	144.8
20	16.6	11.2	80	66.3	44.7	40	116.1	78.3	200	165.8	111.8	60	215.5	145.4
21	17.4	11.7	81	67.1	45.3	141	116.9	78.8	201	166.6	112.4	261	216.4	146.0
22	18.2	12.3	82	68.0	45.9	42	117.7	79.4	02	167.5	113.0	62	217.2	146.5
23	19.1	12.9	83	68.8	46.4	43	118.5	80.0	03	168.3	113.5	63	218.0	147.1
24	19.9	13.4	84	69.6	47.0	44	119.4	80.5	04	169.1	114.1	64	218.9	147.6
25	20.7	14.0	85	70.5	47.5	45	120.2	81.1	05	169.9	114.6	65	219.7	148.2
26	21.6	14.5	86	71.3	48.1	46	121.0	81.6	06	170.8	115.2	66	220.5	148.7
27	22.4	15.1	87	72.1	48.7	47	121.9	82.2	07	171.6	115.8	67	221.3	149.3
28	23.2	15.7	88	73.0	49.2	48	122.7	82.8	08	172.4	116.3	68	222.2	149.9
29	24.0	16.2	89	73.8	49.8	49	123.5	83.3	09	173.3	116.9	69	223.0	150.4
30	24.9	16.8	90	74.6	50.3	50	124.4	83.9	10	174.1	117.4	70	223.8	151.0
31	25.7	17.3	91	75.4	50.9	151	125.2	84.4	211	174.9	118.0	271	224.7	151.5
32	26.5	17.9	92	76.3	51.4	52	126.0	85.0	12	175.7	118.6	72	225.5	152.1
33	27.4	18.5	93	77.1	52.0	53	126.8	85.6	13	176.6	119.1	73	226.3	152.7
34	28.2	19.0	94	77.9	52.6	54	127.7	86.1	14	177.4	119.7	74	227.1	153.2
35	29.0	19.6	95	78.8	53.1	55	128.5	86.7	15	178.2	120.2	75	228.0	153.8
36	29.8	20.1	96	79.6	53.7	56	129.3	87.0	16	179.1	120.8	76	228.8	154.3
37	30.7	20.7	97	80.4	54.2	57	130.2	87.8	17	179.9	121.3	77	229.6	154.9
38	31.5	21.2	98	81.2	54.8	58	131.0	88.4	18	180.7	121.9	78	230.5	155.5
39	32.3	21.8	99	82.1	55.4	59	131.8	88.9	19	181.6	122.5	79	231.3	156.0
40	33.2	22.4	100	82.9	55.9	60	132.6	89.5	20	182.4	123.0	80	232.1	156.6
41	34.0	22.8	101	83.8	56.5	161	133.5	90.0	221	183.2	123.6	281	232.9	157.1
42	34.8	23.5	02	84.6	57.0	62	134.3	90.6	22	184.0	124.1	82	233.8	157.7
43	35.6	24.0	03	85.4	57.6	63	135.1	91.1	23	184.9	124.7	83	234.6	158.3
44	36.5	24.6	04	86.2	58.2	64	136.0	91.7	24	185.7	125.3	84	235.4	158.8
45	37.3	25.2	05	87.0	58.7	65	136.8	92.3	25	186.5	125.8	85	236.3	159.4
46	38.1	25.7	06	87.9	59.3	66	137.6	92.8	26	187.4	126.4	86	237.1	159.9
47	39.0	26.3	07	88.7	59.8	67	138.4	93.4	27	188.2	126.9	87	237.9	160.5
48	39.8	26.8	08	89.5	60.4	68	139.3	93.9	28	189.0	127.5	88	238.8	161.0
49	40.6	27.4	09	90.4	61.0	69	140.1	94.5	29	189.8	128.1	89	239.6	161.6
50	41.5	28.0	10	91.2	61.5	70	140.9	95.1	30	190.7	128.6	90	240.4	162.2
51	42.3	28.5	111	92.0	62.1	171	141.8	95.6	231	191.5	129.2	291	241.2	162.7
52	43.1	29.1	12	92.8	62.6	72	142.6	96.2	32	192.3	129.7	92	242.1	163.3
53	43.9	29.6	13	93.7	63.2	73	143.4	96.7	33	193.2	130.3	93	242.9	163.8
54	44.8	30.2	14	94.5	63.7	74	144.2	97.3	34	194.0	130.9	94	243.7	164.4
55	45.6	30.8	15	95.3	64.3	75	145.1	97.9	35	194.8	131.4	95	244.6	165.0
56	46.4	31.3	16	96.2	64.9	76	145.9	98.4	36	195.6	132.0	96	245.4	165.6
57	47.3	31.9	17	97.0	65.4	77	146.7	99.0	37	196.5	132.5	97	246.2	166.1
58	48.1	32.4	18	97.8	66.0	78	147.6	99.5	38	197.3	133.1	98	247.0	166.6
59	48.9	33.0	19	98.7	66.5	79	148.4	100.1	39	198.1	133.6	99	247.9	167.2
60	49.7	33.6	120	99.5	67.1	180	149.2	100.7	240	199.0	134.2	300	248.7	167.8
Dist	Dep	Lat.	Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 56 Degrees.

TABLE III. Difference of Latitude and Departure for 35 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.8	00.6	61	50.0	35.0	121	99.1	69.4	181	148.2	103.8	241	197.4	138.2
2	01.6	01.1	62	50.8	35.6	22	99.9	70.0	82	149.1	104.4	42	198.2	138.8
3	02.5	01.7	63	51.6	36.1	23	100.7	70.5	83	149.9	105.0	43	199.0	139.4
4	03.3	02.3	64	52.4	36.7	24	101.6	71.1	84	150.7	105.5	44	199.8	139.9
5	04.1	02.9	65	53.2	37.3	25	102.4	71.7	85	151.5	106.1	45	200.6	140.5
6	04.9	03.4	66	54.1	37.9	26	103.2	72.3	86	152.3	106.7	46	201.5	141.1
7	05.7	04.0	67	54.9	38.4	27	104.0	72.8	87	153.1	107.2	47	202.3	141.7
8	06.6	04.6	68	55.7	39.0	28	104.8	73.4	88	154.0	107.8	48	203.1	142.2
9	07.4	05.2	69	56.5	39.6	29	105.6	74.0	89	154.8	108.4	49	203.9	142.8
10	08.2	05.7	70	57.3	40.1	30	106.5	74.6	90	155.6	109.0	50	204.7	143.4
11	09.0	06.3	71	58.1	40.7	131	107.3	75.1	191	156.4	109.5	251	205.6	143.9
12	09.8	06.9	72	59.0	41.3	32	108.1	75.7	92	157.2	110.1	52	206.4	144.5
13	10.6	07.5	73	59.8	41.9	33	108.9	76.3	93	158.1	110.7	53	207.2	145.1
14	11.5	08.0	74	60.6	42.4	34	109.7	76.8	94	158.9	111.3	54	208.0	145.7
15	12.3	08.6	75	61.4	43.0	35	110.6	77.4	95	159.7	111.8	55	208.8	146.2
16	13.1	09.2	76	62.2	43.6	36	111.4	78.0	96	160.5	112.4	56	209.6	146.8
17	13.9	09.7	77	63.1	44.2	37	112.2	78.6	97	161.3	113.0	57	210.5	147.4
18	14.7	10.3	78	63.9	44.7	38	113.0	79.1	98	162.2	113.6	58	211.3	148.0
19	15.6	10.9	79	64.7	45.3	39	113.8	79.7	99	163.0	114.1	59	212.1	148.5
20	16.4	11.5	80	65.5	45.9	40	114.6	80.3	200	163.8	114.7	60	212.9	149.1
21	17.2	12.0	81	66.3	46.5	141	115.5	80.9	201	164.6	115.3	261	213.8	149.7
22	18.0	12.6	82	67.2	47.0	42	116.3	81.4	02	165.4	115.8	62	214.6	150.3
23	18.8	13.2	83	68.0	47.6	43	117.1	82.0	03	166.3	116.4	63	215.4	150.8
24	19.6	13.8	84	68.8	48.2	44	117.9	82.6	04	167.1	117.0	64	216.2	151.4
25	20.5	14.3	85	69.6	48.7	45	118.8	83.2	05	167.9	117.6	65	217.0	152.0
26	21.3	14.9	86	70.4	49.3	46	119.6	83.7	06	168.6	118.1	66	117.8	152.6
27	22.1	15.5	87	71.3	49.9	47	120.4	84.3	07	169.5	118.7	67	218.7	153.1
28	22.9	16.1	88	72.1	50.5	48	121.2	84.9	08	170.3	119.3	68	219.5	153.7
29	23.8	16.6	89	72.9	51.0	49	122.0	85.5	09	171.2	119.9	69	220.3	154.3
30	24.6	17.2	90	73.7	51.6	50	122.8	86.0	10	172.0	120.4	70	221.1	154.8
31	25.4	17.8	91	74.5	52.2	151	123.7	86.6	211	172.8	121.0	271	221.9	155.4
32	26.2	18.4	92	75.3	52.8	52	124.5	87.2	12	173.6	121.6	72	222.8	156.0
33	27.0	18.9	93	76.2	53.3	53	125.3	87.7	13	174.4	122.2	73	223.6	156.6
34	27.8	19.5	94	77.0	53.9	54	126.1	88.3	14	175.3	122.7	74	224.4	157.1
35	28.7	20.1	95	77.8	54.5	55	126.9	88.9	15	176.1	123.3	75	225.2	157.7
36	29.5	20.6	96	78.6	55.1	56	127.8	89.5	16	176.9	123.9	76	226.0	158.3
37	30.3	21.2	97	79.4	55.6	57	128.6	90.0	17	177.7	124.4	77	226.9	158.9
38	31.1	21.8	98	80.3	56.2	58	129.4	90.6	18	178.5	125.0	78	227.7	159.4
39	31.9	22.4	99	81.1	56.8	59	130.2	91.2	19	179.4	125.6	79	228.5	160.0
40	32.8	22.9	100	81.9	57.4	60	131.0	91.8	20	180.2	126.2	80	229.3	160.6
41	33.6	23.5	101	82.7	57.9	161	131.9	92.3	221	181.0	126.7	281	230.1	161.2
42	34.4	24.1	02	83.5	58.5	62	132.7	92.9	22	181.8	127.3	82	231.0	161.7
43	35.2	24.7	03	84.4	59.1	63	133.5	93.5	23	182.6	127.9	83	231.8	162.3
44	36.0	25.2	04	85.2	59.6	64	134.3	94.1	24	183.5	128.5	84	232.6	162.9
45	36.9	25.8	05	86.0	60.2	65	135.1	94.6	25	184.2	129.0	85	233.4	163.4
46	37.7	26.4	06	86.8	60.8	66	136.0	95.2	26	185.1	129.6	86	234.2	164.0
47	38.5	27.0	07	87.6	61.4	67	136.8	95.8	27	185.9	130.2	87	235.0	164.6
48	39.3	27.5	08	88.5	61.9	68	137.6	96.3	28	186.7	130.8	88	235.9	165.2
49	40.1	28.1	09	89.3	62.5	69	138.4	96.9	29	187.5	131.3	89	236.7	165.7
50	41.0	28.7	10	90.1	63.1	70	139.2	97.5	30	188.4	131.9	90	237.5	166.3
51	41.8	29.2	111	90.9	63.7	171	140.0	98.1	231	189.2	132.5	291	238.3	166.9
52	42.6	29.8	12	91.7	64.2	72	140.9	98.6	32	190.0	133.1	92	239.1	167.5
53	43.4	30.4	13	92.5	64.8	73	141.7	99.2	33	190.8	133.6	93	240.0	168.0
54	44.2	31.0	14	93.4	65.4	74	142.5	99.8	34	191.6	134.2	94	240.8	168.6
55	45.0	31.5	15	94.2	66.0	75	143.3	100.4	35	192.5	134.8	95	241.6	169.2
56	45.9	32.1	16	95.0	66.5	76	144.1	100.9	36	193.3	135.3	96	242.4	169.8
57	46.7	32.7	17	95.8	67.1	77	145.0	101.5	37	194.1	135.9	97	243.2	170.3
58	47.5	33.3	18	96.6	67.7	78	145.8	102.1	38	194.9	136.5	98	244.1	170.9
59	48.3	33.8	19	97.5	68.2	79	146.6	102.7	39	195.7	137.1	99	244.9	171.5
60	49.1	34.4	120	98.3	68.8	180	147.4	103.2	240	196.6	137.6	300	245.7	172.1
Dist	Dep	Lat.	Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

Table III. Difference of Latitude and Departure for 36 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.8	00.6	61	49.3	35.9	121	97.9	71.1	181	146.4	106.4	241	195.0	141.7
2	01.6	01.2	62	50.2	36.4	22	98.7	71.7	82	147.2	107.0	42	195.8	142.2
3	02.4	01.8	63	51.0	37.0	23	99.5	72.3	83	148.0	107.6	43	196.6	142.8
4	03.2	02.4	64	51.8	37.6	24	100.3	72.9	84	148.9	108.2	44	197.4	143.4
5	04.0	02.9	65	52.6	38.2	25	101.1	73.5	85	149.7	108.7	45	198.2	144.0
6	04.9	03.5	66	53.4	38.8	26	101.9	74.1	86	150.5	109.3	46	199.0	144.6
7	05.7	04.1	67	54.2	39.4	27	102.7	74.7	87	151.3	109.9	47	199.8	145.2
8	06.5	04.7	68	55.0	40.0	28	103.6	75.2	88	152.1	110.5	48	200.6	145.8
9	07.3	05.3	69	55.8	40.6	29	104.4	75.8	89	152.9	111.1	49	201.4	146.4
10	08.1	05.9	70	56.6	41.1	30	105.2	76.4	90	153.7	111.7	50	202.2	146.9
11	08.9	06.5	71	57.4	41.7	131	106.0	77.0	191	154.5	112.3	251	203.1	147.5
12	09.7	07.1	72	58.2	42.3	32	106.8	77.6	92	155.3	112.9	52	203.9	148.1
13	10.5	07.6	73	59.1	42.9	33	107.6	78.2	93	156.1	113.4	53	204.7	148.7
14	11.3	08.2	74	59.9	43.5	34	108.4	78.8	94	156.9	114.0	54	205.5	149.3
15	12.1	08.8	75	60.7	44.1	35	109.2	79.4	95	157.8	114.6	55	206.3	149.9
16	12.9	09.4	76	61.5	44.7	36	110.0	79.9	96	158.6	115.2	56	207.1	150.5
17	13.8	10.0	77	62.3	45.3	37	110.8	80.5	97	159.4	115.8	57	207.9	151.1
18	14.6	10.6	78	63.1	45.8	38	111.6	81.1	98	160.2	116.4	58	208.7	151.7
19	15.4	11.2	79	63.9	46.4	39	112.5	81.7	99	161.0	117.0	59	209.5	152.2
20	16.2	11.8	80	64.7	47.0	40	113.3	82.3	200	161.8	117.6	60	210.3	152.8
21	17.0	12.3	81	65.5	47.6	141	114.1	82.9	201	162.6	118.1	261	211.1	153.4
22	17.8	12.9	82	66.3	48.2	42	114.9	83.5	02	163.4	118.7	62	212.0	154.0
23	18.6	13.5	83	67.1	48.8	43	115.7	84.1	03	164.2	119.3	63	212.8	154.6
24	19.4	14.1	84	68.0	49.4	44	116.5	84.6	04	165.0	119.9	64	213.6	155.2
25	20.2	14.7	85	68.8	50.0	45	117.3	85.2	05	165.8	120.5	65	214.4	155.8
26	21.0	15.3	86	69.6	50.6	46	118.1	85.8	06	166.7	121.1	66	215.2	156.4
27	21.8	15.9	87	70.4	51.1	47	118.9	86.4	07	167.5	121.7	67	216.0	156.9
28	22.7	16.5	88	71.2	51.7	48	119.7	87.0	08	168.3	122.3	68	216.8	157.5
29	23.5	17.0	89	72.0	52.3	49	120.5	87.6	09	169.1	122.8	69	217.6	158.1
30	24.3	17.6	90	72.8	52.9	50	121.3	88.2	10	169.9	123.4	70	218.4	158.7
31	25.1	18.2	91	73.6	53.5	151	122.2	88.8	211	170.7	124.0	271	219.2	159.5
32	25.9	18.8	92	74.4	54.1	52	123.0	89.3	12	171.5	124.6	72	220.0	159.9
33	26.7	19.4	93	75.2	54.7	53	123.8	89.9	13	172.3	125.2	73	220.9	160.5
34	27.5	20.0	94	76.0	55.3	54	124.6	90.5	14	173.1	125.8	74	221.7	161.1
35	28.3	20.6	95	76.9	55.8	55	125.4	91.1	15	173.9	126.4	75	222.5	161.6
36	29.1	21.2	96	77.7	56.4	56	126.2	91.7	16	174.7	127.0	76	223.3	162.2
37	29.9	21.7	97	78.5	57.0	57	127.0	92.3	17	175.6	127.6	77	224.1	162.8
38	30.7	22.3	98	79.3	57.6	58	127.8	92.9	18	176.4	128.1	78	224.9	163.4
39	31.6	22.9	99	80.1	58.2	59	128.6	93.5	19	177.2	128.7	79	225.7	164.0
40	32.4	23.5	100	80.9	58.8	60	129.4	94.0	20	178.0	129.3	80	226.5	164.6
41	33.2	24.1	101	81.7	59.4	161	130.2	94.6	221	178.8	129.9	281	227.3	165.2
42	34.0	24.7	02	82.5	60.0	62	131.1	95.2	22	179.6	130.5	82	228.1	165.8
43	34.8	25.3	03	83.3	60.5	63	131.9	95.8	23	180.4	131.1	83	228.9	166.3
44	35.6	25.9	04	84.1	61.1	64	132.7	96.4	24	181.2	131.7	84	229.8	166.9
45	36.4	26.5	05	84.9	61.7	65	133.5	97.0	25	182.0	132.3	85	230.6	167.5
46	37.2	27.1	06	85.8	62.3	66	134.3	97.6	26	182.8	132.8	86	231.4	168.1
47	38.0	27.6	07	86.6	62.9	67	135.1	98.2	27	183.6	133.4	87	232.2	168.7
48	38.8	28.2	08	87.4	63.5	68	135.9	98.7	28	184.5	134.0	88	233.0	169.3
49	39.6	28.8	09	88.2	64.1	69	136.7	99.3	29	185.3	134.6	89	233.8	169.9
50	40.5	29.4	10	89.0	64.7	70	137.5	99.9	30	186.1	135.2	90	234.6	170.5
51	41.3	30.0	111	89.8	65.2	171	138.3	100.5	231	186.9	135.8	291	235.4	171.0
52	42.1	30.6	12	90.6	65.8	72	139.1	101.1	32	187.7	136.4	92	236.2	171.6
53	42.9	31.2	13	91.4	66.4	73	140.0	101.7	33	188.5	137.0	93	237.0	172.2
54	43.7	31.7	14	92.2	67.0	74	140.8	102.3	34	189.3	137.5	94	237.8	172.8
55	44.5	32.3	15	93.0	67.6	75	141.6	102.9	35	190.1	138.1	95	238.7	173.4
56	45.3	32.9	16	93.8	68.2	76	142.4	103.5	36	190.9	138.7	96	239.5	174.0
57	46.1	33.5	17	94.7	68.8	77	143.2	104.0	37	191.7	139.3	97	240.3	174.6
58	46.9	34.1	18	95.5	69.4	78	144.0	104.6	38	192.5	139.9	98	241.1	175.2
59	47.7	34.7	19	96.3	69.9	79	144.8	105.2	39	193.3	140.5	99	241.9	175.7
60	48.5	35.3	120	97.1	70.5	180	145.6	105.8	240	194.2	141.1	300	242.7	176.3
Dist	Dep	Lat.	Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 54 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	48.7	36.7	121	96.6	72.8	181	144.5	108.9	241	192.5	145.0
2	01.6	01.2	62	49.5	37.3	22	97.4	73.4	82	145.3	109.5	42	193.3	145.6
3	02.4	01.8	63	50.3	37.9	23	98.2	74.0	83	146.1	110.1	43	194.1	146.2
4	03.2	02.4	64	51.1	38.5	24	99.0	74.6	84	146.9	110.7	44	194.9	146.8
5	04.0	03.0	65	51.9	39.1	25	99.8	75.2	85	147.7	111.3	45	195.7	147.4
6	04.8	03.6	66	52.7	39.7	26	100.6	75.8	86	148.5	111.9	46	196.5	148.0
7	05.6	04.2	67	53.5	40.3	27	101.4	76.4	87	149.3	112.5	47	197.3	148.6
8	06.4	04.8	68	54.3	40.9	28	102.2	77.0	88	150.1	113.1	48	198.1	149.2
9	07.2	05.4	69	55.1	41.5	29	103.0	77.6	89	150.9	113.7	49	198.9	149.8
10	08.0	06.0	70	55.9	42.1	30	103.8	78.2	90	151.7	114.3	50	199.7	150.4
11	08.8	06.6	71	56.7	42.7	131	104.6	78.8	191	152.5	114.9	251	200.4	151.0
12	09.6	07.2	72	57.5	43.3	32	105.4	79.4	92	153.3	115.5	52	201.2	151.6
13	10.4	07.8	73	58.3	43.9	33	106.2	80.0	93	154.1	116.1	53	202.0	152.2
14	11.2	08.4	74	59.1	44.5	34	107.0	80.6	94	154.9	116.7	54	202.8	152.9
15	12.0	09.0	75	59.9	45.1	35	107.8	81.2	95	155.7	117.3	55	203.6	153.5
16	12.8	09.6	76	60.7	45.7	36	108.6	81.8	96	156.5	117.9	56	204.4	154.1
17	13.6	10.2	77	61.5	46.3	37	109.4	82.4	97	157.3	118.6	57	205.2	154.7
18	14.4	10.8	78	62.3	46.9	38	110.2	83.0	98	158.1	119.2	58	206.0	155.3
19	15.2	11.4	79	63.1	47.5	39	111.0	83.6	99	158.9	119.8	59	206.8	155.9
20	16.0	12.0	80	63.9	48.1	40	111.8	84.2	200	159.7	120.4	60	207.6	156.5
21	16.8	12.6	81	64.7	48.7	141	112.6	84.9	201	160.5	121.0	261	208.4	157.1
22	17.6	13.2	82	65.5	49.3	42	113.4	85.5	02	161.3	121.6	62	209.2	157.7
23	18.4	13.8	83	66.3	49.9	43	114.2	86.1	03	162.1	122.2	63	210.0	158.3
24	19.2	14.4	84	67.1	50.6	44	115.0	86.7	04	162.9	122.8	64	210.8	158.9
25	20.0	15.0	85	67.9	51.2	45	115.8	87.3	05	163.7	123.4	65	211.6	159.5
26	20.8	15.6	86	68.7	51.8	46	116.6	87.9	06	164.5	124.0	66	212.4	160.1
27	21.6	16.2	87	69.5	52.4	47	117.4	88.5	07	165.3	124.6	67	213.2	160.7
28	22.4	16.9	88	70.3	53.0	48	118.2	89.1	08	166.1	125.2	68	214.0	161.3
29	23.2	17.5	89	71.1	53.6	49	119.0	89.7	09	166.9	125.8	69	214.8	161.9
30	24.0	18.1	90	71.9	54.2	50	119.8	90.3	10	167.7	126.4	70	215.6	162.5
31	24.8	18.7	91	72.7	54.8	151	120.6	90.9	211	168.5	127.0	271	216.4	163.1
32	25.6	19.3	92	73.5	55.4	52	121.4	91.5	12	169.3	127.6	72	217.2	163.7
33	26.4	19.9	93	74.3	56.0	53	122.2	92.1	13	170.1	128.2	73	218.0	164.3
34	27.2	20.5	94	75.1	56.6	54	123.0	92.7	14	170.9	128.8	74	218.8	164.9
35	28.0	21.1	95	75.9	57.2	55	123.8	93.3	15	171.7	129.4	75	219.6	165.5
36	28.7	21.7	96	76.7	57.8	56	124.6	93.9	16	172.5	130.0	76	220.4	166.1
37	29.5	22.3	97	77.5	58.4	57	125.4	94.5	17	173.3	130.6	77	221.2	166.7
38	30.3	22.9	98	78.3	59.0	58	126.2	95.1	18	174.1	131.2	78	222.0	167.3
39	31.1	23.5	99	79.1	59.6	59	127.0	95.7	19	174.9	131.8	79	222.8	167.9
40	31.9	24.1	100	79.9	60.2	60	127.8	96.3	20	175.7	132.4	80	223.6	168.5
41	32.7	24.7	101	80.7	60.8	161	128.6	96.9	221	176.5	133.0	281	224.4	169.1
42	33.5	25.3	02	81.5	61.4	62	129.4	97.5	22	177.3	133.6	82	225.2	169.7
43	34.3	25.9	03	82.3	62.0	63	130.2	98.1	23	178.1	134.2	83	226.0	170.3
44	35.1	26.5	04	83.1	62.6	64	131.0	98.7	24	178.9	134.8	84	226.8	170.9
45	35.9	27.1	05	83.9	63.2	65	131.8	99.3	25	179.7	135.4	85	227.6	171.5
46	36.7	27.7	06	84.7	63.8	66	132.6	99.9	26	180.5	136.0	86	228.4	172.1
47	37.5	28.3	07	85.5	64.4	67	133.4	100.5	27	181.3	136.6	87	229.2	172.7
48	38.3	28.9	08	86.2	65.0	68	134.2	101.1	28	182.1	137.2	88	230.0	173.3
49	39.1	29.5	09	87.0	65.6	69	135.0	101.7	29	182.9	137.8	89	230.8	173.9
50	39.9	30.1	10	87.8	66.2	70	135.8	102.3	30	183.7	138.4	90	231.6	174.5
51	40.7	30.7	111	88.6	66.8	171	136.6	102.9	231	184.5	139.0	291	232.4	175.1
52	41.5	31.3	12	89.4	67.4	72	137.4	103.5	32	185.3	139.6	92	233.2	175.7
53	42.3	31.9	13	90.2	68.0	73	138.2	104.1	33	186.1	140.2	93	234.0	176.3
54	43.1	32.5	14	91.0	68.6	74	139.0	104.7	34	186.9	140.8	94	234.8	176.9
55	43.9	33.1	15	91.8	69.2	75	139.8	105.3	35	187.7	141.4	95	235.6	177.5
56	44.7	33.7	16	92.6	69.8	76	140.6	105.9	36	188.5	142.0	96	236.4	178.1
57	45.5	34.3	17	93.4	70.4	77	141.4	106.5	37	189.3	142.6	97	237.2	178.7
58	46.3	34.9	18	94.2	71.0	78	142.2	107.1	38	190.1	143.2	98	238.0	179.3
59	47.1	35.5	19	95.0	71.6	79	142.9	107.7	39	190.9	143.8	99	238.8	179.9
60	47.9	36.1	120	95.8	72.2	180	143.7	108.3	240	191.7	144.4	300	239.6	180.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

Table III. Difference of Latitude and Departure for 38 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat	Dep.	Dist	Lat.	Dep	Dist	Lat.	Dep.
1	00.8	00.6	61	48.1	37.6	121	95.3	74.5	181	142.6	111.4	241	189.9	148.4
2	01.6	01.2	62	48.9	38.2	22	96.1	75.1	82	143.4	112.1	42	190.7	149.0
3	02.4	01.8	63	49.6	38.8	23	96.9	75.7	83	144.2	112.7	43	191.5	149.6
4	03.2	02.5	64	50.4	39.4	24	97.7	76.3	84	145.0	113.3	44	192.2	150.2
5	03.9	03.1	65	51.2	40.0	25	98.5	77.0	85	145.8	113.9	45	193.0	150.8
6	04.7	03.7	66	52.0	40.6	26	99.3	77.6	86	146.5	114.5	46	193.8	151.5
7	05.5	04.3	67	52.8	41.3	27	100.1	78.2	87	147.3	115.1	47	194.6	152.1
8	06.3	04.9	68	53.6	41.9	28	100.9	78.8	88	148.1	115.8	48	195.4	152.7
9	07.1	05.5	69	54.4	42.5	29	101.6	79.4	89	148.9	116.4	49	196.2	153.3
10	07.9	06.2	70	55.2	43.1	30	102.4	80.0	90	149.7	117.0	50	197.0	153.9
11	08.7	06.8	71	55.9	43.7	131	103.2	80.7	191	150.5	117.6	251	197.8	154.5
12	09.5	07.4	72	56.7	44.3	32	104.0	81.3	92	151.3	118.2	52	198.5	155.2
13	10.2	08.0	73	57.5	44.9	33	104.8	81.9	93	152.1	118.8	53	199.3	155.8
14	11.0	08.6	74	58.3	45.6	34	105.6	82.5	94	152.9	119.4	54	200.1	156.4
15	11.8	09.2	75	59.1	46.2	35	106.4	83.1	95	153.6	120.1	55	200.9	157.0
16	12.6	09.9	76	59.9	46.8	36	107.1	83.7	96	154.4	120.7	56	201.7	157.6
17	13.4	10.5	77	60.7	47.4	37	107.9	84.4	97	155.2	121.3	57	202.5	158.2
18	14.2	11.1	78	61.5	48.0	38	108.7	85.0	98	156.0	121.9	58	203.3	158.9
19	15.0	11.7	79	62.1	48.6	39	109.5	85.6	99	156.8	122.5	59	204.1	159.5
20	15.8	12.3	80	63.0	49.3	40	110.3	86.2	200	157.6	123.1	60	204.9	160.1
21	16.5	12.9	81	63.8	49.9	141	111.1	86.8	201	158.4	123.8	261	205.6	160.7
22	17.3	13.5	82	64.6	50.5	42	111.9	87.4	02	159.2	124.4	62	206.4	161.3
23	18.1	14.2	83	65.4	51.1	43	112.7	88.0	03	159.9	125.0	63	207.2	161.9
24	18.9	14.8	84	66.2	51.7	44	113.5	88.7	04	160.7	125.6	64	208.0	162.5
25	19.7	15.4	85	67.0	52.3	45	114.2	89.3	05	161.5	126.2	65	208.8	163.2
26	20.5	16.0	86	67.8	53.0	46	115.0	89.9	06	162.3	126.8	66	209.6	163.8
27	21.3	16.6	87	68.5	53.6	47	115.8	90.5	07	163.1	127.4	67	210.4	164.4
28	22.1	17.2	88	69.3	54.2	48	116.6	91.1	08	163.9	128.1	68	211.2	165.0
29	22.9	17.2	89	70.1	54.8	49	117.4	91.7	09	164.7	128.7	69	211.9	165.6
30	23.6	18.5	90	70.9	55.4	50	118.2	92.4	10	165.5	129.3	70	212.7	166.2
31	24.4	19.1	91	71.7	56.0	151	119.7	93.0	211	166.2	129.9	271	213.5	166.9
32	25.2	19.7	92	72.5	56.6	52	119.8	93.6	12	167.0	130.5	72	214.3	167.5
33	26.0	20.3	93	73.3	57.3	53	120.5	94.2	13	167.8	131.1	73	215.1	168.1
34	26.8	20.9	94	74.1	57.9	54	121.3	94.8	14	168.6	131.8	74	215.9	168.7
35	27.6	21.5	95	74.9	58.5	55	122.1	95.4	15	169.4	132.4	75	216.7	169.3
36	28.4	22.2	96	75.6	59.1	56	122.9	96.0	16	170.2	133.0	76	217.5	169.9
37	29.2	22.8	97	76.4	59.7	57	123.7	96.7	17	171.0	133.6	77	218.2	170.5
38	29.9	23.4	98	77.2	60.3	58	124.5	97.3	18	171.8	134.2	78	219.0	171.2
39	30.7	24.0	99	78.0	61.0	59	125.3	97.9	19	172.5	134.8	79	219.8	171.8
40	31.5	24.6	100	78.8	61.6	60	126.1	98.5	20	173.3	135.5	80	220.6	172.4
41	32.3	25.2	101	79.6	62.2	161	126.9	99.1	221	174.1	136.1	281	221.4	173.0
42	33.1	25.9	02	80.4	62.8	62	127.6	99.7	22	174.9	136.7	82	222.2	173.6
43	33.9	26.5	03	81.2	63.4	63	128.4	100.4	23	175.7	137.3	83	223.0	174.2
44	34.7	27.1	04	81.9	64.0	64	129.2	101.0	24	176.5	137.9	84	223.8	174.9
45	35.5	27.7	05	82.7	64.6	65	130.0	101.6	25	177.3	138.5	85	224.5	175.5
46	36.2	28.3	06	83.5	65.3	66	130.8	102.2	26	178.1	139.1	86	225.3	176.1
47	37.0	28.9	07	84.3	65.9	67	131.6	102.8	27	178.9	139.8	87	226.1	176.7
48	37.8	29.6	08	85.1	66.5	68	132.4	103.4	28	179.6	140.4	88	226.9	177.3
49	38.6	30.2	09	85.9	67.1	69	133.2	104.1	29	180.4	141.0	89	227.7	177.9
50	39.4	30.8	10	86.7	67.7	70	133.9	104.7	30	181.2	141.6	90	228.5	178.6
51	40.2	31.4	111	87.5	68.3	171	134.7	105.3	231	182.0	142.2	291	229.3	179.2
52	41.0	32.0	12	88.2	69.0	72	135.5	105.9	32	182.8	142.8	92	230.1	179.8
53	41.8	32.6	13	89.0	69.6	73	136.3	106.5	33	183.6	143.5	93	230.9	180.4
54	42.5	33.2	14	89.8	70.2	74	137.1	107.1	34	184.4	144.1	94	231.6	181.0
55	43.3	33.9	15	90.6	70.8	75	137.9	107.7	35	185.2	144.7	95	232.4	181.6
56	44.1	34.5	16	91.4	71.4	76	138.7	108.4	36	185.9	145.3	96	233.2	182.2
57	44.9	35.1	17	92.2	72.0	77	139.5	109.0	37	186.7	145.9	97	234.0	182.9
58	45.7	35.7	18	93.0	72.7	78	140.2	109.6	38	187.5	146.5	98	234.8	183.5
59	46.5	36.3	19	93.8	73.3	79	141.0	110.2	39	188.3	147.2	99	235.6	184.1
60	47.3	36.9	120	94.5	73.9	180	141.8	110.8	240	189.1	147.8	300	236.4	184.7
Dist	Dep	Lat.	Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 52 Degrees.

Table III. Difference of Latitude and Departure for 39 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.8	00.6	61	47.4	38.4	121	94.0	76.1	181	140.7	113.9	241	187.3	151.7
2	01.6	01.3	62	48.2	39.0	22	94.8	76.8	82	141.4	114.5	42	188.1	152.3
3	02.3	01.9	63	49.0	39.6	23	95.6	77.4	83	142.2	115.2	43	188.8	152.9
4	03.1	02.5	64	49.7	40.3	24	96.4	78.0	84	143.0	115.8	44	189.6	153.6
5	03.9	03.1	65	50.5	40.9	25	97.1	78.7	85	143.8	116.4	45	190.4	154.2
6	04.7	03.8	66	51.3	41.5	26	97.9	79.3	86	144.5	117.1	46	191.2	154.8
7	05.4	04.4	67	52.1	42.2	27	98.7	79.9	87	145.3	117.7	47	191.9	155.4
8	06.2	05.0	68	52.8	42.8	28	99.5	80.6	88	146.1	118.3	48	192.7	156.1
9	07.0	05.7	69	53.6	43.4	29	100.2	81.2	89	146.9	118.9	49	193.5	156.7
10	07.8	06.3	70	54.4	44.1	30	101.0	81.8	90	147.6	119.6	50	194.3	157.3
11	08.5	06.9	71	55.2	44.7	131	101.8	82.4	191	148.4	120.2	251	195.1	158.0
12	09.3	07.6	72	56.0	45.3	32	102.6	83.1	92	149.2	120.8	52	195.8	158.6
13	10.1	08.2	73	56.7	45.9	33	103.4	83.7	93	150.0	121.5	53	196.6	159.2
14	10.9	08.8	74	57.5	46.6	34	104.1	84.3	94	150.8	122.1	54	197.4	159.8
15	11.7	09.4	75	58.3	47.2	35	104.9	85.0	95	151.5	122.7	55	198.2	160.5
16	12.4	10.1	76	59.1	47.8	36	105.7	85.6	96	152.3	123.3	56	198.9	161.1
17	13.2	10.7	77	59.8	48.5	37	106.5	86.2	97	153.1	124.0	57	199.7	161.7
18	14.0	11.3	78	60.6	49.1	38	107.2	86.8	98	153.9	124.6	58	200.5	162.4
19	14.8	12.0	79	61.4	49.7	39	108.0	87.5	99	154.6	125.2	59	201.3	163.0
20	15.5	12.6	80	62.2	50.3	40	108.8	88.1	200	155.4	125.9	60	202.0	163.6
21	16.3	13.2	81	62.9	51.0	141	109.6	88.7	201	156.2	126.5	261	202.8	164.2
22	17.1	13.8	82	63.7	51.6	42	110.3	89.4	02	157.0	127.1	62	203.6	164.9
23	17.9	14.5	83	64.5	52.2	43	111.1	90.0	03	157.8	127.7	63	204.4	165.5
24	18.7	15.1	84	65.3	52.9	44	111.9	90.6	04	158.5	128.4	64	205.2	166.1
25	19.4	15.7	85	66.1	53.5	45	112.7	91.2	05	159.3	129.0	65	205.9	166.8
26	20.2	16.4	86	66.8	54.1	46	113.5	91.9	06	160.1	129.6	66	206.7	167.4
27	21.0	17.0	87	67.6	54.7	47	114.2	92.5	07	160.9	130.3	67	207.5	168.0
28	21.8	17.6	88	68.4	55.4	48	115.0	93.1	08	161.6	130.9	68	208.3	168.7
29	22.5	18.2	89	69.2	56.0	49	115.8	93.8	09	162.4	131.5	69	209.0	169.3
30	23.3	18.9	90	69.9	56.6	50	116.6	94.4	10	163.2	132.2	70	209.8	169.9
31	24.1	19.5	91	70.7	57.3	151	117.3	95.0	211	164.0	132.8	271	210.6	170.5
32	24.9	20.1	92	71.5	57.9	52	118.1	95.7	12	164.7	133.4	72	211.4	171.2
33	25.6	20.8	93	72.3	58.5	53	118.9	96.3	13	165.5	134.0	73	212.1	171.8
34	26.4	21.4	94	73.0	59.2	54	119.7	96.9	14	166.3	134.7	74	212.9	172.4
35	27.2	22.0	95	73.8	59.8	55	120.5	97.5	15	167.1	135.3	75	213.7	173.1
36	28.0	22.7	96	74.6	60.4	56	121.2	98.2	16	167.9	135.9	76	214.5	173.7
37	28.8	23.3	97	75.4	61.0	57	122.0	98.8	17	168.6	136.6	77	215.3	174.3
38	29.5	23.9	98	76.2	61.7	58	122.8	99.4	18	169.4	137.2	78	216.0	174.9
39	30.3	24.5	99	76.9	62.3	59	123.6	100.1	19	170.2	137.8	79	216.8	175.6
40	31.1	25.2	100	77.7	62.9	60	124.3	100.7	20	171.0	138.4	80	217.6	176.2
41	31.9	25.8	101	78.5	63.6	161	125.1	101.3	221	171.7	139.1	281	218.4	176.8
42	32.6	26.4	02	79.3	64.2	62	125.9	101.9	22	172.5	139.7	82	219.1	177.5
43	33.4	27.1	03	80.0	64.8	63	126.7	102.6	23	173.3	140.3	83	219.9	178.1
44	34.2	27.7	04	80.8	65.4	64	127.4	103.2	24	174.1	141.0	84	220.7	178.7
45	35.0	28.3	05	81.6	66.1	65	128.2	103.8	25	174.8	141.6	85	221.5	179.4
46	35.7	28.9	06	82.4	66.7	66	129.0	104.5	26	175.6	142.2	86	222.3	180.0
47	36.5	29.6	07	83.1	67.3	67	129.8	105.1	27	176.4	142.9	87	223.0	180.6
48	37.3	30.2	08	83.9	68.0	68	130.6	105.7	28	177.2	143.5	88	223.8	181.2
49	38.1	30.8	09	84.7	68.6	69	131.3	106.4	29	178.0	144.1	89	224.6	181.9
50	38.9	31.5	10	85.5	69.2	70	132.1	107.0	30	178.7	144.7	90	225.4	182.5
51	39.6	32.1	111	86.3	69.9	171	132.9	107.6	231	179.5	145.4	291	226.1	183.1
52	40.4	32.7	12	87.0	70.5	72	133.7	108.2	32	180.3	146.0	92	226.9	183.8
53	41.2	33.4	13	87.8	71.1	73	134.4	108.9	33	181.1	146.6	93	227.7	184.4
54	42.0	34.0	14	88.6	71.7	74	135.2	109.5	34	181.8	147.3	94	228.5	185.0
55	42.7	34.6	15	89.4	72.4	75	136.0	110.1	35	182.6	147.9	95	229.2	185.6
56	43.5	35.2	16	90.1	73.0	76	136.8	110.8	36	183.4	148.5	96	230.0	186.3
57	44.3	35.9	17	90.9	73.6	77	137.5	111.4	37	184.2	149.1	97	230.8	186.9
58	45.1	36.5	18	91.7	74.3	78	138.3	112.0	38	185.0	149.8	98	231.6	187.5
59	45.8	37.1	19	92.5	74.9	79	139.1	112.6	39	185.7	150.4	99	232.4	188.2
60	46.6	37.8	120	93.3	75.5	180	139.9	113.3	240	186.5	151.0	300	233.1	188.8
Dist	Dep	Lat.	Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 51 Degrees.

TABLE III. Difference of Latitude and Departure for 40 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.8	00.6	61	46.7	39.2	121	92.7	77.8	181	138.6	116.4	241	184.6	154.9
2	01.5	01.3	62	47.5	39.9	22	93.4	78.4	82	139.4	117.0	42	185.4	155.6
3	02.3	01.9	63	48.3	40.5	23	94.2	79.1	83	140.2	117.7	43	186.1	156.2
4	03.1	02.6	64	49.0	41.1	24	95.0	79.7	84	140.9	118.3	44	186.9	156.9
5	03.8	03.2	65	49.8	41.8	25	95.7	80.4	85	141.7	118.9	45	187.7	157.5
6	04.6	03.9	66	50.6	42.4	26	96.5	81.0	86	142.5	119.6	46	188.4	158.1
7	05.4	04.5	67	51.3	43.1	27	97.3	81.6	87	143.2	120.2	47	189.2	158 8
8	06.1	05.1	68	52.1	43.7	28	98.0	82.3	88	144.0	120.9	48	190.0	159.4
9	06.9	05.8	69	52.9	44.4	29	98.8	82.9	89	144.8	121.5	49	190.7	160.1
10	07.7	06.4	70	53.6	45.0	30	99.6	83.6	90	145.5	122.1	50	191.5	160.7
11	08.4	07.1	71	54.4	45.6	131	100.3	84.2	191	146.3	122.8	251	192.3	161.4
12	09.2	07.7	72	55.2	46.3	32	101.1	84.9	92	147.1	123.4	52	193.0	162.0
13	10.0	08.4	73	55.9	46.9	33	101.9	85.5	93	147.8	124.1	53	183.8	162.6
14	10.7	09.0	74	56.7	47.6	34	102.6	86.1	94	148.6	124.7	54	194.6	163.3
15	11.5	09.6	75	57.4	48.2	35	103.4	86.8	95	149.4	125.4	55	195.3	163.9
16	12.3	10.3	76	58.2	48 9	36	104.2	87.4	96	150.1	126.0	56	196.1	164.6
17	13.0	10.9	77	59.0	49.5	37	104.9	88.1	97	150.9	126.6	57	196.9	165.2
18	13.8	11.6	78	59.7	50.1	38	105.7	88.7	98	151.7	127.3	58	197.6	165.9
19	14.6	12.2	79	60.5	50.8	39	106.5	89.4	99	152.4	127.9	59	198.4	166.5
20	15.3	12.9	80	61.3	51.4	40	107.2	90.0	200	153.2	128.6	60	199.2	167.1
21	16.1	13.5	81	62.0	52.1	141	108.0	90.6	201	154.0	129.2	261	199.9	167.8
22	16.9	14.1	82	62.8	52.7	42	108.8	91.3	02	154.7	129.9	62	200.7	168.4
23	17.6	14.8	83	63.6	53.4	43	109.5	91.9	03	155.5	130.5	63	201.4	169.1
24	18.4	15.4	84	64.3	54.0	44	110.3	92.6	04	156.3	131 1	64	202.2	169.7
25	19.2	16.1	85	65.1	54.6	45	111.1	93.2	05	157.0	131.8	65	203.0	170.4
26	19.9	16.7	86	65.9	55.3	46	111.8	93.9	06	157.8	132.4	66	203.7	171.0
27	20.7	17.4	87	66.6	55.9	47	112.6	94.5	07	158.6	133.1	67	204.5	171.6
28	21.4	18.9	88	67.4	56.6	48	113.4	95.1	08	159.3	133.7	68	205.3	172.3
29	22.2	18.6	89	68.2	57.2	49	114.1	95.8	09	160.1	134.4	69	206.0	172.9
30	23.0	19.3	90	68.9	57.9	50	114.9	96.4	10	160.9	135.0	70	206.8	173.6
31	23.7	19.9	91	69.7	58.5	151	115.7	97.1	211	161.6	135.6	271	207.6	174.2
32	24.5	20.6	92	70.5	59.1	52	116.4	97.7	12	162.4	136.3	72	208.3	174.8
33	25.3	21.2	93	71.2	59.8	53	117.2	98.4	13	163.2	136.9	73	209.1	175.5
34	26.0	21.9	94	72.0	60.4	54	118.0	99.0	14	163.9	137.6	74	209.9	176.1
35	26.8	22.5	95	72.8	61.1	55	118.7	99.6	15	164.7	138.2	75	210.6	176.8
36	27.6	23.1	96	73.5	61.7	56	119.5	100.3	16	165.4	138.8	76	211.4	177.4
37	28.3	23.8	97	74.3	62.4	57	120.3	100.9	17	166.2	139.5	77	212.2	178.1
38	29.1	24.4	98	75.1	63.0	58	121.0	101.6	18	167.0	130.1	78	212.9	178.7
39	29.9	25.1	99	75.8	63.6	59	121.8	102.2	19	167.7	140.8	79	213.7	179.3
40	30.6	25.7	100	76.6	64.3	60	122.6	102.8	20	168.5	141.4	80	214.5	180.0
41	31.4	26.4	101	77.4	64.9	161	123.3	103.5	221	169.3	142.1	281	215.2	180.6
42	32.2	27.0	02	78.1	65.6	62	124.1	104.1	22	170.0	142.7	82	216.0	181.3
43	32.9	27.6	03	78 9	66.2	63	124.9	104.8	23	170.8	143.3	83	216.8	181.9
44	33.7	28.3	04	79.7	66.8	64	125.6	105.4	24	171.6	144.0	84	217.5	182.6
45	34.5	28.9	05	80.4	67.5	65	126.4	106.1	25	172.3	144.6	85	218.3	183.2
46	35.2	29.6	06	81.2	68.1	66	127.2	106.7	26	173.1	145.3	86	219.1	183.9
47	36.0	30.2	07	82.0	68.8	67	127.9	107.3	27	173.9	145.9	87	219.8	184.5
48	36.8	30.8	08	82.7	69.4	68	128.7	108.0	28	174.6	146.6	88	220.6	185.1
49	37.5	31.5	09	83.5	70.1	69	129.4	108.6	29	175.4	147.2	89	221.4	185.8
50	38.3	32.1	10	84.3	70.7	70	130.2	109.3	30	176.2	147.9	90	222.1	186.4
51	39.1	32.8	11	85.0	71.3	171	131.0	109.9	231	176.9	148.3	291	222.9	187.1
52	39.8	33.4	12	85.8	72.0	72	131.7	110.6	32	177.7	149.1	92	223.7	187.7
53	40.6	34.1	13	86.6	72.6	73	132.5	111.2	33	178.5	149.8	93	224.4	188.4
54	41.4	34.7	14	87.3	73.3	74	133.3	111.9	34	179.2	150.4	94	225.2	189.0
55	42.1	35.3	15	88.1	73.9	75	134.0	112.5	35	180.0	151.1	95	226.0	189.6
56	42.9	36.0	16	88.9	74.6	76	134.8	113.1	36	180.8	151.7	96	226.7	190.3
57	43.7	36.6	17	89.6	75.2	77	135.6	113.8	37	181.5	152.4	97	227.5	190.9
58	44.4	37.3	18	90.4	75.9	78	136.3	114.4	38	182.3	153.0	98	228.3	191.6
59	45.2	37.9	19	91.2	76.5	79	137.1	115.1	39	183.1	153.6	99	229.0	192.2
60	46.0	38.6	120	91.9	77.1	80	137.9	115.7	240	183.8	154.3	300	229.8	192.9
Dist	Dep	Lat.	Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 50 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.8	00.7	61	46.0	40.0	121	91.3	79.4	181	136.6	118.7	241	181.9	158.1
2	01.5	01.3	62	46.8	40.7	22	92.1	80.0	82	137.4	119.4	42	182.6	158.7
3	02.3	02.0	63	47.5	41.3	23	92.8	80.7	83	138.1	120.0	43	183.4	159.4
4	03.0	02.6	64	48.3	42.0	24	93.6	81.3	84	138.9	120.7	44	184.2	160.0
5	03.8	03.3	65	49.1	42.6	25	94.3	82.0	85	139.6	121.4	45	184.9	160.7
6	04.5	03.9	66	49.8	43.3	26	95.1	82.6	86	140.4	122.0	46	185.7	161.4
7	05.3	04.6	67	50.6	44.0	27	95.8	83.3	87	141.1	122.7	47	186.4	162.0
8	06.0	05.2	68	51.3	44.6	28	96.6	83.0	88	141.9	123.3	48	187.2	162.7
9	06.8	05.9	69	52.1	45.3	29	97.4	84.6	89	142.6	124.0	49	187.9	163.3
10	07.5	06.6	70	52.8	45.9	30	98.1	85.3	90	143.4	124.6	50	188.7	164.0
11	08.3	07.2	71	53.6	46.6	131	98.9	85.9	191	144.2	125.3	251	189.4	164.6
12	09.1	07.9	72	54.3	47.2	32	99.6	86.6	92	144.9	125.9	52	190.2	165.3
13	09.8	08.5	73	55.1	47.9	33	100.4	87.2	93	145.7	126.6	53	190.9	166.0
14	10.6	09.2	74	55.8	48.5	34	101.1	87.9	94	146.4	127.3	54	191.7	166.6
15	11.3	09.8	75	56.6	49.2	35	101.9	88.6	95	147.2	127.9	55	192.5	167.3
16	12.1	10.5	76	57.4	49.9	36	102.6	89 2	96	147.9	128.6	56	193.2	167.9
17	12.8	11.2	77	58.1	50.5	37	103.4	89.9	97	148.7	129.2	57	194.0	168.6
18	13.6	11.8	78	58.9	51.2	38	104.2	90.5	98	149.4	129.9	58	194.7	169.2
19	14.3	12.5	79	59.6	51.8	39	104.9	91.2	99	150.2	130.5	59	195.5	169.9
20	15.1	13.1	80	60.4	52.5	40	105.7	91.8	200	150.9	131.2	60	196.2	170.5
21	15.8	13.8	81	61.1	53.1	141	106.4	92.5	201	151.7	131.8	261	197.0	171.2
22	16.6	14.4	82	61.9	53.8	42	107.2	93.1	02	152.5	132.5	62	197.7	171.9
23	17.4	15.1	83	62.6	54.4	43	107.9	93.8	03	153.2	133 2	63	198.5	172.5
24	18.1	15.7	84	63.4	55.1	44	108.7	94.5	04	154.0	133.8	64	199.2	173.2
25	18.9	16.4	85	64.2	55.8	45	109.4	95.1	05	154.7	134.5	65	200.0	173.8
26	19.6	17.1	86	64.9	56.4	46	110.2	95.8	06	155.5	135.1	66	200.8	174.5
27	20.4	17.7	87	65.7	57.1	47	110.9	96.4	07	156.2	135.8	67	201.5	175.1
28	21.1	18.4	88	66.4	57.7	48	111.7	97.1	08	157.0	136.4	68	202.3	175.8
29	21.9	19.0	89	67.2	58.4	49	112.5	97.7	09	157.7	137.1	69	203.0	176.4
30	22.6	19.7	90	67.9	59.0	50	113.2	98.4	10	158.5	137.7	70	203.8	177.1
31	23.4	20.3	91	68.7	59.7	151	114.0	99.0	211	159.2	138.4	271	204.5	177.8
32	24.2	21.0	92	69.4	60.4	52	114.7	99.7	12	160.0	139.1	72	205.3	178.4
33	24.9	21.6	93	70.2	61.0	53	115.5	100.4	13	160.8	139.7	73	206.0	179.1
34	25.7	32.3	94	70.9	61.7	54	116.2	101.0	14	161.5	140.4	74	206.8	179.7
35	26.4	23.0	95	71.7	62.3	55	117.0	101.7	15	162.3	141.0	75	207.5	180.4
36	27.2	23.6	96	72.5	63.0	56	117.7	102.3	16	163.0	141.7	76	208.3	181.0
37	27.9	24.3	97	73.2	63.6	57	118.5	103.0	17	163.7	142.3	77	209.1	181.7
38	28.7	24.9	98	74.0	64.3	58	119.2	103.6	18	164.5	143.0	78	209.8	182.4
39	29.4	25.6	99	74.7	64.9	59	120.0	104.3	19	165.3	143.6	79	210.6	183.0
40	30.2	26.2	100	75.5	65.6	60	120.8	105.0	20	166.0	144.3	80	211.3	183.7
41	30.9	26.9	101	76.2	66.3	161	121.5	105.6	221	166.8	145.0	281	212.1	184.3
42	31.7	27.6	02	77.0	66.9	62	122.3	106.3	22	167.5	145.6	82	212.8	185.0
43	32.5	28 2	03	77.7	67.6	63	123.0	106.9	23	168.3	146.3	83	213.6	185.6
44	33.2	28.9	04	78.5	68.2	64	123.8	107.6	24	169.1	146.9	84	214 3	186.3
45	34.0	29.5	05	79.2	68.9	65	124.5	108.2	25	169.8	147.6	85	215.1	186.9
46	34.7	30.2	06	80.0	69.5	66	125.3	108.9	26	170.6	148.2	86	215 8	187.6
47	35.5	30.8	07	80.8	70.2	67	126.0	109.5	27	171.3	148.9	87	216.6	188.3
48	36.2	31.5	08	81.5	70.8	68	126.8	110 2	28	172.1	149.6	88	217.4	188.9
49	37.0	32.1	09	82.3	71.5	69	127.5	110.9	29	172.8	150.2	89	218.1	189.6
50	37.7	32.8	10	83.0	72.2	70	128.3	111.5	30	173.6	150.9	90	218.9	190.3
51	38.5	33.5	111	83.8	72.8	171	129.1	112.2	231	174.3	151.5	291	219.6	190.9
52	39.2	34.1	12	84.5	73.5	72	129.8	112 8	32	175.1	152.2	92	220.4	191.5
53	40.0	34.8	13	85.3	74.1	73	130.6	113.5	33	175.8	152.8	93	221.1	192.2
54	40.8	35.4	14	86.0	74.8	74	131.3	114.1	34	176.6	153.5	94	221.9	192.8
55	41.5	36.1	15	86.8	75.4	75	132.1	114.8	35	177.4	154.1	95	222.6	193.5
56	42.3	36.7	16	87.5	76.1	76	132.8	115.4	36	178.1	154.8	96	223.4	194.2
57	43.0	37.4	17	88.3	76.7	77	133.6	116.1	37	178.9	155.5	97	224.2	194.8
58	43.8	38.0	18	89.1	77.4	78	134.3	116.8	38	179.6	156.1	98	224.9	195.5
59	44.5	38.7	19	89.8	78.1	79	135.1	117.4	39	180.4	156.8	99	225.7	196.1
60	45.3	39.4	120	90.6	78.7	180	135.8	118.1	240	181.1	157.4	300	226.4	196.8
Dist	Dep	Lat.	Dist	Dep	Lat	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 49 Degrees.

Table III. Difference of Latitude and Departure for 42 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.7	00.7	61	45.3	40.8	121	89.9	80.9	181	134.5	121.1	241	179.0	161.2
2	01.5	01.3	62	46.1	41.5	22	90.6	81.6	82	135.2	121.8	42	179.8	161.9
3	02.2	02.0	63	46.8	42.1	23	91.4	82.3	83	135.9	122.4	43	180.5	162.6
4	03.0	02.7	64	47.5	42.8	24	92.1	83.0	84	136.7	123.1	44	181.3	163.2
5	03.7	03.3	65	48.3	43.5	25	92.9	83.6	85	137.4	123.8	45	182.0	163.9
6	04.5	04.0	66	49.0	44.2	26	93.6	84.3	86	138.2	124.4	46	182.7	164.6
7	05.2	04.7	67	49.8	44.8	27	94.3	85.0	87	138.9	125.1	47	183.5	165.2
8	05.9	05.4	68	50.5	45.5	28	95.1	85.6	88	139.7	125.8	48	184.2	165.9
9	06.7	06.0	69	51.3	46.2	29	95.8	86.3	89	140.4	126.4	49	185.0	166.6
10	07.4	06.7	70	52.0	46.8	30	96.6	87.0	90	141.1	127.1	50	185.7	167.2
11	08.2	07.4	71	52.7	47.5	131	97.3	87.6	191	141.9	127.8	251	186.5	167.9
12	08.9	08.0	72	53.5	48.2	32	98.1	88.3	92	142.6	128.4	52	187.2	168.6
13	09.7	08.7	73	54.2	48.8	33	98.8	89.0	93	143.4	129.1	53	187.9	169.3
14	10.4	09.4	74	55.0	49.5	34	99.5	89.6	94	144.1	129.8	54	188.7	169.9
15	11.1	10.0	75	55.7	50.2	35	100.3	90.3	95	144.9	130.5	55	189.4	170.6
16	11.9	10.7	76	56.5	50.8	36	101.0	91.0	96	145.6	131.1	56	190.2	171.3
17	12.6	11.4	77	57.2	51.5	37	101.8	91.7	97	146.3	131.8	57	190.9	171.9
18	13.4	12.0	78	57.9	52.2	38	102.5	92.3	98	147.1	132.5	58	191.7	172.6
19	14.1	12.7	79	58.7	52.9	39	103.3	93.0	99	147.8	133.1	59	192 4	173.3
20	14.9	13.4	80	59.4	53.5	40	104.0	93.7	200	148.6	133.6	60	193.1	173.9
21	15.6	14.0	81	60.2	54.2	141	104.7	94.3	201	149.3	134.5	261	193.9	174.6
22	16.3	14.7	82	60.9	54.9	42	105.5	95.0	02	150.1	135.1	62	194.6	175.3
23	17.1	15.4	83	61.7	55.5	43	106.2	95.7	03	150.8	135.8	63	195.4	175.9
24	17.8	16.1	84	62.4	56.2	44	107.0	96.3	04	151.5	136.5	64	196.1	176.6
25	18.6	16.7	85	63.1	56.9	45	107.7	97.0	05	152.3	137.1	65	196.9	177.3
26	19.3	17.4	86	63 9	57.5	46	108.5	97.7	06	153.0	137.8	66	197.6	177.9
27	20.1	18.1	87	64.6	58.2	47	109.2	98.3	07	153.8	138.5	67	198.3	178.6
28	20.8	18.7	88	65.4	58.9	48	109.9	99.0	08	154.5	139.1	68	199.1	179.3
29	21.5	19.4	89	66.1	59.5	49	110.7	99.7	09	155.3	139.8	69	199.8	180.0
30	22.3	20.1	90	66.9	60.2	50	111.4	100.4	10	156.0	140.5	70	200.6	180.6
31	23.0	20.7	91	67.6	60.9	151	112.2	101.0	211	156.7	141.2	271	201.3	181.3
32	23.8	21.4	92	68.3	61.5	52	112.9	101.7	12	157.5	141.8	72	202.1	182.0
33	24.5	22.1	93	69.1	62.2	53	113.7	102.4	13	158.2	142.5	73	202.8	182.6
34	25.3	22.7	94	69.8	62.9	54	114.4	103.0	14	159.0	143.2	74	203.5	183.3
35	26.0	23.4	95	70.6	63.6	55	115.1	103.7	15	159.7	143.8	75	204.3	184.0
36	26.7	24.1	96	71.3	64.2	56	115.9	104.4	16	160.5	144.5	76	205.0	184.6
37	27.5	24.8	97	72.1	64.9	57	116.6	105.0	17	161.2	145.2	77	205.8	185.3
38	28.2	25.4	98	72.8	65.6	58	117.4	105.7	18	161.9	145.8	78	206.5	186.0
39	29.0	26.1	99	73.5	66.2	59	118.1	106.4	19	162.7	146.5	79	207.3	186.6
40	29.7	26 8	100	74.3	66.9	60	118.9	107.0	20	163.4	147.2	80	208.0	187.3
41	30.5	27.4	101	75.0	67.6	161	119.6	107.7	221	164.2	147.8	281	208.7	188.0
42	31.2	28.1	02	75.8	68.2	62	120.3	108.4	22	164.9	148.5	82	209.5	188.7
43	31.9	28.8	03	76.5	68.9	63	121.1	109.0	23	165.7	149.2	83	210.2	189.3
44	32.7	29.4	04	77.3	69.6	64	121.8	109.7	24	166.4	149.9	84	211.0	190.0
45	33.4	30.1	05	78.0	70.2	65	122.6	110.4	25	167.1	150.5	85	211.7	190.7
46	34.2	30.8	06	78.7	70.9	66	123.3	111.0	26	167.9	151.2	86	212.5	191.3
47	34.9	31.4	07	79.5	71.6	67	124.1	111.7	27	168.6	151.9	87	213.2	192.0
48	35.7	32.1	08	80.2	72.3	68	124.8	112.4	28	169.4	152.5	88	213.9	192.7
49	36.4	32.8	09	81.0	72.9	69	125.5	113.1	29	170.1	153.2	89	214.7	193.3
50	37.1	33.5	10	81.7	73.6	70	126.3	113.7	30	170.9	153.9	90	215.4	194.0
51	37.9	34.1	111	82.5	74.3	171	127.0	114.4	231	171.6	154.5	291	216.2	194.7
52	38.6	34.8	12	83.2	74.9	72	127.8	115.1	32	172.3	155.2	92	216.9	195.3
53	39.4	35.5	13	83.9	75.6	73	128.5	115.7	33	173.1	155.9	93	217.7	196.0
54	40.1	36.1	14	84.7	76.3	74	129.3	116.4	34	173.8	156.5	94	218.4	196.7
55	40.9	36.8	15	85.4	76.9	75	130.0	117.1	35	174.6	157.2	95	219.1	197.4
56	41.6	37.5	16	86.2	77.6	76	130.7	117.7	36	175.3	157.9	96	219.9	198.0
57	42.3	38.1	17	86.9	78.3	77	131.5	118.4	37	176.1	158.5	97	220.6	198.7
58	43.1	38.8	18	87.7	78.9	78	132.2	119.1	38	176.8	159.2	98	221.4	199.4
59	43.8	39.5	19	88.4	79.6	79	133.0	119.7	39	177.5	159.9	99	222.1	200.1
60	44.6	40.1	120	89.1	80.2	180	133.7	120.4	240	178.3	160.6	300	222.9	200.8
Dist	Dep	Lat.	Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

for 48 Degrees.

Di	Lat.	Dep	Dist	Lat.	Dep	Dist	.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.7	00.7	61	44.6	41.6	121	88.5	82.5	181	132.4	123.4	241	176.3	164.3
2	01.5	01.4	62	45.3	42.3	22	89.2	83.2	82	133.1	124.1	42	177.0	165.0
3	02.2	02.0	63	46.1	43.0	23	90.0	83.9	83	133.8	124.8	43	177.7	165.7
4	02.9	02.7	64	46.8	43.6	24	90.7	84.6	84	134.6	125.5	44	178.4	166.4
5	03.7	03.4	65	47.5	44.3	25	91.4	85.2	85	135.3	126.2	45	179.2	167.1
6	04.4	04.1	66	48.3	45.0	26	92.1	85.9	86	136.0	126.8	46	179.9	167.7
7	05.1	04.8	67	49.0	45.7	27	92.9	86.6	87	136.8	127.5	47	180.6	168.4
8	05.9	05.5	68	49.7	46.4	28	93.6	87.3	88	137.5	128.2	48	181.4	169.1
9	06.6	06.2	69	50.5	47.1	29	94.3	88.0	89	138.2	128.9	49	182.1	169.8
10	07.3	06.8	70	51.2	47.7	30	95.1	88.6	90	139.0	129.5	50	182.8	170.5
11	08.0	07.5	71	51.9	48.4	131	95.8	89.3	191	139.7	130.2	251	183.6	171.2
12	08.8	08.2	72	52.7	49.1	32	96.5	90.0	92	140.4	130.9	52	184.3	171.8
13	09.5	08.9	73	53.4	49.8	33	97.3	90.7	93	141.1	131.6	53	185.0	172.5
14	10.2	09.5	74	54.1	50.5	34	98.0	91.4	94	141.9	132.3	54	185.8	173.2
15	11.0	10.2	75	54.9	51.2	35	98.7	92.1	95	142.6	133.0	55	186.5	173.9
16	11.7	10.9	76	55.6	51.8	36	99.5	92.7	96	143.3	133.6	56	187.2	174.5
17	12.4	11.6	77	56.3	52.5	37	100.2	93.4	97	144.1	134.3	57	187.9	175.2
18	13.2	12.3	78	57.0	53.2	38	100.9	94.1	98	144.8	135.0	58	188.7	175.9
19	13.9	13.0	79	57.8	53.9	39	101.7	94.8	99	145.5	135.7	59	189.4	176.6
20	14.6	13.6	80	58.5	54.5	40	102.4	95.5	200	146.3	136.4	60	190.1	177.3
21	15.4	14.3	81	59.2	55.2	141	103.1	96.2	201	147.0	137.1	261	190.9	178.0
22	16.1	15.0	82	60.0	55.9	42	103.9	96.8	02	147.7	137.7	62	191.6	178.6
23	16.8	15.7	83	60.7	56.6	43	104.6	97.5	03	148.5	138.4	63	192.3	179.3
24	17.6	16.4	84	61.4	57.3	44	105.3	98.2	04	149.2	139.1	64	193.1	180.0
25	18.3	17.1	85	62.2	58.0	45	106.0	98.9	05	149.9	139.8	65	183.8	180.7
26	19.0	17.1	86	62.9	58.6	46	106.8	99.5	06	150.7	140.5	66	194.5	181.4
27	19.7	18.4	87	63.6	59.3	47	107.5	100.2	07	151.4	141.2	67	195.3	182.1
28	20.5	19.1	88	64.4	60.0	48	108.2	100.9	08	152.1	141.8	68	196.0	182.7
29	21.2	19.8	89	65.1	60.7	49	109.0	101.6	09	152.9	142.5	69	196.7	183.4
30	21.9	20.5	90	65.8	61.4	50	109.7	102.3	10	153.6	143.2	70	197.5	184.1
31	22.7	21.2	91	66.5	62.1	151	110.4	103.0	211	154.4	143.9	271	198.2	184.8
32	23.4	21.8	92	67.3	62.7	52	111.2	103.6	12	155.0	144.5	72	198.9	185.5
33	24.1	22.5	93	68.0	63.4	53	111.9	104.3	13	155.8	145.2	73	199.7	186.2
34	24.9	23.2	94	68.7	64.1	54	112.6	105.0	14	156.5	145.9	74	200.4	186.8
35	25.6	23.9	95	69.5	64.8	55	113.4	105.7	15	157.2	146.6	75	201.1	187.5
36	26.3	24.5	96	70.2	65.5	56	114.1	106.4	16	158.0	147.3	76	201.9	188.2
37	27.1	25.2	97	70.9	66.2	57	114.8	107.1	17	158.7	148.0	77	202.6	188.9
38	27.8	25.9	98	71.7	66.8	58	115.6	107.7	18	159.4	148.6	78	203.3	189.5
39	28.5	26.6	99	72.4	67.5	59	116.3	108.4	19	160.2	149.3	79	204.0	190.2
40	29.3	27.3	100	73.1	68.2	60	117.0	109.1	20	160.9	150.0	80	204.8	190.9
41	30.0	28.0	101	73.9	68.9	161	117.7	109.8	221	161.6	150.7	281	205.5	191.6
42	30.7	28.6	02	74.6	69.5	62	118.5	110.5	22	162.4	151.4	82	206.2	192.3
43	31.4	29.3	03	75.3	70.2	63	119.2	111.2	23	163.1	152.1	83	207.0	193.0
44	32.2	30.0	04	76.1	70.9	64	119.9	111.8	24	163.8	152.7	84	207.7	193.6
45	32.9	30.7	05	76.8	71.6	65	120.7	112.5	25	164.6	153.4	85	208.4	194.3
46	33.6	31.4	06	77.5	72.3	66	121.4	113.2	26	165.3	154.1	86	209.2	195.0
47	34.4	32.1	07	78.3	73.0	67	122.1	113.9	27	166.0	154.8	87	209.9	195.7
48	35.1	32.7	08	79.0	73.6	68	122.9	114.5	28	166.7	155.5	88	210.6	196.4
49	35.8	33.4	09	79.7	74.3	69	123.6	115.2	29	167.5	156.2	89	211.4	197.1
50	36.6	34.1	10	80.4	75.0	70	124.3	115.9	30	168.2	156.8	90	212.1	197.7
51	37.3	34.8	111	81.2	75.7	171	125.1	116.6	231	168.9	157.5	291	212.8	198.4
52	38.0	35.5	12	81.9	76.4	72	125.8	117.3	32	169.7	158.2	92	213.6	199.1
53	38.8	36.2	13	82.6	77.1	73	126.5	118.0	33	170.4	158.9	93	214.3	199.8
54	39.5	36.8	14	83.4	77.7	74	127.3	118.6	34	171.1	159.5	94	215.0	200.5
55	40.2	37.5	15	84.1	78.4	75	128.0	119.3	35	171.9	160.2	95	215.7	201.2
56	41.0	38.2	16	84.8	79.1	76	128.7	120.0	36	172.6	160.9	96	216.5	201.8
57	41.7	38.9	17	85.6	79.8	77	129.4	120.7	37	173.3	161.6	97	217.2	202.5
58	42.4	39.5	18	86.3	80.5	78	130.2	121.4	38	174.1	162.3	98	218.0	203.2
59	43.1	40.2	19	87.0	81.2	79	130.9	122.1	39	174.8	163.0	99	218.7	203.9
60	43.9	40.9	120	87.8	81.8	80	131.6	122.7	240	175.5	163.6	300	219.4	204.6
Dist	Dep	Lat.	Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.		Dep.	Lat.

Table III. Difference of Latitude and Departure for 44 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep.	Dist	Lat.	Dep.	Dist	Lat.	Dep.
1	00.7	00.7	61	43.9	42.4	121	87.0	84.0	181	130.2	125.7	241	173.4	167.4
2	01.4	01.4	62	44.6	43.1	22	87.8	84.7	82	130.9	126.4	42	174.1	168.1
3	02.2	02.1	63	45.3	43.8	23	88.5	85.4	83	131.6	127.1	43	174.8	168.8
4	02.9	02.8	64	46.0	44.5	24	89.2	86.1	84	132.4	127.8	44	175.5	169.5
5	03.6	03.5	65	46.8	45.1	25	89.9	86.8	85	133.1	128.5	45	176.2	170.2
6	04.3	04.2	66	47.5	45.8	26	90.6	87.5	86	133.8	129.2	46	176.9	170.9
7	05.0	04.9	67	48.2	46.5	27	91.4	88.2	87	134.5	129.9	47	177.7	171.6
8	05.8	05.6	68	48.9	47.2	28	92.1	88.9	88	135.2	130.6	48	178.4	172.3
9	06.5	06.3	69	49.6	47.9	29	92.8	89.6	89	135.9	131.3	49	179.1	173.0
10	07.2	06.9	70	50.3	48.6	30	93.5	90.3	90	136.7	132.0	50	179.8	173.6
11	07.9	07.6	71	51.1	49.3	131	94.2	91.0	191	137.4	132.7	25	180.5	174.3
12	08.6	08.3	72	51.8	50.0	32	94.9	91.7	92	138.1	133.4	52	181.3	175.0
13	09.4	09.0	73	52.5	50.7	33	95.7	92.4	93	138.8	134.1	53	182.0	175.7
14	10.1	09.7	74	53.2	51.4	34	96.4	93.1	94	139.5	134.8	54	182.7	176.4
15	10.8	10.4	75	53.9	52.1	35	97.1	93.8	95	140.3	135.4	55	183.4	177.1
16	11.5	11.1	76	54.7	52.8	36	97.8	94.5	96	141.0	136.1	56	184.1	177.8
17	12.2	11.8	77	55.4	53.5	37	98.5	95.2	97	141.7	136.8	57	184.9	178.5
18	12.9	12.5	78	56.1	54.2	38	99.3	95.9	98	142.4	137.5	58	185.6	179.2
19	13.7	13.2	79	56.8	54.9	39	100.0	96.5	99	143.1	138.2	59	186.3	179.9
20	14.4	13.9	80	57.5	55.6	40	100.7	97.2	200	143.9	138.9	60	187.0	180.6
21	15.1	14.6	81	58.3	56.3	141	101.4	97.9	201	144.6	139.6	261	187.7	181.3
22	15.8	15.3	82	59.0	57.0	42	102.1	98.6	02	145.3	140.3	62	188.4	182.0
23	16.5	16.0	83	59.7	57.7	43	102.9	99.3	03	146.0	141.0	63	189.2	182.7
24	17.3	16.7	84	60.4	58.3	44	103.6	100.0	04	146.7	141.7	64	189.9	183.4
25	18.0	17.4	85	61.1	59.0	45	104.3	100.7	05	147.5	142.4	65	190.6	184.1
26	18.7	18.1	86	61.9	59.7	46	105.0	101.4	06	148.2	143.1	66	191.3	184.8
27	19.4	18.8	87	62.6	60.4	47	105.7	102.1	07	148.9	143.8	67	192.1	185.5
28	20.1	19.4	88	63.3	61.1	48	106.5	102.8	08	149.6	144.5	68	192.8	186.1
29	20.9	20.1	89	64.1	61.8	49	107.2	103.5	09	150.3	145.2	69	193.5	186.8
30	21.6	20.8	90	64.7	62.5	50	107.9	104.2	10	151.1	145.9	70	194.2	187.5
31	22.3	21.5	91	65.5	63.2	151	108.6	104.9	211	151.8	146.6	271	194.9	188.2
32	23.0	22.2	92	66.2	63.9	52	109.3	105.6	12	152.5	147.3	72	195.6	188.9
33	23.7	22.9	93	66.9	64.6	53	110.1	106.3	13	153.2	147.9	73	196.4	189.6
34	24.5	23.6	94	67.6	65.3	54	110.8	107.0	14	153.9	148.6	74	197.1	190.3
35	25.2	24.3	95	68.3	66.0	55	111.5	107.7	15	154.6	149.3	75	197.8	191.0
36	25.9	25.0	96	69.1	66.7	56	112.2	108.4	16	155.4	150.0	76	198.5	191.7
37	26.6	25.7	97	69.8	67.4	57	112.9	109.1	17	156.1	150.7	77	199.2	192.4
38	27.3	26.4	98	70.5	68.1	58	113.7	109.7	18	156.8	151.4	78	200.0	193.1
39	28.1	27.1	99	71.2	68.8	59	114.4	110.4	19	157.5	152.1	79	200.7	193.8
40	28.8	27.8	100	71.9	69.5	60	115.1	111.1	20	158.2	152.8	80	201.4	194.5
41	29.5	28.5	101	72.6	70.2	161	115.8	111.8	221	159.0	153.5	281	202.1	195.2
42	30.2	29.2	02	73.4	70.8	62	116.5	112.5	22	159.7	154.2	82	202.8	195.9
43	30.9	29.9	03	74.1	71.5	63	117.2	113.2	23	160.4	154.9	83	203.6	196.6
44	31.6	30.6	04	74.8	72.2	64	118.0	113.9	24	161.1	155.6	84	204.3	197.3
45	32.4	31.3	05	75.5	72.9	65	118.7	114.6	25	161.8	156.3	85	205.0	198.0
46	33.1	32.0	06	76.2	73.6	66	119.4	115.3	26	162.6	157.0	86	205.7	198.7
47	33.8	32.6	07	77.0	74.3	67	120.1	116.0	27	163.3	157.7	87	206.4	199.3
48	34.5	33.3	08	77.7	75.0	68	120.8	116.7	28	164.0	158.4	88	207.2	200.0
49	35.2	34.0	09	78.4	75.7	69	121.6	117.4	29	164.7	159.1	89	207.9	200.7
50	36.0	34.7	10	79.1	76.4	70	122.3	118.1	30	165.4	159.8	90	208.6	201.4
51	36.7	35.4	111	79.8	77.1	171	123.0	118.8	231	166.2	160.4	291	209.3	202.1
52	37.4	36.1	12	80.6	77.8	72	123.7	119.5	32	166.9	161.1	92	210.0	202.8
53	38.1	36.8	13	81.3	78.5	73	124.4	120.2	33	167.6	161.8	93	210.8	203.5
54	38.8	37.5	14	82.0	79.2	74	125.2	120.9	34	168.3	162.5	94	211.5	204.2
55	39.6	38.2	15	82.7	79.9	75	125.9	121.6	35	169.0	163.2	95	212.2	204.9
56	40.3	38.9	16	83.4	80.6	76	126.6	122.2	36	169.8	163.9	96	212.9	205.6
57	41.0	39.6	17	84.2	81.3	77	127.3	122.9	37	170.5	164.6	97	213.6	206.3
58	41.7	40.3	18	84.9	82.0	78	128.0	123.6	38	171.2	165.3	98	214.4	207.0
59	42.4	41.0	19	85.6	82.7	79	128.8	124.3	39	171.9	166.0	99	215.1	207.7
60	43.2	41.7	120	86.3	83.4	180	129.5	125.0	240	172.6	166.7	300	215.8	208.4
Dist	Dep	Lat.	Dist	Dep	Lat.	Dist	Dep	Lat.	Dist	Dep.	Lat	Dist	Dep.	Lat

for 46 Degrees.

Dist	Lat.	Dep	Dist	Lat.	Dep	Dist	Lat.	Dep.	Dist	Lat.	Dep	Dist	Lat.	Dep.
1	00.7	00.7	61	43.1	43.1	121	85.6	85.6	181	128.0	128.0	241	170.4	170.4
2	01.4	01.4	62	43.8	43.8	22	86.3	86.3	82	128.7	128 7	42	171.1	171.1
3	02.1	02.1	63	44.5	44.5	23	87.0	87.0	83	129.4	129.4	43	171.8	171.8
4	02.8	02.8	64	45.3	45.3	24	87.7	87.7	84	130.1	130.1	44	172.5	172.5
5	03.5	03.5	65	46.0	46.0	25	88.4	88.4	85	130.8	130.8	45	173.2	173.2
6	04.2	04.2	66	46.7	46.7	26	89.1	89.1	86	131.5	131.5	46	173.9	173.9
7	04.9	04.9	67	47.4	47.4	27	89.8	89.8	87	132.2	132.2	47	174.6	174.6
8	05.7	05.7	68	48.1	48.1	28	90.5	90.5	88	132 9	132.9	48	175.4	175.4
9	06.4	06.4	69	48.8	48.8	29	91.2	91.2	89	133.6	133 6	49	176.1	176.1
10	07.1	07.1	70	49.5	49.5	30	91.9	91.9	90	134.3	134.3	50	176.8	176.8
11	07.8	07.8	71	50.2	50.2	131	92.7	92.7	191	135.1	135.1	251	177.5	177.5
12	08.5	08.5	72	50.9	50.9	32	93.3	93.3	92	135.8	135.8	52	178.2	178.2
13	09.2	09.2	73	51.6	51.6	33	94.0	94.0	93	136.5	136.5	53	178.9	178.9
14	09.9	09.9	74	52.3	52.3	34	94.7	94.7	94	137.2	137.2	54	179.6	179.6
15	10.6	10.6	75	53.0	53.0	35	95.5	95.5	95	137.9	137.9	55	180.8	180.3
16	11.3	11.3	76	53.7	53.7	36	96.2	96 2	96	138.6	138.6	56	181.0	181.0
17	12.0	12.0	77	54.4	54.4	37	96.9	96.9	97	139.3	139.3	57	181.7	181.7
18	12.7	12.7	78	55.2	55.2	38	97.6	97 6	98	140.0	140.0	58	182.4	182.4
19	13.4	13.4	79	55.9	55.9	39	98.3	98.3	99	140.7	140.7	59	183.1	183.1
20	14.1	14.1	80	56.6	56.6	40	99.0	99.0	200	141.4	141.4	60	183.8	183.8
21	14.8	14.8	81	57.3	57.3	141	99.7	99.7	201	142.1	142.1	261	184.5	184.5
22	15.6	15.6	82	58.0	58.0	42	100.4	100.4	02	142.8	142.8	62	185.3	185.3
23	16.3	16.3	83	58.7	58.7	43	101.1	101.1	03	143.5	143.5	63	186.0	186.0
24	17.0	17.0	84	59.4	59.4	44	101.8	101.8	04	144.2	144.2	64	186.7	186.7
25	17.7	17.7	85	60.1	60.1	45	102.5	102.5	05	144.9	144.9	65	187.4	187.4
26	18.4	18.4	86	60.8	60.8	46	103.2	103.2	06	145 7	145.7	66	188.1	188.1
27	19.1	19.1	87	61.5	61.5	47	103.9	103.9	07	146.4	146.4	67	188.8	188.8
28	19.8	19.8	88	62.2	62.2	48	104.6	104.6	08	147.1	147.1	68	189.5	189.5
29	20.5	20.5	89	62.9	62.9	49	105.4	105.4	09	147.8	147.8	69	190.2	190.2
30	21.2	21.2	90	63.6	63.6	50	106.1	106.1	10	148.5	148.5	70	190.9	190.9
31	21.9	21.9	91	64.3	64.3	151	106.8	106.8	211	149.2	149.2	271	191.6	191.6
32	22.6	22.6	92	65.1	65.1	52	107.5	107.5	12	149.9	149.9	72	192.3	192.3
33	23.3	23.3	93	65.8	65.8	53	108.2	108.2	13	150.6	150.6	73	193.0	193.0
34	24.0	24.0	94	66.5	66.5	54	108.9	109.9	14	151.3	151.3	74	193.7	193.7
35	24.7	24.7	95	67.2	67.2	55	109.6	109.6	15	152.0	152.0	75	194.4	194.4
36	25.5	25.5	96	67.9	67.9	56	110.3	110.3	16	152.7	152.7	76	195.2	195.2
37	26.2	26.2	97	68.6	68.6	57	111.0	111.0	17	153.4	153.4	77	195.9	195.9
38	26.9	26.9	98	69.3	69.3	58	111.7	111.7	18	154.1	154.1	78	196.6	196.6
39	27.6	27.6	99	70.0	70.0	59	112.4	112.4	19	154.8	154.8	79	197.3	197.3
40	28.3	28.3	100	70.7	70.7	60	113.1	113.1	20	155.6	155.6	80	198.0	198.0
41	29.0	29.0	101	71.4	71.4	161	113.8	113.8	221	156.3	156.3	281	198.7	198.7
42	29.7	29.7	02	72.1	72.1	62	114.5	114.5	22	157.0	157.0	82	199.4	199.4
43	30.4	30.4	03	72.8	72.8	63	115.3	115.3	23	157.7	157 7	83	200.1	200.1
44	31.1	31.1	04	73.5	73.5	64	116.0	116.0	24	158.4	158.4	84	200.8	200.8
45	31.8	31.8	05	74.2	74.2	65	116.7	116.7	25	159.1	159.1	85	201.5	201.5
46	32.5	32.5	06	74.9	74.9	66	117.4	117.4	26	159.8	159.8	86	202.2	202.2
47	33.2	33.2	07	75.7	75.7	67	118.1	118.1	27	160.5	160.5	87	202.9	202.9
48	33.9	33.9	08	76.4	76.4	68	118.8	118.8	28	161.2	161.2	88	203.6	203.6
49	34.6	34.6	09	77.1	77.1	69	119.5	119.5	29	161.9	161.9	89	204.3	204.3
50	35.4	35.4	10	77.8	77.8	70	120.2	120.2	30	162.6	162.6	90	205.1	205.1
51	36.1	36.1	111	78.5	78.5	171	120.9	120.9	231	163.3	163.3	291	205.8	205.8
52	36.8	36.8	12	79.2	79.2	72	121.6	121.6	32	164.0	164.0	92	206.5	206.5
53	37.5	37.5	13	79.9	79.9	73	122.3	122.3	33	164.7	164.7	93	207.2	207.2
54	38.2	38.2	14	80.6	80.6	74	123.0	123.0	34	165.5	165.5	94	207.9	207.9
55	38.9	38.9	15	81.3	81.3	75	123.7	123.7	35	166.2	166.2	95	208.6	208.6
56	39.6	39.6	16	82.0	82.0	76	124.4	124.4	36	166.9	166.9	96	209.3	209.3
57	40.3	40.3	17	82.7	82.7	77	125.2	125.2	37	167.6	167.6	97	210.0	210.0
58	41.0	41.0	18	83.4	83.4	78	125.9	125.9	38	168.3	168.3	98	210.7	210.7
59	41.7	41.7	19	84.1	84.1	79	126.6	126.6	39	169.0	169.0	95	211.4	211.4
60	42.4	42.4	120	84.8	84.8	180	127.3	127.3	240	169.7	169.7	300	212.1	212.1
Dist	Dep	Lat.	Dist	Dep	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.	Dist	Dep.	Lat.

Of Logarithmic Sines, Tangents, and Secants, to every Point and Quarter Point of the Compass.

Points.	Sines.	Co-sines.	Tangent.	Co-tang.	Secant.	Co-secant.	Points.
0	9.00000	10.00000	0.00000	Infinite.	10.00000	Infinite.	8
0 1/4	8.69079	9.99947	8.69131	11.30867	10.00052	11.30921	7 3/4
0 1/2	8.99130	9.99790	8.99340	11.00660	10.00210	11.00870	7 1/2
0 3/4	9.16652	9.99527	9.17125	10.82875	10.00473	10.83348	7 1/4
1	9.29024	9.99157	9.29866	10.70134	10.00843	10.70976	7
1 1/4	9.38557	9.98679	9.39878	10.60122	10.01321	10.61443	6 3/4
1 1/2	9.46282	9.98088	9.48194	10.51806	10.01912	10.53718	6 1/2
1 3/4	9.52742	9.97385	9.55365	10.44635	10.02616	10.47258	6 1/4
2	9.58284	9.96562	9.61722	10.38278	10.03438	10.41716	6
2 1/4	9.63099	9.95616	9.67483	10.32517	10.04384	10.36901	5 3/4
2 1/2	9.67339	9.94543	9.72796	10.27204	10.05457	10.32661	5 1/2
2 3/4	9.71105	9.93335	9.77770	10.22230	10.06665	10.28895	5 1/4
3	9.74474	9.91985	9.82489	10.17511	10.08015	10.25526	5
3 1/4	9.77503	9.90483	9.87020	10.12980	10.09517	10.22497	4 3/4
3 1/2	9.80236	9.88819	9.91417	10.08583	10.11181	10.19764	4 1/2
3 3/4	9.82708	9.86979	9.95729	10.04270	10.13021	10.17292	4 1/4
4	9.84948	9.84948	10.00000	10.00000	10.15052	10.15052	4
	Co-sines.	Sines.	Co-tang.	Tangents	Co-secant.	Secant.	

A Table of Logarithms, from 1 to 120.

No.	Log.	No.	Log.	No.	Log.	No.	Log.	No.	Log.	No.	Log.
1	0.00000	21	1.32222	41	1.61278	61	1.78533	81	1.90849	101	2.00432
2	30103	22	34242	42	62325	62	79239	82	91381	02	00860
3	47712	23	36173	43	63347	63	79934	83	91908	03	01284
4	60206	24	38021	44	64345	64	80618	84	92428	04	01703
5	69897	25	39794	45	65321	65	81291	85	92942	05	02119
6	77815	26	41497	46	66276	66	81954	86	93450	06	02531
7	84510	27	43136	47	67210	67	82607	87	93952	07	02938
8	90309	28	44716	48	68124	68	83251	88	94448	08	03342
9	95424	29	46240	49	69020	69	83885	89	94939	09	03743
10	1.00000	30	47712	50	69897	70	84510	90	95424	110	04139
11	1.04139	31	1.49136	51	1.70757	71	1.85126	91	1.95904	111	2.04532
12	07918	32	50515	52	71600	72	85733	92	96379	12	04922
13	11394	33	51851	53	72428	73	86332	93	96848	13	05308
14	14613	34	53148	54	73239	74	86923	94	97313	14	05690
15	17609	35	54407	55	74036	75	87506	95	97772	15	06070
16	20412	36	55630	56	74819	76	88081	96	98227	16	06446
17	23045	37	56820	57	75587	77	88649	97	98677	17	06819
18	25527	38	57978	58	76343	78	89209	98	99123	18	07188
19	27875	39	59106	59	77085	79	89763	99	99564	19	07555
20	30103	40	60206	60	77815	80	90309	100	2.00000	120	07198

A Table of Logarithms from 1 to 10,000.

No.	0	1	2	3	4	5	6	7	8	9
100	2.00000	2.00043	2.00087	2.00130	2.00173	2.00217	2.00260	2.00303	2.00346	2.00389
01	00432	00475	00518	00561	00604	00647	00689	00732	00775	00187
02	00860	00903	00945	00988	01030	01072	01115	01157	01199	01242
03	01284	01326	01368	01410	01452	01494	01536	01578	01620	01661
04	01703	01745	01787	01828	01870	01912	01953	01995	02036	01078
05	02119	02160	02202	02243	02284	02325	02366	02407	02449	02490
06	02531	02572	02612	02653	02694	02735	02776	02816	02857	02898
07	02938	02979	03019	03060	03100	03141	03181	03222	03262	03302
08	03342	03383	03423	03463	03503	03543	03583	03623	03663	03703
09	03743	03782	03822	03862	03902	03941	03981	04021	04060	04100
110	2.04139	2.04179	2.04218	2.04258	2.04297	2.04336	2.04376	2.04415	2.04454	2.04493
11	04532	04571	04610	04650	04689	04727	04766	04805	04844	04883
12	04922	04961	04999	05038	05077	05115	05154	05192	05231	05269
13	05308	05346	05385	05423	05461	05500	05538	05576	05614	05652
14	05690	05729	05767	05805	05843	05881	05918	05956	05994	06032
15	06070	06108	06145	06183	06221	06258	06296	06333	06371	06408
16	06446	06483	06521	06558	06595	06633	06670	06707	06744	06781
17	06819	06856	06893	06930	06967	07004	07041	07078	07115	07151
18	07188	07225	07262	07298	07335	07372	07408	07445	07482	07518
19	07555	07591	07628	07664	07700	07737	07773	07809	07846	07882
120	2.07918	2.07954	2.07990	2.08027	2.08063	2.08099	2.08135	2.08171	2.08207	2.08243
21	08279	08314	08350	08386	08422	08458	08493	08529	08565	08600
22	08636	08672	08707	08743	08778	08814	08849	08884	08920	08955
23	08991	09026	09061	09096	09132	09167	09202	09237	09272	09307
24	09342	09377	09412	09447	09482	09517	09552	09587	09621	09656
25	09691	09726	09760	09795	09830	09864	09899	09934	09968	10003
26	10037	10072	10106	10140	10175	10209	10243	10278	10312	10346
27	10380	10415	10449	10483	10517	10551	10585	10619	10653	10687
28	10721	10755	10789	10823	10857	10890	10924	10958	10992	11025
29	11059	11093	11126	11160	11193	11227	11260	11294	11327	11361
130	2.11394	2.11428	2.11461	2.11494	2.11528	2.11561	2.11594	2.11628	2.11661	2.11694
31	11727	11760	11793	11826	11860	11893	11926	11959	11992	12024
32	12057	12090	12123	12156	12189	12222	12254	12287	12320	12352
33	12383	12418	12450	12483	12516	12548	12581	12613	12646	12678
34	12710	12743	12775	12808	12840	12872	12905	12937	12969	13001
35	13033	13066	13098	13130	13162	13194	13226	13258	13290	13322
36	13354	13386	13418	13450	13481	13513	13545	13577	13609	13640
37	13672	13704	13735	13767	13799	13830	13862	13893	13925	13956
38	13988	14019	14051	14082	14114	14145	14176	14208	14239	14270
39	14301	14333	14364	14395	14426	14457	14489	14520	14551	14582
140	2.14613	2.14644	2.14675	2.14706	2.14737	2.14768	2.14799	2.14829	2.14860	2.14891
41	14922	14953	14983	15014	15045	15076	15106	15137	15168	15198
42	15229	15259	15290	15320	15351	15381	15412	15442	15473	15503
43	15534	15564	15594	15625	15655	15685	15715	15746	15776	15806
44	15836	15866	15897	15927	15957	15987	16017	16047	16077	16107
45	16137	16167	16197	16227	16256	16286	16316	16346	16376	16406
46	16435	16465	16495	16524	16554	16584	16613	16643	16673	16702
47	16732	16761	16791	16820	16850	16879	16909	16938	16967	16997
48	17026	17056	17085	17114	17143	17173	17202	17231	17260	17289
49	17319	17348	17377	17406	17435	17464	17493	17522	17551	17580
150	2.17609	2.17638	2.17667	2.17696	2.17725	2.17754	2.17782	2.17811	2.17840	2.17869
51	17898	17926	17955	17984	18013	18041	18070	18099	18127	18156
52	18184	18213	18241	18270	18298	18327	18355	18384	18412	18441
53	18469	18498	18526	18554	18583	18611	18639	18667	18696	18724
54	18752	18780	18808	18837	18865	18893	18921	18949	18977	19005
55	19033	19061	19089	19117	19145	19173	19201	19229	19257	19285
56	19312	19340	19368	19396	19424	19451	19479	19507	19535	19562
57	19590	19618	19645	19673	19700	19728	19756	19783	19811	19838
58	19866	19893	19921	19948	19976	20003	20030	20058	20085	20112
159	20140	20167	20194	20222	20249	20276	20303	20330	20358	20385

A Table of Logarithms from 1 to 10,000.

No	0	1	2	3	4	5	6	7	8	9
160	2.20412	2.20439	2.20466	2.20493	2.20520	2.20548	2.20575	2.20602	2.20629	2.20656
61	20683	20710	20737	20763	20790	20817	20844	20871	20898	20925
62	20951	20978	21005	21032	21059	21085	21112	21139	21165	21192
63	21219	21245	21272	21299	21325	21352	21378	21405	21431	21458
64	21484	21511	21537	21564	21590	21617	21643	21669	21696	21722
65	21748	21775	21801	21827	21854	21880	21906	21932	21958	21985
66	22011	22037	22063	22089	22115	22141	22167	22194	22220	22246
67	22272	22298	22324	22350	22376	22401	22427	22453	22479	22505
68	22531	22557	22583	22608	22634	22660	22686	22712	22737	22763
69	22789	22814	22840	22866	22891	22917	22943	22968	22994	23019
170	2.23045	2.23070	2.23096	2.23121	2.23147	2.23172	2.23198	2.23223	2.23249	2.23274
71	23300	23325	23350	23376	23401	23426	23452	23477	23502	23528
72	23553	23578	23603	23629	23654	23679	23704	23729	23754	23779
73	23805	23830	23855	23880	23905	23930	23955	23980	24005	24030
74	24055	24080	24105	24130	24155	24180	24204	24229	24254	24279
75	24304	24329	24353	24378	24403	24428	24452	24477	24502	24527
76	24551	24576	24601	24625	24650	24674	24699	24724	24748	24773
77	24797	24822	24846	24871	24895	24920	24944	24969	24993	25018
78	25042	25066	25091	25115	25139	25164	25188	25212	25237	25261
79	25285	25310	25334	25358	25382	25406	25431	25455	25479	25503
180	2.25527	2.25551	2.25575	2.25600	2.25624	2.25648	2.25672	2.25696	2.25720	2.25744
81	25768	25792	25816	25840	25864	25888	25912	25935	25959	25983
82	26007	26031	26055	26079	26102	26126	26150	26174	26198	26221
83	26245	26269	26292	26316	26340	26364	26387	26411	26434	26458
84	26482	26505	26529	26553	26576	26600	26623	26647	26670	26694
85	26717	26741	26764	26788	26811	26834	26858	26881	26905	26928
86	26951	26975	26998	27021	27045	27068	27091	27114	27138	27161
87	27184	27207	27231	27254	27277	27300	27323	27346	27370	27393
88	27416	27439	27462	27485	27508	27531	27554	27577	27600	27623
89	27646	27669	27692	27715	27738	27761	27784	27807	27830	27852
190	2.27875	2.27898	2.27921	2.27944	2.27967	2.27989	2.28012	2.28035	2.28058	2.28081
91	28103	28126	28149	28171	28194	28217	28240	28262	28285	28307
92	28330	28353	28375	28398	28421	28443	28466	28488	28511	28533
93	28556	28578	28601	28623	28646	28668	28691	28713	28735	28758
94	28780	28803	28825	28847	28870	28892	28914	28937	28959	28981
95	29003	29026	29048	29070	29092	29115	29137	29159	29181	29203
96	29226	29248	29270	29292	29314	29336	29358	29380	29403	29425
97	29447	29469	29491	29513	29535	29557	29579	29601	29623	29645
98	29667	29688	29710	29732	29754	29776	29798	29820	29842	29863
99	29885	29907	29929	29951	29973	29994	30016	30038	30060	30081
200	2.30103	2.30125	2.30146	2.30168	2.30190	2.30211	2.30233	2.30255	2.30276	2.30298
01	30320	30341	30363	30384	30406	30428	30449	30471	30492	30514
02	30535	30557	30578	30600	30621	30643	30664	30685	30707	30728
03	30750	30771	30792	30814	30835	30856	30878	30899	30920	30942
04	30963	30984	31006	31027	31048	31069	31091	31112	31133	31154
05	31175	31197	31218	31239	31260	31281	31302	31323	31345	31366
06	31387	31408	31429	31450	31471	31492	31513	31534	31555	31576
07	31597	31618	31639	31660	31681	31702	31723	31744	31765	31785
08	31806	31827	31848	31869	31890	31911	31931	31952	31973	31994
09	32015	32035	32056	32077	32098	32118	32139	32160	32181	32201
210	2.32222	2.32243	2.32263	2.32284	2.32305	2.32325	2.32346	2.32366	2.32387	2.32408
11	32428	32449	32469	32490	32510	32531	32552	32572	32593	32613
12	32634	32654	32675	32695	32715	32736	32756	32777	32797	32818
13	32838	32858	32879	32899	32919	32940	32960	32980	33001	33021
14	33041	33062	33082	33102	33122	33143	33163	33185	33203	33224
15	33244	33264	33284	33304	33325	33345	33365	33385	33405	33425
16	33445	33465	33486	33506	33526	33546	33566	33586	33606	33626
17	33646	33666	33686	33706	33726	33746	33766	33786	33806	33826
18	33846	33866	33885	33905	33925	33945	33965	33985	34005	34025
19	34044	34064	34084	34104	34124	34143	34163	34183	34203	34223

A Table of Logarithms from 1 to 10,000.

No	0	1	2	3	4	5	6	7	8	9
220	2.34242	2.34262	2.34282	2.34301	2.34321	2.34341	2.34361	2.34380	2.34400	2.34420
21	34439	34459	34479	34498	34518	34537	34557	34577	34596	34616
22	34635	34655	34674	34694	34713	34733	34753	34772	34792	34811
23	34830	34850	34869	34889	34908	34928	34947	34967	34986	35005
24	35025	35044	35064	35083	35102	35122	35141	35160	35180	35199
25	35218	35238	35257	35276	35295	35315	35334	35353	35372	35392
26	35411	35430	35449	35468	35488	35507	35526	35545	35564	35583
27	35603	35622	35641	35660	35679	35698	35717	35736	35755	35774
28	35793	35813	35832	35851	35870	35889	35908	35927	35946	35965
29	35984	36003	36021	36040	36059	36078	36097	36116	36135	36154
230	2.36173	2.36192	2.36211	2.36229	2.36248	2.36267	2.36286	2.36305	2.36324	2.36342
31	36361	36380	36399	36418	36436	36455	36474	36493	36511	36530
32	36549	36568	36586	36605	36624	36642	36661	36680	36698	36717
33	36736	36754	36773	36791	36810	36829	36847	36866	36884	36903
34	36922	36940	36959	36977	36996	37014	37033	37051	37070	37088
35	37107	37125	37144	37162	37181	37199	37218	37236	37254	37273
36	37291	37310	37328	37346	37365	37383	37401	37420	37438	37457
37	37475	37493	37511	37530	37548	37566	37585	37603	37621	37639
38	37658	37676	37694	37712	37731	37749	37767	37785	37803	37822
39	37840	37858	37876	37894	37912	37931	37949	37967	37985	38003
240	2.38021	2.38039	2.38057	2.38075	2.38093	2.38112	2.38130	2.38148	2.38166	2.38184
41	38202	38220	38238	38256	38274	38292	38310	38328	38346	38364
42	38382	38399	38417	38435	38453	38471	38489	38507	38525	38543
43	38561	38578	38596	38614	38632	38650	38668	38686	38703	38721
44	38739	38757	38775	38792	38810	38828	38846	38863	38881	38899
45	38917	38934	38952	38970	38987	39005	39023	39041	39058	39076
46	38093	39111	39129	39146	39164	39182	39199	39217	39235	39252
47	38270	39287	39305	39322	39340	39358	39375	39393	39410	39428
48	39445	39463	39480	39498	39515	39533	39550	39568	39585	39603
49	39620	39637	39655	39672	39690	39707	39724	39742	39759	39777
250	2.39794	2.39811	2.39829	2.39846	2.39863	2.39881	2.39898	2.39915	2.39933	2.39950
51	39967	39985	40002	40019	40037	40054	40071	40088	40106	40123
52	40140	40157	40175	40192	40209	40226	40243	40261	40278	40295
53	40312	40329	40346	40364	40381	40398	40415	40432	40449	40466
54	40483	40500	40518	40535	40552	40569	40586	40603	40620	40637
55	40654	40671	40688	40705	40722	40739	40756	40773	40790	40807
56	40824	40841	40858	40875	40892	40909	40926	40943	40959	40976
57	40993	41010	41027	41044	41061	41078	41095	41111	41128	41145
58	41162	41179	41196	41212	41229	41246	41263	41280	41296	41313
59	41330	41347	41363	41380	41397	41414	41430	41447	41464	41481
260	2.41497	2.41514	2.41531	2.41547	2.41564	2.41581	2.41597	2.41614	2.41631	2.41647
61	41664	41681	41697	41714	41731	41747	41764	41780	41797	41814
62	41830	41847	41863	41880	41896	41913	41929	41946	41963	41979
63	41996	42012	42029	42045	42062	42078	42095	42111	42127	42144
64	42160	42177	42193	42210	42226	42243	42259	42275	42292	42308
65	42325	42341	42357	42374	42390	42406	42423	42439	42455	42472
66	42488	42504	42521	42537	42553	42570	42586	42602	42619	42635
67	42651	42667	42684	42700	42716	42732	42749	42765	42781	42797
68	42813	42830	42846	42862	42878	42894	42911	42927	42943	42959
69	42975	42991	43008	43024	43040	43056	43072	43088	43104	43120
270	2.43136	2.43152	2.43169	2.43185	2.43201	2.43217	2.43233	2.43249	2.43265	2.43281
71	43297	43313	43320	43345	43361	43377	43393	43409	43425	43441
72	43457	43473	43489	43505	43521	43537	43553	43569	43584	43600
73	43616	43632	43648	43664	43680	43696	43712	43727	43743	43759
74	43775	43791	43807	43823	43838	43854	43870	43886	43902	43917
75	43933	43949	43965	43981	43996	44012	44028	44044	44059	44075
76	44091	44107	44122	44138	44154	44170	44185	44201	44217	44232
77	44248	44264	44279	44295	44311	44326	44342	44358	44373	44389
78	44404	44420	44436	44451	44467	44483	44498	44514	44529	44545
79	44560	44576	44592	44607	44623	44638	44654	44669	44685	44700

A Table of Logarithms from 1 to 10,000.

N	0	1	2	3	4	5	6	7	8	9
280	2.44716	2.44731	2.44747	2.44762	2.44778	2.44793	2.44809	2.44824	2.44840	2.44855
81	44871	44886	44902	44917	44932	44948	44963	44979	44994	45010
82	45025	45040	45056	45071	45086	45102	45117	45133	45148	45163
83	45179	45194	45209	45225	45240	45255	45271	45286	45301	45317
84	45332	45347	45362	45378	45393	45408	45423	45439	45454	45469
85	45484	45500	45515	45530	45545	45561	45576	45591	45606	45621
86	45637	45652	45667	45682	45697	45712	45728	45743	45758	45773
87	45788	45803	45818	45834	45849	45864	45879	45894	45909	45924
88	45939	45954	45969	45984	46000	46015	46030	46045	46060	46075
89	46090	46105	46120	46135	46150	46165	46180	46195	46210	46225
290	2.46240	2.46255	2.46270	2.46285	2.46300	2.46315	2.46330	2.46344	2.46359	2.46374
91	46389	46404	46419	46434	46449	46464	46479	46494	46509	46523
92	46538	46553	46568	46583	46598	46613	46627	46642	46657	46672
93	46687	46702	46716	46731	46746	46761	46776	46790	46805	46820
94	46835	46849	46864	46879	46894	46909	46923	46938	46953	46967
95	46982	46997	47012	47026	47041	47056	47070	47085	47100	47114
96	47129	47144	47159	47173	47188	47202	47217	47232	47246	47261
97	47276	47290	47305	47319	47334	47349	47363	47378	47392	47407
98	47422	47436	47451	47465	47480	47494	47510	47524	47538	47553
99	47567	47582	47596	47611	47625	47640	47654	47669	47683	47698
300	2.47712	2.47727	2.47741	2.47756	2.47770	2.47784	2.47799	2.47813	2.47828	2.47842
01	47857	47871	47885	47900	47914	47929	47943	47958	47972	47986
02	48001	48015	48029	48044	48058	48073	48087	48101	48116	48130
03	48144	48159	48173	48187	48202	48216	48230	48244	48259	48273
04	48287	48302	48316	48330	48344	48359	48373	48387	48401	48416
05	48430	48444	48458	48473	48487	48501	48515	48530	48544	48558
06	48572	48586	48601	48615	48629	48643	48657	48671	48686	48700
07	48714	48728	48742	48756	48770	48785	48799	48813	48827	48841
08	48855	48869	48883	48897	48911	48926	48940	48954	48968	48982
09	48996	49010	49024	49038	49052	49066	49080	49094	49108	49122
310	2.49136	2.49150	2.49164	2.49178	2.49192	2.49206	2.49220	2.49234	2.49248	2.49262
11	49276	49290	49304	49318	49332	49346	49360	49374	49388	[illegible]
12	49415	49429	49443	49457	49471	49485	49499	49513	49527	49541
13	49554	49568	49582	49596	49610	49624	49638	49651	49665	49679
14	49693	49707	49721	49734	49748	49762	49776	49790	49803	49817
15	49831	49845	49859	49872	49886	49900	49914	49927	49941	49955
16	49969	49982	49996	50010	50024	50037	50051	50065	50079	50092
17	50106	50120	50133	50147	50161	50174	50188	50202	50215	50229
18	50243	50256	50270	50284	50297	50311	50325	50338	50352	50365
19	50379	50393	50406	50420	50433	50447	50461	50474	50488	50501
320	2.50515	2.50529	2.50542	2.50556	2.50569	2.50583	2.50596	2.50610	2.50623	2.50637
21	50650	50664	50678	50691	50705	50718	50732	50745	50759	50772
22	50786	50799	50813	50826	50839	50853	50866	50880	50893	50907
23	50920	50934	50947	50961	50974	50987	51001	51014	51028	51041
24	51054	51068	51081	51095	51108	51121	51135	51148	51162	51175
25	51188	51202	51215	51228	51242	51255	51268	51282	51295	51308
26	51312	51335	51348	51362	51375	51388	51402	51415	51128	51441
27	51455	51468	51481	51495	51508	51521	51534	51548	51561	51574
28	51587	51601	51614	51627	51640	51654	51667	51680	51693	51706
29	51720	51733	51746	51759	51772	51786	51799	51812	51825	51838
330	2.51851	2.51865	2.51878	2.51891	2.51904	2.51917	2.51930	2.51943	2.51957	2.51970
31	51983	51996	52009	52022	52035	52048	52061	52075	52088	52101
32	52114	52127	52140	52153	52166	52179	52192	52205	52218	52231
33	52244	52257	52270	52284	52297	52310	52323	52336	52349	52362
34	52375	52388	52401	52414	52427	52440	52453	52466	52479	52492
35	52504	52517	52530	52543	52556	52569	52582	52595	52608	52621
36	52634	52647	52660	52673	52686	52699	52711	52724	52737	52750
37	52763	52776	52789	52802	52815	52827	52840	52853	52866	52879
38	52892	52905	52917	52930	52943	52956	52969	52982	52994	53007
39	53020	53033	53046	53058	53071	53084	53097	53110	53122	53135

A Table of Logarithms from 1 10,000.

No	0	1	2	3	4	5	6	7	8	9
340	2.53148	2.53161	2.53173	2.53186	2.53199	2.53212	2.53224	2.53237	2.53250	2.53263
41	53275	53288	53301	53314	53326	53339	53352	53364	53377	53390
42	53403	53415	53428	53441	53453	53466	53479	53491	53504	53517
43	53529	53542	53555	53567	53580	53593	53605	53618	53631	53643
44	53656	53668	53681	53694	53706	53719	53732	53744	53757	53769
45	53782	53794	53807	53820	53832	53845	53857	53870	53882	53895
46	53908	53920	53933	53945	53958	53970	53983	53995	54008	54020
47	54033	54045	54058	54070	54083	54095	54108	54120	54133	54145
48	54158	54170	54183	54195	54208	54220	54233	54245	54258	54270
49	54283	54295	54307	54320	54332	54345	54357	54370	54382	54394
350	2.54407	2.54419	2.54432	2.54444	2.54456	2.54469	2.54481	2.54494	2.54506	2.54518
51	54531	54543	54555	54568	54580	54592	54605	54617	54630	54642
52	54654	54667	54679	54691	54704	54716	54728	54741	54753	54765
53	54777	54790	54802	54814	54827	54839	54851	54864	54876	54888
54	54900	54913	54925	54937	54949	54962	54974	54986	54998	55011
55	55023	55035	55047	55060	55072	55084	55096	55108	55121	55133
56	55145	55157	55169	55182	55194	55206	55218	55230	55242	55255
57	55267	55279	55291	55303	55315	55328	55340	55352	55364	55376
58	55388	55400	55413	55425	55437	55449	55461	55473	55485	55497
59	55509	55522	55534	55546	55558	55570	55582	55594	55606	55618
360	2.55630	2.55642	2.55654	2.55666	2.55678	2.55691	2.55703	2.55715	2.55727	2.55739
61	55751	55763	55775	55787	55799	55811	55823	55835	55847	55859
62	55871	55883	55895	55907	55919	55931	55943	55955	55967	55979
63	55991	56003	56015	56027	56038	56050	56062	56074	56086	56098
64	56110	56122	56134	56146	56158	56170	56182	56194	56206	56217
65	56229	56241	56253	56265	56277	56289	56301	56312	56324	56336
66	56348	56360	56372	56384	56396	56407	56419	56431	56443	56455
67	56467	56478	56490	56502	56514	56526	56538	56549	56561	56573
68	56585	56597	56608	56620	56632	56644	56656	56667	56679	56691
69	56703	56714	56726	56738	56750	56761	56773	56785	56797	56808
370	2.56820	2.56832	2.56844	2.56855	2.56867	2.56879	2.56891	2.56902	2.56914	2.56926
71	56937	56949	56961	56972	56984	56996	57008	57019	57031	57043
72	57054	57066	57078	57089	57101	57113	57124	57136	57148	57159
73	57171	57183	57194	57206	57217	57229	57241	57252	57264	57276
74	57287	57299	57310	57322	57334	57345	57357	57368	57380	57392
75	57403	57415	57426	57438	57449	57461	57473	57484	57496	57507
76	57519	57530	57542	57553	57565	57576	57588	57600	57611	57623
77	57634	57646	57657	57669	57680	57692	57703	57715	57726	57738
78	57749	57761	57772	57784	57795	57807	57818	57830	57841	57852
79	57864	57875	57887	57898	57910	57921	57933	57944	57955	57967
380	2.57978	2.57990	2.58001	2.58013	2.58024	2.58035	2.58047	2.58058	2.58070	2.58081
81	58092	58104	58115	58127	58138	58149	58161	58172	58184	58195
82	58206	58218	58229	58240	58252	58263	58274	58286	58297	58309
83	58320	58331	58343	58354	58365	58377	58388	58399	58410	58422
84	58433	58444	58456	58467	58478	58490	58501	58512	58524	58535
85	58546	58557	58569	58580	58591	58602	58614	58625	58636	58647
86	58659	58670	58681	58692	58704	58715	58726	58737	58748	58760
87	58771	58782	58794	58805	58816	58827	58838	58850	58861	58872
88	58883	58894	58906	58917	58928	58939	58950	58961	58973	58984
89	58995	59006	59017	59028	59040	59051	59062	59072	59084	59095
390	2.59106	2.59118	2.59129	2.59140	2.59151	2.59162	2.59173	2.59184	2.59195	2.59207
91	59218	59229	59240	59251	59262	59273	59284	59295	[illegible]	59318
92	59329	59340	59351	59361	59373	59384	59395	[illegible]	[illegible]	[illegible]
93	59439	59450	59461	59472	59483	59494	59506	[illegible]	[illegible]	59539
94	59550	59561	59572	59583	59594	59605	59616	59627	[illegible]	59649
95	59660	59671	59682	59693	59704	59715	59726	59733	[illegible]	[illegible]
96	59770	59780	59791	59802	59813	59824	59835	59846	[illegible]	[illegible]
97	59879	59890	59901	59912	59923	5993	59945	59956	[illegible]	[illegible]
98	59988	59999	60010	[illegible]	60032	60043	60054	60065	60076	60086
9	60097	60108	60119	[illegible]	60141	60152	60163	60173	60184	60195

TABLE IV.

A Table of Logarithms from 1 to 10,000.

N°	0	1	2	3	4	5	6	7	8	9
400	2.60206	2.60217	2.60228	2.60239	2.60249	2.60260	2.60271	2.60282	2.60293	2.60304
01	60314	60325	60336	60347	60358	60369	60379	60390	60401	60412
02	60423	60433	60444	60455	60466	60477	60487	60498	60509	60520
03	60530	60541	60552	60563	60574	60584	60595	60606	60617	60627
04	60638	60649	60660	60670	60681	60692	60703	60713	60724	60735
05	60746	60756	60767	60778	60788	60799	60810	60820	60831	60842
06	60853	60863	60874	60885	60895	60906	60917	60927	60938	60949
07	60959	60970	60981	60991	61002	61013	61023	61034	61045	61055
08	61066	61077	61087	61098	61109	61119	61130	61140	61151	61162
09	61172	61183	61194	61204	61215	61225	61236	61247	61257	61268
410	2.61278	2.61289	2.61300	2.61310	2.61321	2.61331	2.61342	2.61352	2.61363	2.61374
11	61384	61395	61405	61416	61426	61437	61448	61458	61469	61479
12	61490	61500	61511	61521	61532	61542	61553	61563	61574	61584
13	61595	61606	61616	61627	61637	61648	61658	61669	61679	61690
14	61700	61711	61721	61731	61742	61752	61763	61773	61784	61794
15	61805	61815	61826	61836	61847	61857	61868	61878	61888	61899
16	61909	61920	61930	61941	61951	61961	61972	61982	61993	62003
17	62014	62024	62034	62045	62055	62066	62076	62086	62097	62107
18	62118	62128	62138	62149	62159	62170	62180	62190	62201	62211
19	62221	62232	62242	62252	62263	62273	62284	62294	62304	62315
420	2.62325	2.62335	2.62346	2.62356	2.62366	2.62377	2.62387	2.62397	2.62408	2.62418
21	62428	62439	62449	62459	62469	62480	62490	62500	62511	62521
22	62531	62542	62552	62562	62572	62583	62593	62603	62613	62624
23	62634	62644	62655	62665	62675	62685	62696	62706	62716	62726
24	62737	62747	62757	62767	62778	62788	62798	62808	62818	62829
25	62839	62849	62859	62870	62880	62890	62900	62910	62921	62931
26	62941	62951	62961	62972	62982	62992	63002	63012	63022	63033
27	63043	63053	63063	63073	63083	63094	63104	63114	63124	63134
28	63144	63155	63165	63175	63185	63195	63205	63215	63225	63236
29	63246	63256	63266	63276	63286	63296	63306	63317	63327	63337
430	2.63347	2.63357	2.63367	2.63377	2.63387	2.63397	2.63407	2.63417	2.63428	2.63438
31	63448	63458	63468	63478	63488	63498	63508	63518	63528	63538
32	63548	63558	63568	63579	63589	63599	63609	63619	63629	63639
33	63649	63659	63669	63679	63689	63699	63709	63719	63729	63739
34	63749	63759	63769	63779	63789	63799	63809	63819	63829	63839
35	63849	63859	63869	63879	63889	63899	63909	63919	63929	63939
36	63949	63959	63969	63979	63988	63998	64008	64018	64028	64038
37	64048	64058	64068	64078	64088	64098	64108	64118	64128	64137
38	64147	64157	64167	64177	64187	64197	64207	64217	64227	64237
39	64246	64256	64266	64276	64286	64296	64306	64316	64326	64335
440	2.64345	2.64355	2.64365	2.64375	2.64385	2.64395	2.64404	2.64414	2.64424	2.64434
41	64444	64454	64464	64473	64483	64493	64503	64513	64523	64532
42	64542	64552	64562	64572	64582	64591	64601	64611	64621	64631
43	64640	64650	64660	64670	64680	64689	64699	64709	64719	64729
44	64738	64748	64758	64768	64777	64787	64797	64807	64816	64826
45	64836	64846	64856	64865	64875	64885	64895	64904	64914	64924
46	64933	64943	64953	64963	64972	64982	64992	65002	65011	65021
47	65031	65040	65050	65060	65070	65079	65089	65099	65108	65118
48	65128	65137	65147	65157	65167	65176	65186	65196	65205	65215
49	65225	65234	65244	65254	65263	65273	65283	65292	65302	65312
450	2.65321	2.65331	2.65341	2.65350	2.65360	2.65369	2.65379	2.65389	2.65398	2.65408
51	65418	65427	65437	65447	65456	65466	65475	65485	65495	65504
52	65514	65523	65533	65543	65552	65562	65571	65581	65591	65600
53	65610	65619	65629	65639	65648	65658	65667	65677	65686	65696
54	[illegible]	65715	65725	65734	65744	65753	65763	65772	65782	65792
55	[illegible]	65811	65820	65830	65839	65849	65858	65868	65877	65887
[illegible]	65896	65906	65916	65925	65935	65944	65954	65963	65973	65982
57	65992	66001	66011	66020	66030	66039	66049	66058	66068	66077
58	66087	66096	66106	66115	66124	66134	66143	66153	66162	66172
459	66181	66191	66200	66210	66219	66229	66238	66247	66257	66266

A Table of Logarithms from 1 to 10,000.

N°	0	1	2	3	4	5	6	7	8	9
60	2.66276	2.66285	2.66295	2.66304	2.66314	2.66323	2.66332	2.66342	2.66351	2.66361
61	66370	66380	66389	66398	66408	66417	66427	66436	66445	66455
62	66464	66474	66483	66492	66502	66511	66521	66530	66539	66549
63	66558	66567	66577	66586	66596	66605	66614	66624	66633	66642
64	66652	66661	66671	66680	66689	66699	66708	66717	66727	66736
65	66745	66755	66764	66773	66783	66792	66801	66811	66820	66829
66	66839	66848	66857	66867	66876	66885	66894	66904	66913	66922
67	66932	66941	66950	66960	66969	66978	66987	66997	67006	67015
68	67025	67034	67043	67052	67062	67071	67080	67089	67099	67108
69	67117	67127	67136	67145	67154	67164	67173	67182	67191	67201
470	2.67210	2.67219	2.67228	2.67237	2.67247	2.67256	2.67265	2.67274	2.67284	2.67293
71	67302	67311	67321	67330	67339	67348	67357	67367	67376	67385
72	67394	67403	67413	67422	67431	67440	67449	67459	67468	67477
73	67486	67495	67504	67514	67523	67532	67541	67550	67560	67569
74	67578	67587	67596	67605	67614	67624	67633	67642	67651	67660
75	67669	67678	67688	67697	67706	67715	67724	67733	67742	67752
76	67761	67770	67779	67788	67797	67806	67815	67825	67834	67843
77	67852	67861	67870	67879	67888	67897	67906	67916	67925	67934
78	67943	67952	67961	67970	67979	67988	67997	68006	68015	68024
79	68034	68043	68052	68061	68070	68079	68088	68097	68106	68115
480	2.68124	2.68133	2.68142	2.68151	2.68160	2.68169	2.68178	2.68187	2.68196	2.68205
81	68215	68224	68233	68242	68251	68260	68269	68278	68287	68296
82	68305	68314	68323	68332	68341	68350	68359	68368	68377	68386
83	68395	68404	68413	68422	68431	68440	68449	68458	68467	68476
84	68485	68494	68502	68511	68520	68529	68538	68547	68556	68565
85	68574	68583	68592	68601	68610	68619	68628	68637	68646	68655
86	68664	68673	68681	68690	68699	68708	68717	68726	68735	68744
87	68753	68762	68771	68780	68789	68797	68806	68815	68824	68833
88	68842	68851	68860	68869	68878	68886	68895	68904	68913	68922
89	68931	68940	68949	68958	68966	68975	68984	68993	69002	69011
490	2.69020	2.69028	2.69037	2.69046	2.69055	2.69064	2.69073	2.69082	2.69090	2.69099
91	69108	69117	69126	69135	69144	69152	69161	69170	69179	69188
92	69197	69205	69214	69223	69232	69241	69249	69258	69267	69276
93	69285	69293	69302	69311	69320	69329	69338	69346	69355	69364
94	69373	69381	69390	69399	69408	69417	69425	69434	69443	69452
95	69461	69469	69478	69487	69496	69504	69513	69522	69531	69539
96	69548	69557	69566	69574	69583	69592	69601	69609	69618	69627
97	69636	69644	69653	69662	69671	69679	69688	69697	69705	69714
98	69723	69732	69740	69749	69758	69767	69775	69784	69793	69801
99	69810	69819	69827	69836	69845	69854	69862	69871	69880	69888
500	2.69897	2.69906	2.69914	2.69923	2.69932	2.69940	2.69949	2.69958	2.69966	2.69975
01	69984	69992	70001	70010	70018	70027	70036	70044	70053	70062
02	70070	70079	70088	70096	70105	70114	70122	70131	70140	70148
03	70157	70165	70174	70183	70191	70200	70209	70217	70226	70234
04	70243	70252	70260	70269	70278	70286	70295	70303	70312	70321
05	70329	70338	70346	70355	70364	70372	70381	70389	70398	70406
06	70415	70424	70432	70441	70449	70458	70467	70475	70484	70492
07	70501	70509	70518	70526	70535	70544	70552	70561	70569	70578
08	70586	70595	70603	70612	70621	70629	70638	70646	70655	70663
09	70672	70680	70689	70697	70706	70714	70723	70731	70740	70748
510	2.70757	2.70766	2.70774	2.70783	2.70791	2.70800	2.70808	2.70817	2.70825	2.70834
11	70842	70851	70859	70868	70876	70885	70893	70902	70910	70919
12	70927	70935	70944	70952	70961	70969	70978	70986	70995	71003
13	71012	71020	71029	71037	71046	71054	71062	71071	71079	71088
14	71096	71105	71113	71122	71130	71139	71147	71155	71164	71172
15	71181	71189	71198	71206	71214	71223	71231	71240	71248	71257
16	71265	71273	71282	71290	71299	71307	71315	71324	71332	71341
17	71349	71357	71366	71374	71383	71391	71399	71408	71416	71425
18	71433	71441	71450	71458	71466	71475	71483	71492	71500	71508
519	71517	71525	71533	71542	71550	71559	71567	71575	71584	71592

TABLE IV.

A Table of Logarithms from 1 to 10,000.

N°	0	1	2	3	4	5	6	7	8	9
520	2.71600	2.71609	2.71617	2.71625	2.71634	2.71642	2.71650	2.71659	2.71667	2.71675
21	71684	71692	71700	71709	71717	71725	71734	71742	71750	71759
22	71767	71775	71784	71792	71800	71809	71817	71825	71834	71842
23	71850	71858	71867	71875	71883	71892	71900	71908	71917	71925
24	71933	71941	71950	71958	71966	71975	71983	71991	71999	72008
25	72016	72024	72032	72041	72049	72057	72066	72074	72082	72090
26	72099	72107	72115	72123	72132	72140	72148	72156	72165	72173
27	72181	72189	72198	72206	72214	72222	72230	72239	72247	72255
28	72263	72272	72280	72288	72296	72304	72313	72321	72329	72337
29	72346	72354	72362	72370	72378	72387	72395	72403	72411	72410
530	2.72428	2.72436	2.72444	2.72452	2.72460	2.72469	2.72477	2.72485	2.72493	2.72501
31	72509	72518	72526	72534	72542	72550	72558	72567	72575	72583
32	72591	72599	72607	72616	72624	72632	72640	72648	72656	72665
33	72673	72681	72689	72697	72705	72713	72722	72730	72738	72746
34	72754	72762	72770	72779	72787	72795	72803	72811	72819	72827
35	72835	72843	72852	72860	72868	72876	72884	72892	72900	72908
36	72916	72925	72933	72941	72949	72957	72965	72973	72981	72989
37	72997	73006	73014	73022	73030	73038	73046	73054	73062	73070
38	73078	73086	73094	73102	73111	73119	73127	73135	73143	73151
39	73159	73167	73175	73183	73191	73199	73207	73215	73223	73231
540	2.73239	2.73247	2.73255	2.73263	2.73272	2.73280	2.73288	2.73296	2.73304	2.73312
41	73320	73328	73336	73344	73352	73360	73368	73376	73384	73392
42	73400	73408	73416	73424	73432	73440	73448	73566	73464	73472
43	73480	73488	73496	73504	73512	73520	73528	73536	73544	73552
44	73560	73568	73576	73584	73592	73600	73608	73616	73624	73632
45	73640	73648	73656	73664	73672	73679	73687	73695	73703	73711
46	73719	73727	73735	73743	73751	73759	73767	73775	73783	73791
47	73799	73807	73815	73823	73830	73838	73846	73854	73862	73870
48	73878	73886	73894	73902	73910	73918	73926	73933	73941	73949
49	73957	73965	73973	73981	73989	73997	74005	74013	74020	74028
550	2.74036	2.74044	2.74052	2.74060	2.74068	2.74076	2.74084	2.74092	2.74099	2.74107
51	74115	74123	74131	74139	74147	74155	74162	74170	74178	74186
52	74194	74202	74210	74218	74225	74233	74241	74249	74257	74265
53	74273	74280	74288	74296	74304	74312	74320	74327	74335	74343
54	74351	74359	74367	74374	74382	74390	74398	74406	74414	74421
55	74429	74437	74445	74453	74461	74468	74476	74484	74492	74500
56	74507	74515	74523	74531	74539	74547	74554	74562	74570	74578
57	74586	74593	74601	74609	74617	74624	74632	74640	74648	74656
58	74663	74671	74679	74687	74695	74702	74710	74718	74726	74733
59	74741	74749	74757	74764	74772	74780	74788	74796	74803	74811
560	2.74819	2.74827	2.74834	2.74842	2.74850	2.74858	2.74865	2.74873	2.74881	2.74889
61	74896	74904	74912	74920	74927	74935	74943	74950	74958	74966
62	74974	74981	74989	74997	75005	75012	75020	75028	75035	75043
63	75051	75059	75066	75074	75082	75089	75097	75105	75113	75120
64	75128	75136	75143	75151	75159	75166	75174	75182	75189	75197
65	75205	75213	75220	75228	75236	75243	75251	75259	75266	75274
66	75282	75289	75297	75305	75312	75320	75328	75335	75343	75351
67	75358	75366	75374	75381	75389	75397	75404	75412	75420	75427
68	75435	75442	75450	75458	75465	75473	75481	75488	75496	75504
69	75511	75519	75526	75534	75542	75549	75557	75565	75572	75580
570	2.75587	2.75595	2.75603	2.75610	2.75618	2.75626	2.75633	2.75641	2.75648	2.75656
71	75664	75671	75679	75686	75694	75702	75709	75717	75724	75732
72	75740	75747	75755	75762	75770	75778	75785	75793	75800	75808
73	75815	75823	75831	75838	75846	75853	75861	75868	75876	75884
74	75891	75899	75906	75914	75921	75929	75937	75944	75952	75959
75	75967	75974	75982	75989	75997	76005	76012	76020	76027	76035
76	76042	76050	76057	76065	76072	76080	76087	76095	76103	76110
77	76118	76125	76133	76140	76148	76155	76163	76170	76178	76185
78	76193	76200	76208	76215	76223	76230	76238	76245	76253	76260
79	76268	76275	76283	76290	76298	76305	76313	76320	76328	76335

A Table of Logarithms from 1 to 10,000.

N°	0	1	2	3	4	5	6	7	8	9
580	2.76343	2.76350	2.76358	2.76365	2.76373	2.76380	76388	2.76395	76403	2.76410
81	76418	76425	76433	76440	76448	76455	76462	76470	76477	76485
82	76492	76500	76507	76515	76522	76530	76537	76545	76552	76559
83	76567	76574	76582	76589	76597	76604	76612	76619	76626	76634
84	76641	76649	76656	76664	76671	76678	76686	76693	76701	76708
85	76716	76723	76730	76738	76745	76753	76760	76768	76775	76782
86	76790	76797	76805	76812	76819	76827	76834	76842	76849	76856
87	76864	76871	76879	76886	76893	76901	76908	76916	76923	76930
88	76938	76945	76953	76960	76967	76975	76982	76989	76997	77004
89	77012	77019	77026	77034	77041	77048	77056	77063	77070	77078
590	2.77085	2.77093	2.77100	2.77107	2.77115	2.77122	2.77129	2.77137	2.77144	2.77151
91	77159	77166	77173	77181	77188	77195	77203	77210	77217	77225
92	77232	77240	77247	77254	77262	77269	77276	77283	77291	77298
93	77305	77313	77320	77327	77335	77342	77349	77357	77364	77371
94	77379	77386	77393	77401	77408	77415	77422	77430	77437	77444
95	77452	77459	77466	77474	77481	77488	77495	77503	77510	77517
96	77525	77532	77539	77546	77554	77561	77568	77576	77583	77590
97	77597	77605	77612	77619	77627	77634	77641	77648	77656	77663
98	77670	77677	77685	77692	77699	77706	77714	77721	77728	77735
99	77743	77750	77757	77764	77772	77779	77786	77793	77801	77808
600	2.77815	2.77822	2.77830	2.77837	2.77844	2.77851	2.77859	2.77866	2.77873	2.77880
01	77887	77895	77902	77909	77916	77924	77931	77938	77945	77952
02	77960	77967	77974	77981	77988	77996	78003	78010	78017	78025
03	78032	78039	78046	78053	78061	78068	78075	78082	78089	78097
04	78104	78111	78118	78125	78132	78140	78147	78154	78161	78168
05	78176	78183	78190	78197	78204	78211	78219	78226	78233	78240
06	78247	78254	78262	78269	78276	78283	78290	78297	78305	78312
07	78319	78326	78333	78340	78347	78355	78362	78369	78376	78383
08	78390	78398	78405	78412	78419	78426	78433	78440	78447	78455
09	78462	78469	78476	78483	78490	78497	78504	78512	78519	78526
610	2.78533	2.78540	2.78547	2.78554	2.78561	2.78569	2.78576	2.78583	2.78590	2.78597
11	78604	78611	78618	78625	78633	78640	78647	78654	78661	78668
12	78675	78682	78689	78696	78704	78711	78718	78725	78732	78739
13	78746	78753	78760	78767	78774	78781	78789	78796	78803	78810
14	78817	78824	78831	78838	78845	78852	78859	78866	78873	78880
15	78888	78895	78902	78909	78916	78923	78930	78937	78944	78951
16	78958	78965	78972	78979	78986	78993	79000	79007	79014	79021
17	79029	79036	79043	79050	79057	79064	79071	79078	79085	79092
18	79099	79106	79113	79120	79127	79134	79141	79148	79155	79162
19	79169	79176	79183	79190	79197	79204	79211	79218	79225	79232
620	2.79239	2.79246	2.79253	2.79260	2.79267	2.79274	2.79281	2.79288	2.79295	2.79302
21	79309	79316	79323	79330	79337	79344	79351	79358	79365	79372
22	79379	79386	79393	79400	79407	79414	79421	79428	79435	79442
23	79449	79456	79463	79470	79477	79484	79491	79498	79505	79511
24	79518	79525	79532	79539	79546	79553	79560	79567	79574	79581
25	79588	79595	79602	79609	79616	79623	79630	79637	79644	79650
26	79657	79664	79671	79678	79685	79692	79699	79706	79713	79720
27	79727	79734	79741	79748	79754	79761	79768	79775	79782	79789
28	79796	79803	79810	79817	79824	79831	79837	79844	79851	79858
29	79865	79872	79879	79886	79893	79900	79906	79913	79920	79927
630	2.79934	2.79941	2.79948	2.79955	2.79962	2.79969	2.79975	2.79982	2.79989	2.79996
31	80003	80010	80017	80024	80030	80037	80044	80051	80058	80065
32	80072	80079	80085	80092	80099	80106	80113	80120	80127	80134
33	80140	80147	80154	80161	80168	80175	80182	80188	80195	80202
34	80209	80216	80223	80229	80236	80243	80250	80257	80264	80271
35	80277	80284	80291	80298	80305	80312	80318	80325	80332	80339
36	80346	80353	80359	80366	80373	80380	80387	80393	80400	80407
37	80414	80421	80428	80434	80441	80448	80455	80462	80468	80475
38	80482	80489	80496	80502	80509	80516	80523	80530	80536	80543
639	80550	80557	80564	80570	80577	80584	80591	80598	80604	80611

A Table of Logarithms from 1 to 10,000.

N°	0	1	2	3	4	5	6	7	8	9
640	2.80618	2.80625	2.80632	2.80638	2.80645	2.80652	2.80659	2.80665	2.80672	2.80679
41	80686	80693	80699	80706	80713	80720	80726	80733	80740	80747
42	80754	80760	80767	80774	80781	80787	80794	80801	80808	80814
43	80821	80828	80835	80841	80848	80855	80862	80868	80875	80882
44	80889	80895	80902	80909	80916	80922	80929	80936	80943	80949
45	80956	80963	80969	80976	80983	80990	80996	81003	81010	81017
46	81023	81030	81037	81043	81050	81057	81064	81070	81077	81084
47	81090	81097	81104	81111	81117	81124	81131	81137	81144	81151
48	81158	81164	81171	81178	81184	81191	81198	81204	81211	81218
49	81224	81231	81238	81245	81251	81258	81265	81271	81278	81285
650	2.81291	2.81298	2.81305	2.81311	2.81318	2.81325	2.81331	2.81338	2.81345	2.81351
51	81358	81365	81371	81378	81385	81391	81398	81405	81411	81418
52	81425	81431	81438	81445	81451	81458	81465	81471	81478	81485
53	81491	81498	81505	81511	81518	81525	81531	81538	81544	81551
54	81558	81564	81571	81578	81584	81591	81598	81604	81611	81617
55	81624	81631	81637	81644	81651	81657	81664	81671	81677	81684
56	81690	81697	81704	81710	81717	81723	81730	81737	81743	81750
57	81757	81763	81770	81776	81783	81790	81796	81803	81809	81816
58	81823	81829	81836	81842	81849	81856	81862	81869	81875	81882
59	81889	81895	81902	81908	81915	81921	81928	81935	81941	81948
660	2.81954	2.81961	2.81968	2.81974	2.81981	2.81987	2.81994	2.82000	2.82007	2.82014
61	82020	82027	82033	82040	82046	82053	82060	82066	82073	82079
62	82086	82092	82099	82105	82112	82119	82125	82132	82138	82145
63	82151	82158	82164	82171	82178	82184	82191	82197	82204	82210
64	82217	82223	82230	82236	82243	82249	82256	82263	82269	82276
65	82282	82289	82295	82302	82308	82315	82321	82328	82334	82341
66	82347	82354	82360	82367	82373	82380	82387	82393	82400	82406
67	82413	82419	82426	82432	82439	82445	82452	82458	82465	82471
68	82478	82484	82491	82497	82504	82510	82517	82523	82530	82536
69	82543	82549	82556	82562	82569	82575	82582	82588	82595	82601
670	2.82607	2.82614	2.82620	2.82627	2.82633	2.82640	2.82646	2.82653	2.82659	2.82666
71	82672	82679	82685	82692	82698	82705	82711	82718	82724	82730
72	82737	82743	82750	82756	82763	82769	82776	82782	82789	82795
73	82802	82808	82814	82821	82827	82834	82840	82847	82853	82860
74	82866	82872	82879	82885	82892	82898	82905	82911	82918	82924
75	82930	82937	82943	82950	82956	82963	82969	82975	82982	82988
76	82995	83001	83008	83014	83020	83027	83033	83040	83046	83052
77	83059	83065	83072	83078	83085	83091	83097	83104	83110	83117
78	83123	83129	83136	83142	83149	83155	83161	83168	83174	83181
79	83187	83193	83200	83206	83213	83299	83225	83232	83238	83245
680	2.83251	2.83257	2.83264	2.83270	2.83276	2.83283	2.83289	2.83296	2.83302	2.83308
81	83315	83321	83327	83334	83340	83347	83353	83359	83366	83372
82	83378	83385	83391	83398	83404	83410	83417	83423	83429	83436
83	83442	83448	83455	83461	83467	83474	83480	83487	83493	83499
84	83506	83512	83518	83525	83531	83537	83544	83550	83556	83563
85	83569	83575	83582	83585	83594	83601	83607	83613	83620	83626
86	83632	83639	83645	83651	83658	83664	83670	83677	83683	83689
87	83696	83702	83708	83715	83721	83727	83734	83740	83746	83753
88	83759	83765	83771	83778	83784	83790	83797	83803	83809	83816
89	83822	83828	83834	83841	83847	83853	83860	83866	83872	83879
690	2.83885	2.83891	2.83897	2.83904	2.83910	2.83916	2.83923	2.83929	2.83935	2.83942
91	83948	83954	83960	83967	83973	83979	83985	83992	83998	84004
92	84011	84017	84023	84029	84036	84042	84048	84055	84061	84067
93	84073	84080	84086	84092	84098	84105	84111	84117	84123	84130
94	84136	84142	84148	84155	84161	84167	84173	84180	84186	84192
95	84198	84205	84211	84217	84223	84230	84236	84242	84248	84255
96	84261	84267	84273	84280	84286	84292	84298	84305	84311	84317
97	84323	84330	84336	84342	84348	84354	84361	84367	84373	84379
98	84386	84392	84398	84404	84410	84417	84423	84429	84435	84442
99	84448	84454	84460	84466	84473	84479	84485	84491	84497	84504

A Table of Logarithms from 1 to 10,000.

No	0	1	2	3	4	5	6	7	8	9
700	2.84510	2.84516	2.84522	2.84528	2.84535	2.84541	2.84547	2.84553	2.84559	2.84566
01	84572	84578	84584	84590	84597	84603	84609	84615	84621	84628
02	84634	84640	84646	84652	84658	84665	84671	84677	84683	84689
03	84696	84702	84708	84714	84720	84726	84733	84739	84745	84751
04	84757	84763	84770	84776	84782	84788	84794	84800	84807	84813
05	84819	84825	84831	84837	84844	84850	84856	84862	84868	84874
06	84880	84887	84893	84899	84905	84911	84917	84924	84930	84936
07	84942	84948	84954	84960	84967	84973	84979	84985	84991	84997
08	85003	85009	85016	85022	85028	85034	85040	85046	85052	85058
09	85065	85071	85077	85083	85089	85095	85101	85107	85114	85120
710	2.85126	2.85132	2.85138	2.85144	2.85150	2.85156	2.85163	2.85169	2.85175	2.85181
11	85187	85193	85199	85205	85211	85217	85224	85230	85236	85242
12	85248	85254	85260	85266	85272	85278	85285	85291	85297	85303
13	85309	85315	85321	85327	85333	85339	85345	85352	85358	85364
14	85370	85376	85382	85388	85394	85400	85406	85412	85418	85425
15	85431	85437	85443	85449	85455	85461	85467	85473	85479	85485
16	85491	85497	85503	85509	85516	85522	85528	85534	85540	85546
17	85552	85558	85564	85570	85576	85582	85588	85594	85600	85606
18	85612	85618	85625	85631	85637	85643	85649	85655	85661	85667
19	85673	85679	85685	85691	85697	85703	85709	85715	85721	85727
720	2.85733	2.85739	2.85745	2.85751	2.85757	2.85763	2.85769	2.85775	2.85781	2.85788
21	85794	85800	85806	85812	85818	85824	85830	85836	85842	85848
22	85853	85860	85866	85872	85878	85884	85890	85896	85902	85908
23	85914	85920	85926	85932	85938	85944	85950	85956	85962	85968
24	85974	85980	85986	85992	85998	86004	86010	86016	86022	86028
25	86034	86040	86046	86052	86058	86064	86070	86076	86082	86088
26	86094	86100	86106	86112	86118	86124	86130	86136	86141	86147
27	86153	86159	86165	86171	86177	86183	86189	86195	86201	86207
28	86213	86219	86225	86231	86237	86243	86249	86255	86261	86267
29	86273	86279	86285	86291	86297	86303	86308	86314	86320	86326
730	2.86332	2.86338	2.86344	2.86350	2.86356	2.86362	2.86368	2.86374	2.86380	2.86386
31	86392	86398	86404	86410	86415	86421	86427	86433	86439	86445
32	86451	86457	86463	86469	86475	86481	86487	86493	86499	86504
33	86510	86516	86522	86528	86534	86540	86546	86552	86558	86564
34	86570	86576	86581	86587	86593	86599	86605	86611	86617	86623
35	86629	86635	86641	86646	86652	86658	86664	86670	86676	86682
36	86688	86694	86700	86705	86711	86717	86723	86729	86735	86741
37	86747	86753	86759	86764	86770	86776	86782	86788	86794	86800
38	86806	86812	86817	86823	86829	86835	86841	86847	86853	86859
39	86864	86870	86876	86882	86888	86894	86900	86906	86911	86917
740	2.86923	2.86929	2.86935	2.86941	2.86947	2.86953	2.86958	2.86964	2.86970	2.86976
41	86982	86988	86994	86999	87005	87011	87017	87023	87029	87035
42	87040	87046	87052	87058	87064	87070	87075	87081	87087	87093
43	87099	87105	87111	87116	87122	87128	87134	87140	87146	87151
44	87157	87163	87169	87175	87181	87186	87192	87198	87204	87210
45	87216	87221	87227	87233	87239	87245	87251	87256	87262	87268
46	87274	87280	87286	87291	87297	87303	87309	87315	87320	87326
47	87332	87338	87344	87349	87355	87361	87367	87373	87379	87384
48	87390	87396	87402	87408	87413	87419	87425	87431	87437	87442
49	87448	87454	87460	87466	87471	87477	87483	87489	87495	87500
750	2.87506	2.87512	2.87518	2.87523	2.87529	2.87535	2.87541	2.87547	2.87552	2.87558
51	87564	87570	87576	87581	87587	87593	87599	87604	87610	87616
52	87622	87628	87633	87639	87645	87651	87656	87662	87668	87674
53	87679	87685	87691	87697	87703	87708	87714	87720	87726	87731
54	87737	87743	87749	87754	87760	87766	87772	87777	87783	87789
55	87795	87800	87806	87812	87818	87823	87829	87835	87841	87846
56	87852	87858	87864	87869	87875	87881	87887	87892	87898	87904
57	87910	87915	87921	87927	87933	87938	87944	87950	87955	87961
58	87967	87973	87978	87984	87990	87996	88001	88007	88013	88018
759	88024	88030	88036	88041	88047	88053	88058	88064	88070	88076

A Table of Logarithms from 1 to 10,000.

N°	0	1	2	3	4	5	6	7	8	9
760	2.88081	2.88087	2.88093	2.88098	2.88104	2.88110	2.88116	2.88121	2.88127	2.88133
61	88138	88144	88150	88156	88161	88167	88173	88178	88184	88190
62	88195	88201	88207	88213	88218	88224	88230	88235	88241	88247
63	88252	88258	88264	88270	88275	88281	88287	88292	88298	88304
64	88309	88315	88321	88326	88332	88338	88343	88349	88355	88360
65	88366	88372	88377	88383	88389	88395	88400	88406	88412	88417
66	88423	88429	88434	88440	88446	88451	88457	88463	88468	88474
67	88480	88485	88491	88497	88502	88508	88513	88519	88525	88530
68	88536	88542	88547	88553	88559	88564	88570	88576	88581	88587
69	88593	88598	88604	88610	88615	88621	88627	88632	88638	88643
770	2.88649	2.88655	2.88660	2.88666	2.88672	2.88677	2.88683	2.88689	2.88694	2.88700
71	88705	88711	88717	88722	88728	88734	88739	88745	88750	88756
72	88762	88767	88773	88779	88784	88790	88795	88801	88807	88812
73	88818	88824	88829	88835	88840	88846	88852	88857	88863	88868
74	88874	88880	88885	88891	88897	88902	88908	88913	88919	88925
75	88930	88936	88941	88947	88953	88958	88964	88969	88975	88981
76	88986	88992	88997	89003	89009	89014	89020	89025	89031	89037
77	89042	89048	89053	89059	89064	89070	89076	89081	89087	89092
78	89098	89104	89109	89115	89120	89126	89131	89137	89143	89148
79	89154	89159	89165	89170	89176	89182	89187	89193	89198	89204
780	2.89209	2.89215	2.89221	2.89226	2.89232	2.89237	2.89243	2.89248	2.89254	2.89260
81	89265	89271	89276	89282	89287	89293	89298	89304	89310	89315
82	89321	89326	89332	89337	89343	89348	89354	89360	89365	89371
83	89376	89382	89387	89393	89398	89404	89409	89415	89421	89426
84	89432	89437	89443	89448	89454	89459	89465	89470	89476	89481
85	89487	89492	89498	89504	89509	89515	89520	89526	89531	89537
86	89542	89548	89553	89559	89564	89570	89575	89581	89586	89592
87	89597	89603	89609	89614	89620	89625	89631	89636	89642	89647
88	89653	89658	89664	89669	89675	89680	89686	89691	89697	89702
89	89708	89713	89719	89724	89730	89735	89741	89746	89752	89757
790	2.89763	2.89768	2.89774	2.89779	2.89785	2.89790	2.89796	2.89801	2.89807	2.89812
91	89818	89823	89829	89834	89840	89845	89851	89856	89862	89867
92	89873	89878	89883	89889	89894	89900	89905	89911	89916	89922
93	89927	89933	89938	89944	89949	89955	89960	89966	89971	89977
94	89982	89988	89993	89998	90004	90009	90015	90020	90026	90031
95	90037	90042	90048	90053	90059	90064	90069	90075	90080	90086
96	90091	90097	90102	90108	90113	90119	90124	90129	90135	90140
97	90146	90151	90157	90162	90168	90173	90179	90184	90189	90195
98	90200	90206	90211	90217	90222	90227	90233	90238	90244	90249
99	90255	90260	90266	90271	90276	90282	90287	90293	90298	90304
800	2.90309	2.90314	2.90320	2.90325	2.90331	2.90336	2.90342	2.90347	2.90352	2.90358
01	90363	90369	90374	90380	90385	90390	90396	90401	90407	90412
02	90417	90423	90428	90434	90439	90445	90450	90455	90461	90466
03	90472	90477	90482	90488	90493	90499	90504	90509	90515	90520
04	90526	90531	90536	90542	90547	90553	90558	90563	90569	90574
05	90580	90585	90590	90596	90601	90607	90612	90617	90623	90628
06	90634	90639	90644	90650	90655	90660	90666	90671	90677	90682
07	90687	90693	90698	90703	90709	90714	90720	90725	90730	90736
08	90741	90747	90752	90757	90767	90768	90773	90779	90784	90789
09	90795	90800	90806	90811	90816	90822	90827	90832	90838	90843
810	2.90849	2.90854	2.90859	2.90865	2.90870	2.90875	2.90881	2.90886	2.90891	2.90897
11	90902	90907	90913	90918	90924	90929	90934	90940	90945	90950
12	90956	90961	90966	90972	90977	90982	90988	90993	90998	91004
13	91009	91014	91020	91025	91030	91036	91041	91046	91052	91057
14	91062	91068	91073	91078	91084	91089	91094	91100	91105	91110
15	91116	91121	91126	91132	91137	91142	91148	91153	91158	91164
16	91169	91174	91180	91185	91190	91196	91201	91206	91212	91217
17	91222	91228	91233	91238	91243	91249	91254	91259	91265	91270
18	91275	91281	91286	91291	91297	91302	91307	91312	91318	91323
819	91328	91334	91339	91344	91350	91355	91360	91365	91371	91376

A Table of Logarithms from 1 to 10,000.

N°	0	1	2	3	4	5	6	7	8	9
820	2.91381	2.91387	2.91392	2.91397	2.91403	2.91408	2.91413	2.91418	2.91424	2.91429
21	91434	91440	91445	91450	91455	91461	91466	91471	91477	91482
22	91487	91492	91498	91503	91508	91514	91519	91524	91529	91535
23	91540	91545	91551	91556	91561	91566	91572	91577	91582	91587
24	91593	91598	91603	91608	91614	91619	91624	91630	91635	91640
25	91645	91651	91656	91661	91666	9167	91677	91682	91687	91693
26	91698	91703	91709	91714	91719	91724	91730	91735	91740	91745
27	91751	91756	91761	91766	91772	91777	91782	91787	91793	91798
28	91803	91808	91814	91819	91824	91829	91834	91840	91845	91850
29	91855	91861	91866	91871	91876	91882	91887	91892	91897	91903
830	2.91908	2.91913	2.91918	2.91924	2.91929	2.91934	2.91939	2.91944	2.91950	91955
31	91960	91965	91971	91976	91981	91986	91991	91997	92002	92007
32	92012	92018	92023	92028	92033	92038	92044	92049	92054	92059
33	92065	92070	92075	92080	92085	92091	92096	92101	92106	92111
34	92117	92122	92127	92132	92137	92143	92148	92153	92158	92163
35	92169	92174	92179	92184	92189	92195	92200	92205	92210	92215
36	92221	92226	92231	92236	92241	92247	92252	92257	92262	92267
37	92273	92278	92283	92288	92293	92298	92304	92309	92314	92319
38	92324	92330	92335	92340	92345	92350	92355	92361	92366	92371
39	92376	92381	92387	92392	92397	92402	92407	92412	92418	92423
840	2.92428	2.92433	2.92438	2.92443	2.92449	2.92454	2.92459	2.92464	2.92469	2.92474
41	92480	92485	92490	92495	92500	92505	92511	92516	92521	92526
42	92531	92536	92542	92547	92552	92557	92562	92567	92572	92578
43	92583	92588	92593	92598	92603	92609	92614	92619	92624	92629
44	92634	92639	92645	92650	92655	92660	92665	92270	92675	92681
45	92686	92691	92696	92701	92706	92711	92716	92722	92727	92732
46	92737	92742	92747	92752	92758	92763	92768	92773	92778	92783
47	92788	92793	92799	92804	92809	92814	92819	92824	92829	92834
48	92840	92845	92850	92855	92860	92865	92870	92875	92881	92886
49	92891	92896	92901	92906	92911	92916	92921	92927	92932	92937
850	2.92942	2.92947	2.92952	2.92957	2.92962	2.92967	2.92973	2.92978	2.92983	2.92988
51	92993	92998	93003	93008	93013	93018	93024	93029	93034	93039
52	93044	93049	93054	93059	93064	93069	93075	93080	93085	93090
53	93095	93100	93105	93110	93115	93120	93125	93131	93136	93141
54	93146	93151	93156	93161	93166	93171	93176	93181	93186	93192
55	93197	93202	93207	93212	93217	93222	93227	93232	93237	93242
56	93247	93252	93258	93263	93268	93273	93278	93283	93288	93294
57	93298	93303	93308	93313	93318	93323	93328	93334	93339	93344
58	93349	93354	93359	93364	93369	93374	93379	93384	93389	93394
59	93399	93404	93409	93414	93420	93425	93430	92435	93440	93445
860	2.93450	2.93455	2.93460	2.93465	2.93470	2.93475	2.93480	2.93485	2.93490	2.93495
61	93500	93505	93510	93515	93520	93526	93531	93536	93541	93546
62	93551	93556	93561	93566	93571	93576	93581	93586	93591	93596
63	93601	93606	93611	93616	93621	93626	93631	93636	93641	93646
64	93651	93656	93661	93666	93671	93676	93682	93687	93692	93697
65	93702	93707	93712	93717	93722	93727	93732	93737	93742	93747
66	93752	93757	93762	93767	93772	93777	93782	93787	93792	93797
67	93802	93807	93812	93817	93822	93827	93832	93837	93842	93847
68	93852	93857	93862	93867	93872	93877	93882	93887	93892	93897
69	93902	93907	93912	93917	93922	93927	93932	93937	93942	93947
870	2.93952	2.93957	2.93962	2.93967	2.93972	2.93977	2.93982	2.93987	2.93992	2.93997
71	94002	94007	94012	94017	94022	94027	94032	94037	94042	94047
72	94052	94057	94062	94067	94072	94077	94082	94086	94091	94096
73	94101	94106	94111	94116	94121	94126	94131	94136	94141	94146
74	94151	94156	94161	94166	94171	94176	94181	94186	94191	94196
75	94201	94206	94211	94216	94221	94226	94231	94236	94240	94245
76	94250	94255	54260	94265	94270	94275	94280	94285	94290	94295
77	94300	94305	94310	94315	94320	94325	94330	94335	94340	94345
78	94349	94354	94359	94364	94369	94374	94379	94384	94389	94394
79	94399	94404	94409	94414	94419	94424	94429	94433	94438	94443

A Table of Logarithms from 1 to 10,000.

N°	0	1	2	3	4	5	6	7	8	9
880	2.94448	2.94453	2.94458	2.94463	2.94468	2.94473	2.94478	2.94483	2.94488	2.94493
81	94498	94501	94507	94512	94517	94522	94527	94532	94537	94542
82	94547	94552	94557	94562	94567	94571	94576	94581	94586	94591
83	94596	94601	94606	94611	94616	94621	94626	94630	94635	94640
84	94645	94650	94655	94660	94665	94670	94675	94680	94685	94689
85	94694	94699	94704	94709	94714	94719	94724	94729	94734	94738
86	94743	94748	94753	94758	94763	94768	94773	94778	94783	94787
87	94792	94797	94802	94807	94811	94817	94822	94827	94832	94836
88	94841	94846	94851	94856	94861	94866	94871	94876	94880	94885
89	94890	94895	94900	94905	94910	94915	94919	94924	94929	94934
890	2.94939	2.94944	2.94949	2.94954	2.94959	2.94963	2.94968	2.94973	2.94978	2.94983
91	94988	94993	94998	95002	95007	95012	95017	95022	95027	95032
92	95036	95041	95046	95051	95056	95061	95066	95071	95075	95080
93	95085	95090	95095	95100	95105	95110	95114	95119	95124	95129
94	95134	95139	95143	95148	95153	95158	95163	95168	95173	95177
95	95182	95187	95192	95197	95202	95207	95211	95216	95221	95226
96	95231	95236	95240	95245	95250	95255	95260	95265	95270	95274
97	95279	95284	95289	95294	95299	95303	95308	95313	95318	95323
98	95328	95332	95337	95342	95347	95352	95357	95361	95366	95371
99	95376	95381	95386	95390	95395	95400	95405	95410	95415	95419
900	2.95424	2.95429	2.95434	2.95439	2.95444	2.95448	2.95453	2.95458	2.95463	2.95468
01	95472	95477	95482	95487	95492	95497	95501	95506	95511	95516
02	95521	95525	95530	95535	95540	95545	95550	95554	95559	95564
03	95569	95574	95578	95583	95588	95593	95598	95602	95607	95612
04	95617	95622	95626	95631	95636	95641	95646	95650	95655	95660
05	95665	95670	95674	95679	95684	95689	95694	95698	95703	95708
06	95713	95718	95722	95727	95732	95737	95742	95746	95751	95756
07	95761	95766	95770	95775	95780	95785	95789	95794	95799	95804
08	95809	95813	95818	95823	95828	95832	95837	95842	95847	95852
09	95856	95861	95866	95871	95875	95880	95885	95890	95895	95899
910	2.95904	2.95909	2.95914	2.95918	2.95923	2.95928	2.95933	2.95938	2.95942	2.95947
11	95952	95957	95961	95966	95971	95976	95980	95985	95990	95995
12	95999	96004	96009	96014	96019	96023	96028	96033	96038	96042
13	96047	96052	96057	96061	96066	96071	96076	96080	96085	96090
14	96095	96099	96104	96109	96114	96118	96123	96128	96133	96137
15	96142	96147	96152	96156	96161	96166	96171	96175	96180	96185
16	96190	96194	96199	96204	96209	96213	96218	96223	96227	96232
17	96237	96242	96246	96251	96256	96261	96265	96270	96275	96280
18	96284	96289	96294	96298	96303	96308	96313	96317	96322	96327
19	96332	96336	96341	96346	96350	96355	96360	96365	96369	96374
920	2.96379	2.96384	2.96388	2.96393	2.96398	2.96402	2.96407	2.96412	2.96417	2.96421
21	96426	96431	96435	96440	96445	96450	96454	96459	96464	96468
22	96473	96478	96483	96487	96492	96497	96501	96506	96511	96515
23	96520	96525	96530	96534	96539	96544	96548	96553	96558	96563
24	96567	96572	96577	96581	96586	96591	96595	96600	96605	96609
25	96614	96619	96624	96628	96633	96638	96642	96647	96652	96656
26	96661	96666	96670	96675	96680	96685	96689	96694	96699	96703
27	96708	96713	96717	96722	96727	96731	96736	96741	96745	96750
28	96755	96759	96764	96769	96774	96778	96783	96788	96792	96797
29	96802	96806	96811	96816	96820	96825	96830	96834	96839	96844
930	2.96848	2.96853	2.96858	2.96862	2.96867	2.96872	2.96876	2.96881	2.96886	2.96890
31	96895	96900	96904	96909	96914	96918	96923	96928	96932	96937
32	96942	96946	96951	96956	96960	96965	96970	96974	96979	96984
33	96988	96993	96997	97002	97007	97011	97016	97021	97025	97030
34	97035	97039	97044	97049	97053	97058	97063	97067	97072	97077
35	97081	97086	97090	97095	97100	97104	97109	97114	97118	97123
36	97128	97132	97137	97142	97146	97151	97155	97160	97165	97169
37	97174	97179	97183	97188	97192	97197	97202	97206	97211	97216
38	97220	97225	97230	97234	97239	97243	97248	97253	97257	97262
39	97267	97271	97276	97280	97285	97290	97294	97299	97304	97308

A Table of Logarithms from 1 to 10,000.

No	0	1	2	3	4	5	6	7	8	9
940	2.97313	2.97317	2.97322	2.97327	2.97331	2.97336	2.97340	2.97345	2.97350	2.97354
41	97359	97364	97368	97373	97377	97382	97387	97391	97396	97400
42	97405	97410	97414	97419	97424	97428	97433	97437	97442	97447
43	97451	97456	97460	97465	97470	97474	97479	97483	97488	97493
44	97497	97502	97506	97511	97516	97520	97525	97529	97534	97539
45	97543	97548	97552	97557	97562	97566	97571	97575	97580	97585
46	97589	97594	97598	97603	97607	97612	97617	97621	97626	97630
47	97635	97640	97644	97649	97653	97658	97663	97667	97672	97676
48	97681	97685	97690	97695	97699	97704	97708	97713	97717	97722
49	97727	97731	97736	97740	97745	97749	97754	97759	97763	97768
950	2.97772	2.97777	2.97782	2.97786	2.97791	2.97795	2.97800	2.97804	2.97809	2.97813
51	97818	97823	97827	97832	97836	97841	97845	97850	97855	97859
52	97864	97868	97873	97877	97882	97886	97891	97896	97900	97905
53	97909	97914	97918	97923	97928	97932	97937	97941	97946	97950
54	97955	97959	97964	97968	97973	97978	97982	97987	97991	97996
55	98000	98005	98009	98014	98019	98023	98028	98032	98037	98041
56	98046	98050	98055	98059	98064	98068	98073	98078	98082	98087
57	98091	98096	98100	98105	98109	98114	98118	98123	98127	98132
58	98137	98141	98146	98150	98155	98159	98164	98168	98173	98177
59	98182	98186	98191	98195	98200	98204	98209	98214	98218	98223
960	2.98227	2.98232	2.98236	2.98241	2.98245	2.98250	2.98254	2.98259	2.98263	2.98268
61	98272	98277	98281	98286	98290	98295	98299	98304	98308	98313
62	98318	98322	98327	98331	98336	98340	98345	98349	98354	98358
63	98363	98367	98372	98376	98381	98385	98390	98394	98399	98403
64	98408	98412	98417	98421	98426	98430	98435	98439	98444	98448
65	98453	98457	98462	98466	98471	98475	98480	98484	98489	98493
66	98498	98502	98507	98511	98516	98520	98525	98529	98534	98538
67	98543	98547	98552	98556	98561	98565	98570	98574	98579	98583
68	98588	98592	98597	98601	98605	98610	98614	98619	98623	98628
69	98632	98637	98641	98646	98650	98655	98659	98664	98668	98673
970	2.98677	2.98682	2.98686	2.98691	2.98695	2.98700	2.98704	2.98709	2.98713	2.98717
71	98722	98726	98731	98735	98740	98744	98749	98753	98758	98762
72	98767	98771	98776	98780	98784	98789	98793	98798	98802	98807
73	98811	98816	98820	98825	98829	98834	98838	98843	98847	98851
74	98856	98860	98865	98869	98874	98878	98883	98887	98892	98896
75	98900	98905	98909	98914	98918	98923	98927	98932	98936	98941
76	98945	98949	98954	98958	98963	98967	98972	98976	98981	98985
77	98989	98994	98998	99003	99007	99012	99016	99021	99025	99029
78	99034	99038	99043	99047	99052	99056	99061	99065	99069	99074
79	99078	99083	99087	99092	99096	99100	99105	99109	99114	99118
980	2.99123	2.99127	2.99131	2.99136	2.99140	2.99145	2.99149	2.99154	2.99158	2.99162
81	99167	99171	99176	99180	99185	99189	99193	99198	99202	99207
82	99211	99216	99220	99224	99229	99233	99238	99242	99247	99251
83	99255	99260	99264	99269	99273	99277	99282	99286	99291	99295
84	99300	99304	99308	99313	99317	99322	99326	99330	99335	99339
85	99344	99348	99352	99357	99361	99366	99370	99374	99379	99383
86	99388	99392	99396	99401	99405	99410	99414	99419	99423	99427
87	99432	99436	99441	99445	99449	9945	99458	99463	99467	99471
88	99476	99480	99484	99489	99493	9941	99502	99506	99511	99515
89	99520	99524	99528	99533	99537	99542	99546	99550	99555	99559
990	2.99564	2.99568	2.99572	2.99577	2.99581	2.99585	2.99590	2.99594	2.99599	2.99603
91	99607	99612	99616	99621	99625	99629	99634	99638	99642	99647
92	99651	99656	99660	99664	99669	99673	99677	99682	99686	99691
93	99695	99699	99704	99708	99712	99717	99721	99726	99730	99734
94	99739	99743	99747	99752	99756	99760	99765	99769	99774	99778
95	99782	99787	99791	99795	99800	99804	99808	99813	99817	99822
96	99826	99830	99835	99839	99843	99848	99852	99856	99861	99865
97	99870	99874	99878	99883	99887	99891	99896	99900	99904	99909
98	99913	99917	99922	99926	99930	99935	99939	99944	99948	99952
999	99917	99961	99965	99970	99974	99978	99983	99987	99991	99996

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	10.00000	10.00000	10.00000	Infinite.	10.00000	Infinite.	60
1	6.46373	00000	6.46372	13.53627	10.00000	13.53627	59
2	76476	00000	76476	23524	00000	23524	58
3	94085	00000	94085	05915	00000	05915	57
4	7.06579	00000	7.06579	12.93421	00000	12.93421	56
5	16270	00000	16270	83730	00000	83730	55
6	24188	00000	24188	75812	00000	75812	54
7	30882	00000	30882	69118	00000	69118	53
8	36681	00000	36682	63318	00000	63318	52
9	41797	00000	41797	58203	00000	58203	51
10	46373	00000	46373	53627	00000	53627	50
11	7.40512	10.00000	7.50512	12.49488	10.00000	12.49488	49
12	54291	00000	54291	45709	00000	45709	48
13	57767	00000	57767	42233	00000	42233	47
14	60985	00000	60986	39014	00000	39015	46
15	63982	00000	63982	36018	00000	36018	45
16	66784	00000	66785	33215	00000	33216	44
17	69417	9.99999	69418	30582	00000	30583	43
18	71900	99999	71900	28100	00001	28100	42
19	74248	99999	74248	25752	00001	25752	41
20	76475	99999	76476	23524	00001	23525	40
21	7.78594	9.99999	7.78595	12.21405	10.00001	12.21406	39
22	80615	99999	80615	19385	00001	19385	38
23	82545	99999	82546	17454	00001	17455	37
24	84393	99999	84394	15606	00001	15607	36
25	86166	99999	86167	13833	00001	13834	35
26	87870	99999	87871	12130	00001	12130	34
27	89509	99999	89510	10490	00001	10491	33
28	92088	99999	91089	08911	00001	08912	32
29	92612	99999	92613	07387	00002	07388	31
30	94084	99999	94086	05914	00002	05915	30
31	7.95508	9.99998	7.95510	12.04490	10.00002	12.04492	29
32	96887	99998	96889	03111	00002	03113	28
33	98223	99998	98225	01775	00002	01777	27
34	99520	99998	99522	00478	00002	00480	26
35	8.00779	99998	8.00781	11.99219	00002	11.99221	25
36	02002	99998	02004	97996	00002	97998	24
37	03192	99997	03194	96805	00002	96808	23
38	04350	99997	04353	95647	00003	95650	22
39	05478	99997	05481	94519	00003	94522	21
40	06578	99997	06581	93419	00003	93422	20
41	8.07650	9.99997	8.07653	11.92347	10.00003	11.92350	19
42	08696	99997	08700	91300	00003	91304	18
43	09718	99997	09722	90278	00003	90281	17
44	10717	99996	10720	89280	00004	89283	16
45	11693	99996	11696	88304	00004	88307	15
46	12647	99996	12651	87349	00004	87356	14
47	13581	99996	13585	86415	00004	86419	13
48	14495	99996	14500	85500	00004	85505	12
49	15391	99996	15395	84605	00005	84609	11
50	16268	99995	16273	83727	00005	83732	10
51	8.17128	9.99995	8.17132	11.82867	10.00005	11.82872	9
52	17971	99995	17976	82024	00005	82029	8
53	18798	99995	18804	81196	00005	81202	7
54	19610	99995	19616	80384	00005	80390	6
55	20407	99994	20413	79587	00006	79593	5
56	21189	99994	21195	78805	00006	78811	4
57	21958	99994	21964	78036	00006	78042	3
58	22713	99994	22719	77280	00006	77206	2
59	23456	99994	23462	76538	00006	76544	1
60	24186	99993	24192	75808	00006	75814	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	8.24185	9.99993	8.24192	11.75808	10.00007	11.75814	60
1	24903	99993	24910	75090	00007	75097	59
2	25609	99993	25616	74384	00007	74391	58
3	26304	99993	26311	73688	00007	73696	57
4	26988	99992	26996	73004	00007	73012	56
5	27661	99992	27669	72331	00008	72339	55
6	28324	99992	28332	71668	00008	71676	54
7	28977	99992	28985	71014	00008	71023	53
8	29621	99991	29629	70371	00008	70379	52
9	30255	99991	29263	69737	00009	69745	51
10	8.30879	9.99991	8.30888	11.69112	10.00009	11.69121	50
11	31495	99991	31505	68495	00009	68505	49
12	32103	99990	32112	67888	00009	67897	48
13	32702	99990	32711	67289	00010	67298	47
14	33292	99990	33302	66697	00010	66708	46
15	33875	99989	33886	66114	00010	66125	45
16	34450	99989	34461	65539	00011	65510	44
17	35018	99989	35029	64971	00011	64982	43
18	35578	99989	35589	64410	00011	64422	42
19	36131	99989	36143	63857	00011	63868	41
20	8.36678	9.99988	8.36689	11.63310	10.00012	11.63322	40
21	37217	99988	37229	62771	00012	62783	39
22	37750	99988	37762	62238	00012	62250	38
23	38276	99987	38289	61711	00013	61724	37
24	38796	99987	38809	61191	00013	61204	36
25	39310	99987	39323	60677	00013	60690	35
26	39818	99986	39832	60168	00014	60182	34
27	40320	99986	40334	59666	00014	59680	33
28	40816	99986	40830	59170	00014	59184	32
29	41307	99985	41321	58679	00015	58693	31
30	8.41792	9.99985	8.41807	11.58193	10.00015	11.58208	30
31	42272	99985	42287	57713	00015	57728	29
32	42746	99984	42762	57238	00016	57254	28
33	43216	99984	43231	56768	00016	56784	27
34	43680	99984	43696	56304	00016	56320	26
35	44139	99983	44156	55844	00017	55861	25
36	44594	99983	44611	55389	00017	55406	24
37	45044	99983	45061	54939	00017	54956	23
38	45489	99982	45507	54493	00018	54510	22
39	45930	99982	45948	54052	00018	54070	21
40	8.46366	9.99982	8.46385	11.53615	10.00018	11.53633	20
41	46798	99981	46817	53183	00019	53201	19
42	47226	99981	47245	52755	00019	52774	18
43	47650	99980	47669	52331	00019	52350	17
44	48069	99980	48089	51911	00020	51931	16
45	48485	99980	48505	51495	00020	51515	15
46	48896	99979	48917	51083	00021	51104	14
47	49304	99979	49325	50675	00021	50696	13
48	49708	99979	49729	50271	00021	50292	12
49	50108	99978	50130	49870	00022	49892	11
50	8.50504	9.99978	8.50527	11.49473	10.00022	11.49495	10
51	50897	99977	50920	49080	00023	49103	9
52	51287	99977	51310	48690	00023	48713	8
53	51673	99976	51696	48304	00023	48328	7
54	52055	99976	52079	47921	00024	47945	6
55	52434	99976	52459	47541	00024	47566	5
56	52810	99975	52835	47165	00025	47190	4
57	53183	99975	53208	46792	00025	46817	3
58	53552	99974	53578	46422	00026	46448	2
59	53919	99974	53945	46055	00026	46081	1
60	54282	99973	54308	45692	00026	45718	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	8.54282	9.99973	8.54309	11.45692	10.00026	11.45718	60
1	54642	99973	54669	45331	00027	45358	59
2	54999	99973	55027	44973	00027	45000	58
3	55354	99972	55382	44618	00028	44646	57
4	55705	99972	55734	44266	00028	44295	56
5	56054	99971	56083	43917	00029	43946	55
6	56400	99971	56429	43572	00029	43600	54
7	56743	99970	56773	43227	00030	43257	53
8	57084	99970	57114	42886	00030	42916	52
9	57421	99970	57452	42548	00030	42579	51
10	8.57757	9.99969	8.57788	11.42212	10.00031	11.42243	50
11	58089	99968	58121	41879	00031	41911	49
12	58419	99968	58451	41549	00032	41581	48
13	58747	99967	58779	41221	00032	41253	47
14	59072	99967	59105	40895	00033	40927	46
15	59395	99966	59428	40572	00033	40605	45
16	59715	99966	59749	40251	00034	40285	44
17	60033	99965	60068	39932	00034	39967	43
18	60349	99965	60384	39616	00035	36951	42
19	60662	99964	60698	39302	00035	39338	41
20	8.60973	9.99964	8.61009	11.38991	10.00036	11.39027	40
21	61282	99963	61319	38681	00036	38718	39
22	61589	99963	61626	38374	00037	38411	38
23	61894	99962	61931	38069	00038	38106	37
24	62196	99962	62234	37766	00038	37804	36
25	62496	99961	62535	37465	00039	37503	35
26	62795	99961	62834	37166	00039	37205	34
27	63091	99960	63131	36869	00040	36909	33
28	63385	99960	63426	36574	00040	36615	32
29	63678	99959	63718	36281	00041	36322	31
30	8.63968	9.99959	8.64009	11.35991	10.00041	11.36032	30
31	64256	99958	64298	35702	00042	35744	29
32	64543	99957	64585	35415	00042	35457	28
33	64827	99957	64870	35130	00043	35173	27
34	65110	99956	65154	34846	00044	34890	26
35	65391	99956	65435	34565	00044	34609	25
36	65670	99955	65715	34285	00045	34330	24
37	65947	99955	65993	34007	00045	34052	23
38	66223	99954	66269	33731	00046	33777	22
39	66497	99953	66543	33457	00046	33503	21
40	8.66769	9.99953	8.66816	11.33184	10.00047	11.33231	20
41	67039	99952	67087	32913	00048	32961	19
42	67308	99952	67356	32644	00048	32692	18
43	67575	99951	67624	32376	00049	32425	17
44	67840	99951	67890	32110	00049	32160	16
45	68104	99950	68154	31846	00050	31896	15
46	68366	99949	68417	31583	00051	31633	14
47	68627	99949	68678	31322	00051	31373	13
48	68886	99948	68938	31062	00052	31114	12
49	69144	99947	69196	30804	00052	30856	11
50	8.69400	9.99947	8.69453	11.30547	10.00053	11.30600	10
51	69654	99946	69708	30292	00054	30346	9
52	69907	99946	69962	30038	00054	30093	8
53	70159	99945	70214	29786	00055	29841	7
54	70409	99944	70465	29535	00056	29591	6
55	70658	99944	70714	29286	00056	29342	5
56	70905	99943	70962	29038	00057	29095	4
57	71151	99942	71208	28792	00058	28849	3
58	71395	99942	71453	28546	00058	28605	2
59	71638	99941	71697	28303	00059	28361	1
60	71880	99940	71940	28060	00059	28120	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	8.71880	9.99940	8.71940	11.28060	10.00059	11.28120	60
1	72120	99940	72181	27819	00060	27880	59
2	72359	99939	72420	27580	00061	27640	58
3	72597	99938	72659	27341	00062	27403	57
4	72834	99938	72896	27104	00062	27166	56
5	73069	99937	73132	26868	00063	26931	55
6	73303	99936	73366	26634	00064	26697	54
7	73535	99936	73600	26400	00064	26465	53
8	73767	99935	73832	26168	00065	26233	52
9	73997	99934	74063	25937	00065	26003	51
10	8.74226	9.99934	8.74292	11.25708	10.00066	11.25774	50
11	74454	99933	74521	25479	00067	25546	49
12	74680	99932	74748	25252	00068	25320	48
13	74905	99931	74974	25026	00068	25094	47
14	75130	99931	75199	24801	00069	24870	46
15	75353	99930	75423	24577	00070	24647	45
16	75575	99929	75645	24355	00070	24425	44
17	75795	99929	75867	24133	00071	24204	43
18	76015	99928	76087	23913	00072	23985	42
19	76234	99927	76306	23693	00073	23766	41
20	8.76451	9.99926	8.76525	11.23475	10.00073	11.23549	40
21	76667	99926	76742	23258	00074	23332	39
22	76883	99925	76958	23042	00075	23117	38
23	77097	99924	77173	22827	00076	22903	37
24	77310	99923	77387	22613	00076	22690	36
25	77522	99923	77599	22400	00077	22478	35
26	77733	99922	77811	22189	00078	22267	34
27	77943	99921	78022	21978	00079	22057	33
28	78152	99920	78232	21768	00079	21848	32
29	78360	99920	78441	21559	00080	21639	31
30	8.78567	9.99919	8.78849	11.21351	10.00081	11.21432	30
31	78774	99918	78855	21145	00082	21226	29
32	78979	99917	79061	20939	00083	21021	28
33	79183	99917	79266	20734	00083	20817	27
34	79386	99916	79470	20530	00084	20614	26
35	79588	99915	79673	20327	00085	20412	25
36	79789	99914	79875	20125	00086	20211	24
37	79990	99913	80076	19924	00087	20010	23
38	80189	99913	80276	19723	00087	19811	22
39	80388	99912	80476	19523	00088	19612	21
40	8.80585	9.99911	8.80674	11.19326	10.00089	11.19415	20
41	80782	99910	80872	19128	00090	19218	19
42	80978	99909	81068	18932	00091	19022	18
43	81173	99909	81264	18736	00091	18827	17
44	81367	99908	81459	18541	00092	18633	16
45	81560	99907	81653	18347	00093	18440	15
46	81752	99906	81846	18154	00094	18248	14
47	81944	99905	82038	17962	00095	18056	13
48	82134	99904	82230	17770	00096	17866	12
49	82324	99904	82420	17579	00097	17676	11
50	8.82513	9.99903	8.82610	11.17390	10.00097	11.17487	10
51	82701	99902	82799	17201	00098	17299	9
52	82888	99901	82987	17013	00099	17112	8
53	83075	99900	83175	16825	00100	16925	7
54	83261	99899	83361	16639	00101	16739	6
55	83446	99898	83547	16453	00102	16554	5
56	83630	99898	83732	16268	00102	16370	4
57	83813	99897	83916	16084	00103	16187	3
58	83996	99896	84100	15900	00104	16004	2
59	84177	99895	84282	15717	00105	15823	1
60	84358	99894	84464	15536	00106	15642	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	8.84358	9.99894	8.84464	11.15536	10.00106	11.15642	60
1	84539	99893	84645	15355	00107	15461	59
2	84718	99892	84826	15175	00108	15282	58
3	84897	99891	85006	14995	00109	15103	57
4	85075	99890	85185	14814	00109	14925	56
5	85252	99890	85363	14637	00110	14748	55
6	85429	99889	85540	14460	00111	14571	54
7	85605	99888	85717	14283	00112	14395	53
8	85780	99887	85893	14107	00113	14220	52
9	85955	99886	86069	13931	00114	14045	51
10	8.86128	9.99885	8.86243	11.13757	10.00115	11.13872	50
11	86301	99884	86417	13583	00116	13699	49
12	86474	99883	86590	13409	00117	13526	48
13	86645	99882	86763	13237	00118	13355	47
14	86816	99881	86935	13065	00119	13183	46
15	86987	99880	87106	12894	00120	13013	45
16	87156	99879	87277	12723	00120	12843	44
17	87325	99878	87447	12553	00121	12674	43
18	87494	99878	87616	12384	00122	12506	42
19	87661	99877	87785	12215	00123	12338	41
20	8.87829	9.99876	8.87953	11.12047	10.00124	11.12171	40
21	87995	99875	88120	11880	00125	12005	39
22	88161	99874	88287	11713	00126	11839	38
23	88326	99873	88453	11547	00127	11674	37
24	88490	99872	88618	11381	00128	11510	36
25	88654	99871	88783	11217	00129	11346	35
26	88817	99870	88948	11052	00130	11183	34
27	88980	99869	89111	10889	00131	11020	33
28	89142	99868	89274	10726	00132	10858	32
29	89304	99867	89437	10563	00133	10696	31
30	8.89464	9.99866	8.89598	11.10402	10.00134	11.10536	30
31	89624	99865	89760	10240	00135	10375	29
32	89784	99864	89920	10080	00136	10216	28
33	89943	99863	90080	09920	00137	10057	27
34	90102	99862	90240	09760	00138	09898	26
35	90260	99861	90399	09601	00139	09740	24
36	90417	99860	90557	09443	00140	09583	25
37	90574	99859	90715	09285	00141	09426	23
38	90730	99858	90872	09128	00142	09270	22
39	90885	99857	91028	08971	00143	09115	21
40	8.91040	9.99856	8.91185	11.08815	10.00144	11.08960	20
41	91195	99855	91340	08660	00145	08805	19
42	91349	99854	91495	08505	00146	08651	18
43	91502	99853	91649	08350	00147	08498	17
44	91655	99852	91803	08197	00148	08345	16
45	91807	99851	91957	08043	00149	08193	15
46	91959	99849	92110	07890	00150	08041	14
47	92110	99848	92262	07738	00151	07890	13
48	92261	99847	92414	07586	00153	07739	12
49	92411	99846	92565	07435	00154	07589	11
50	8.92561	9.99845	8.92716	11.07284	10.00155	11.07439	10
51	92710	99844	92866	07134	00156	07290	9
52	92859	99843	93015	06984	00157	07141	8
53	93007	99842	93165	06835	00158	06993	7
54	93154	99841	93313	06687	00159	06846	6
55	93301	99840	93462	06538	00160	06698	5
56	93448	99839	93609	06391	00161	06552	4
57	93594	99838	93756	06243	00162	06406	3
58	93740	99837	93903	06097	00163	06260	2
59	93885	99835	94049	05951	00164	06115	1
60	94030	99834	94195	05805	00166	05970	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	8.94039	9.99834	8.94195	11.05805	10.00166	11.05970	60
1	94174	99833	94340	05660	00167	05826	59
2	94317	99832	94485	05515	00168	05683	58
3	94461	99831	94629	05370	00169	05539	57
4	94603	99830	94773	05227	00170	05397	56
5	94746	99829	94917	05083	00171	05254	55
6	94887	99828	95060	04940	00172	05113	54
7	95029	99827	95202	04798	00173	04971	53
8	95170	99825	95344	04656	00174	04830	52
9	95310	99824	95486	04514	00175	04690	51
10	8.95450	9.99823	8.95627	11.04373	10.00177	11.04550	50
11	95590	99822	95767	04233	00178	04411	49
12	95728	99821	95907	04092	00179	04272	48
13	95867	99820	96047	03953	00180	04133	47
14	96005	99819	96187	03813	00181	03995	46
15	96143	99817	96325	03675	00183	03857	45
16	96280	99816	96464	03536	00184	03720	44
17	96417	99815	96602	03398	00185	03583	43
18	96553	99814	96739	03261	00186	03447	42
19	96689	99813	96877	03123	00187	03311	41
20	8.96825	9.99812	8.97013	11.02987	10.00188	11.03175	40
21	96960	99810	97150	02850	00190	03040	39
22	97095	99809	97285	02714	00191	02905	38
23	97229	99808	97421	02579	00192	02771	37
24	97363	99807	97556	02444	00193	02637	36
25	97496	99806	97691	02309	00194	02504	35
26	97629	99804	97825	02175	00196	02371	34
27	97762	99803	97959	02041	00197	02238	33
28	97894	99802	98092	01908	00198	02106	32
29	98026	99801	98225	01775	00199	01974	31
30	8.98157	9.99800	8.98358	11.01642	10.00200	11.01843	30
31	98288	99798	98490	01510	00202	01712	29
32	98419	99797	98622	01378	00203	01581	28
33	98549	99796	98753	01247	00204	01450	27
34	98679	99795	98884	01116	00205	01321	26
35	98808	99793	99015	00985	00206	01192	25
36	98937	99792	99145	00855	00208	01063	24
37	99066	99791	99275	00725	00209	00934	23
38	99194	99790	99405	00595	00210	00806	22
39	99322	99788	99534	00466	00211	00678	21
40	8.99450	9.99787	8.99662	11.00338	10.00213	11.00550	20
41	99577	99786	99791	00209	00214	00423	19
42	99704	99785	99919	00081	00215	00296	18
43	99830	99783	9.00046	10.99954	00216	00170	17
44	99956	99782	00174	99826	00218	00044	16
45	9.00082	99781	00301	99699	00219	10.99918	15
46	00207	99780	00427	99573	00220	99793	14
47	00332	99779	00553	99447	00222	99668	13
48	00456	99777	00679	99321	00223	99544	12
49	00580	99776	00805	99195	00224	99419	11
50	9.00704	9.99774	9.00930	10.99070	10.00225	10.99296	10
51	00828	99773	01055	98945	00227	99172	9
52	00951	99772	01179	98821	00228	99049	8
53	01074	99771	01303	98697	00229	98926	7
54	01196	99769	01427	98573	00231	98884	6
55	01318	99768	01550	98450	00232	98682	5
56	01440	99767	01673	98327	00233	98560	4
57	01561	99765	01796	98204	00234	98439	3
58	01682	99764	01918	98082	00236	98318	2
59	01803	99763	02040	97960	00237	98197	1
60	01923	99761	02162	97838	00239	98077	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	9.01923	9.99761	9.02162	10.97838	10.00239	10.98076	60
1	02043	99760	02283	97717	00240	97956	59
2	02163	99759	02404	97596	00241	97837	58
3	02283	99757	02525	97475	00243	97717	57
4	02402	99756	02645	97354	00244	97598	56
5	02520	99755	02765	97234	00245	97480	55
6	02639	99753	02885	97115	00247	97361	54
7	02757	99752	03005	96995	00248	97243	53
8	02874	99751	03124	96876	00249	97126	52
9	02992	99749	03242	96757	00251	97008	51
10	9.03109	9.99748	9.03361	10.96639	10.00252	10.96891	50
11	03226	99747	03479	96521	00253	96774	49
12	03342	99745	03597	96403	00255	96658	48
13	03458	99744	03714	96286	00256	96542	47
14	03574	99742	03832	96168	00257	96426	46
15	03690	99741	03948	96051	00259	96310	45
16	03805	99740	04065	95935	00260	96195	44
17	03920	99738	04181	95819	00262	96080	43
18	04034	99737	04297	95703	00263	95966	42
19	04149	99735	04413	95587	00264	95851	41
20	9.04262	9.99734	9.04528	10.95472	10.00266	10.95737	40
21	04376	99733	04643	95357	00267	95624	39
22	04489	99731	04758	95242	00269	95510	38
23	04603	99730	04873	95127	00270	95397	37
24	04715	99728	04987	95013	00271	95285	36
25	04828	99727	05101	94899	00273	95172	35
26	04940	99726	05214	94786	00274	95060	34
27	05052	99724	05328	94672	00276	94948	33
28	05164	99723	05441	94559	00277	94836	32
29	05275	99721	05553	94447	00279	94725	31
30	9.05386	9.99720	9.05666	10.94334	10.00280	10.94614	30
31	05497	99718	05778	94222	00281	94503	29
32	05607	99717	05890	94110	00283	94393	28
33	05717	99716	06002	93998	00284	94283	27
34	05827	99714	06113	93887	00286	94173	26
35	05937	99713	06224	93776	00287	94063	25
36	06046	99711	06335	93665	00289	93954	24
37	06155	99710	06445	93555	00290	93845	23
38	06264	99708	06556	93444	00292	93736	22
39	06372	99707	06665	93334	00293	93628	21
40	9.06481	9.99705	9.06775	10.93225	10.00295	10.93519	20
41	06588	99704	06885	93115	00296	93411	19
42	06696	99702	06994	93006	00298	93304	18
43	06804	99701	07103	92897	00299	93196	17
44	06911	99699	07211	92789	00301	93089	16
45	07018	99698	07320	92680	00302	92982	15
46	07124	99696	07428	92572	00304	92876	14
47	07231	99695	07536	92464	00305	92769	13
48	07337	99693	07643	92357	00307	92663	12
49	07442	99692	07750	92249	00308	92558	11
50	9.07548	9.99690	9.07858	10.92142	11.00310	10.92452	10
51	07653	99689	07964	92036	00311	92347	9
52	07758	99687	08071	91929	00313	92242	8
53	07863	99686	08177	91823	00314	92137	7
54	07968	99684	08283	91717	00316	92032	6
55	08072	99683	08389	91611	00317	91928	5
56	08176	99681	08495	91505	00319	91824	4
57	08280	99680	08601	91400	00320	91720	3
58	08383	99678	08705	91295	00322	91617	2
59	08486	99677	08810	91190	00323	91514	1
60	08589	99675	08914	91086	00325	91411	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	9.08589	9.99675	9.08914	10.91086	10.00325	10.91411	60
1	08692	99673	09019	90981	00326	91308	59
2	08795	99672	09123	90877	00328	91205	58
3	08897	99670	09227	90773	00330	91103	57
4	08999	99669	00330	90670	00331	91001	56
5	09101	99667	09434	90566	00333	90899	55
6	09202	99666	09537	90463	00334	90798	54
7	09304	99664	09640	90360	00336	90696	53
8	09405	99662	09742	90258	00337	90595	52
9	09506	99661	09845	90155	00339	90494	51
10	9.09606	9.99659	9.09947	10.90053	10.00341	10.90394	50
11	09706	99658	10049	89951	00342	90293	49
12	09807	99656	10150	89850	00344	90193	48
13	09906	99655	10252	89748	00345	90093	47
14	10006	99653	10353	89647	00347	89994	46
15	10106	99651	10454	89546	00349	89894	45
16	10205	99650	10555	89445	00350	89795	44
17	10304	99648	10656	89344	00352	89696	43
18	10402	99647	10756	89244	00353	89597	42
19	10501	99645	10856	89144	00355	89499	41
20	9.10599	9.99643	9.10956	10.89044	10.00357	10.89401	40
21	10697	99642	11056	88944	00358	89303	39
22	10795	99640	11155	88845	00360	89205	38
23	10893	99638	11254	88746	00362	89107	37
24	10990	99637	11353	88647	00363	89010	36
25	11087	99635	11452	88548	00365	88913	35
26	11184	99633	11551	88449	00366	88816	34
27	11281	99632	11649	88351	00368	88719	33
28	11377	99630	11747	88253	00370	88623	32
29	11474	99628	11845	88155	00371	88526	31
30	9.11570	9.99627	9.11943	10.88057	10.00373	10.88430	30
31	11666	99625	12040	87960	00375	88334	29
32	11761	99623	12138	87862	00376	88239	28
33	11857	99622	12235	87765	00378	88143	27
34	11952	99620	12332	87668	00380	88048	26
35	12047	99618	12428	87572	00381	87953	25
36	12142	99617	12525	87475	00383	87858	24
37	12236	99615	12621	87379	00385	87764	23
38	12331	99613	12717	87283	00387	87669	22
39	12425	99611	12813	87187	00388	87575	21
40	9.12519	9.99610	9.12909	10.87091	10.00390	10.87481	20
41	12612	99608	13004	86996	00392	87387	19
42	12706	99607	13099	86901	00393	87294	18
43	12799	99605	13194	86806	00395	87201	17
44	12892	99603	13289	86711	00397	87107	16
45	12985	99601	13384	86616	00398	86015	15
46	13078	99600	13478	86522	00400	86922	14
47	13171	99598	13573	86427	00402	86829	13
48	13263	99596	13667	86333	00404	86737	12
49	13355	99595	13760	86239	00405	86645	11
50	9.13447	9.99593	9.13854	10.86146	10.00407	10.86553	10
51	13539	99591	13948	86052	00409	86461	9
52	13630	99589	14041	85959	00411	86370	8
53	13722	99588	14134	85866	00412	86278	7
54	13813	99586	14227	85773	00414	86187	6
55	13904	99584	14320	85680	00416	86096	5
56	13994	99582	14412	85588	00418	86006	4
57	14085	99581	14504	85496	00419	85915	3
58	14175	99579	14596	85403	00421	85825	2
59	14266	99577	14688	85311	00423	85734	1
60	14356	99575	14780	85220	00425	85644	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	9.14356	9.99575	9.1478	10.85220	10.00425	10.85644	60
1	14445	99573	14872	85128	00426	85555	59
2	14535	99572	14963	85037	00428	85465	58
3	14624	99570	15054	84946	00430	85376	57
4	14714	99568	15145	84855	00432	85286	56
5	14803	99566	15236	84764	00434	85197	55
6	14891	99565	15327	84673	00435	85108	54
7	14980	99563	15417	84583	00437	85020	53
8	15069	99561	15508	84492	00439	84931	52
9	15157	99559	15598	84402	00441	84843	51
10	9.15245	9.99557	9.15688	10.84312	10.00443	10.84755	50
11	15333	99555	15777	84222	00444	84667	49
12	15421	99554	15867	84133	00446	84579	48
13	15508	99552	15956	84043	00448	84492	47
14	15596	99550	16046	83954	00450	84404	46
15	15683	99548	16135	83865	00452	84317	45
16	15770	99546	16224	83776	00454	84230	44
17	15857	99545	16312	83688	00455	84143	43
18	15943	99543	16401	83599	00457	84056	42
19	16030	99541	16489	83511	00459	83970	41
20	9.16116	9.99539	9.16577	10.83423	10.00461	10.83884	40
21	16202	99537	16665	83335	00463	83797	39
22	16289	99535	16753	83247	00465	83711	38
23	16374	99533	16841	83159	00467	83626	37
24	16460	99532	16928	83072	00468	83540	36
25	16545	99530	17016	82984	00470	83455	35
26	16631	99528	17103	82897	00472	83369	34
27	16716	99526	17190	82810	00474	83284	33
28	16801	99524	17277	82723	00476	83199	32
29	16886	99522	17363	82637	00478	83114	31
30	9.16971	9.99520	9.17450	10.82550	10.00480	10.83030	30
31	17055	99518	17536	82464	00482	82945	29
32	17139	99517	17622	82378	00483	82861	28
33	17223	99515	17708	82292	00485	82777	27
34	17307	99513	17794	82206	00487	82693	26
35	17391	99511	17880	82120	00489	82609	25
36	17474	99509	17965	82034	00491	82526	24
37	17558	99507	18051	81949	00493	82442	23
38	17641	99505	18136	81864	00495	82359	22
39	17724	99503	18221	81779	00497	82276	21
40	9.17807	9.99501	9.18306	10.81694	10.00499	10.82193	20
41	17890	99499	18391	81609	00501	82110	19
42	17973	99497	18475	81525	00503	82027	18
43	18055	99495	18560	81440	00504	81945	17
44	18137	99493	18644	81356	00506	81863	16
45	18220	99492	18728	81272	00508	81780	15
46	18302	99490	18812	81188	00510	81698	14
47	18383	99488	18896	81104	00512	81617	13
48	18465	99486	18979	81021	00514	81535	12
49	18547	99484	19063	80937	00516	81453	11
50	9.18628	9.99482	9.19146	10.80854	10.00518	10.81372	10
51	18709	99480	19229	80771	00520	81291	9
52	18790	99478	19312	80688	00522	81210	8
53	18871	99476	19395	80605	00524	81129	7
54	18952	99474	19478	80522	00526	81048	6
55	19033	99472	19561	80436	00528	80967	5
56	19113	99470	19643	80357	00530	80887	4
57	19193	99468	19725	80275	00532	80807	3
58	19273	99466	19807	80193	00534	80727	2
59	19353	99464	19889	80111	00536	80647	1
60	19433	99462	19971	80029	00538	80567	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

TABLE V. Of ARTIFICIAL Sines, Tangents, and Secants, 79 Degrees.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	9.19433	9.99462	9.19971	10.80029	10.00538	10.80567	60
1	19513	99460	20053	79947	00540	80487	59
2	19592	99458	20134	79865	00542	80408	58
3	19672	99456	20216	79784	00544	80328	57
4	19751	99454	20297	79703	00546	80249	56
5	19830	99452	20378	79621	00548	80170	55
6	19909	99450	20459	79541	00550	80091	54
7	19988	99448	20540	79460	00552	80012	53
8	20067	99446	20621	79379	00554	79933	52
9	20145	99444	20701	79299	00556	79855	51
10	9.20223	9.99442	9.20782	10.79218	10.00558	10.79777	50
11	20302	99440	20862	79138	00560	79698	49
12	20380	99438	20942	79058	00562	79620	48
13	20458	99436	21022	78978	00564	79542	47
14	20535	99434	21102	78898	00566	79465	46
15	20613	99432	21181	78818	00568	79387	45
16	20691	99429	21261	78739	00570	79309	44
17	20768	99427	21340	78659	00573	79232	43
18	20845	99425	21420	78580	00575	79155	42
19	20922	99423	21499	78501	00577	79078	41
20	9.20999	9.99421	9.21578	10.78422	10.00579	10.79001	40
21	21076	99419	21657	78343	00581	78924	39
22	21153	99417	21736	78264	00583	78847	38
23	21229	99415	21814	78186	00585	78771	37
24	21305	99413	21893	78107	00587	78694	36
25	21382	99411	21971	78029	00589	78618	35
26	21458	99409	22049	77951	00591	78542	34
27	21534	99407	22127	77873	00593	78465	33
28	21610	99404	22205	77795	00595	78390	32
29	21665	99402	22283	77717	00598	78315	31
30	9.21761	9.99400	9.22361	10.77639	10.00600	10.78239	30
31	21836	99398	22438	77562	00602	78164	29
32	21912	99396	22516	77484	00604	78088	28
33	21987	99394	22593	77407	00606	78013	27
34	22062	99392	22670	77330	00608	77938	26
35	22137	99390	22747	77253	00610	77863	25
36	22211	99388	22824	77177	00612	77788	24
37	22286	99385	22901	77099	00615	77714	23
38	22361	99383	22977	77022	00617	77639	22
39	22435	99381	23054	76946	00619	77565	21
40	9.22509	9.99379	9.23130	10.76870	10.00621	10.77491	20
41	22583	99377	23206	76793	00623	77417	19
42	22657	99375	23283	76717	00625	77343	18
43	22731	99372	23355	76641	00628	77269	17
44	22805	99370	23435	76565	00630	77195	16
45	22878	99368	23510	76490	00632	77122	15
46	22952	99366	23586	76414	00634	77048	14
47	23025	99364	23661	76339	00636	76975	13
48	23098	99362	23737	76263	00638	76902	12
49	23171	99359	23812	76188	00641	76829	11
50	9.23244	9.99357	9.23887	10.76113	10.00643	10.76756	10
51	23317	99355	23962	76038	00645	76683	9
52	23390	99353	24037	75963	00647	76610	8
53	23462	99351	24112	75888	00649	76538	7
54	23535	99348	24186	75813	00652	76465	6
55	23607	99346	24261	75739	00654	76393	5
56	23679	99344	24335	75665	00656	76321	4
57	23751	99342	24410	75590	00658	76248	3
58	23823	99340	24484	75516	00660	76177	2
59	23895	99337	24558	75442	00663	76105	1
60	23967	99335	24633	75368	00665	76033	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

80 Degrees.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	9.23967	9.99335	9.24632	10.75368	10.00665	10.76033	60
1	24039	99333	24706	75294	00667	75961	59
2	24110	99331	24779	75221	00669	75890	58
3	24181	99328	24853	75147	00672	75819	57
4	24253	99326	24926	75074	00674	75747	56
5	24324	99324	25000	75000	00676	75676	55
6	24395	99322	25073	74927	00678	75605	54
7	24466	99319	25146	74854	00680	75534	53
8	24536	99317	25219	74781	00683	75464	52
9	24607	99315	25292	74708	00685	75393	51
10	9.24677	9.99313	9.25365	10.74635	10.00687	10.75323	50
11	24748	99310	25437	74563	00690	75252	49
12	24818	99308	25510	74490	00692	75182	48
13	24888	99306	25582	74418	00694	75112	47
14	24958	99304	25655	74345	00696	75042	46
15	25028	99301	25727	74273	00699	74972	45
16	25098	99299	25799	74201	00701	74902	44
17	25168	99297	25871	74129	00703	74832	43
18	25237	99294	25943	74057	00706	74762	42
19	25307	99292	26015	73985	00708	74693	41
20	9.25376	9.99290	9.26086	10.73914	10.00710	10.74623	40
21	25445	99288	26158	73842	00712	74555	39
22	25514	99285	26229	73771	00715	74486	38
23	25583	99283	26301	73699	00717	74417	37
24	25652	99281	26372	73628	00719	74348	36
25	25721	99278	26443	73557	00722	74279	35
26	25790	99276	26514	73486	00724	74210	34
27	25858	99274	26585	73415	00726	74142	33
28	25927	99271	26655	73344	00729	74073	32
29	25995	99269	26726	73274	00731	74005	31
30	9.26063	9.99267	9.26797	10.73203	10.00733	10.73937	30
31	26131	99264	26867	73133	00736	73869	29
32	26199	99262	26937	73063	00738	73801	28
33	26267	99260	27008	72992	00741	73733	27
34	26335	99257	27078	72922	00743	73665	26
35	26403	99255	27148	72852	00745	73597	25
36	26470	99252	27218	72782	00747	73530	24
37	26538	99250	27288	72712	00750	73462	23
38	26605	99248	27357	72643	00752	73395	22
39	26672	99245	27427	72573	00755	73328	21
40	9.26739	9.99243	9.27496	10.72504	10.00757	10.73261	20
41	26806	99241	27566	72434	00759	73193	19
42	26873	99238	27635	72365	00762	73127	18
43	26940	99236	27704	72296	00764	73060	17
44	27007	99233	27773	72227	00766	72993	16
45	27073	99231	27842	72158	00769	72927	15
46	27140	99229	27911	72089	00771	72860	14
47	27206	99226	27980	72020	00774	72794	13
48	27273	99224	28049	71951	00776	72727	12
49	27339	99221	28117	71883	00779	72661	11
50	9.27405	9.99219	9.28186	10.71814	10.00781	10.72595	10
51	27471	99217	28254	71746	00783	72529	9
52	27537	99214	28323	71677	00786	72463	8
53	27602	99212	28391	71609	00788	72398	7
54	27668	99209	28459	71541	00791	72332	6
55	27734	99207	28527	71473	00793	72266	5
56	27799	99204	28595	71405	00796	72201	4
57	27864	99202	28662	71338	00798	72136	3
58	27930	99200	28730	71270	00800	72070	2
59	27995	99197	28798	71202	00803	72005	1
60	28060	99195	28865	71135	00805	72040	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	9.28060	9.99195	9.28865	10.71135	10.00805	10.71940	60
1	28125	99192	28933	71067	00808	71875	59
2	28190	99190	29000	71000	00810	71810	58
3	28254	99187	29067	70933	00813	71746	57
4	28319	99185	29134	70866	00815	71681	56
5	28384	99182	29201	70799	00818	71616	55
6	28448	99180	29268	70732	00820	71552	54
7	28512	99177	29335	70665	00823	71488	53
8	28577	99175	29402	70598	00825	71423	52
9	28641	99172	29468	70532	00828	71359	51
10	9.28705	9.99170	9.29535	10.70465	10.00830	10.71295	50
11	28769	99167	29601	70399	00833	71231	49
12	28833	99165	29668	70332	00835	71167	48
13	28896	99162	29734	70266	00838	71104	47
14	28960	99160	29800	70200	00840	71040	46
15	29024	99157	29866	70134	00843	70975	45
16	29087	99155	29932	70068	00845	70913	44
17	29150	99152	29998	70002	00848	70850	43
18	29214	99150	30064	69936	00850	70786	42
19	29277	99147	30130	69870	00853	70723	41
20	9.29340	9.99145	9.30195	10.69805	10.00855	10.70660	40
21	29403	99142	30261	69739	00858	70597	39
22	29466	99140	30326	69674	00860	70534	38
23	29529	99137	30391	69609	00863	70471	37
24	29591	99135	30457	69543	00865	70409	36
25	29654	99132	30522	69478	00868	70346	35
26	29716	99130	30587	69413	00870	70284	34
27	29779	99127	30652	69348	00873	70221	33
28	29841	99124	30717	69283	00876	70159	32
29	29903	99122	30782	69218	00878	70097	31
30	9.29966	9.99119	9.30846	10.69154	10.00881	10.70034	30
31	30028	99117	30911	69089	00883	69972	29
32	30090	99114	30975	69025	00886	69910	28
33	30151	99112	31040	68960	00888	69849	27
34	30213	99109	31104	68896	00891	69787	26
35	30275	99106	31168	68831	00894	69725	25
36	30336	99104	31233	68767	00896	69664	24
37	30398	99101	31297	68703	00899	69602	23
38	30459	99099	31361	68639	00901	69541	22
39	30521	99096	31424	68575	00904	69479	21
40	9.30582	9.99093	9.31489	10.68511	10.00907	10.69418	20
41	30643	99091	31552	68448	00909	69357	19
42	30704	99088	31616	68384	00912	69296	18
43	30765	99086	31679	68320	00914	69235	17
44	30826	99083	31743	68257	00917	69174	16
45	30887	99080	31806	68194	00920	69113	15
46	30947	99078	31870	68130	00922	69053	14
47	31008	99075	31933	68067	00925	68992	13
48	31068	99072	31996	68004	00928	68931	12
49	31129	99070	32059	67941	00930	68871	11
50	9.31189	9.99067	9.32122	10.67878	10.00933	10.68811	10
51	31249	99064	32185	67815	00936	68750	9
52	31310	99062	32248	67752	00938	68690	8
53	31370	99059	32311	67689	00941	68630	7
54	31430	99056	32373	67627	00944	68570	6
55	31490	99054	32436	67564	00946	68510	5
56	31549	99051	32498	67502	00949	68451	4
57	31609	99048	32561	67439	00952	68391	3
58	31669	99046	32623	67377	00954	68331	2
59	31728	99043	32685	67315	00957	68272	1
60	31788	99040	32747	67252	00960	68212	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	9.31788	9.99040	9.32747	10.67253	10.00960	10.68212	60
1	31847	99038	32810	67190	00962	68153	59
2	31907	99035	32872	67128	00965	68093	58
3	31966	99032	32933	67067	00968	68034	57
4	32025	99030	32995	67005	00970	67975	56
5	32084	99027	33057	66943	00973	67916	55
6	32143	99024	33119	66881	00976	67857	54
7	32202	99022	33180	66820	00978	67798	53
8	32261	99019	33242	66758	00981	67739	52
9	32319	99016	33303	66697	00984	67681	51
10	9.32378	9.99013	9.33365	10.66635	10.00987	10.67622	50
11	32437	99011	33426	66574	00989	67563	49
12	32495	99008	33487	66513	00992	67505	48
13	32553	99005	33548	66452	00995	67447	47
14	32612	99002	33609	66391	00998	67388	46
15	32670	99000	33670	66430	01000	67330	45
16	32728	98997	33731	66269	01003	67272	44
17	32786	98994	33792	66208	01006	67214	43
18	32844	98991	33853	66147	01009	67156	42
19	32902	98989	33913	66087	01011	67098	41
20	9.32960	98986	9.33974	10.66026	10.01014	10.67040	40
21	33018	98983	34034	65966	01017	66982	39
22	33075	98980	34095	65905	01020	66925	38
23	33133	98978	34155	65845	01022	66867	37
24	33190	98975	34215	65784	01025	66810	36
25	33248	98972	34276	65724	01028	66752	35
26	33305	98969	34336	65664	01031	66695	34
27	33362	98967	34396	65604	01033	66638	33
28	33420	98964	34456	65544	01036	66580	32
29	33477	98961	34516	65484	01039	66523	31
30	9.33534	9.98958	9.34576	10.65424	10.01042	10.66466	30
31	33591	98955	34635	65365	01045	66409	29
32	33647	98953	34695	65305	01047	66352	28
33	33704	98950	34755	65245	01050	66296	27
34	33761	98947	34814	65186	01053	66239	26
35	33818	98944	34874	65126	01056	66182	25
36	33874	98941	34933	65067	01059	66126	24
37	33931	98938	34992	65008	01062	66069	23
38	33987	98936	35051	64949	01064	66013	22
39	34043	98933	35111	64889	01067	65957	21
40	9.34100	9.98930	9.35170	10.64830	10.01070	10.65900	20
41	34156	98927	35229	64771	01073	65844	19
42	34212	98924	35288	64712	01076	65788	18
43	34268	98921	35346	64653	01079	65732	17
44	34324	98919	35405	64595	01081	65676	16
45	34380	98916	35464	64536	01084	65620	15
46	34435	98913	35523	64478	01087	65564	14
47	34491	98910	35581	64419	01090	65509	13
48	34547	98907	35640	64360	01093	65453	12
49	34602	98904	35698	64302	01096	65398	11
50	9.34658	9.98901	9.35757	10.64243	10.01099	10.65342	10
51	34713	98898	35815	64185	01102	65287	9
52	34769	98896	35873	64127	01104	65231	8
53	34824	98893	35931	64069	01107	65176	7
54	34879	98890	35989	64011	01110	65121	6
55	34934	98887	36047	63953	01113	65066	5
56	34989	98884	36105	63895	01116	65011	4
57	35044	98881	36163	63837	01119	64956	3
58	35099	98878	36221	63779	01122	64901	2
59	35154	98875	36279	63721	01125	64846	1
60	35209	98872	36336	63664	01128	64791	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	9.35209	9.98872	9.36336	10.63664	10.01128	10.64791	60
1	35263	98869	36394	63606	01130	64736	59
2	35318	98867	36451	63548	01133	64682	58
3	35373	98864	36509	63491	01136	64627	57
4	35427	98861	36566	63434	01139	64573	56
5	35481	98858	36624	63376	01142	64518	55
6	35536	98855	36681	63319	01145	64464	54
7	35590	98852	36738	63262	01148	64410	53
8	35644	98849	36795	63205	01151	64356	52
9	35698	98846	36852	63148	01154	64302	51
10	9.35752	9.98843	9.36909	10.63091	10.01157	10.64248	50
11	35806	98840	36966	63034	01160	64194	49
12	35860	98837	37023	62977	01163	64140	48
13	35914	98834	37088	62920	01166	64086	47
14	35968	98831	37137	62863	01169	64032	46
15	36021	98828	37193	62807	01172	63978	45
16	36075	98825	37250	62750	01175	63925	44
17	36129	98822	37306	62694	01178	63871	43
18	36182	98819	37363	62637	01181	63818	42
19	36236	98816	37419	62581	01184	63764	41
20	9.36289	9.98813	9.37476	10.62524	10.01187	10.63711	40
21	36342	98810	37532	62468	01190	63658	39
22	36395	98807	37588	62412	01193	63605	38
23	36448	98804	37644	62356	01196	63551	37
24	36502	98801	37700	62300	01199	63498	36
25	36555	98798	37756	62244	01202	63445	35
26	36607	98795	37812	62188	01205	63392	34
27	36660	98792	37868	62132	01208	63340	33
28	36713	98789	37934	62076	01211	63287	32
29	36766	98786	37980	62020	01214	63234	31
30	9.36818	9.98783	9.38035	10.61965	10.01217	10.63181	30
31	36871	98780	38091	61909	01220	63129	29
32	36924	98777	38147	61853	01223	63076	28
33	36976	98774	38202	61798	01226	63024	27
34	37028	98771	38257	61743	01229	62971	26
35	37081	98768	38313	61687	01232	62919	25
36	37133	98765	38368	61632	01235	62867	24
37	37185	98762	38423	61577	01238	62815	23
38	37237	98759	38479	61521	01241	62763	22
39	37289	98756	38534	61466	01244	62711	21
40	9.37341	9.98753	9.38589	10.61411	10.01247	10.62659	20
41	37393	98749	38644	61356	01250	62607	19
42	37445	98746	38699	61301	01254	62555	18
43	37497	98743	38754	61246	01257	62503	17
44	37549	98740	38808	61192	01260	62451	16
45	37600	98737	38863	61137	01263	62400	15
46	37652	98734	38918	61082	01266	62348	14
47	37703	98731	38972	61028	01269	62296	13
48	37755	98728	39027	60973	01272	62245	12
49	37806	98725	39081	60918	01275	62194	11
50	9.37858	9.98722	9.39135	10.60864	10.01278	10.62142	10
51	37909	98719	39190	60810	01281	62091	9
52	37960	98715	39245	60755	01285	62040	8
53	38011	98712	39299	60701	01288	61989	7
54	38062	98709	39353	60647	01291	61938	6
55	38113	98706	39407	60593	01294	61887	5
56	38164	98703	39461	60539	01297	61836	4
57	38215	98700	39515	60485	01300	61785	3
58	38266	98697	39569	60431	01303	61734	2
59	38317	98694	39623	60377	01306	61683	1
60	38368	98690	39677	60323	01310	61632	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	9.38368	9.98690	9.39677	10.60323	10.01310	10.61632	60
1	38418	98687	39731	60269	01313	61582	59
2	38469	98684	39785	60215	01316	61531	58
3	38519	98681	39838	60162	01319	61481	57
4	38570	98678	39892	60108	01322	61430	56
5	38620	98675	39945	60054	01325	61380	55
6	38670	98671	39999	60001	01329	61330	54
7	38721	98668	40052	59948	01332	61280	53
8	38771	98665	40106	59894	01335	61229	52
9	38821	98662	40159	59841	01338	61179	51
10	9.38871	9.98659	9.40212	10.59788	10.01341	10.61129	50
11	38921	98655	40266	59734	01344	61079	49
12	38971	98652	40319	59681	01348	61029	48
13	39021	98649	40372	59628	01351	60979	47
14	39071	98646	40425	59575	01354	60929	46
15	39121	98643	40478	59522	01357	60879	45
16	39170	98640	40531	59469	01360	60830	44
17	39220	98636	40584	59416	01364	60780	43
18	39270	98633	40636	59363	01367	60730	42
19	39319	98630	40689	59311	01370	60681	41
20	9.39369	9.98627	9.40742	10.59258	10.01373	10.60631	40
21	39418	98623	40795	59205	01377	60582	39
22	39467	98620	40847	59153	01380	60533	38
23	39517	98617	40900	59100	01383	60483	37
24	39566	98614	40952	59048	01386	60434	36
25	39615	98610	41004	58995	01390	60385	35
26	39664	98607	41057	58943	01393	60336	34
27	39713	98604	41109	58891	01396	60287	33
28	39762	98601	41161	58839	01399	60238	32
29	39811	98597	41214	58786	01403	60189	31
30	9.39860	9.98594	9.41266	10.58734	10.01406	10.60140	30
31	39909	98591	41318	58682	01409	60091	29
32	39957	98588	41370	58630	01412	60042	28
33	40006	98584	41422	58578	01416	59994	27
34	40055	98581	41474	58526	01419	59945	26
35	40103	98578	41526	58474	01422	59896	25
36	40152	98574	41577	58422	01426	59848	24
37	40200	98571	41629	58371	01429	59800	23
38	40249	98568	41681	58319	01432	59751	22
39	40297	98565	41733	58267	01435	59703	21
40	9.40345	9 98561	9.41784	10.58216	10.01439	10.59654	20
41	40394	98558	41836	58164	01442	59606	19
42	40442	98555	41887	58113	01445	59558	18
43	40490	98551	41939	58061	01449	59510	17
44	40538	98548	41990	58010	01452	59462	16
45	40586	98545	42041	57958	01455	59414	15
46	40634	98541	42093	57907	01459	59366	14
47	40682	98538	42144	57856	01462	59318	13
48	40730	98535	42195	57805	01465	59270	12
49	40778	98531	42246	57754	01469	59222	11
50	9.40825	9.98528	9.42297	10.57703	10.01472	10.59175	10
51	40873	98525	42348	57652	01475	59127	9
52	40921	98521	42399	57601	01479	59079	8
53	40968	98518	42450	57550	01482	59032	7
54	41016	98515	42501	57499	01485	58984	6
55	41063	98511	42552	57448	01489	58937	5
56	41111	98508	42603	57397	01492	58889	4
57	41158	98504	42653	57347	01495	58842	3
58	41205	98501	42704	57296	01499	58795	2
59	41252	98498	42755	57245	01502	58748	1
60	41300	98494	42805	57195	01506	58700	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	9.41300	9.98494	9.42805	10.57195	10.01506	10.58700	60
1	41347	98491	42856	57144	01509	58653	59
2	41394	98488	42906	57094	01512	58606	58
3	41441	98484	42957	57043	01516	58559	57
4	41488	98481	43007	56993	01519	58512	56
5	41535	98477	43057	56943	01523	58465	55
6	41582	98474	43108	56892	01526	58418	54
7	41628	98471	43158	56842	01529	58372	53
8	41675	98467	43208	56792	01533	58325	52
9	41722	98464	43258	56742	01536	58178	51
10	9.41768	9.98460	9.43308	10.56692	10.01540	10.58232	50
11	41815	98457	43358	56642	01543	58185	49
12	41861	98453	43408	56592	01547	58138	48
13	41908	98450	43458	56542	01550	58092	47
14	41954	98447	43508	56492	01553	58046	46
15	42001	98443	43558	56442	01557	57999	45
16	42047	98440	43607	56393	01560	57953	44
17	42093	98436	43657	56343	01564	57907	43
18	42139	98433	43707	56293	01567	57860	42
19	42186	98429	43756	56244	01571	57814	41
20	9.42232	9.98426	9.43806	10.56194	10.01574	10.57768	40
21	42278	98422	43855	56145	01578	57722	39
22	42324	98419	43905	56095	01581	57676	38
23	42370	98415	43954	56046	01584	57630	37
24	42416	98412	44004	55996	01588	57584	36
25	42461	98409	44053	55947	01591	57538	35
26	42507	98405	44102	55898	01595	57493	34
27	42553	98402	44151	55848	01598	57447	33
28	42599	98398	44201	55799	01602	57401	32
29	42644	98395	44250	55750	01605	57356	31
30	9.42690	9.98391	9.44299	10.55701	10.01609	10.57310	30
31	42735	98388	44348	55652	01612	57265	29
32	42781	98384	44397	55603	01616	57219	28
33	42826	98381	44446	55554	01619	57174	27
34	42872	98377	44495	55505	01623	57128	26
35	42917	98373	44544	55456	01626	57083	25
36	42962	98370	44592	55408	01630	57038	24
37	43007	98366	44641	55359	01634	56993	23
38	43053	98363	44690	55310	01637	56947	22
39	43098	98359	44738	55262	01641	56902	21
40	9.43143	9.98356	9.44787	10.55213	10.01644	10.56857	20
41	43188	98352	44836	55164	01648	56812	19
42	43233	98349	44884	55116	01651	56767	18
43	43278	98345	44933	55067	01655	56722	17
44	43323	98342	44981	55019	01658	56677	16
45	43367	98338	45029	54971	01662	56632	15
46	43412	98334	45078	54922	01666	56588	14
47	43457	98331	45126	54874	01669	56543	13
48	43502	98327	45174	54826	01673	56498	12
49	43546	98324	45222	54778	01676	56454	11
50	9.43591	9.98320	9.45271	10.54729	10.01680	10.56409	10
51	43635	98317	45319	54681	01683	56365	9
52	43680	98313	45367	54633	01687	56320	8
53	43724	98309	45415	54585	01691	56276	7
54	43769	98306	45463	54537	01694	56231	6
55	43813	98302	45511	54489	01698	56187	5
56	43857	98299	45559	54441	01701	56143	4
57	43901	98295	45606	54394	01705	56099	3
58	43946	98291	45654	54346	01709	56054	2
59	43990	98288	45702	54298	01712	56010	1
60	44034	98284	45750	54250	01716	55966	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	9.44034	9.98284	9.45750	10.54250	10.01716	10.55966	60
1	44078	98281	45797	54203	01719	55922	59
2	44122	98277	45845	54155	01723	55878	58
3	44166	98273	45892	54108	01727	55834	57
4	44210	98270	45940	54060	01730	55790	56
5	44253	98266	45987	54013	01734	55746	55
6	44297	98262	46035	53965	01738	55703	54
7	44341	98259	46082	53918	01741	55659	53
8	44385	98255	46130	53870	01745	55615	52
9	44428	98251	46177	53823	01749	55572	51
10	9.44472	9.98248	9.46224	10.53776	10.01752	10.55528	50
11	44515	98244	46271	53728	01756	55484	49
12	44559	98240	46319	53681	01760	55441	48
13	44602	98237	46366	53634	01763	55397	47
14	44646	98233	46413	53587	01767	55354	46
15	44689	98229	46460	53540	01771	55311	45
16	44733	98226	46507	53493	01774	55267	44
17	44776	98222	46554	53446	01778	55224	43
18	44819	98218	46601	53399	01782	55181	42
19	44862	98215	46648	53352	01785	55138	41
20	9.44905	9.98211	9.46694	10.53306	10.01789	10.55095	40
21	44948	98207	46741	53259	01793	55051	39
22	44991	98203	46788	53212	01796	55008	38
23	45035	98200	46835	53165	01800	54965	37
24	45077	98196	46881	53119	01804	54923	36
25	45120	98192	46928	53072	01808	54880	35
26	45163	98189	46975	53025	01811	54837	34
27	45206	98185	47021	52979	01815	54794	33
28	45249	98181	47068	52932	01819	54751	32
29	45292	98177	47114	52886	01823	54708	31
30	9.45334	9.98174	9.47160	10.52840	10.01826	10.54666	30
31	45377	98170	47207	52793	01830	54624	29
32	45419	98166	47253	52747	01834	54581	28
33	45462	98162	47299	52701	01838	54538	27
34	45504	98159	47346	52654	01841	54496	26
35	45547	98155	47392	52608	01845	54453	24
36	45589	98151	47438	52562	01849	54411	25
37	45632	98147	47484	52516	01853	54368	23
38	45674	98144	47530	52470	01856	54326	22
39	45716	98140	47576	52424	01860	54284	21
40	9.45758	9.98136	9.47622	10.52378	10.01864	10.54242	20
41	45801	98132	47668	52332	01868	53199	19
42	45843	98128	47714	52286	01871	53157	18
43	45885	98125	47760	52240	01875	53115	17
44	45927	98121	47806	52194	01879	53073	16
45	45969	98117	47852	52148	01883	53031	15
46	46011	98113	47897	52102	01887	53989	14
47	46053	98109	47943	52057	01890	53947	13
48	46095	98106	47989	52011	01894	53905	12
49	46136	98102	48034	51965	01898	53864	11
50	9.46178	9.98098	9.48080	10.51920	10.01902	10.53822	10
51	46220	98094	48126	51874	01906	53780	9
52	46262	98090	48171	51829	01910	53738	8
53	46303	98087	48217	51783	01913	53697	7
54	46345	98083	48262	51738	01917	53655	6
55	46386	98079	48307	51692	01921	53614	5
56	46428	98075	48353	51647	01925	53572	4
57	46469	98071	48398	51602	01929	53531	3
58	46511	98067	48443	51557	01933	53489	2
59	46552	98063	48489	51511	01937	53448	1
60	46594	98060	48534	51466	01940	53406	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	9.46593	9.98060	9.48534	10.51466	10.01940	10.53406	60
1	46635	98056	48579	51421	01944	53365	59
2	46676	98052	48624	51376	01948	53324	58
3	46717	98048	48669	51331	01952	53283	57
4	46758	98044	48714	51286	01956	53241	56
5	46800	98040	48759	51241	01960	53200	55
6	46841	98036	48804	51196	01964	53159	54
7	46882	98032	48849	51151	01968	53118	53
8	46923	98029	48894	51106	01971	53077	52
9	46964	98025	48939	51061	01975	53036	51
10	9.47005	9.98021	9.48984	10.51016	10.01979	10.52995	50
11	47045	98017	49029	50971	01983	52954	49
12	47086	98013	49073	50927	01987	52914	48
13	47127	98009	49118	50882	01991	52873	47
14	47168	98005	49163	50837	01995	52832	46
15	47209	98001	49207	50793	01999	52791	45
16	47249	97997	49252	50748	02003	52751	44
17	47290	97993	49296	50703	02007	52710	43
18	47330	97989	49341	50659	02010	52670	42
19	47371	97986	49385	50614	02014	52629	41
20	9.47411	9.97982	9.49430	10.50570	10.02018	10.52588	40
21	47452	97978	49474	50526	02022	52548	39
22	47492	97974	49519	50481	02026	52508	38
23	47533	97970	49563	50437	02030	52467	37
24	47573	97966	49607	50393	02034	52427	36
25	47613	97962	49651	50348	02038	52387	35
26	47654	97958	49696	50304	02042	52346	34
27	47694	97954	49740	50260	02046	52306	33
28	47734	97950	49784	50216	02050	52266	32
29	47774	97946	49828	50172	02054	52226	31
30	9.47814	9.97942	9.49872	10.50128	10.02058	10.52186	30
31	47854	97938	49916	50084	02062	52146	29
32	47894	97934	49960	50040	02066	52106	28
33	47934	97930	50004	49996	02070	52066	27
34	47974	97926	50048	49952	02074	52026	26
35	48014	97922	50092	49908	02078	51986	25
36	48054	97918	50136	49864	02082	51946	24
37	48094	97914	50180	49820	02086	51906	23
38	48133	97910	50223	49776	02090	51867	22
39	48173	97906	50267	49733	02094	51827	21
40	9.48213	9.97902	9.50311	10.49689	10.02098	10.51787	20
41	48252	97898	50355	49645	02102	51747	19
42	48292	97894	50398	49602	02106	51708	18
43	48332	97890	50442	49558	02110	51668	17
44	48371	97886	50485	49515	02114	51629	16
45	48411	97882	50529	49471	02118	51589	15
46	48450	97878	50572	49428	02122	51550	14
47	48489	97874	50616	49384	02126	51510	13
48	48529	97870	50659	49341	02130	51471	12
49	48568	97866	50703	49297	02134	51432	11
50	9.48607	9.97861	9.50746	10.49254	10.02139	10.51392	10
51	48647	97857	50789	49211	02143	51353	9
52	48686	97853	50833	49167	02147	51314	8
53	48725	97849	50876	49124	02151	51275	7
54	48764	97845	50919	49081	02155	51236	6
55	48803	97841	50962	49038	02159	51197	5
56	48842	97837	51005	48995	02163	51158	4
57	48881	97833	51048	48951	02167	51119	3
58	48920	97829	51092	48908	02171	51080	2
59	48959	97825	51135	48865	02175	51041	1
60	48998	97821	51178	48822	02179	51002	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	9.48998	9.97821	9.51178	10.48822	10.02179	10.51002	60
1	49037	97817	51221	48779	02183	50963	59
2	49076	97812	51264	48736	02188	50924	58
3	49115	97808	51306	48694	02192	50885	57
4	49153	97804	51349	48651	02196	50847	56
5	49192	97800	51392	48608	02200	50808	55
6	49231	97796	51435	48565	02204	50769	54
7	49269	97792	51478	48522	02208	50731	53
8	49308	97788	51520	48480	02212	50692	52
9	49347	97784	51563	48437	02216	50653	51
10	9.49385	9.97779	9.51606	10.48394	10.02221	10.50615	50
11	49424	97775	51648	48352	02225	50576	49
12	49462	97771	51691	48309	02229	50538	48
13	49500	97767	51734	48266	02233	50500	47
14	49539	97763	51776	48224	02237	50461	46
15	49577	97759	51819	48181	02241	50423	45
16	49615	97754	51861	48139	02246	50385	44
17	49654	97750	51903	48097	02250	50346	43
18	49692	97746	51946	48054	02254	50308	42
19	49730	97742	51988	48012	02258	50270	41
20	9.49768	9.97738	9.52031	10.47969	10.02262	10.50232	40
21	49806	97733	52073	47927	02266	50194	39
22	49844	97729	52115	47885	02271	50156	38
23	49882	97725	52157	47843	02275	50118	37
24	49920	97721	52200	47800	02279	50080	36
25	49958	97717	52242	47758	02283	50042	35
26	49996	97713	52284	47716	02287	50004	34
27	50034	97708	52326	47674	02292	49966	33
28	50072	97704	52368	47632	02296	49928	32
29	50110	97700	52410	47590	02300	49890	31
30	9.50148	9.97696	9.52452	10.47548	10.02304	10.49852	30
31	50185	97691	52494	47506	02309	49815	29
32	50223	97687	52536	47464	02313	49777	28
33	50261	97683	52578	47422	02317	49739	27
34	50298	97679	52620	47380	02321	49702	26
35	50336	97674	52661	47339	02326	49664	25
36	50373	97670	52703	47297	02330	49626	24
37	50411	97666	52745	47255	02334	49589	23
38	50448	97662	52787	47213	02338	49551	22
39	50486	97657	52829	47171	02343	49514	21
40	9.50523	9.97653	9.52870	10.47130	10.02347	10.49477	20
41	50561	97649	52912	47088	02351	49439	19
42	50598	97645	52953	47047	02355	49402	18
43	50635	97640	52995	47005	02360	49365	17
44	50673	97636	53037	46963	02364	49327	16
45	50710	97632	53078	46922	02368	49290	15
46	50747	97627	53120	46880	02372	49253	14
47	50784	97623	53161	46839	02377	49216	13
48	50821	97619	53202	46797	02381	49179	12
49	50858	97615	53244	46756	02385	49142	11
50	9.50896	9.97610	9.53285	10.46715	10.02390	10.49104	10
51	50933	97606	53327	46673	02394	49067	9
52	50970	97602	53368	46632	02398	49030	8
53	51006	97597	53409	46591	02403	48993	7
54	51043	97593	53450	46550	02407	48957	6
55	51080	97589	53492	46508	02411	48920	5
56	51117	97584	53533	46467	02416	48883	4
57	51154	97580	53574	46426	02420	48846	3
58	51191	97576	53615	46385	02424	48809	2
59	51227	97571	53656	46344	02429	48773	1
60	51264	97567	53697	46303	02433	48736	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	9.51264	9.97567	9.53697	10.46303	10.02433	10.48736	60
1	51301	97563	53738	46262	02437	48699	59
2	51337	97558	53779	46221	02442	48662	58
3	51374	97554	53820	46180	02446	48626	57
4	51411	97550	53861	46139	02450	48589	56
5	51447	97545	53902	46098	02455	48553	55
6	51484	97541	53943	46057	02459	48516	54
7	51520	97536	53984	46016	02464	48480	53
8	51557	97532	54025	45975	02468	48443	52
9	51593	97528	54065	45935	02472	48407	51
10	9.51629	9.97523	9.54106	10.45894	10.02477	10.48371	50
11	51666	97519	54147	45853	02481	48334	49
12	51702	97514	54187	45813	02485	48298	48
13	51738	97510	54228	45772	02490	48262	47
14	51774	97506	54269	45731	02494	48226	46
15	51811	97501	54309	45691	02499	48189	45
16	51847	97497	54350	45650	02503	48153	44
17	51883	97492	54390	45610	02508	48117	43
18	51919	97488	54431	45569	02512	48081	42
19	51955	97484	54471	45529	02516	48045	41
20	9.51991	9.97479	9.54512	10.45488	10.02521	10.48009	40
21	52027	97475	54552	45448	02525	47973	39
22	52063	97470	54593	45407	02530	47937	38
23	52099	97466	54633	45367	02534	47901	37
24	52135	97461	54673	45326	02539	47865	36
25	52171	97457	54714	45286	02543	47829	35
26	52207	97452	54754	45246	02547	47793	34
27	52242	97448	54794	45206	02552	47758	33
28	52278	97444	54835	45165	02556	47722	32
29	52314	97439	54875	45125	02561	47686	31
30	9.52350	9.97435	9.54915	10.45085	10.02565	10.47650	30
31	52385	97430	54955	45045	02570	47615	29
32	52421	97426	54995	45005	02574	47579	28
33	52456	97421	55035	44965	02579	47544	27
34	52492	97417	55075	44925	02583	47508	26
35	52527	97412	55115	44885	02588	47473	25
36	52563	97408	55155	44845	02592	47437	24
37	52598	97403	55195	44805	02597	47402	23
38	52634	97399	55235	44765	02601	47366	22
39	52669	97394	55275	44725	02606	47331	21
40	9.52705	9.97390	9.55315	10.44685	10.02610	10.47295	20
41	52740	97385	55355	44645	02615	47260	19
42	52775	97381	55395	44605	02619	47225	18
43	52810	97376	55434	44566	02624	47189	17
44	52846	97372	55474	44526	02628	47154	16
45	52881	97367	55514	44486	02633	47119	15
46	52916	97362	55554	44446	02637	47084	14
47	52951	97358	55593	44407	02642	47049	13
48	52986	97353	55633	44367	02647	47014	12
49	53021	97349	55673	44327	02651	46979	11
50	9.53056	9.97344	9.55712	10.44288	10.02656	10.46944	10
51	53091	97340	55752	44248	02660	46908	9
52	53126	97335	55791	44209	02665	46873	8
53	53161	97331	55831	44169	02669	46839	7
54	53196	97326	55870	44130	02674	46804	6
55	53231	97322	55910	44090	02678	46769	5
56	53266	97317	55949	44051	02683	46734	4
57	53301	97312	55989	44011	02688	46699	3
58	53336	97308	56028	43972	02692	46664	2
59	53370	97303	56067	43933	02697	46630	1
60	53405	97299	56107	43893	02701	46595	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

78.37

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	9.53405	9.97299	9.56107	10.43893	10.02701	10.46595	60
1	53440	97294	56146	43854	02706	46560	59
2	53475	97289	56185	43815	02711	46525	58
3	53509	97285	56224	43776	02715	46491	57
4	53544	97280	56264	43736	02720	46456	56
5	53578	97275	56303	43697	02724	46422	55
6	53613	97271	56342	43658	02729	46387	54
7	53647	97266	56381	43619	02734	46353	53
8	53682	97262	56420	43580	02738	46318	52
9	53716	97257	56459	43541	02743	46284	51
10	9.53751	9.97252	9.56498	10.43502	10.02748	10.46249	50
11	53785	97248	56537	43463	02752	46215	49
12	53819	97243	56576	43424	02757	46181	48
13	53854	97238	56615	43385	02762	46146	47
14	53888	97234	56654	43346	02766	46112	46
15	53922	97229	56693	43307	02771	46078	45
16	53957	97224	56732	43268	02776	46043	44
17	53991	97220	56771	43229	02780	46009	43
18	54025	97215	56810	43190	02785	45975	42
19	54059	97210	56849	43151	02789	45941	41
20	9.54093	9.97206	9.56887	10.43113	10.02794	10.45909	40
21	54127	97201	56926	43074	02799	45873	39
22	54161	97196	56965	43035	02804	45839	38
23	54195	97192	57004	42996	02808	45805	37
24	54229	97187	57042	42958	02813	45771	36
25	54263	97182	57081	42919	02818	45737	35
26	54297	97178	57120	42880	02822	45703	34
27	54331	97173	57158	42842	02827	45669	33
28	54365	97168	57197	42803	02832	45635	32
29	54399	97163	57235	42765	02837	45601	31
30	9.54432	9.97159	9.57274	10.42726	10.02841	10.45567	30
31	54466	97154	57312	42688	02846	45534	29
32	54500	97149	57351	42649	02851	45500	28
33	54534	97145	57389	42611	02855	45466	27
34	54567	97140	57428	42572	02860	45433	26
35	54601	97135	57466	42534	02865	45399	25
36	54635	97130	57504	42496	02870	45365	24
37	54668	97126	57543	42457	02874	45332	23
38	54702	97121	57581	42419	02879	45298	22
39	54735	97116	57619	42381	02884	45265	21
40	9.54769	9.97111	9.57658	10.42342	10.02889	10.45231	20
41	54802	97106	57696	42304	02893	45198	19
42	54836	97102	57734	42266	02898	45164	18
43	54869	97097	57772	42228	02903	45131	17
44	54903	97092	57810	42190	02908	45097	16
45	54936	97087	57849	42151	02913	45064	15
46	54969	97083	57887	42113	02917	45031	14
47	55003	97078	57925	42075	02922	44997	13
48	55036	97073	57963	42037	02927	44964	12
49	55069	97068	58001	41999	02932	44931	11
50	9.55102	9.97063	9.58039	10.41961	10.02937	10.44898	10
51	55136	97059	58077	41923	02941	44864	9
52	55169	97054	58115	41885	02946	44831	8
53	55202	97049	58153	41847	02951	44798	7
54	55235	97044	58191	41809	02956	44765	6
55	55268	97039	58229	41771	02961	44732	5
56	55301	97034	58267	41733	02965	44699	4
57	55334	97030	58304	41696	02970	44666	3
58	55367	97025	58342	41658	02975	44633	2
59	55400	97020	58380	41620	02980	44600	1
60	55433	97015	58418	41582	02985	44567	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	9.55433	9.97015	9.58418	10.41582	10.02985	10.44567	60
1	55466	97010	58455	41545	02990	44534	59
2	55499	97005	58493	41507	02995	44501	58
3	55531	97001	58531	41469	02999	44468	57
4	55564	96996	58569	41431	03004	44436	56
5	55597	96991	58606	41394	03009	44403	55
6	55630	96986	58644	41356	03014	44370	54
7	55663	96981	58681	41319	03019	44337	53
8	55695	96976	58719	41281	03024	44305	52
9	55728	96971	58757	41243	03029	44272	51
10	9.55761	9.96966	9.58794	10.41206	10.03034	10.44239	50
11	55793	96962	58832	41168	03038	44207	49
12	55826	96957	58869	41131	03043	44174	48
13	55858	96952	58907	41093	03048	44142	47
14	55891	96947	58944	41056	03053	44109	46
15	55923	96942	58981	41019	03058	44077	45
16	55956	96937	59019	40981	03063	44044	44
17	55988	96932	59056	40944	03068	44012	43
18	56021	96927	59094	40906	03073	43979	42
19	56053	96922	59131	40869	03078	43947	41
20	9.56085	9.96917	9.59168	10.40832	10.03083	10.43914	40
21	56118	96912	59205	40795	03088	43882	39
22	56150	96907	59243	40757	03093	43850	38
23	56182	96903	59280	40720	03097	43818	37
24	56215	96898	59317	40683	03102	43785	36
25	56247	96893	59354	40646	03107	43753	35
26	56279	96888	59391	40609	03112	43721	34
27	56311	96883	59429	40571	03117	43689	33
28	56343	96878	59466	40534	03122	43657	32
29	56375	96873	59503	40497	03127	43625	31
30	9.56408	9.96868	9.59540	10.40460	10.03132	10.43592	30
31	56440	96863	59577	40423	03137	43560	29
32	56472	96858	59614	40386	03142	43528	28
33	56504	96853	59651	40349	03147	43496	27
34	56536	96848	59688	40312	03152	43464	26
35	56568	96843	59725	40275	03157	43432	25
36	56599	96838	59762	40238	03162	43400	24
37	56631	96833	59799	40201	03167	43369	23
38	56663	96828	59835	40165	03172	43337	22
39	56695	96823	59872	40128	03177	43305	21
40	9.56727	9.96818	9.59909	10.40091	10.03182	10.43273	20
41	56759	96813	59946	40054	03187	43241	19
42	56790	96808	59983	40017	03192	43210	18
43	56822	96803	60019	39981	03197	43178	17
44	56854	96798	60056	39944	03202	43146	16
45	56886	96793	60093	39907	03207	43114	15
46	56917	96788	60130	39870	03212	43083	14
47	56949	96783	60166	39834	03217	43051	13
48	56980	96778	60203	39797	03222	43020	12
49	57012	96772	60240	39760	03228	42988	11
50	9.57044	9.96767	9.60276	10.39724	10.03232	10.42956	10
51	57075	96762	60313	39687	03238	42925	9
52	57107	96757	60349	39651	03243	42893	8
53	57138	96752	60386	39614	03248	42862	7
54	57169	96747	60422	39578	03253	42830	6
55	57201	96742	60459	39541	03258	42790	5
56	57232	96737	60495	39505	03263	42768	4
57	57264	96732	60532	39468	03268	42736	3
58	57295	96727	60568	39432	03273	42705	2
59	57326	96722	60605	39395	03278	42674	1
60	57357	96717	60641	39359	03283	42642	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	
0	9.57358	9.96717	9.60641	10.39359	10.03283	10.42642	60
1	57389	96711	60677	39323	03289	42611	59
2	57420	96706	60714	39286	03294	42580	58
3	57451	96701	60750	39250	03299	42549	57
4	57482	96696	60786	39214	03304	42518	56
5	57514	96691	60823	39177	03309	42486	55
6	57545	96686	60859	39141	03314	42455	54
7	57576	96681	60895	39105	03319	42424	53
8	57607	96676	60931	39069	03324	42393	52
9	57638	96670	60967	39033	03330	42362	51
10	9.57669	9.96665	9.61004	10.38996	10.03335	10.42331	50
11	57700	96660	61040	38960	03340	42300	49
12	57731	96655	61076	38924	03345	42269	48
13	57762	96650	61112	38888	03350	42238	47
14	57793	96645	61148	38852	03355	42207	46
15	57824	96640	61184	38816	03360	42176	45
16	57854	96634	61220	38780	03366	42145	44
17	57885	96629	61256	38744	03371	42115	43
18	57916	96624	61292	38708	03376	42084	42
19	57947	96619	61328	38672	03381	42053	41
20	9.57978	9.96614	9.61367	10.38636	10.03386	10.42022	40
21	58008	96608	61400	38600	03392	41992	39
22	58039	96603	61436	38564	03397	41961	38
23	58070	96598	61472	38528	03402	41930	37
24	58100	96593	61508	38492	03407	41899	36
25	58131	96588	61544	38456	03412	41869	35
26	58162	96582	61579	38421	03418	41838	34
27	58192	96577	61615	38385	03423	41808	33
28	58223	96572	61651	38349	03428	41777	32
29	58253	96567	61687	38313	03433	41747	31
30	9.58284	9.96562	9.61722	10.38287	10.03438	10.41716	30
31	58314	96556	61758	38242	03444	41686	29
32	58345	96551	61794	38206	03449	41655	28
33	58375	96546	61830	38170	03454	41625	27
34	58406	96541	61865	38135	03459	41594	26
35	58436	96535	61901	38099	03465	41564	25
36	58467	96530	61936	38063	03470	41533	24
37	58497	96525	61972	38028	03475	41503	23
38	58527	96520	62008	37992	03480	41473	22
39	58557	96514	62043	37957	03486	41443	21
40	9.58588	9.96509	9.62079	10.37921	10.03491	10.41412	20
41	58618	96504	62114	37886	03496	41382	19
42	58648	96498	62150	37850	03502	41352	18
43	58678	96493	62185	37815	03507	41322	17
44	58708	96488	62221	37779	03512	41291	16
45	58739	96483	62256	37744	03517	41261	15
46	58769	96477	62291	37708	03523	41231	14
47	58799	96472	62327	37673	03528	41201	13
48	58829	96467	62362	37638	03533	41171	12
49	58859	96461	62398	37602	03539	41141	11
50	9.58889	9.96456	9.62433	10.37567	10.03544	10.41111	10
51	58919	96451	62468	37532	03549	41081	9
52	58949	96445	62504	37496	03555	41051	8
53	58979	96440	62539	37461	03560	41021	7
54	58009	96435	62574	37426	03565	40991	6
55	58039	96429	62609	37391	03571	40961	5
56	58069	96424	62645	37355	03576	40931	4
57	58098	96419	62680	37320	03581	40902	3
58	58128	96413	62715	37285	03587	40872	2
59	58158	96408	62750	37250	03592	40842	1
60	58188	96403	62785	37215	03597	40812	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	9.59188	9.96403	9.62785	10.37215	10.03597	40812	60
1	59217	96397	62820	37180	03603	40782	59
2	59247	96392	62855	37145	03608	40753	58
3	59277	96386	62890	37110	03613	40723	57
4	59307	96381	62926	37074	03619	40693	56
5	59336	96376	62961	37039	03624	40664	55
6	59366	96370	62996	37004	03630	40634	54
7	59396	96364	63031	36969	03635	40604	53
8	59425	96360	63066	36934	03640	40575	52
9	59455	96354	63101	36899	03646	40545	51
10	9.59484	9.96349	9.63135	10.36865	10.03651	10.40516	50
11	59514	96343	63170	36830	03657	40486	49
12	59543	96338	63205	36795	03662	40457	48
13	59573	96333	63240	36760	03667	40427	47
14	59602	96327	63275	36725	03673	40398	46
15	59632	96322	63310	36690	03678	40368	45
16	59661	96316	63345	36655	03684	40339	44
17	59690	96311	63379	36620	03689	40310	43
18	59720	96305	63414	36586	03695	40280	42
19	59749	96300	63449	36551	03700	40251	41
20	9.59778	9.96294	9.63484	10.36516	10.03706	10.40222	40
21	59808	96289	63519	36481	03711	40192	39
22	59837	96284	63553	36447	03716	40163	38
23	59866	96278	63588	36412	03722	40134	37
24	59895	96273	63623	36377	03727	40105	36
25	59924	96267	63657	36343	03733	40076	35
26	59954	96262	63692	36308	03738	40046	34
27	59983	96256	63726	36274	03744	40017	33
28	60012	96251	63761	36239	03749	39988	32
29	60041	96245	63796	36204	03755	39959	31
30	9.60070	9.96240	9.63830	10.36170	10.03760	10.39930	30
31	60099	96234	63865	36135	03766	39901	29
32	60128	96229	63899	36101	03771	39872	28
33	60157	96223	63934	36066	03777	39843	27
34	60186	96218	63968	36032	03782	39814	26
35	60215	96212	64003	35997	03788	39785	25
36	60244	96207	64037	35963	03793	39756	24
37	60273	96201	64072	35928	03798	39727	23
38	60302	96196	64106	35894	03804	39698	22
39	60331	96190	64140	35860	03810	39667	21
40	9.60359	9.96185	9.64175	10.35825	10.03815	10.39641	20
41	60388	96179	64209	35791	03821	39612	19
42	60417	96174	64243	35757	03826	39583	18
43	60446	96168	64278	35722	03832	39554	17
44	60474	96162	64312	35688	03838	39525	16
45	60503	96157	64346	35654	03843	39497	15
46	60532	96151	64381	35619	03849	39468	14
47	60561	96146	64415	35585	03855	39439	13
48	60589	96140	64449	35551	03860	39411	12
49	60618	96135	64483	35517	03866	39382	11
50	9.60646	9.96129	9.64517	10.35483	10.03871	10.39353	10
51	60675	96123	64552	35448	03877	39325	9
52	60704	96118	64586	35414	03882	39296	8
53	60732	96112	64620	35380	03888	39268	7
54	60761	96107	64654	35346	03893	39239	6
55	60789	96101	64688	35312	03899	39211	5
56	60818	96095	64722	35278	03905	39182	4
57	60846	96090	64756	35244	03910	39154	3
58	60874	96084	64790	35210	03916	39125	2
59	60903	96079	64824	35176	03921	39097	1
60	60931	96073	64858	35142	03927	39060	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	9.60931	9.96073	9.64858	10.35142	10.03927	10.39069	60
1	60960	96067	64892	35108	03933	39040	59
2	60988	96062	64926	35074	03938	39012	58
3	61016	96056	64960	35040	03944	38984	57
4	61045	96050	64994	35006	03950	38955	56
5	61073	96045	65028	34972	03955	38927	55
6	61101	96039	65062	34938	03961	38899	54
7	61129	96034	65096	34904	03966	38871	53
8	61158	96028	65130	34870	03972	38842	52
9	61186	96022	65164	34836	03978	38814	51
10	9.61214	9.96017	9.65197	10.34803	10.03983	10.38786	50
11	61242	96011	65231	34769	03989	38758	49
12	61270	96005	65265	34735	03995	38730	48
13	61298	95999	65299	34701	04000	38702	47
14	61326	95994	65333	34667	04006	38674	46
15	61354	95988	65366	34634	04012	38646	45
16	61382	95982	65400	34600	04018	38618	44
17	61411	95977	65434	34566	04023	38589	43
18	61438	95971	65467	34533	04029	38561	42
19	61466	95965	65501	34499	04035	38534	41
20	9.61494	9.95960	9.65535	10.34465	10.04040	10.38506	40
21	61522	95954	65568	34432	04046	38478	39
22	61550	95948	65602	34398	04052	38450	38
23	61578	95942	65636	34364	04058	38422	37
24	61606	95937	65669	34331	04063	38394	36
25	61634	95931	65703	34297	04069	38366	35
26	61662	95925	65736	34264	04075	38338	34
27	61689	95920	65770	34230	04080	38311	33
28	61717	95914	65803	34197	04086	38283	32
29	61745	95908	65837	34163	04092	38255	31
30	9.61773	9.95902	9.65870	10.34130	10.04098	10.38227	30
31	61800	95896	65904	34096	04103	38200	29
32	61828	95891	65937	34063	04109	38172	28
33	61856	95885	65971	34029	04115	38144	27
34	61883	95879	66004	33996	04121	38117	26
35	61911	95873	66038	33962	04127	38089	25
36	61939	95868	66071	33929	04132	38061	24
37	61966	95862	66104	33896	04138	38034	23
38	61994	95856	66138	33862	04144	38006	22
39	62021	95850	66171	33829	04150	37979	21
40	9.62049	9.95844	9.66204	10.33796	10.04156	10.37951	20
41	62076	95839	66238	33762	04161	37924	19
42	62104	95833	66271	33729	04167	37896	18
43	62131	95827	66304	33696	04173	37869	17
44	62159	95821	66337	33663	04179	37841	16
45	62186	95815	66371	33629	04185	37814	15
46	62214	95810	66404	33596	04190	37786	14
47	62241	95804	66437	33563	04196	37759	13
48	62268	95798	66470	33530	04202	37732	12
49	62296	95792	66503	33497	04208	37704	11
50	9.62323	9.95786	9.66537	10.33463	10.04214	10.37677	10
51	62350	95780	66570	33430	04220	37650	9
52	62377	95775	66603	33397	04225	37623	8
53	62405	95769	66636	33364	04231	37595	7
54	62432	95763	66669	33331	04237	37568	6
55	62459	95757	66702	33298	04243	37541	5
56	62486	95751	66735	33265	04249	37514	4
57	62513	95745	66768	33232	04255	37487	3
58	62541	95739	66801	33199	04261	37459	2
59	62568	95733	66834	33166	04267	37432	1
60	62595	95728	66867	33133	04272	37405	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	9.62595	9.95728	9.66867	10.33133	10.04272	10.37405	60
1	62622	95722	66900	33100	04278	37378	59
2	62649	95716	66933	33067	04284	37351	58
3	62676	95710	66966	33034	04290	37324	57
4	62703	95704	66999	33001	04296	37297	56
5	62730	95698	67032	32968	04302	37270	55
6	62757	95692	67065	32935	04308	37243	54
7	62784	95686	67098	32902	04314	37216	53
8	62811	95680	67131	32869	04320	37189	52
9	62838	95674	67163	32837	04326	37161	51
10	9.62865	9.95668	9.67196	10.32804	10.04332	10.37135	50
11	62892	95662	67229	32771	04337	37108	49
12	62918	95657	67262	32738	04343	37082	48
13	62945	95651	67295	32705	04349	37055	47
14	62972	95645	67327	32673	04355	37028	46
15	62999	95639	67360	32640	04361	37001	45
16	63026	95633	67393	32607	04367	36974	44
17	63052	95627	67426	32574	04373	36948	43
18	63079	95621	67458	32542	04379	36921	42
19	63106	95615	67491	32505	04385	36894	41
20	9.63133	9.95609	9.67524	10.32476	10.04391	10.36867	40
21	63159	95603	67556	32444	04397	36841	39
22	63186	95597	67589	32411	04403	36814	38
23	63212	95591	67622	32378	04409	36787	37
24	63239	95585	67654	32346	04415	36761	36
25	63266	95579	67687	32313	04421	36734	35
26	63292	95573	67719	32281	04427	36708	34
27	63319	95567	67752	32248	04433	36681	33
28	63345	95561	67785	32215	04439	36655	32
29	63372	95555	67817	32183	04445	36628	31
30	9.63398	9.95549	9.67850	10.32150	10.04451	10.36602	30
31	63425	95543	67882	32118	04457	36575	29
32	63451	95537	67915	32085	04463	36549	28
33	63478	95531	67947	32053	04469	36522	27
34	63504	95525	67980	32020	04475	36496	26
35	63531	95519	68012	31988	04481	36469	25
36	63557	95513	68044	31956	04487	36443	24
37	63583	95507	68077	31923	04493	36417	23
38	63610	95500	68109	31891	04500	36390	22
39	63636	95494	68142	31858	04506	36364	21
40	9.63662	9.95488	9.68174	10.31826	10.04512	10.36338	20
41	63689	95482	68206	31794	04518	36311	19
42	63715	95476	68239	31761	04524	36285	18
43	63741	95470	68271	31729	04530	36259	17
44	63767	95464	68303	31697	04536	36233	16
45	63793	95458	68336	31664	04542	36206	15
46	63820	95452	68368	31632	04548	36180	14
47	63846	95446	68400	31600	04554	36154	13
48	63872	95440	68432	31568	04560	36128	12
49	63898	95434	68465	31535	04566	36102	11
50	9.63924	9.95427	9.68497	10.31503	10.04573	10.36076	10
51	63950	95421	68529	31471	04579	36050	9
52	63976	95415	68561	31439	04585	36024	8
53	64002	95409	68593	31407	04591	35998	7
54	64028	95403	68626	31374	04597	35972	6
55	64054	95397	68658	31342	04603	35946	5
56	64080	95391	68690	31210	04609	35920	4
57	64106	95384	68722	31278	04616	35894	3
58	64132	95378	68754	31246	04622	35868	2
59	64158	95372	68786	31214	04628	35842	1
60	64184	95366	68818	31182	04634	35816	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	9.64184	9.95366	9.68818	10.31182	10.04634	10.35816	60
1	64210	95360	68850	31150	04640	35790	59
2	64236	95354	68882	31118	04646	35764	58
3	64262	95348	68914	31086	04652	35738	57
4	64288	95341	68946	31054	04659	35712	56
5	64313	95335	68978	31022	04665	35687	55
6	64339	95329	69010	30990	04671	35661	54
7	64361	95323	69042	30958	04677	35635	53
8	64395	95317	69074	30926	04683	35609	52
9	64417	95310	69106	30894	04690	35583	51
10	9.64442	9.95304	9.69138	10.30862	10.04696	10.35558	50
11	64468	95298	69170	30830	04702	35532	49
12	64494	95292	69202	30798	04708	35506	48
13	64519	95286	69234	30766	04714	35481	47
14	64545	95279	69266	30734	04721	35455	46
15	64571	95273	69298	30702	04727	35429	45
16	64596	95267	69329	30671	04733	35404	44
17	64622	95261	69361	30639	04739	35378	43
18	64647	95254	69393	30607	04746	35353	42
19	64673	95248	69425	30575	04752	35327	41
20	9.64698	9.95242	9.69457	10.30543	10.04758	10.35302	40
21	64724	95236	69488	30512	04764	35276	39
22	64749	95229	69520	30480	04771	35251	38
23	64775	95223	69552	30448	04777	35225	37
24	64800	95217	69584	30416	04783	35200	36
25	64826	95211	69615	30385	04789	35174	35
26	64851	95204	69647	30353	04796	35149	34
27	64877	95198	69679	30321	04802	35123	33
28	64902	95192	69710	30290	04808	35098	32
29	64927	95185	69742	30258	04815	35073	31
30	9.64953	9.95179	9.69774	10.30226	10.04821	10.35047	30
31	64978	95173	69805	30195	04827	35022	29
32	65003	95167	69837	30163	04833	34997	28
33	65029	95160	69868	30132	04840	34971	27
34	65054	95154	69900	30100	04846	34946	26
35	65079	95148	69932	30068	04852	34921	25
36	65104	95141	69963	30037	04859	34896	24
37	65130	95135	69995	30005	04865	34870	23
38	65155	95129	70026	29974	04871	34845	22
39	65180	95122	70058	29942	04878	34820	21
40	9.65205	9.95116	9.70089	10.29911	10.04884	10.34795	20
41	65230	95110	70121	29879	04890	34770	19
42	65255	95103	70152	29848	04897	34745	18
43	65281	95097	70184	29816	04903	34719	17
44	65306	95090	70215	29785	04910	34694	16
45	65331	95084	70247	29753	04916	34669	15
46	65356	95078	70278	29722	04922	34644	14
47	65381	95071	70309	29691	04929	34619	13
48	65406	95065	70341	29659	04935	34594	12
49	65431	95059	70372	29628	04941	34569	11
50	9.65456	9.95052	9.70404	10.29596	10.04948	10.34544	10
51	65481	95046	70435	29565	04954	34519	9
52	65506	95039	70466	29534	04961	34494	8
53	65531	95033	70498	29502	04967	34469	7
54	65556	95027	70529	29471	04973	34444	6
55	65580	95020	70560	29440	04980	34420	5
56	65605	95014	70592	29408	04986	34395	4
57	65630	95007	70623	29377	04993	34370	3
58	65655	95001	70654	29346	04999	34345	2
59	65680	94994	70685	29315	05005	34320	1
60	65705	94988	70717	29280	05012	34295	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	9.65705	9.94988	9.70717	10.29283	10.05012	10.34295	60
1	65729	94982	70748	29252	05018	34271	59
2	65754	94975	70779	29221	05025	34246	58
3	65779	94969	70810	29190	05031	34221	57
4	65804	94962	70841	29159	05038	34196	56
5	65828	94956	70873	29127	05044	34172	55
6	65853	94949	70904	29096	05051	34147	54
7	65878	94943	70935	29065	05057	34122	53
8	65902	94936	70966	29034	05064	34098	52
9	65927	94930	70997	29003	05070	34073	51
10	9.65952	9.94923	9.71028	10.28972	10.05077	10.34048	50
11	65976	94917	71059	28941	05083	34024	49
12	66001	94910	71090	28910	05089	33999	48
13	66025	94904	71121	28879	05096	33975	47
14	66050	94898	71153	28847	05102	33950	46
15	66075	94891	71184	28816	05109	33925	45
16	66099	94884	71215	28785	05115	33901	44
17	66124	94878	71246	28754	05122	33876	43
18	66148	94871	71277	28723	05129	33852	42
19	66173	94865	71308	28692	05135	33827	41
20	9.66197	9.94858	9.71339	10.28661	10.05142	10.33803	40
21	66221	94852	71370	28630	05148	33779	39
22	66246	94845	71401	28599	05155	33754	38
23	66270	94839	71431	28568	05161	33730	37
24	66295	94832	71462	28538	05168	33705	36
25	66319	94826	71493	28507	05174	33681	35
26	66343	94819	71524	28476	05181	33657	34
27	66368	94813	71555	28445	05187	33632	33
28	66392	94806	71586	28414	05194	33608	32
29	66416	94799	71617	28383	05201	33584	31
30	9.66441	9.94793	9.71648	10.28352	10.05207	10.33559	30
31	66465	94786	71679	28321	05214	33535	29
32	66489	94780	71709	28291	05220	33511	28
33	66513	94773	71740	28260	05227	33487	27
34	66537	94767	71771	28229	05233	33463	26
35	66562	94760	71802	28198	05240	33438	24
36	66586	94753	71833	28167	05247	33414	25
37	66610	94747	71863	28137	05253	33390	23
38	66634	94740	71894	28106	05260	33366	22
39	66658	94734	71925	28075	05266	33342	21
40	9.66682	9.94727	9.71955	10.28045	10.05273	10.33318	20
41	66706	94720	71986	28014	05280	33293	19
42	66731	94714	72017	27983	05286	33269	18
43	66755	94707	72048	27952	05293	33245	17
44	66779	94700	72078	27922	05300	33221	16
45	66803	94694	72109	27891	05306	33197	15
46	66827	94687	72140	27860	05313	33173	14
47	66851	94680	72170	27830	05320	33149	13
48	66875	94674	72201	27799	05326	33125	12
49	66899	94667	72231	27769	05333	33101	11
50	9.66922	9.94660	9.72262	10.27738	10.05340	10.33078	10
51	66946	94654	72293	27707	05346	33054	9
52	66970	94647	72323	27678	05353	33030	8
53	66994	94640	72354	27646	05360	33006	7
54	67018	94634	72384	27616	05366	32982	6
55	67042	94627	72415	27585	05373	32958	5
56	67066	94620	72445	27555	05380	32934	4
57	67090	94614	72476	27524	05386	32910	3
58	67113	94607	72506	27493	05393	32887	2
59	67137	94600	72537	27463	05400	32863	1
60	67161	94593	72567	27433	05407	32839	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	9.67161	9.94593	9.72567	10.27433	10.05407	10.32839	60
1	67185	94587	72598	27402	05413	32815	59
2	67208	94580	72628	27372	05420	32792	58
3	67232	94573	72659	27341	05427	32768	57
4	67256	94567	72689	27311	05433	32744	56
5	67280	94560	72720	27280	05440	32720	55
6	67303	94553	72750	27259	05447	32697	54
7	67327	94546	72780	27220	05454	32673	53
8	67350	94540	72811	27189	05460	32650	52
9	67374	94533	72841	27159	05467	32625	51
10	9.67398	9.94526	9.72872	10.27128	10.05474	10.32602	50
11	67421	94519	72902	27098	05481	32579	49
12	67445	94513	72932	27068	05487	32555	48
13	67468	94506	72963	27037	05494	32532	47
14	67492	94499	72993	27007	05501	32508	46
15	67515	94492	73023	26977	05508	32485	45
16	67539	94485	73054	26946	05515	32461	44
17	67562	94479	73084	26916	05521	32438	43
18	67586	94472	73114	26886	05528	32414	42
19	67609	94465	73144	26856	05535	32391	41
20	9.67633	9.94458	9.73175	10.26825	10.05542	10.32367	40
21	67656	94451	73205	26795	05549	32344	39
22	67680	94445	73235	26765	05555	32320	38
23	67703	94438	73265	26735	05562	32297	37
24	67726	94431	73295	26705	05569	32274	36
25	67750	94424	73326	26674	05576	32250	35
26	67773	94417	73356	26644	05583	32227	34
27	67796	94410	73386	26614	05590	32204	33
28	67820	94404	73416	26584	05596	32180	32
29	67843	94397	73446	26554	05603	32157	31
30	9.67866	9.94390	9.73476	10.26524	10.05610	10.32134	30
31	67890	94383	73507	26493	05617	32110	29
32	67913	94376	73537	26463	05624	32087	28
33	67936	94369	73567	26433	05631	32064	27
34	67959	94362	73597	26403	05638	32041	26
35	67982	94355	73627	26373	05645	32018	25
36	68006	94349	73657	26343	05651	31994	24
37	68029	94342	73687	26313	05658	31971	23
38	68052	94335	73717	26283	05665	31948	22
39	68075	94328	73747	26253	05672	31925	21
40	9.68098	9.94321	9.73777	10.26223	10.05679	10.31902	20
41	68121	94314	73807	26193	05686	31879	19
42	68144	94307	73837	26163	05693	31856	18
43	68167	94300	73867	26133	05700	31833	17
44	68190	94293	73897	26103	05707	31810	16
45	68213	94286	73927	26073	05714	31787	15
46	68237	94279	73957	26043	05721	31763	14
47	68260	94273	73987	26013	05727	31740	13
48	68282	94266	74017	25983	05734	31718	12
49	68305	94259	74047	25953	05741	31695	11
50	9.68328	9.94252	9.74077	10.25923	10.05748	10.31672	10
51	68351	94245	74107	25893	05755	31649	9
52	68374	94238	74137	25863	05762	31626	8
53	68397	94231	74166	25833	05769	21603	7
54	68420	94224	74196	25803	05776	31580	6
55	68443	94217	74226	25774	05783	31557	5
56	68466	94210	74256	25744	05790	31534	4
57	68489	94203	74286	25714	05797	31511	3
58	68511	94196	74316	25684	05804	31488	2
59	68534	94189	74345	25655	05811	31466	1
60	68557	94182	74375	25625	05818	31443	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	9.68557	9.94182	9.74375	10.25625	10.05818	10.31443	60
1	68580	94175	74405	25595	05825	31420	59
2	68603	94168	74435	25565	05832	31397	58
3	68625	94161	74465	25535	05839	31375	57
4	68648	94154	74495	25506	05846	31352	56
5	68671	94147	74524	25476	05853	31329	55
6	68694	94140	74554	25446	05860	31306	54
7	68716	94133	74583	25417	05867	31284	53
8	68739	94126	74613	25387	05874	31261	52
9	68762	94119	74643	25357	05881	31238	51
10	9.68784	9.94112	9.74673	10.25327	10.05888	10.31216	50
11	68807	94105	74702	25298	05895	31193	49
12	68829	94098	74732	25268	05902	31170	48
13	68852	94090	74762	25238	05910	31148	47
14	68875	94083	74791	25209	05917	31125	46
15	68897	94076	74821	25179	05924	31103	45
16	68920	94069	74851	25149	05931	31080	44
17	68942	94062	74880	25120	05938	31058	43
18	68965	94055	74910	25090	05945	31035	42
19	68987	94048	74939	25061	05952	31013	41
20	9.69010	9.94041	9.74969	10.25031	10.05959	10.30990	40
21	69032	94034	74998	25002	05966	30968	39
22	69055	94027	75028	24972	05973	30945	38
23	69077	94020	75058	24942	05980	30923	37
24	69100	94012	75087	24913	05988	30900	36
25	69122	94005	75117	24883	05995	30878	35
26	69144	93998	75146	24854	06002	30856	34
27	69167	93991	75176	24824	06009	30833	33
28	69189	93984	75205	24795	06016	30811	32
29	69212	93977	75235	24765	06023	30788	31
30	9.69234	9.93970	9.75264	10.24736	10.06030	10.30766	30
31	69256	93963	75294	24706	06037	30744	29
32	69279	93955	75323	24677	06045	30721	28
33	69301	93948	75353	24647	06052	30699	27
34	69323	93941	75382	24618	06059	30677	26
35	69345	93934	75411	24588	06066	30655	25
36	69368	93927	75441	24559	06073	30632	24
37	69390	93919	75470	24530	06080	30610	23
38	69412	93912	75500	24500	06088	30588	22
39	69434	93905	75529	24471	06095	30566	21
40	9.69456	9.93898	9.75558	10.24441	10.06102	10.30544	20
41	69479	93891	75588	24412	06109	30521	19
42	69501	93884	75617	24383	06116	30499	18
43	69523	93876	75647	24353	06124	30477	17
44	69545	93869	75676	24324	06131	30455	16
45	69567	93862	75705	24295	06138	30433	15
46	69589	93855	75735	24265	06145	30411	14
47	69611	93847	75764	24236	06153	30389	13
48	69633	93840	75793	24207	06160	30367	12
49	69655	93833	75822	24178	06167	30345	11
50	9.69677	9.93826	9.75852	10.24148	10.06174	10.30323	10
51	69699	93819	75881	24119	06181	30301	9
52	69721	93811	75910	24090	06189	30279	8
53	69743	93804	75939	24060	06196	30256	7
54	69765	93797	75969	24031	06203	30235	6
55	69787	93789	75998	24002	06210	30213	5
56	69809	93782	76027	23973	06218	30191	4
57	69831	93775	76056	23944	06225	30169	3
58	69853	93768	76086	23914	06232	30147	2
59	69875	93760	76115	23885	06240	30125	1
60	69897	93753	76144	23856	06247	30103	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	9.69897	9.93753	9.76144	10.23856	10.06247	10.30103	60
1	69919	93746	76173	23827	06254	30081	59
2	69941	93738	76202	23798	06261	30059	58
3	69963	93731	76231	23769	06269	30037	57
4	69984	93724	76261	23739	06276	30016	56
5	70006	93717	76290	23710	06283	29994	55
6	70028	93709	76319	23681	06291	29972	54
7	70050	93702	76348	23652	06298	29950	53
8	70072	93695	76377	23623	06305	29928	52
9	70093	93687	76406	23594	06313	29907	51
10	9.70115	9.93680	9.76435	10.23565	10.06520	10.29885	50
11	70137	93673	76464	23536	06327	29864	49
12	70159	93665	76493	23507	06335	29841	48
13	70180	93658	76522	23478	06342	29820	47
14	70202	93650	76551	23449	06350	29798	46
15	70224	93643	76580	23420	06357	29776	45
16	70245	93636	76609	23391	06364	29755	44
17	70267	93628	76639	23361	06372	29733	43
18	70288	93621	76668	23332	06379	29712	42
19	70310	93614	76697	23303	06386	29690	41
20	9.70332	9.93606	9.76725	10.23274	10.06394	10.29668	40
21	70353	93599	76754	23246	06401	29647	39
22	70375	93591	76783	23217	06409	29625	38
23	70396	93584	76812	23188	06416	29604	37
24	70418	93577	76841	23159	06423	29582	36
25	70439	93569	76870	23130	06431	29561	35
26	70461	93562	76899	23101	06438	29539	34
27	70482	93554	76928	23072	06446	29518	33
28	70504	93547	76957	23043	06453	29496	32
29	70525	93539	76986	23014	06461	29475	31
30	9.70547	9.93532	9.77015	10.22985	10.06468	10.29453	30
31	70568	93525	77044	22956	06475	29432	29
32	70590	93517	77073	22927	06483	29410	28
33	70611	93510	77101	22899	06490	29389	27
34	70633	93502	77130	22870	06498	29367	26
35	70654	93495	77159	22841	06505	29346	25
36	70675	93487	77188	22812	06513	29325	24
37	70697	93480	77217	22783	06520	29303	23
38	70718	93472	77246	22754	06528	29282	22
39	70739	93465	77274	22726	06535	29261	21
40	9.70761	9.93457	9.77303	10.22697	10.06543	10.29239	20
41	70782	93450	77332	22668	06550	29218	19
42	70803	93442	77361	22639	06558	29197	18
43	70824	93435	77390	22610	06565	29175	17
44	70846	93427	77418	22582	06573	29154	16
45	70867	93420	77447	22553	06580	29133	15
46	70888	93412	77476	22524	06588	29112	14
47	70909	93405	77505	22495	06595	29091	13
48	70931	93397	77533	22467	06603	29069	12
49	70952	93390	77562	22438	06610	29048	11
50	9.70973	9.93382	9.77591	10.22409	10.06618	10.29027	10
51	70994	93375	77619	22381	06625	29006	9
52	71015	93367	77648	22352	06633	28985	8
53	71036	93360	77677	22323	06640	28964	7
54	71058	93352	77705	22294	06648	28942	6
55	71079	93344	77734	22266	06656	28921	5
56	71100	93337	77763	22237	06663	28900	4
57	71121	93329	77791	22208	06671	28879	3
58	71142	93322	77820	22180	06678	28858	2
59	71163	93314	77849	22151	06686	28837	1
60	71184	93307	77877	22123	06693	28816	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	9.71184	9.93307	9.77877	10.22123	10.06693	10.28816	60
1	71205	93299	77906	22094	06701	28795	59
2	71226	93291	77935	22065	06709	28774	58
3	71247	93284	77963	22037	06716	28753	57
4	71268	93276	77992	22008	06724	28732	56
5	71289	93269	78021	21980	06731	28711	55
6	71310	93261	78049	21951	06739	28690	54
7	71331	93253	78077	21923	06747	28669	53
8	71352	93246	78106	21894	06754	28648	52
9	71373	93238	78135	21865	06762	28627	51
10	9.71393	9.93230	9.78163	10.21837	10.06770	10.28607	50
11	71414	93223	78192	21808	06777	28586	49
12	71435	93215	78220	21780	06785	28565	48
13	71456	93207	78249	21751	06792	28544	47
14	71477	93200	78277	21723	06800	28523	46
15	71498	93192	78306	21694	06808	28502	45
16	71519	93184	78334	21666	06816	28481	44
17	71539	93177	78363	21637	06823	28461	43
18	71560	93169	78391	21609	06831	28440	42
19	71581	93161	78419	21580	06839	28419	41
20	9.71602	9.93154	9.78448	10.21552	10.06846	10.28398	40
21	71622	93146	78476	21524	06854	28378	39
22	71643	93138	78505	21495	06862	28357	38
23	71664	93131	78533	21467	06869	28336	37
24	71685	93123	78562	21438	06877	28315	36
25	71705	93115	78590	21410	06885	28295	35
26	71726	93107	78618	21382	06893	28274	34
27	71747	93100	78647	21353	06900	28253	33
28	71767	93092	78675	21325	06908	28233	32
29	71788	93084	78704	21296	06916	28212	31
30	9.71809	9.93077	9.78732	10.21268	10.06923	10.28191	30
31	71829	93069	78760	21240	06931	28171	29
32	71850	93061	78789	21211	06939	28150	28
33	71870	93053	78817	21183	06947	28130	27
34	71891	93046	78845	21155	06954	28109	26
35	71911	93038	78874	21126	06962	28089	25
36	71932	93030	78902	21098	06970	28068	24
37	71952	93022	78930	21070	06978	28048	23
38	71973	93014	78959	21041	06985	28027	22
39	71993	93007	78987	21013	06993	28007	21
40	9.72014	9.92999	9.79015	10.20985	10.07001	10.27986	20
41	72034	92991	79043	20957	07009	27965	19
42	72055	92983	79072	20928	07017	27945	18
43	72075	92975	79100	20900	07024	27925	17
44	72096	92968	79128	20872	07032	27904	16
45	72116	92960	79156	20844	07040	27884	15
46	72137	92952	79185	20815	07048	27863	14
47	72157	92944	79213	20787	07056	27843	13
48	72177	92936	79241	20759	07064	27823	12
49	72198	92929	79269	20731	07071	27802	11
50	9.72218	9.92921	9.79297	10.20703	10.07079	10.27782	10
51	72238	92913	79326	20674	07087	27761	9
52	72259	92905	79354	20646	07095	27741	8
53	72279	92897	79382	20618	07103	27721	7
54	72299	92889	79410	20590	07111	27701	6
55	72320	92881	79438	20562	07119	27680	5
56	72340	92874	79466	20534	07126	27660	4
57	72360	92866	79495	20505	07134	27640	3
58	72381	92858	79523	20477	07142	27619	2
59	72401	92850	79551	20449	07150	27599	1
60	72421	92842	79579	20421	07158	27579	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	9.72421	9.92842	9.79579	10.20421	10.07158	10.27579	60
1	72441	92834	79607	20393	07166	27559	59
2	72461	92826	79635	20365	07174	27539	58
3	72482	92818	79663	20337	07182	27518	57
4	72502	92810	79691	20309	07190	27498	56
5	72522	92803	79719	20281	07197	27478	55
6	72542	92795	79747	20253	07205	27458	54
7	72562	92787	79776	20224	07213	27438	53
8	72582	92779	79804	20196	07221	27418	52
9	72602	92771	79832	20168	07229	27398	51
10	9.72622	9.92763	9.79860	10.20140	10.07237	10.27378	50
11	72643	92755	79888	20112	07245	27357	49
12	72663	92747	79916	20084	07253	27337	48
13	72683	92739	79944	20056	07261	27317	47
14	72703	92731	79972	20028	07269	27297	46
15	72723	92723	80000	20000	07277	27277	45
16	72743	92715	80028	19972	07285	27257	44
17	72763	92707	80056	19944	07293	27237	43
18	72783	92699	80084	19916	07301	27217	42
19	72803	92691	80112	19888	07309	27197	41
20	9.72823	9.92683	9.80140	10.19860	10.07317	10.27177	40
21	72843	92675	80168	19832	07325	27157	39
22	72863	92667	80195	19805	07333	27137	38
23	72883	92659	80223	19778	07341	27117	37
24	72902	92651	80251	19749	07349	27098	36
25	72922	92643	80279	19721	07357	27078	35
26	72942	92635	80307	19693	07365	27058	34
27	72962	92627	80335	19665	07373	27038	33
28	72982	92619	80363	19637	07381	27018	32
29	73002	92611	80391	19609	07389	26998	31
30	9.73022	9.92603	9.80419	10.19581	10.07397	10.26978	30
31	73041	92595	80447	19553	07405	26959	29
32	73061	92587	80474	19526	07413	26939	28
33	73081	92579	80502	19498	07421	26919	27
34	73101	92571	80530	19470	07429	26899	26
35	73121	92563	80558	19442	07437	26879	25
36	73140	92556	80585	19414	07445	26860	24
37	73160	92546	80614	19386	07454	26840	23
38	73180	92538	80642	19358	07462	26820	22
39	73200	92530	80669	19331	07470	26800	21
40	9.73219	9.92522	9.80697	10.19303	10.07478	10.26781	20
41	73239	92514	80725	19275	07486	26761	19
42	73259	92506	80753	19247	07494	26741	18
43	73278	92498	80781	19219	07502	26722	17
44	73298	92490	80808	19192	07510	26702	16
45	73318	92482	80836	19164	07518	26682	15
46	73337	92473	80864	19136	07527	26663	14
47	73357	92465	80892	19108	07535	26643	13
48	73377	92457	80919	19081	07543	26623	12
49	73396	92449	80947	19053	07551	26604	11
50	9.73416	9.92441	9.80975	10.19025	10.07559	10.26584	10
51	73435	92433	81003	18997	07567	26565	9
52	73455	92425	81030	18970	07575	26545	8
53	73474	92416	81058	18942	07584	26526	7
54	73494	92408	81086	18914	07592	26506	6
55	73513	92400	81113	18887	07600	26487	5
56	73533	92392	81141	18859	07608	26467	4
57	73552	92384	81169	18831	07616	26448	3
58	73572	92376	81196	18804	07624	26428	2
59	73591	92367	81224	18776	07633	26409	1
60	73611	92359	81252	18748	07641	26389	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	9.73611	9.92359	9 81252	10.18748	10.07641	10.26389	60
1	73630	92351	81279	18721	07649	26370	59
2	73650	92343	81307	18693	07657	26350	58
3	73669	92334	81335	18665	07666	26331	57
4	73689	92326	81362	18638	07674	26311	56
5	73708	92318	81390	18610	07682	26292	55
6	73727	92310	81417	18582	07690	26273	54
7	73747	92302	81445	18555	07698	26253	53
8	73766	92293	81473	18527	07707	26234	52
9	73785	92285	81500	18500	07715	26215	51
10	9.73805	9.92277	9.81528	10.18472	10.07723	10.26195	50
11	73824	92269	81556	18444	07731	26176	49
12	73843	92260	81583	18417	07740	26157	48
13	73863	92252	81611	18389	07748	26137	47
14	73882	92244	81638	18362	07756	26118	46
15	73901	92235	81666	18334	07765	26099	45
16	73921	92227	81693	18307	07773	26079	44
17	73940	92219	81721	18279	07781	26060	43
18	73959	92211	81748	18252	07789	26041	42
19	73978	92202	81776	18224	07798	26022	41
20	9.73997	9.92194	9.81803	10.18197	10.07806	10.26002	40
21	74017	92186	81831	18169	07814	25983	39
22	74036	92177	81858	18142	07823	25964	38
23	74055	92169	81886	18114	07831	25945	37
24	74074	92161	81913	18087	07839	25926	36
25	74093	92152	81941	18059	07848	25907	35
26	74112	92144	81968	18032	07856	25887	34
27	74132	92136	81996	18004	07864	25868	33
28	74151	92127	82023	17977	07873	25849	32
29	74170	92119	82051	17949	07881	25830	31
30	9.74189	9.92111	9.82078	10.17922	10.07889	10.25811	30
31	74208	92102	82106	17894	07898	25792	29
32	74227	92094	82133	17867	07906	25773	28
33	74246	92086	82161	17839	07914	25754	27
34	74265	92077	82188	17812	07923	25735	26
35	74284	92069	82215	17784	07931	25716	25
36	74303	92060	82243	17757	07940	25697	24
37	74322	92052	82270	17730	07948	25678	23
38	74341	92044	82298	17702	07956	25659	22
39	74360	92035	82325	17675	07965	25640	21
40	9.74379	9.92027	9.82352	10.17648	10.07973	10.25621	20
41	74398	92018	82380	17620	07982	25602	19
42	74417	92010	82407	17593	07990	25583	18
43	74436	92002	82434	17565	07998	25564	17
44	74455	91993	82462	17538	08007	25545	16
45	74474	91985	82489	17511	08015	25526	15
46	74493	91976	82517	17483	08024	25507	14
47	74512	91968	82544	17456	08032	25488	13
48	74531	91959	82571	17429	08041	25469	12
49	74549	91951	82599	17401	08049	25451	11
50	9.74568	9.91942	9.82626	10.17374	10.08058	10.25432	10
51	74587	91934	82653	17347	08066	25413	9
52	74606	91925	82681	17319	08075	25394	8
53	74625	91917	82708	17292	08083	25375	7
54	74644	91908	82735	17265	08092	25356	6
55	74662	91900	82762	17238	08100	25338	5
56	74681	91891	82790	17210	08109	25319	4
57	74700	91883	82817	17183	08117	25300	3
58	74719	91874	82844	17156	08126	25281	2
59	74737	91866	82871	17129	08134	25263	1
60	74756	91857	82899	17101	08143	25244	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
1	9.74756	9.91857	9.82899	10.17101	10.08143	10.25244	60
0	74775	91849	82926	17074	08151	25225	59
2	74794	91840	82953	17047	08160	25206	58
3	74812	91832	82980	17020	08168	25188	57
4	74831	91823	83008	16992	08177	25169	56
5	74850	91815	83035	16965	08185	25150	55
6	74868	91806	83062	16938	08194	25132	54
7	74887	91798	83089	16911	08202	25113	53
8	74906	91789	83116	16883	08211	25094	52
9	74924	91780	83144	16856	08219	25076	51
10	9.74943	9.91772	9.83171	10.16829	10.08228	10.25057	50
11	74961	91763	83198	16802	08237	25039	49
12	74980	91755	83225	16775	08245	25020	48
13	74999	91746	83252	16748	08254	25001	47
14	75017	91738	83279	16720	08262	24983	46
15	75036	91729	83307	16693	08271	24964	45
16	75054	91720	83334	16666	08280	24946	44
17	75073	91712	83361	16639	08288	24927	43
18	75091	91703	83388	16612	08297	24909	42
19	75110	91694	83415	16585	08305	24890	41
20	9.75128	9 91686	9.83442	10.16558	10.08314	10.24872	40
21	75147	91677	83470	16530	08323	24853	39
22	75165	91668	83497	16503	08331	24835	38
23	75184	91660	83524	16476	08340	24816	37
24	75202	91651	83551	18449	08349	24798	36
25	75221	91643	83578	16422	08357	24779	35
26	75239	91634	83605	16395	08366	24761	34
27	75258	91625	83632	16368	08375	24742	33
28	75276	91617	83659	16341	08383	24724	32
29	75294	91608	83686	16314	08392	24706	31
30	9.75313	9.91599	9.83713	10.16287	10.08401	10.24687	30
31	75331	91591	83740	16260	08409	24669	29
32	75349	91582	83767	16232	08418	24650	28
33	75368	91573	83795	16205	08427	24632	27
34	75386	91565	83822	16178	08435	24614	26
35	75405	91556	83849	16151	08444	24595	24
36	75423	91547	83876	16124	08453	24577	25
37	75441	91538	83903	16097	08462	24559	23
38	75459	91530	83930	16070	08470	24541	22
39	75478	91521	83957	16043	08479	24522	21
40	9.75496	9.91512	9.83984	10.16016	10.08488	10.24504	20
41	75514	91503	84011	15989	08496	24486	19
42	75533	91495	84038	15962	08505	24467	18
43	75551	91486	84065	15935	08514	24449	17
44	75569	91477	84092	15908	08523	24431	16
45	75587	91468	84119	15881	08531	24413	15
46	75605	91460	84146	15854	08540	24395	14
47	75624	91451	84173	15827	08549	24376	13
48	75642	91442	84200	15800	08558	24358	12
49	75660	91433	84227	15773	08567	24340	11
50	9.75678	9.91425	9.84254	10.15746	10.08575	10.24322	10
51	75696	91416	84280	15720	08584	24304	9
52	75714	91407	84307	15693	08593	24286	8
53	75732	91398	84334	15666	08602	24267	7
54	75751	91389	84361	15639	08611	24249	6
55	75769	91381	84388	15612	08619	24231	5
56	75787	91372	84415	15585	08628	24213	4
57	75805	91363	84442	15558	08637	24195	3
58	75823	91354	84469	15531	08646	24177	2
59	75841	91345	84496	15504	08655	24159	1
60	75859	91336	84523	15477	08664	24141	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	

Table V. Of Artificial Sines, Tangents, and Secants.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	9.75859	9.91336	9.84523	10.15477	10.08664	10.24141	60
1	75877	91328	84550	15450	08672	24123	59
2	75895	91319	84576	15424	08681	24105	58
3	75913	91310	84603	15397	08690	24087	57
4	75931	91301	84630	15370	08699	24069	56
5	75949	91292	84657	15343	08708	24051	55
6	75967	91283	84684	15316	08717	24033	54
7	75985	91274	84711	15289	08726	24015	53
8	76003	91267	84738	15262	08734	23997	52
9	76021	91257	84764	15236	08743	23979	51
10	9.76039	9.91248	9.84791	10.15209	10.08752	10.23961	50
11	76057	91239	84818	15182	08761	23943	49
12	76075	91230	84845	15155	08770	23925	48
13	76093	91221	84872	15128	08779	23907	47
14	76111	91212	84899	15101	08788	23889	46
15	76129	91203	84925	15075	08797	23871	45
16	76146	91194	84952	15048	08806	23854	44
17	76164	91185	84979	15021	08815	23836	43
18	76182	91176	85006	14994	08824	23818	42
19	76200	91167	85033	14967	08833	23800	41
20	9.76218	9.91158	9.85059	10.14941	10.08842	10.23782	40
21	76236	91149	85086	14914	08851	23764	39
22	76253	91141	85113	14887	08859	23747	38
23	76271	91132	85140	14860	08868	23729	37
24	76289	91123	85166	14834	08877	23711	36
25	76307	91114	85193	14807	08886	23693	35
26	76324	91105	85220	14780	08895	23676	34
27	76342	91096	85247	14753	08904	23658	33
28	76360	91087	85273	14727	08913	23640	32
29	76378	91078	85300	14700	08922	23622	31
30	9.76395	9.91069	9.85327	10.14673	10.08931	10.23605	30
31	76413	91090	85354	14646	08940	23587	29
32	76431	91051	85380	14620	08949	23569	28
33	76448	91042	85407	14593	08958	23552	27
34	76466	91034	85434	14566	08966	23534	26
35	76484	91023	85460	14540	08977	23516	25
36	76501	91014	85487	14513	08987	23499	24
37	76519	91005	85514	14486	08995	23481	23
38	76537	90996	85540	14460	09004	23463	22
39	76554	90987	85567	14433	09013	23446	21
40	9.76572	9.90978	9.85594	10.14406	10.09022	10.23428	20
41	76590	90969	85620	14380	09031	23410	19
42	76607	90960	85647	14353	09040	23393	18
43	76625	90951	85674	14326	09049	23375	17
44	76642	90942	85700	14300	09058	23358	16
45	76660	90933	85727	14273	09067	23340	15
46	76677	90924	85754	14246	09076	23323	14
47	76695	90915	85780	14220	09085	23305	13
48	76712	90905	85807	14193	09095	23288	12
49	76730	90896	85834	14166	09104	23270	11
50	9.76747	9.90887	9.85860	10.14140	10.09113	10.23253	10
51	76765	90878	85887	14113	09122	23235	9
52	76782	90869	85913	14087	09131	23218	8
53	76800	90860	85940	14060	09140	23200	7
54	76817	90851	85967	14033	09149	23183	6
55	76835	90842	85993	14007	09158	23165	5
56	76852	90832	86020	13980	09168	23148	4
57	76870	90823	86046	13954	09177	23130	3
58	76887	90814	86073	13927	09186	23113	2
59	76904	90805	86100	13900	09195	23096	1
60	76922	90796	86126	13874	09204	23078	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co secant.	Secant	M.

	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	76922	9.90796	9.86126	10.13874	10.09204	10.23078	60
1	76939	90787	86153	13847	09213	23061	59
2	76957	90777	86179	13821	09223	23043	58
3	76974	90768	86206	13794	09232	23026	57
4	76992	90759	86232	13768	09241	23009	56
5	77009	90750	86259	13741	09250	22991	55
6	77026	90741	86285	13715	09259	22974	54
7	77043	90731	86312	13688	09269	22957	53
8	77061	90722	86338	13662	09278	22939	52
9	77078	90713	86365	13635	09287	22922	51
10	9.77095	9.90704	9.86392	10.13608	10.09296	10.22905	50
11	77112	90694	86418	13582	09306	22888	49
12	77130	90685	86445	13555	09315	22870	48
13	77147	90676	86471	13529	09324	22853	47
14	77164	90667	86498	13502	09333	22836	46
15	77181	90657	86524	13476	09343	22819	45
16	77199	90648	86551	13449	09352	22801	44
17	77216	90639	86577	13423	09361	22784	43
18	77233	90630	86603	13397	09370	22767	42
19	77250	90620	86630	13370	09380	22750	41
20	9.77268	9.90611	9.86655	10.13344	10.09389	10.22732	40
21	77285	90602	86683	13317	09398	22715	39
22	77302	90592	86709	13291	09408	22698	38
23	77319	90583	86736	13264	09417	22681	37
24	77336	90574	86762	13238	09426	22664	36
25	77353	90565	86789	13211	09435	22647	35
26	77370	90555	86815	13185	09445	22630	34
27	77387	90546	86842	13158	09454	22613	33
28	77405	90537	86868	13132	09463	22595	32
29	77422	90527	86894	13106	09473	22578	31
30	9.77439	9.90518	9.86921	10.13079	10.09482	10.22561	30
31	77456	90509	86947	13053	09491	22544	29
32	77473	90499	86974	13026	09501	22527	28
33	77490	90490	87000	13000	09510	22510	27
34	77507	90480	87027	12973	09520	22493	26
35	77524	90471	87053	12947	09529	22476	25
36	77541	90462	87079	12921	09538	22459	24
37	77558	90453	87106	12894	09548	22442	23
38	77575	90443	87132	12868	09557	22425	22
39	77592	90434	87158	12842	09566	22408	21
40	9.77609	9.90424	9.87185	10.12815	10.09576	10.22391	20
41	77626	90415	87211	12789	09585	22374	19
42	77643	90405	87238	12762	09595	22357	18
43	77660	90396	87264	12736	09604	22340	17
44	77677	90386	87290	12710	09613	22324	16
45	77694	90377	87317	12683	09623	22306	15
46	77711	90368	87343	12657	09632	22289	14
47	77727	90358	87369	12631	09642	22272	13
48	77744	90349	87396	12604	09651	22256	12
49	77761	90339	87422	12578	09661	22239	11
50	9.77778	9.90330	9.87448	10.12552	10.09670	10.22222	10
51	77795	90320	87475	12525	09680	22205	9
52	77812	90311	87501	12499	09689	22188	8
53	77829	90301	87527	12473	09699	22171	7
54	77846	90292	87554	12446	09708	22154	6
55	77862	90282	87580	12420	09718	22138	5
56	77879	90273	87606	12394	09727	22121	4
57	77896	90263	87633	12367	09737	22104	3
58	77913	90254	87659	12341	09746	22087	2
59	77930	90244	87685	12315	09756	22070	1
60	77946	90235	87711	12289	09765	22054	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M	Sine.	Co-sine.	Tangen	Co-tang.	Secant.	Co-secant.	
0	9.77946	9.90235	9.87711	10.12289	10.09765	10.22054	60
1	77963	90225	87738	12262	09775	22037	59
2	77980	90216	87764	12236	09784	22020	58
3	77997	90206	87790	12210	09794	22003	57
4	78013	90197	87817	12183	09803	21987	56
5	78030	90187	87843	12157	09813	21970	55
6	78047	90178	87869	12131	09822	21953	54
7	78063	90168	87895	12105	09832	21937	53
8	78080	90159	87922	12078	09841	21920	52
9	78097	90149	87948	12052	09851	21903	51
10	9.78113	9.90139	9.87974	10.12026	10.09861	10.21887	50
11	78130	90130	88000	12000	09870	21870	49
12	78147	90120	88027	11973	09880	21853	48
13	78163	90111	88053	11947	09889	21837	47
14	78180	90101	88079	11921	09899	21820	46
15	78197	90091	88105	11895	09909	21803	45
16	78213	90082	88131	11869	09918	21787	44
17	78230	90072	88158	11842	09928	21770	43
18	78246	90063	88184	11816	09937	21754	42
19	78263	90053	88210	11790	09947	21737	41
20	9.78280	9.90043	9.88236	10.11764	10.09957	10.21720	40
21	78296	90034	88262	11738	09966	21704	39
22	78313	90024	88289	11711	09976	21687	38
23	78329	90014	88315	11685	09986	21671	37
24	78346	90005	88341	11659	09995	21654	36
25	78362	89995	88367	11633	10005	21638	35
26	78379	89985	88393	11607	10015	21621	34
27	78395	89976	88420	11580	10024	21605	33
28	78412	89966	88446	11554	10034	21588	32
29	78428	89956	88472	11528	10044	21572	31
30	9.78445	9.89947	9.88498	10.11501	10.10053	10.21555	30
31	78461	89937	88524	11476	10063	21539	29
32	78478	89927	88550	11450	10073	21522	28
33	78494	89917	88576	11424	10082	21506	27
34	78510	89908	88603	11397	10092	21490	26
35	78527	89898	88629	11371	10102	21473	25
36	78543	89888	88655	11345	10112	21457	24
37	78560	89879	88681	11319	10121	21440	23
38	78576	89869	88707	11293	10131	21424	22
39	78592	89859	88733	11267	10141	21408	21
40	9.78609	9.89849	9.88759	10.11241	10.10151	10.21391	20
41	78625	89840	88786	11214	10160	21375	19
42	78642	89830	88812	11188	10170	21358	18
43	78658	89820	88838	11162	10180	21342	17
44	78674	89810	88864	11136	10190	21326	16
45	78691	89801	88890	11110	10199	21309	15
46	78707	89791	88916	11084	10209	21293	14
47	78723	89781	88942	11058	10219	21277	13
48	78739	89771	88968	11032	10229	21261	12
49	78756	89761	88994	11006	10239	21244	11
50	9.78772	9.89752	9.89020	10.10980	10.10248	10.21228	10
51	78788	89742	89046	10954	10258	21212	9
52	78805	89732	89073	10927	10268	21195	8
53	78821	89722	89099	10901	10278	21179	7
54	78837	89712	89125	10875	10288	21163	6
55	78853	89702	89151	10849	10298	21147	5
56	78869	89693	89177	10823	10307	21131	4
57	78886	89683	89203	10797	10317	21114	3
58	78902	89673	89229	10771	10327	21098	2
59	78918	89663	89255	10745	10337	21082	1
60	78934	89653	89281	10719	10347	21066	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	9.78934	9.89653	9.89281	10.10719	10.10347	10.21066	60
1	78950	89643	89307	10693	10357	21050	59
2	78967	89633	89333	10667	10367	21033	58
3	78983	89624	89359	10641	10376	21017	57
4	78999	89614	89385	10615	10386	21001	56
5	79015	89604	89411	10589	10396	20985	55
6	79031	89594	89437	10563	10406	20969	54
7	79047	89584	89463	10537	10416	20953	53
8	79063	89574	89489	10511	10426	20937	52
9	79079	89564	89515	10485	10436	20921	51
10	9.79095	9.89554	9.89571	10.10459	10.10446	10.20905	50
11	79111	89544	89567	10433	10456	20889	49
12	79128	89534	89593	10407	10466	20872	48
13	79144	89524	89619	10381	10476	20856	47
14	79160	89514	89645	10355	10486	20840	46
15	79176	89504	89671	10329	10496	20824	45
16	79192	89495	89697	10303	10505	20808	44
17	79208	89485	89723	10277	10515	20792	43
18	79224	89475	89749	10251	10525	20776	42
19	79240	89465	89775	10225	10535	20760	41
20	9.79256	9.89455	9.89801	10.10199	10.10545	10.20744	40
21	79272	89445	89827	10173	10555	20728	39
22	79288	89435	89853	10147	10565	20712	38
23	79304	89425	89879	10121	10575	20696	37
24	79319	89415	89905	10095	10585	20681	36
25	79335	89405	89931	10069	10595	20665	35
26	79351	89395	89957	10043	10605	20649	34
27	79367	89385	89983	10017	10615	20633	33
28	79383	89375	90009	09991	10625	20617	32
29	79399	89365	90035	09965	10636	20601	31
30	9.79415	9.89354	9.90060	10.09939	10.10646	10.20585	30
31	79431	89344	90086	09914	10656	20569	29
32	79447	89334	90112	09888	10666	20553	28
33	79463	89324	90138	09862	10676	20537	27
34	79478	89314	90164	09836	10686	20522	26
35	79494	89304	90190	09810	10696	20506	25
36	79510	89294	90216	09784	10706	20490	24
37	79526	89284	90242	09758	10716	20474	23
38	79542	89274	90268	09732	10726	20458	22
39	79558	89264	90294	09706	10736	20442	21
40	9.79573	9.89254	9.90320	10.09680	10.10746	10.20427	20
41	79589	89244	90346	09654	10756	20411	19
42	79605	89233	90371	09629	10767	20395	18
43	79621	89223	90397	09603	10777	20379	17
44	79636	89213	90423	09577	10787	20364	16
45	79652	89203	90449	09551	10797	20348	15
46	79668	89193	90475	09525	10807	20332	14
47	79684	89183	90501	09499	10817	20316	13
48	79699	89173	90527	09473	10827	20301	12
49	79715	89162	90553	09447	10838	20285	11
50	9.79731	9.89152	9.90578	10.09422	10.10848	10.20269	10
51	79746	89142	90604	09396	10858	20254	9
52	79762	89132	90630	09370	10868	20238	8
53	79778	89122	90656	09344	10878	20222	7
54	79793	89112	90682	09318	10888	20207	6
55	79809	89101	90708	09292	10899	20191	5
56	79825	89091	90734	09266	10909	20175	4
57	79840	89081	90759	09241	10919	20160	3
58	79856	89071	90785	09215	10929	20144	2
59	79872	89060	90811	09189	10940	20128	1
60	79887	89050	90837	09163	10950	20113	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Tangent.	Co-secant.	
0	9.79887	9.89050	9.90837	10.09163	10.10950	10.20113	
1	79903	89040	90863	09137	10960	20097	59
2	79918	89030	90889	09111	10970	20082	58
3	79934	89020	90914	09086	10980	20066	57
4	79950	89009	90940	09060	10991	20050	56
5	79965	88999	90966	09034	11001	20035	55
6	79982	88989	90992	09008	11011	20019	54
7	79996	88978	91018	08982	11022	20004	53
8	80012	88968	91043	08957	11032	19988	52
9	80027	88958	91069	08931	11042	19973	51
10	9.80043	9.88948	9.91095	10.08905	10.11052	10.19957	50
11	80058	88937	91121	08879	11063	19942	49
12	80074	88927	91147	08853	11073	19926	48
13	80089	88917	91172	08828	11083	19911	47
14	80105	88906	91198	08802	11094	19895	46
15	80120	88896	91224	08776	11104	19880	45
16	80136	88886	91250	08750	11114	19864	44
17	80151	88875	91276	08724	11125	19849	43
18	80166	88865	91301	08699	11135	19834	42
19	80182	88855	91327	08673	11145	19818	41
20	9.80197	9.88844	9.91353	10.08647	10.11156	10.19803	40
21	80213	88834	91379	08621	11166	19787	39
22	80228	88824	91404	08596	11176	19772	38
23	80244	88813	91430	08570	11187	19756	37
24	80259	88803	91456	08544	11197	19741	36
25	80274	88793	91482	08518	11207	19726	35
26	80290	88782	91507	08493	11218	19710	34
27	80305	88772	91533	08467	11228	19695	33
28	80320	88761	91559	08441	11239	19680	32
29	80336	88751	91585	08415	11249	19664	1
30	9.80351	9.88741	9.91610	10.08390	10.11259	10.19649	30
31	80366	88730	91636	08364	11270	19634	29
32	80382	88720	91662	08338	11280	19618	28
33	80397	88709	91688	08312	11291	19603	27
34	80412	88699	91713	08287	11301	19588	26
35	80428	88688	91739	08261	11312	19572	25
36	80443	88678	91765	08235	11322	19557	24
37	80458	88668	91791	08209	11332	19542	23
38	80473	88657	91816	08184	11343	19527	22
39	80489	88647	91842	08158	11353	19511	21
40	9.80504	9.88636	9.91868	10.08132	10.11364	10.19496	20
41	80519	88626	91893	08107	11374	19482	19
42	80534	88615	91919	08081	11385	19465	18
43	80550	88605	91945	08055	11395	19450	17
44	80565	88594	91971	08029	11406	19435	16
45	80580	88584	91996	08004	11416	19420	15
46	80595	88573	92022	07978	11427	19405	14
47	80610	88563	92048	07952	11437	19390	13
48	80625	88552	92073	07927	11448	19375	12
49	80641	88542	92099	07901	11458	19359	11
50	9.80656	9 88531	9.92125	10.07875	10.11469	10.19344	10
51	80671	88521	92150	07850	11479	19329	9
52	80686	88510	92176	07824	11490	19314	8
53	80701	88499	92202	07798	11501	19299	7
54	80716	88489	92227	07773	11511	19284	6
55	80731	88478	92253	07747	11522	19269	5
56	80746	88468	92279	07721	11532	19254	4
57	80762	88457	92304	07696	11543	19238	3
58	80777	88447	92330	07670	11553	19223	2
59	80792	88436	92356	07644	11564	19208	1
60	80807	88425	92381	07619	11575	19193	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	9.80807	9.88425	9.92381	10.07619	10.11575	10.19193	60
1	80822	88415	92407	07593	11585	19178	59
2	80837	88404	92433	07567	11596	19163	58
3	80852	88394	92458	07542	11606	19148	57
4	80867	88383	92484	07516	11617	19133	56
5	80882	88372	92510	07490	11628	19118	55
6	80897	88362	92535	07465	11638	19103	54
7	80912	88351	92561	07439	11649	19088	53
8	80927	88340	92587	07413	11660	19073	52
9	80942	88330	92612	07388	11670	19058	51
10	9.80957	9.88319	9.92638	10.07362	10.11681	10.19043	50
11	80972	88308	92663	07337	11692	19028	49
12	80987	88298	92689	07311	11702	19013	48
13	81002	88287	92715	07285	11713	18998	47
14	81017	88276	92740	07260	11724	18983	46
15	81032	88266	92766	07234	11734	18968	45
16	81046	88255	92792	07208	11745	18954	44
17	81061	88244	92817	07183	11756	18939	43
18	81076	88234	92843	07157	11766	18924	42
19	81091	88223	92868	07132	11777	18909	41
20	9.81106	9.88212	9.92894	10.07106	10.11788	10.18894	40
21	81121	88201	92920	07080	11799	18879	39
22	81136	88191	92945	07055	11809	18864	38
23	81151	88180	92971	07029	11820	18849	37
24	81166	88169	92996	07004	11831	18834	36
25	81180	88158	93022	06978	11842	18820	35
26	81195	88148	93048	06952	11852	18805	34
27	81210	88137	93073	06927	11863	18790	33
28	81225	88126	93099	06901	11874	18775	32
29	81240	88115	93124	06876	11885	18760	31
30	9.81254	9.88105	9.93150	10.06850	10.11895	10.18746	30
31	81269	88094	93175	06825	11906	18731	29
32	81284	88083	93201	06799	11917	18716	28
33	81299	88072	93227	06773	11928	18701	27
34	81314	88061	93252	06748	11939	18686	26
35	81328	88050	93278	06722	11949	18672	25
36	81343	88040	93303	06697	11960	18657	24
37	81358	88029	93329	06671	11971	18642	23
38	81372	88018	93354	06646	11982	18628	22
39	81387	88007	93380	06620	11993	18613	21
40	9.81402	9.87996	9.93406	10.06594	10.12004	10.18598	20
41	81417	87985	93431	06569	12015	18583	19
42	81431	87975	93457	06543	12025	18569	18
43	81446	87964	93482	06518	12036	18554	17
44	81461	87953	93508	06492	12047	18539	16
45	81475	87942	93533	06467	12058	18525	15
46	81490	87931	93559	06441	12069	18510	14
47	81505	87920	93584	06416	12080	18495	13
48	81519	87909	93610	06390	12091	18481	12
49	81534	87898	93635	06364	12102	18466	11
50	9.81549	9.87887	9.93661	10.06339	10.12113	10.18451	10
51	81563	87877	93687	06313	12123	18437	9
52	81578	87866	93712	06288	12134	18422	8
53	81592	87855	93738	06262	12145	18408	7
54	81607	87844	93763	06237	12156	18393	6
55	81622	87833	93789	06211	12167	18378	5
56	81636	87822	93814	06186	12178	18364	4
57	81651	87811	93840	06160	12189	18349	3
58	81665	87800	93865	06135	12200	18335	2
59	81680	87789	93891	06109	12211	18320	1
60	81694	88778	93916	06084	12222	18306	0
	Co sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	9.81694	9.87778	9.93916	10.06084	10.12222	10.18306	60
1	81709	87767	93942	06058	12233	18291	59
2	81723	87756	93967	06033	12244	18277	58
3	81738	87745	93993	06007	12255	18262	57
4	81752	87734	94018	05982	12266	18248	56
5	81767	87723	94044	05956	12277	18233	55
6	81781	87712	94069	05931	12288	18219	54
7	81796	87601	94095	05905	12299	18204	53
8	81810	87690	94120	05880	12310	18190	52
9	81825	87679	94146	05854	12321	18175	51
10	9.81839	9.87668	9.94171	10.05829	10.12332	10.18161	50
11	81854	87657	94197	05803	12343	18146	49
12	81868	87646	94222	05778	12354	18132	48
13	81882	87635	94248	05752	12365	18118	47
14	81897	87624	94273	05727	12376	18103	46
15	81911	87613	94299	05701	12387	18089	45
16	81926	87601	94324	05676	12399	18074	44
17	81940	87590	94350	05650	12410	18060	43
18	81954	87579	94375	05625	12421	18046	42
19	81969	87568	94401	05599	12432	18031	41
20	9.81983	9.87557	9.94426	10.05574	10.12443	10.18017	40
21	81998	87546	94452	05548	12454	18002	39
22	82012	87535	94477	05523	12465	17988	38
23	82026	87524	94503	05497	12476	17974	37
24	82041	87513	94528	05472	12487	17959	36
25	82055	87591	94554	05446	12499	17945	35
26	82069	87490	94579	05421	12510	17931	34
27	82084	87479	94604	05396	12521	17916	33
28	82098	87468	94630	05370	12532	17902	32
29	82112	87457	94655	05345	12543	17888	31
30	9.82126	9.87446	9.94681	10.05319	10.12554	10.17874	30
31	82141	87434	94706	05294	12566	17859	29
32	82155	87423	94732	05268	12577	17845	28
33	82169	87412	94757	05243	12588	17831	27
34	82184	87401	94783	05217	12599	17816	26
35	82198	87390	94808	05192	12610	17802	25
36	82212	87378	94834	05166	12622	17788	24
37	82226	87367	94859	05141	12633	17774	23
38	82240	87356	94884	05116	12644	17760	22
39	82255	87345	94910	05090	12655	17745	21
40	9.82269	9.87334	9.94935	10.05065	10.12666	10.17731	20
41	82283	87322	94961	05039	12678	17717	19
42	82297	87311	94986	05014	12689	17703	18
43	82311	87300	95012	04988	12700	17689	17
44	82326	87288	95037	04963	12711	17674	16
45	82340	87277	95062	04938	12723	17660	15
46	82354	87266	95088	04912	12734	17646	14
47	82368	87255	95113	04887	12745	17632	13
48	82382	87243	95139	04861	12757	17618	12
49	82396	87232	95164	04836	12768	17604	11
50	9.82410	9.87221	9.95190	10.04810	10.12779	10.17590	10
51	82424	87209	95215	04785	12791	17576	9
52	82439	87198	95240	04760	12802	17561	8
53	82453	87187	95266	04734	12813	17547	7
54	82467	87175	95291	04709	12825	17533	6
55	82481	87164	95317	04683	12836	17519	5
56	82495	87153	95342	04658	12847	17505	4
57	82509	87141	95368	04632	12859	17491	3
58	82523	87130	95393	04607	12870	17477	2
59	82537	87119	95418	04582	12881	17463	1
60	82551	87107	95444	04556	12893	17449	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	9.82551	87107	9.95444	10.04556	10.12893	10.17449	60
1	82565	87096	95469	04531	12904	17435	59
2	82579	87085	95495	04505	12915	17421	58
3	82593	87073	95520	04480	12927	17407	57
4	82507	87062	95545	04455	12938	17393	56
5	82621	87050	95571	04429	12950	17379	55
6	82635	87039	95596	04404	12961	17365	54
7	82649	87028	95621	04378	12973	17351	53
8	82663	87017	95647	04353	12984	17337	52
9	82677	87005	95672	04328	12995	17323	51
10	9.82691	9.86993	9.95698	10.04302	10.13007	10.17309	50
11	82705	86982	95723	04277	13018	17295	49
12	82719	86970	95748	04252	13030	17281	48
13	82733	86959	95774	04226	13041	17267	47
14	82747	86947	95799	04201	13053	17253	46
15	82761	86936	95825	04175	13064	17239	45
16	82775	86924	95850	04150	13076	17226	44
17	82788	86913	95875	04125	13087	17212	43
18	82802	86902	95901	04099	13098	17198	42
19	82816	86890	95926	04074	13110	17184	41
20	9.82830	9.86879	9.95952	10.04048	10.13121	10.17170	40
21	82844	86867	95977	04023	13133	17156	39
22	82858	86855	96002	03998	13145	17142	38
23	82872	86844	96028	03972	13156	17128	37
24	82885	86832	96053	03947	13168	17115	36
25	82899	86821	96078	03922	13179	17101	35
26	82913	86809	96104	03896	13191	17087	34
27	82927	86798	96129	03871	13202	17073	33
28	82941	86786	96155	03845	13214	17059	32
29	82955	86775	96180	03820	13225	17045	31
30	9.82968	9.86763	9.96205	10.03795	10.13237	10.17032	30
31	82982	86752	96231	03769	13248	17018	29
32	82996	86740	96256	03744	13260	17004	28
33	83010	86728	96282	03719	13272	16990	27
34	83023	86717	96307	03693	13283	16977	26
35	83037	86705	96332	03668	13295	16963	25
36	83051	86694	96357	03643	13306	16949	24
37	83065	86682	96383	03617	13318	16935	23
38	83078	86670	96408	03592	13330	16922	22
39	83092	86659	96433	03567	13341	16908	21
40	9.83106	9.86647	9.96459	10.03541	10.13353	10.16894	20
41	83119	86635	96484	03516	13365	16880	19
42	83133	86624	96510	03490	13376	16867	18
43	83147	86612	96535	03465	13388	16853	17
44	83161	86600	96560	03440	13400	16839	16
45	83174	86589	96586	03414	13411	16826	15
46	83188	86577	96611	03389	13423	16812	14
47	83202	86565	96636	03364	13435	16798	13
48	83215	86554	96662	03338	13446	16785	12
49	83229	86542	96687	03313	13458	16771	11
50	9.83242	9.86530	9.96712	10.03288	10.13470	10.16758	10
51	83256	86518	96738	03262	13482	16744	9
52	83270	86507	96763	03237	13493	16730	8
53	83283	86495	96788	03212	13505	16717	7
54	83297	86483	96814	03186	13517	16703	6
55	83310	86472	96839	03161	13528	16690	5
56	83324	86460	96864	03136	13540	16676	4
57	83338	86448	96890	03110	13552	16662	3
58	83351	86436	96915	03085	13564	16649	2
59	83365	86425	96940	03060	13575	16635	1
60	83378	86413	96966	03034	13587	16622	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
0	9.83378	9.86413	9.96966	10.03034	10.13587	10.16622	60
1	83392	86401	96991	03009	13599	16608	59
2	83405	86389	97016	02984	13611	16595	58
3	83419	86377	97042	02958	13623	16581	57
4	83432	86366	97067	02933	13634	16568	56
5	83446	86354	97092	02908	13646	16554	55
6	83459	86342	97118	02882	13658	16541	54
7	83473	86330	97143	02857	13670	16527	53
8	83486	86318	97168	02832	13682	16513	52
9	83500	86306	97193	02807	13694	16500	51
10	9.83513	9.86295	9.97219	10.02781	10.13705	10.16487	50
11	83527	86283	97244	02756	13717	16473	49
12	83540	86271	97269	02731	13729	16460	48
13	83554	86259	97294	02705	13741	16446	47
14	83567	86247	97320	02680	13753	16433	46
15	83581	86235	97345	02655	13765	16419	45
16	83594	86223	97371	02629	13777	18406	44
17	83607	86211	97396	02604	13789	16392	43
18	83621	86200	97421	02579	13800	16379	42
19	83634	86188	97447	02553	13812	16366	41
20	9.83648	9.86176	9.97472	10.02528	10.13824	10.16352	40
21	83661	86164	97497	02503	13836	16339	39
22	83674	86152	97523	02477	13848	16326	38
23	83688	86140	97548	02452	13860	16312	37
24	83701	86128	97573	02427	13872	16299	36
25	83715	86116	97598	02402	13884	16285	35
26	83728	86104	97624	02376	13896	16272	34
27	83741	86092	97649	02351	13908	16259	33
28	83755	86080	97674	02326	13920	16245	32
29	83768	86068	97700	02300	13932	16232	31
30	9.83781	9.86056	9.97725	10.02275	10.13944	10.16219	30
31	83795	86044	97750	02250	13956	16205	29
32	83808	86032	97776	02224	13968	16192	28
33	83821	86020	97801	02199	13980	16179	27
34	83834	86008	97826	02174	13992	16166	26
35	83848	85996	97851	02149	14004	16152	25
36	83861	85984	97877	02123	14016	16139	24
37	83874	85972	97902	02098	14028	16126	23
38	83887	85960	97927	02073	14049	16113	22
39	83901	85948	97953	02047	14052	16099	21
40	9.83914	9.85936	9.97978	10.02022	10.14064	10.16086	20
41	83927	85924	98003	01997	14076	16073	19
42	83940	85912	98029	01971	14088	16060	18
43	83954	85900	98054	01946	14100	16046	17
44	83967	85888	98079	01921	14112	16033	16
45	83980	85876	98104	01896	14124	16020	15
46	83993	85864	98130	01870	14136	16007	14
47	84006	85851	98155	01845	14149	15994	13
48	84020	85839	98180	01820	14161	15980	12
49	84033	85827	98206	01794	14173	15967	11
50	9.84046	9.85815	9.98231	10.01769	10.14185	10.15954	10
51	84059	85803	98256	01744	14197	15941	9
52	84072	85791	98281	01719	14209	15928	8
53	84085	85779	98307	01693	14221	15915	7
54	84098	85766	98332	01668	14234	15902	6
55	84112	85754	98357	01643	14246	15888	5
56	84125	85742	98383	01617	14258	15875	4
57	84138	85730	98408	01592	14270	15862	3
58	84151	85718	98433	01567	14282	15849	2
59	84164	85706	98458	01542	14294	15836	1
60	84177	85693	98484	01516	14307	15823	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	
1	9.84177	9.85693	9.98484	10.01516	10.14307	10.15823	60
0	84190	85681	98509	01491	14319	15810	59
2	84203	85669	98534	01466	14331	15797	58
3	84216	85657	98560	01440	14343	15784	57
4	84229	85645	98585	01415	14355	15771	56
5	84242	85632	98610	01390	14368	15758	55
6	84255	85620	98635	01365	14380	15745	54
7	84269	85608	98661	01339	14392	15731	53
8	84282	85596	98686	01314	14404	15718	52
9	84295	85583	98711	01289	14417	15705	51
10	9.84308	9.85571	9.98737	10.01263	10.14429	10.15692	50
11	84321	85559	98762	01238	14441	15679	49
12	84334	85546	98787	01213	14454	15666	48
13	84347	85534	98812	01188	14466	15653	47
14	84360	85522	98838	01162	14478	15640	46
15	84372	85510	98863	01137	14490	15627	45
16	84385	85497	98888	01112	14503	15614	44
17	84398	85485	98913	01087	14515	15602	43
18	84411	85473	98939	01061	14527	15589	42
19	84424	85460	98964	01036	14540	15576	41
20	9.84437	9.85448	9.98989	10.01011	10.14552	10.15563	40
21	84450	85436	99014	00985	14564	15550	39
22	84463	85423	99040	00960	14577	15537	38
23	84476	85411	99065	00935	14589	15524	37
24	84489	85399	99090	00910	14601	15511	36
25	84502	85386	99116	00884	14614	15498	35
26	84515	85374	99141	00859	14626	15485	34
27	84528	85361	99166	00834	14639	15472	33
28	84540	85349	99191	00809	14651	15460	32
29	84553	85337	99217	00783	14663	15447	31
30	9.84566	9.85324	9.99242	10.00758	10.14676	10.15434	30
31	84579	85312	99267	00733	14688	15421	29
32	84592	85299	99293	00707	14701	15408	28
33	84605	85287	99318	00682	14713	15395	27
34	84618	85274	99343	00657	14726	15382	26
35	84630	85262	99368	00632	14738	15370	24
36	84643	85250	99394	00606	14750	15357	25
37	84656	85237	99419	00581	14763	15344	23
38	84669	85225	99444	00556	14775	15331	22
39	84682	85212	99469	00531	14788	15318	21
40	9.84694	9.85200	9.99495	10.00505	10.14800	10.15306	20
41	84707	85187	99520	00480	14813	15293	19
42	84720	85175	99545	00455	14825	15280	18
43	84733	85162	99570	00430	14838	15267	17
44	84745	85150	99596	00404	14850	15255	16
45	84758	85137	99621	00379	14863	15242	15
46	84771	85125	99646	00354	14875	15229	14
47	84784	85112	99672	00328	14888	15216	13
48	84796	85100	99697	00303	14900	15204	12
49	84809	85087	99722	00278	14913	15191	11
50	9.84822	9.85074	9.99747	10.00253	10.14926	10.15178	10
51	84834	85062	99773	00227	14938	15166	9
52	84847	85049	99798	00202	14951	15153	8
53	84860	85037	99823	00177	14963	15140	7
54	84873	85024	99848	00152	14976	15127	6
55	84885	85012	99874	00126	14988	15115	5
56	84898	84999	99899	00101	15001	15102	4
57	84911	84986	99924	00076	15014	15089	3
58	84923	84974	99949	00051	15026	15077	2
59	84936	84961	99975	00025	15039	15064	1
60	84948	84948	10.00000	10.00000	15052	15051	0
	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

A TABLE for finding the 6 HOUR.

M.	S.	½ Elapſ. Time.	Middle Time.	Riſing.		M.	S.	½ Elapſ. Time.	Middle Time.	Riſing.
0	30	2.66121	2.63982	9.37654	Co. ar.	30	30	0.87717	4.42386	2.94656
1	00	2.36018	2.94085	97860		31	00	87015	43088	96067
1	30	2.18409	3.11694	0.33078		31	30	86324	43779	97454
2	00	2.05916	24187	58066		32	00	85644	44459	98820
2	30	1.96225	33878	77448		32	30	84976	45127	3.00164
3	00	88307	41796	93284		33	00	84317	45786	01488
3	30	81613	48490	1.06673		33	30	83669	46434	02792
4	00	75814	54289	18271		34	00	83030	47073	04077
4	30	70700	59403	28502		34	30	82401	47702	05342
5	00	65125	63978	37653		35	00	81780	48323	06590
5	30	1.61986	3.68117	1.45931		35	30	0.81169	4.48934	3.07819
6	00	58208	71895	53488		36	00	80567	49536	09032
6	30	54733	75370	60440		36	30	79973	50130	10227
7	00	51515	78588	66877		37	00	79387	50716	11406
7	30	48526	81583	72869		37	30	78809	51294	12570
8	00	45718	84385	78474		38	00	78239	51864	13718
8	30	43086	87017	83730		38	30	77677	52426	14850
9	00	40605	89498	88703		39	00	77122	52981	15969
9	30	38258	91845	93399		39	30	76574	53529	17072
10	00	36032	94071	97854		40	00	76033	54070	18162
10	30	1.33915	3.96188	2.02091		40	30	0.75499	4.54604	3.19238
11	00	31896	98207	06131		41	00	74972	55131	20301
11	30	29967	4.00136	09991		41	30	74451	55652	21351
12	00	28120	01983	13687		42	00	73937	56166	22389
12	30	26349	03754	17223		42	30	73429	56674	23414
13	00	24647	05456	20638		43	00	72926	57176	24427
13	30	23010	07093	23915		43	30	72430	57673	25428
14	00	21432	08671	27073		44	00	71940	58163	26418
14	30	19910	10193	30120		44	30	71455	58648	27396
15	00	18440	11663	33063		45	00	70976	59127	28363
15	30	1.17018	4.13085	2.35910		45	30	0.70503	4.59600	3.29320
16	00	15642	14461	38667		46	00	70034	60069	30268
16	30	14307	15796	41338		46	30	69571	60532	31202
17	00	13013	17090	43930		47	00	69113	60990	32128
17	30	11757	18346	46447		47	30	68660	61443	33044
18	00	10536	19567	48893		48	00	68212	61891	33950
18	30	09348	20755	51271		48	30	67769	62334	34847
19	00	08193	21910	53586		49	00	67330	62773	35734
19	30	07067	23036	55841		49	30	66896	63207	36613
20	00	05970	24133	58039		50	00	66406	63637	37482
20	30	1.04901	4.25202	2.60182		50	30	0.66041	4.64062	3.38345
21	00	03857	26246	62274		51	00	65620	64483	39195
21	30	02838	27265	64316		51	30	65204	64899	40039
22	00	01843	28260	66312		52	00	64791	65312	40875
22	30	00870	29233	68262		52	30	64383	65720	41702
23	00	0.99918	30185	70170		53	00	63978	66125	42523
23	30	98988	31115	72036		53	30	63578	66525	43334
24	00	98077	32026	73863		54	00	63181	66922	44138
24	30	97184	32919	75652		54	30	62789	67314	44935
25	00	96310	33793	77405		55	00	62400	67703	45724
25	30	0.95454	4.34649	2.79124		55	30	0.62014	4.68089	3.46507
26	00	94614	35489	80809		56	00	61632	68471	47282
26	30	93791	36313	82461		56	30	61254	68849	48050
27	00	92982	37121	84083		57	00	60879	69224	48811
27	30	92189	37914	85675		57	30	60508	69595	49566
28	00	91411	38692	87238		58	00	60140	69963	50314
28	30	90646	39457	88773		58	30	59775	70328	51056
29	00	89894	40289	902 2		59	00	59414	70689	51791
29	30	89156	40947	91765		59	30	59056	71047	52520
30	00	88430	41673	93223		60	00	58700	71403	53243

LATITUDE by two Altitudes. 1 HOUR.

M.	S.	½ Elapſ. Time.	Middle Time.	Riſing.	M.	S.	½ Elapſ. Time.	Middle Time.	Riſing.
00	30	0.58348	4.71755	3.53959	30	30	0.41488	4.88615	3.88625
01	00	57999	72104	54670	31	00	41261	88842	89097
01	30	57653	72450	55375	31	30	41036	89067	89567
02	00	57310	72793	56074	32	00	40812	89291	90034
02	30	56970	73133	56767	32	30	40590	89513	90498
03	00	56633	73470	57455	33	00	40368	89734	90960
03	30	56298	73805	58137	33	30	40149	89954	91420
04	00	55966	74137	58814	34	00	39930	90173	91876
04	30	55637	74466	59486	34	30	39713	90390	92331
05	00	55311	74792	60152	35	00	39497	90606	92782
05	30	0.54987	4.75116	3.60813	35	30	0.39282	4.90821	3.93232
06	00	54666	75437	61469	36	00	39069	91034	93679
06	30	54347	75756	62120	36	30	38856	91247	94123
07	00	54031	76072	62766	37	00	38646	91457	94566
07	30	53718	76385	63407	37	30	38436	91667	95005
08	00	53406	76697	64043	38	00	38227	91876	95443
08	30	53097	77005	64675	38	30	38020	92083	95878
09	00	52791	77312	65302	39	00	37814	92289	96311
09	30	52487	77616	65924	39	30	37609	92494	96742
10	00	52186	77917	66542	40	00	37405	92698	97170
10	30	0.51886	4.78217	3.67156	40	30	0.37203	4.92900	3.97597
11	00	51589	78514	67765	41	00	37001	93102	98021
11	30	51294	78809	68369	41	30	36801	93301	98443
12	00	51002	79101	68969	42	00	36602	93501	98862
12	30	50711	79392	69566	42	30	36403	93700	99280
13	00	50423	79680	70158	43	00	36206	93897	99696
13	30	50137	79966	70745	43	30	36011	94097	4.00109
14	00	49852	80251	71329	44	00	35816	94287	00521
14	30	49570	80533	71909	44	30	35622	94481	00930
15	00	49290	80813	72485	45	00	35429	94673	01337
15	30	0.49012	4.81091	3.73057	45	30	0.35238	4.94865	4.01743
16	00	48736	81367	73625	46	00	35047	95056	02146
16	30	48462	81641	74189	46	30	34858	95245	02547
17	00	48189	81914	74750	47	00	34669	95434	02947
17	30	47919	82184	75307	47	30	34482	95621	03344
18	00	47650	82453	75860	48	00	34295	95808	03740
18	30	47384	82719	76409	48	30	34110	95993	04134
19	00	47119	82984	76955	49	00	33925	96178	04526
19	30	46856	83247	77498	49	30	33742	96361	04916
20	00	46595	83508	78037	50	00	33559	96544	05304
20	30	0.46335	4.83768	3.78573	50	30	0.33378	9.96725	4.05690
21	00	46078	84025	79105	51	00	33197	96906	06074
21	30	45822	84281	79634	51	30	33018	97085	06457
22	00	45567	84536	80159	52	00	32839	97264	06838
22	30	45315	84788	80682	52	30	32661	97442	07217
23	00	45064	85039	81201	53	00	32485	97618	07595
23	30	44815	85288	81717	53	30	32309	97794	07970
24	00	44567	85536	82230	54	00	32134	97969	08344
24	30	44321	85782	82739	54	30	31960	98143	08716
25	00	44077	86026	83240	55	00	31787	98316	09087
25	30	0.43834	4.86269	3.83749	55	30	0.31614	4.98489	4.09456
26	00	43592	86511	84250	56	00	31443	98660	09823
26	30	43353	86750	84748	56	30	31272	98831	10188
27	00	43114	86989	85242	57	00	31103	99000	10552
27	30	42878	87225	85734	57	30	30934	99169	10914
28	00	42642	87461	86223	58	00	30766	99337	11275
28	30	42409	87694	86709	58	30	30599	99504	11634
29	00	42176	87927	87192	59	00	30433	99670	11992
29	30	41945	88158	87672	59	30	30268	99835	12348
30	00	41716	88387	88150	60	00	30103	5.00000	12702

A TABLE for finding the 2 HOURS.

M.	S.	½ Elapſ. Time.	Middle Time.	Riſing.	M.	S.	½ Elapſ. Time.	Middle Time.	Riſing.
00	30	0.29939	5.00164	4.13055	30	30	0.21432	5.08671	4.31801
01	00	29776	00327	13406	31	00	21309	08794	32079
01	30	29614	00489	13756	31	30	21187	08916	32355
02	00	29453	00650	14104	32	00	21066	09037	32631
02	30	29293	00810	14451	32	30	20945	09158	32906
03	00	29133	00970	14797	33	00	20824	09279	33180
03	30	28974	01129	15140	33	30	20704	09399	33452
04	00	28816	01287	15483	34	00	20585	09510	33724
04	30	28659	01444	15824	34	30	20466	09637	33995
05	00	28502	01601	16163	35	00	20348	09755	34265
05	30	0.28346	5.01757	4.16501	35	30	0.20230	5.09873	4.34534
06	00	28191	01912	16838	36	00	20113	09990	34802
06	30	28037	02066	17173	36	30	19996	10107	35069
07	00	27884	02219	17507	37	00	19880	10223	35335
07	30	27731	02372	17839	37	30	19764	10339	35600
08	00	27579	02524	18171	38	00	19648	10454	35865
08	30	27428	02675	18500	38	30	19534	10569	36128
09	00	27277	02826	18829	39	00	19420	10683	36391
09	30	27127	02976	19156	39	30	19306	10797	36652
10	00	26978	03125	19482	40	00	19193	10910	36913
10	30	0.26830	5.03275	4.19806	40	30	0.19080	5.11023	4.37173
11	00	26682	03421	20129	41	00	18968	11135	37432
11	30	26535	03568	20451	41	30	18857	11246	37690
12	00	26389	03714	20771	42	00	18746	11357	37948
12	30	26244	03859	21091	42	30	18635	11468	38204
13	00	26099	04004	21409	43	00	18525	11578	38460
13	30	25955	04148	21725	43	30	18415	11688	38714
14	00	25811	04292	22041	44	00	18306	11797	38968
14	30	25668	04435	22355	44	30	18197	11906	39221
15	00	25526	04577	22668	45	00	18089	12014	39473
15	30	0.25385	5.04718	4.22980	45	30	0.17981	5.12122	4.39724
16	00	25244	04859	23290	46	00	17874	12229	39975
16	30	25104	04999	23599	46	30	17767	12336	40225
17	00	24964	05139	23907	47	00	17660	12443	40474
17	30	24825	05278	24214	47	30	17554	12549	40722
18	00	24687	05416	24520	48	00	17449	12654	40969
18	30	24550	05553	24825	48	30	17344	12759	41215
19	00	24413	05690	25128	49	00	17239	12864	41461
19	30	24277	05826	25430	49	30	17135	12968	41706
20	00	24141	05962	25731	50	00	17031	13071	41950
20	30	0.24006	5.06097	4.26031	50	30	0.16928	5.13174	4.42193
21	00	23871	06232	26330	51	00	16826	13277	42435
21	30	23738	06365	26628	51	30	16724	13379	42677
22	00	23605	06498	26924	52	00	16622	13481	42918
22	30	23472	06631	27220	52	30	16520	13583	43158
23	00	23340	06763	27514	53	00	16419	13684	43398
23	30	23209	06894	27807	53	30	16319	13784	43636
24	00	23078	07025	28099	54	00	16219	13884	43874
24	30	22948	07155	28391	54	30	16119	13984	44111
25	00	22819	07284	28681	55	00	16029	14083	44348
25	30	0.22690	5.07413	4.28969	55	30	0.15921	5.14182	4.44583
26	00	22561	07542	29257	56	00	15823	14280	44818
26	30	22433	07670	29544	56	30	15725	14378	45052
27	00	22306	07797	29830	57	00	15627	14476	45286
27	30	22180	07923	30115	57	30	15530	14573	45518
28	00	22054	08049	30398	58	00	15434	14669	45750
28	30	21928	08175	30681	58	30	15338	14765	45981
29	00	21803	08300	30963	59	00	15242	14861	46212
29	30	21679	08424	31244	59	30	15146	14957	46442
30	00	21555	08548	31523	60	00	15051	15052	46671

LATITUDE by Two Altitudes. 3 HOURS.

M.	S.	½ Elapſ. Time.	Middle Time.	Riſing.	M.	S.	½ Elapſ. Time.	Middle Time.	Riſing.
0	30	0.14957	5.15146	4.46899	30	30	0.09981	5.20122	4.59436
1	00	14863	15240	47127	31	00	09909	20194	59627
1	30	14769	15334	47354	31	30	09837	20266	59818
2	00	14676	15427	47580	32	00	09766	20338	60008
2	30	14583	15520	47806	32	30	09694	20409	60198
3	00	14490	15613	48031	33	00	09623	20480	60388
3	30	14398	15705	48255	33	30	09552	20551	60577
4	00	14306	15797	48479	34	00	09482	20621	60765
4	30	14215	15888	48702	34	30	09412	20691	60952
5	00	14124	15979	48924	35	00	09342	20760	61139
5	30	0.14034	5.16069	4.49145	35	30	0.09273	5.20830	4.61326
6	00	13944	16159	49366	36	00	09204	20899	61512
6	30	13854	16249	49586	36	30	09135	20968	61698
7	00	13765	16338	49806	37	00	09067	21036	61883
7	30	13676	16427	50025	37	30	08999	21104	62068
8	00	13587	16516	50243	38	00	08931	21172	62252
8	30	13499	16604	50460	38	30	08864	21239	62436
9	00	13411	16692	50677	39	00	08797	21306	62619
9	30	13324	16779	50893	39	30	08730	21373	62802
10	00	13237	16866	51109	40	00	08664	21439	62984
10	30	0.13150	5.16953	4.51324	40	30	0.08597	5.21505	4.63166
11	00	13064	17039	51539	41	00	08531	21571	63347
11	30	12971	17125	51753	41	30	08466	21637	63528
12	00	12893	17210	51966	42	00	08401	21702	63708
12	30	12808	17295	52178	42	30	08336	21767	63888
13	00	12723	17380	52390	43	00	08271	21832	64067
13	30	12638	17465	52601	43	30	08207	21896	64246
14	00	12554	17549	52812	44	00	08143	21960	64425
14	30	12471	17633	53022	44	30	08079	22025	64603
15	00	12387	17716	53231	45	00	08015	22088	64780
15	30	0.12305	5.17799	4.53440	45	30	0.07952	5.22151	4.64957
16	00	12222	17881	53648	46	00	07889	22214	65134
16	30	12140	17963	53856	46	30	07827	22276	65310
17	00	12058	18045	54063	47	00	07765	22338	65486
17	30	11977	18126	54269	47	30	07703	22400	65661
18	00	11896	18207	54475	48	00	07641	22462	65836
18	30	11815	18288	54680	48	30	07579	22524	66010
19	00	11734	18369	54885	49	00	07518	22585	66184
19	30	11654	18449	55089	49	30	07457	22646	66357
20	00	11574	18529	55293	50	00	07397	22707	66530
20	30	0.11495	5.18608	4.55496	50	30	0.07337	5.22766	4.66702
21	00	11416	18687	55698	51	00	07277	22826	66874
21	30	11337	18766	55900	51	30	07217	22886	67046
22	00	11259	18844	56101	52	00	07158	22945	67217
22	30	11181	18922	56301	52	30	07099	23004	67388
23	00	11104	18999	56501	53	00	07040	23062	67558
23	30	11027	19076	56701	53	30	06981	23123	67728
24	00	10950	19153	56900	54	00	06923	23180	67897
24	30	10873	19230	57098	54	30	06865	23238	68066
25	00	10797	19306	57296	55	00	06808	23295	68235
25	30	0.10721	5.19382	4.57494	55	30	0.06751	5.23352	4.68403
26	00	10645	19456	57690	56	00	06694	23409	68571
26	30	10570	19533	57886	56	30	06637	23466	68738
27	00	10495	19608	58082	57	00	06580	23523	68905
27	30	10421	19682	58277	57	30	06524	23579	69071
28	00	10347	19756	58471	58	00	06468	23635	69237
28	30	10273	19830	58665	58	30	06412	23691	69403
29	00	10199	19904	58859	59	00	06357	23746	69568
29	30	10126	19977	59052	59	30	06302	23801	69733
30	00	10053	20050	59244	60	00	06247	23856	69897

A TABLE for finding the 4 HOURS.

M.	S.	½ Elapſ. Time.	Middle Time.	Riſing.	M.	S.	½ Elapſ. Time.	Middle Time.	Riſing.
00	30	0.06192	5.23911	4.70061	30	30	0.03399	5.26703	4.79193
01	00	06138	23965	70224	31	00	03360	26743	79334
01	30	06084	24019	70387	31	30	03321	26782	79475
02	00	06030	24073	70550	32	00	03283	26820	79616
02	30	05977	24126	70712	32	30	03245	26858	79756
03	00	05924	24179	70874	33	00	03207	26896	79896
03	30	05871	24232	71036	33	30	03170	26934	80036
04	00	05818	24285	71197	34	00	03132	26971	80175
04	30	05766	24337	71357	34	30	03095	27008	80314
05	00	05714	24389	71518	35	00	03058	27045	80452
05	30	0.05662	5.24441	4.71678	35	30	0.03021	5.27082	4.80591
06	00	05610	24493	71837	36	00	02985	27118	80729
06	30	05559	24544	71996	36	30	02949	27154	80867
07	00	05508	24595	72155	37	00	02913	27190	81004
07	30	05457	24646	72313	37	30	02877	27226	81141
08	00	05406	24697	72471	38	00	02841	27262	81278
08	30	05356	24747	72628	38	30	02806	27297	81414
09	00	05306	24797	72786	39	00	02771	27332	81550
09	30	05256	24847	72942	39	30	02736	27367	81686
10	00	05207	24897	73098	40	00	02701	27402	81821
10	30	0.05158	5.24945	4.73254	40	30	0.02667	5.27436	4.81956
11	00	05109	24994	73410	41	00	02633	27470	82091
11	30	05060	25043	73565	41	30	02599	27504	82226
12	00	05012	25091	73720	42	00	02565	27538	82360
12	30	04964	25139	73874	42	30	02532	27571	82494
13	00	04916	25187	74028	43	00	02499	27604	82628
13	30	04868	25235	74182	43	30	02466	27637	82761
14	00	04821	25282	74335	44	00	02433	27670	82894
14	30	04774	25329	74488	44	30	02400	27703	83027
15	00	04727	25376	74641	45	00	02368	27735	83159
15	30	0.04680	5.25423	4.74793	45	30	0.02336	5.27767	4.83291
16	00	04634	25469	74945	46	00	02304	27799	83423
16	30	04588	25515	75096	46	30	02272	27831	83554
17	00	04542	25561	75247	47	00	02241	27862	83685
17	30	04496	25607	75398	47	30	02210	27893	83816
18	00	04451	25652	75549	48	00	02179	27924	83947
18	30	04406	25697	75699	48	30	02148	27955	84077
19	00	04361	25742	75848	49	00	02118	27985	84207
19	30	04316	25787	75997	49	30	02088	28015	84337
20	00	04272	25831	76146	50	00	02058	28045	84466
20	30	0.04228	5.25875	4.76295	50	30	0.02028	5.28075	4.84595
21	00	04184	25919	76443	51	00	01998	28105	84724
21	30	04141	25962	76591	51	30	01969	28134	84853
22	00	04098	26005	76738	52	00	01940	28163	84981
22	30	04055	26048	76885	52	30	01911	28192	85109
23	00	04012	26091	77032	53	00	01882	28221	85236
23	30	03969	26134	77179	53	30	01854	28249	85363
24	00	03927	26176	77325	54	00	01826	28277	85490
24	30	03885	26218	77471	54	30	01798	28305	85617
25	00	03843	26260	77616	55	00	01770	28333	85744
25	30	0.03801	5.26302	4.77761	55	30	0.01743	5.28360	4.85870
26	00	03760	26343	77906	56	00	01716	28387	85996
26	30	03719	26384	78050	56	30	01689	28414	86121
27	00	03678	26425	78194	57	00	01662	28441	86246
27	30	03638	26466	78338	57	30	01635	28468	86371
28	00	03597	26506	78481	58	00	01609	28494	86496
28	30	03557	26546	78624	58	30	01583	28520	86621
29	00	03517	26586	78767	59	00	01557	28546	86745
29	30	03478	26626	78909	59	30	01531	28572	86869
30	00	03438	26665	79051	60	00	01505	28598	86993

LATITUDE by Two Altitudes 5 HOURS.

M.	S.	½ Elapſ. Time.	Middle Time.	Riſing.	M.	S.	½ Elapſ. Time.	Middle Time.	Riſing.
0	30	0.01480	5.28623	4.87116	30	30	0.00361	5.29742	4.94033
1	00	01455	28648	87239	31	00	00349	29754	94141
1	30	01430	28673	87362	31	30	00337	29766	94248
2	00	01405	28698	87484	32	00	00325	29778	94356
2	30	01381	28722	87606	32	30	00313	29790	94463
3	00	01357	28746	87728	33	00	00302	29801	94570
3	30	01333	28770	87850	33	30	00291	29812	94676
4	00	01309	28794	87971	34	00	00280	29823	94782
4	30	01286	28817	88092	34	30	00269	29834	94888
5	00	01263	28840	88213	35	00	00259	29844	94994
5	30	0.01240	5.28863	4.88334	35	30	0.00249	5.29854	4.95100
6	00	01217	28886	88454	36	00	00239	29864	95205
6	30	01194	28909	88574	36	30	00229	29874	95310
7	00	01172	28931	88694	37	00	00219	29884	95415
7	30	01150	28953	88814	37	30	00209	29894	95520
8	00	01128	28975	88933	38	00	00200	29903	95624
8	30	01106	28997	89052	38	30	00191	29912	95728
9	00	01084	29019	89171	39	00	00182	29911	95832
9	30	01063	29040	89289	39	30	00174	29920	95936
10	00	01042	29061	89407	40	00	00166	29937	96040
10	30	0.01021	5.29082	4.89525	40	30	0.00157	5.29945	4.96143
11	00	01000	29103	89643	41	00	00150	29953	96246
11	30	00980	29123	89760	41	30	00142	29961	96349
12	00	00960	29143	89877	42	00	00134	29969	96452
12	30	00940	29163	89994	42	30	00127	29976	96554
13	00	00920	29183	90111	43	00	00120	29983	96656
13	30	00900	29203	90227	43	30	00113	29990	96758
14	00	00881	29222	90343	44	00	00106	29997	96860
14	30	00862	29241	90459	44	30	00099	30004	96961
15	00	00843	29260	90575	45	00	00093	30010	97062
15	30	0.00824	5.29279	4.90690	45	30	0.00087	5.30016	4.97163
16	00	00805	29298	90805	46	00	00081	30022	97264
16	30	00787	29316	90920	46	30	00075	30028	97365
17	00	00769	29334	91035	47	00	00070	30033	97465
17	30	00751	29352	91149	47	30	00065	30038	97565
18	00	00733	29370	91263	48	00	00060	30043	97665
18	30	00716	29387	91377	48	30	00055	30048	97765
19	00	00699	29404	91490	49	00	00050	30053	97865
19	30	00682	29421	91603	49	30	00045	30058	97964
20	00	00665	29438	91716	50	00	00041	30062	98063
20	30	0.00648	5.29455	4.91829	50	30	0.00037	5.30066	4.98162
21	00	00632	29471	91942	51	00	00033	30070	98261
21	30	00616	29487	92054	51	30	00029	30074	98359
22	00	00600	29503	92166	52	00	00026	30077	98457
22	30	00584	29519	92278	52	30	00023	30080	98555
23	00	00568	29535	92390	53	00	00020	30083	98653
23	30	00553	29550	92501	53	30	00017	30086	98751
24	00	00538	29565	92612	54	00	00015	30088	98848
24	30	00523	29580	92723	54	30	00012	30090	98945
25	00	00508	29595	92834	55	00	00010	30092	99042
25	30	0.00494	5.29609	4.92944	55	30	0.00008	5.30094	4.99139
26	00	00480	29623	93054	56	00	00007	30096	99236
26	30	00466	29637	93164	56	30	00005	30098	99332
27	00	00452	29651	93274	57	00	00004	30099	99428
27	30	00438	29665	93383	57	30	00003	30100	99524
28	00	00425	29678	93492	58	00	00002	30101	99620
28	30	00412	29691	93601	58	30	00001	30102	99715
29	00	00399	29704	93709	59	00	00000	30103	99810
29	30	00386	29717	93817	59	30	00000	30103	99905
30	00	00373	29730	93925	60	00	00000	30105	5.00000

TABLE VII. For computing the Altitude and Time, when the Sun or Star, is more than 6 Hours Distant from the Meridian.

6 Hours.						7 Hours.						8 Hours.					
M	S.	Log. Rising.	M	S.	Log. Rising.	M	S.	Log. Rising.	M	S.	Log. Rising.	M	S.	Log. Rising.	M	S.	Log. Rising.
0	30	5.00094	30	30	5.05410	0	30	5.10068	30	30	5.14134	0	30	5.17663	30	30	5.20695
1	00	00188	31	00	05493	1	00	10140	31	00	14198	1	00	17717	31	00	20742
1	30	00282	31	30	05576	1	30	10212	31	30	14261	1	30	17772	31	30	20788
2	00	00376	32	00	05659	2	00	10284	32	00	14324	2	00	17826	32	00	20835
2	30	00469	32	30	05740	2	30	10356	32	30	14386	2	30	17880	32	30	20881
3	00	00563	33	00	05822	3	00	10429	33	00	14449	3	00	17934	33	00	20926
3	30	00657	33	30	05904	3	30	10501	33	30	14511	3	30	17988	33	30	20972
4	00	00751	34	00	05985	4	00	10573	34	00	14573	4	00	18042	34	00	21018
4	30	00844	34	30	06067	4	30	10643	34	30	14635	4	30	18095	34	30	21063
5	00	00936	35	00	06149	5	00	10714	35	00	14697	5	00	18148	35	00	21109
5	30	01028	35	30	06230	5	30	10785	35	30	14759	5	30	18202	35	30	21155
6	00	01121	36	00	06312	6	00	10856	36	00	14821	6	00	18255	36	00	21201
6	30	01213	36	30	06392	6	30	10926	36	30	14882	6	30	18308	36	30	21245
7	00	01305	37	00	06472	7	00	10997	37	00	14943	7	00	18361	37	00	21290
7	30	01398	37	30	06553	7	30	11068	37	30	15004	7	30	18414	37	30	21335
8	00	01490	38	00	06633	8	00	11139	38	00	15065	8	00	18467	38	00	21379
8	30	01580	38	30	06713	8	30	11208	38	30	15126	8	30	18519	38	30	21424
9	00	01671	39	00	06793	9	00	11278	39	00	15187	9	00	18571	39	00	21469
9	30	01762	39	30	06873	9	30	11347	39	30	15248	9	30	18623	39	30	21513
10	00	01853	40	00	06954	10	00	11417	40	00	15309	10	00	18675	40	00	21558
10	30	01943	40	30	07033	10	30	11486	40	30	15369	10	30	18727	40	30	21602
11	00	02034	41	00	07111	11	00	11556	41	00	15428	11	00	18779	41	00	21645
11	30	02125	41	30	07190	11	30	11625	41	30	15488	11	30	18831	41	30	21689
12	00	02215	42	00	07269	12	00	11694	42	00	15548	12	00	18883	42	00	21733
12	30	02304	42	30	07348	12	30	11763	42	30	15608	12	30	18934	42	30	21777
13	00	02394	43	00	07427	13	00	11831	43	00	15667	13	00	18985	43	00	21820
13	30	02483	43	30	07505	13	30	11899	43	30	15727	13	30	19035	43	30	21864
14	00	02572	44	00	07584	14	00	11967	44	00	15787	14	00	19086	44	00	21908
14	30	02661	44	30	07662	14	30	12036	44	30	15846	14	30	19137	44	30	21950
15	00	02750	45	00	07739	15	00	12104	45	00	15904	15	00	19188	45	00	21993
15	30	02839	45	30	07816	15	30	12172	45	30	15963	15	30	19239	45	30	22036
16	00	02928	46	00	07894	16	00	12240	46	00	16022	16	00	19290	46	00	22078
16	30	03016	46	30	07971	16	30	12307	46	30	16080	16	30	19340	46	30	22121
17	00	03104	47	00	08049	17	00	12374	47	00	16139	17	00	19390	47	00	22164
17	30	03191	47	30	08126	17	30	12441	47	30	16197	17	30	19440	47	30	22206
18	00	03279	48	00	08203	18	00	12508	48	00	16256	18	00	19489	48	00	22249
18	30	03366	48	30	08280	18	30	12575	48	30	16314	18	30	19539	48	30	22291
19	00	03454	49	00	08356	19	00	12642	49	00	16371	19	00	19589	49	00	22332
19	30	03542	49	30	08432	19	30	12709	49	30	16429	1	30	19639	49	30	22374
20	00	03629	50	00	08508	20	00	12776	50	00	16486	20	00	19689	50	00	22416
20	30	03715	50	30	08584	20	30	12841	50	30	16544	20	30	19738	50	30	22457
21	00	03801	51	00	08660	21	00	12907	51	00	16601	21	00	19786	51	00	22499
21	30	03887	51	30	08736	21	30	12973	51	30	16659	21	30	19835	51	30	22541
22	00	03974	52	00	08812	22	00	13039	52	00	16716	22	00	19884	52	00	22583
22	30	04060	52	30	08887	22	30	13104	52	30	16773	22	30	19933	52	30	22623
23	00	04146	53	00	08961	23	00	13170	53	00	16829	23	00	19982	53	00	22664
23	30	04232	53	30	09036	23	30	13236	53	30	16885	23	30	20030	53	30	22705
24	00	04318	54	00	09111	24	00	13302	54	00	16942	24	00	20079	54	00	22745
24	30	04402	54	30	09185	24	30	13366	54	30	16998	24	30	20127	54	30	22786
25	00	04487	55	00	09260	25	00	13431	55	00	17054	25	00	20175	55	00	22827
25	30	04571	55	30	09335	25	30	13495	55	30	17111	25	30	20222	55	30	22868
26	00	04656	56	00	09409	26	00	13560	56	00	17167	26	00	20270	56	00	22908
26	30	04740	56	30	09483	26	30	13624	56	30	17222	26	30	20318	56	30	22948
27	00	04825	57	00	09556	27	00	13689	57	00	17277	27	00	20366	57	00	22988
27	30	04910	57	30	09629	27	30	13753	57	30	17333	27	30	20413	57	30	23027
28	00	04994	58	00	09703	28	00	13818	58	00	17388	28	00	20461	58	00	23067
28	30	05077	58	30	09776	28	30	13881	58	30	17443	28	30	20508	58	30	23107
29	00	05160	59	00	09850	29	00	13944	59	00	17498	29	00	20555	59	00	23126
29	30	05243	59	30	09923	29	30	14008	59	30	17554	29	30	20601	59	30	23186
30	00	05327	60	00	09996	30	00	14071	60	00	17609	30	00	20648			

Tale VIII. Of Natural Sines.

	0°		1°		2°		3°		4°		
M.	N sine	N. cos.	N sine	N.cos.	N sine	N.cos.	N sine	N.cos.	N sine	N.cos	M.
0	00	100000	1745	99985	3490	99939	5234	99863	6976	99756	60
1	29	0000	1774	984	3519	938	5263	861	7005	754	59
2	58	0000	1803	984	3548	937	5292	860	7034	752	58
3	87	0000	1832	983	3577	936	5321	858	7063	750	57
4	116	0000	1862	983	3606	935	5350	857	7092	748	56
5	145	0000	1891	982	3635	934	5379	855	7121	746	55
6	175	0000	1920	982	3664	933	5408	854	7150	744	54
7	204	100000	1949	99981	3693	99932	5437	99852	7179	99742	53
8	233	0000	1978	980	3723	931	5466	851	7208	740	52
9	262	0000	2007	980	3752	930	5495	849	7237	738	51
10	291	0000	2036	979	3781	929	5524	847	7266	736	50
11	320	99999	2065	979	3810	927	5553	846	7295	734	49
12	349	999	2094	978	3839	926	5582	844	7324	731	48
13	378	99999	2123	99977	3868	99925	5611	99844	7353	99729	47
14	407	999	2152	977	3897	924	5640	841	7382	727	46
15	436	999	2181	976	3926	923	5669	839	7411	725	45
16	465	999	2211	976	3955	922	5698	838	7440	723	44
17	495	999	2240	975	3984	921	5727	836	7469	721	43
18	524	999	2269	974	4013	919	5756	834	7498	719	42
19	553	99998	2298	99974	4042	99918	5785	99833	7527	99716	41
20	582	9998	2327	973	4071	917	5814	831	7556	714	40
21	611	9998	2356	972	4100	916	5843	829	7585	712	39
22	640	9998	2385	972	4129	915	5873	827	7614	710	38
23	669	9998	2414	971	4159	913	5902	826	7643	708	37
24	698	9998	2443	970	4188	912	5931	824	7672	705	36
25	727	99997	2472	99969	4217	99911	5960	99822	7701	99703	35
26	756	997	2501	969	4246	910	5989	821	7730	701	34
27	785	997	2530	968	4275	909	6018	819	7759	699	33
28	814	997	2560	967	4304	907	6047	817	7788	696	32
29	844	996	2589	966	4333	906	6076	815	7817	694	31
30	873	996	2618	966	4362	905	6105	813	7846	692	30
31	902	99996	2647	99965	4391	99904	6134	99812	7875	99689	29
32	931	996	2676	964	4420	902	6163	810	7904	687	28
33	960	995	2705	963	4449	901	6192	808	7933	685	27
34	989	995	2734	963	4478	900	6221	806	7962	683	26
35	1018	995	2763	962	4507	898	6250	804	7991	680	25
36	1047	995	2792	961	4536	897	6279	803	8020	678	24
37	1076	994	2821	99960	4565	99896	6308	99801	8049	99676	23
38	1105	994	2850	959	4594	894	6337	799	8078	673	22
39	1134	994	2879	959	4623	893	6366	797	8107	671	21
40	1164	993	2908	958	4653	892	6395	795	8136	668	20
41	1193	993	2938	957	4682	890	6424	793	8165	666	19
42	1222	993	2967	956	4711	889	6453	792	8194	664	18
43	1251	99992	2996	99955	4740	99888	6482	99790	8223	99661	17
44	1280	992	3025	954	4769	886	6511	788	8252	659	16
45	1309	991	3054	953	4798	885	6540	786	8281	657	15
46	1338	991	3083	952	4827	883	6569	784	8310	654	14
47	1367	991	3112	952	4856	882	6598	782	8339	652	13
48	1396	990	3141	951	4885	881	6627	780	8368	649	12
49	1425	99990	3170	99950	4914	99879	6656	99778	8397	99647	11
50	1454	989	3199	949	4943	878	6685	776	8426	644	10
51	1483	989	3228	948	4972	876	6714	774	8455	642	9
52	1513	989	3257	947	5001	875	6743	772	8484	639	8
53	1542	988	3286	946	5030	873	6773	770	8513	637	7
54	1571	988	3316	945	5059	872	6802	768	8542	635	6
55	1600	99987	3345	99944	5088	99870	6831	99766	8571	99632	5
56	1629	987	3374	943	5117	869	6860	764	8600	630	4
57	1658	986	3403	942	5146	867	6889	762	8629	627	3
58	1687	986	3432	941	5175	866	6918	760	8658	625	2
59	1716	985	3461	940	5205	864	6947	758	8687	622	1
	N.cos.	N. sine.	N.cos	N sine	N cos	N sine	N.cos	N sine	N cos	N sine	M.
	89°		88°		87°		86°		85°		

Table VIII. Of Natural Sines.

	5°		6°		7°		8°		9°		
M.	N sine	N cos.	N sine	N cos.	N sine	N cos.	N sine	N cos.	N sine	N cos	M.
0	8716	99619	10453	99452	12187	99255	13917	99027	15643	98769	60
1	8745	617	482	449	216	251	946	023	672	764	59
2	8774	614	511	446	245	248	975	019	701	760	58
3	8803	612	540	443	274	244	14004	015	730	755	57
4	8831	609	569	440	302	240	033	011	758	751	56
5	8860	607	597	437	331	237	061	006	787	746	55
6	8889	604	626	434	360	233	090	002	816	741	54
7	8918	99602	10655	99431	12389	99230	14119	98998	15845	98737	53
8	8947	599	684	428	418	226	148	994	873	732	52
9	8976	596	713	424	447	222	177	990	902	728	51
10	9005	594	742	421	476	219	205	986	931	723	50
11	9034	591	771	418	504	215	234	982	959	718	49
12	9063	588	800	415	533	211	263	978	988	714	48
13	9092	99586	10829	99412	12562	99208	14292	98973	16017	98709	47
14	9121	583	858	409	591	204	320	969	046	704	46
15	9150	580	887	406	620	200	349	965	074	700	45
16	9179	578	916	402	649	197	378	961	103	695	44
17	9208	575	945	399	678	193	407	957	132	690	43
18	9237	572	973	396	706	189	436	953	161	686	42
19	9266	99570	11002	99393	12735	99186	14464	98948	16189	98681	41
20	9295	567	031	390	764	182	493	944	218	676	40
21	9324	564	060	386	793	178	522	940	246	671	39
22	9353	562	089	383	822	175	551	936	275	667	38
23	9382	559	118	380	851	171	580	931	304	662	37
24	9411	556	147	377	880	167	608	927	333	657	36
25	9440	99553	11176	99374	12908	99163	14637	98923	16361	98652	33
26	9469	551	205	370	937	160	666	919	390	648	34
27	9498	548	234	367	966	156	695	914	419	643	35
28	9527	545	263	364	995	152	723	910	447	638	32
29	9556	542	291	360	13024	148	752	906	476	633	31
30	9585	540	320	357	053	144	781	902	505	629	30
31	9614	99537	11349	99354	13081	99141	14810	98897	16533	98624	29
32	9642	534	378	351	110	137	838	893	562	619	28
33	9671	531	407	347	139	133	867	889	591	614	27
34	9700	528	436	344	168	129	896	884	620	609	26
35	9729	526	465	341	197	125	925	880	648	604	25
36	9758	523	494	337	226	122	954	876	677	600	24
37	9787	99520	11523	99334	13254	99118	14982	98871	16706	98595	23
38	9816	517	552	331	283	114	15011	867	734	590	22
39	9845	514	580	327	312	110	040	863	763	585	21
40	9874	511	609	324	341	106	069	858	792	580	20
41	9903	508	638	320	370	102	097	854	820	575	19
42	9932	506	667	317	399	098	126	849	849	570	18
43	9961	99503	11696	99314	13427	99094	15155	98845	16878	98565	17
44	9990	500	725	310	456	091	184	841	906	561	16
45	10019	497	754	307	485	087	212	836	935	556	15
46	10048	494	783	303	514	083	241	832	964	551	14
47	10077	491	812	300	543	079	270	827	992	546	13
48	10106	488	840	297	572	075	299	823	17021	541	12
49	10135	99485	11869	99293	13600	99071	15327	98818	17050	98536	11
50	164	482	898	290	629	067	356	814	078	531	10
51	192	479	927	286	658	063	385	809	107	526	9
52	221	476	956	283	687	059	414	805	136	521	8
53	250	473	985	279	716	055	442	800	164	516	7
54	279	470	12014	276	744	051	471	796	193	511	6
55	10308	99467	12043	99272	13773	99047	15500	98791	17222	98506	5
56	337	464	071	269	802	043	529	787	250	501	4
57	366	461	100	265	831	039	557	782	279	496	3
58	395	458	129	262	860	035	586	778	308	491	2
59	424	455	158	258	889	031	615	773	336	486	1
M.	N cos.	N sine	N cos.	N sine	N cos.	N sine	N cos	N sine	N cos.	N sine	M.
	84°		83°		82°		81°		80°		

	10°		11°		12°		13°		14°		
M.	N sine	N cos	N sine	N cos	N sine	N cos	N sine	N cos	N sine	N cos	M.
0	17365	98481	19081	98163	20791	97815	22495	97437	24192	97030	60
1	393	476	109	157	820	809	523	430	220	023	59
2	422	471	138	152	848	803	552	424	249	015	58
3	451	466	167	146	877	797	580	417	277	008	57
4	479	461	195	140	905	791	608	411	305	001	56
5	508	455	224	135	933	784	637	404	33	96994	55
6	537	450	252	129	962	778	665	398	362	987	54
7	17565	98445	19281	98124	20990	97772	22693	97391	24390	96980	53
8	594	440	309	118	21019	766	722	384	418	973	52
9	623	435	338	112	047	760	750	378	446	966	51
10	651	430	366	107	076	754	778	371	474	959	50
11	680	425	395	101	104	748	807	365	503	952	49
12	708	420	423	096	132	742	835	358	531	945	48
13	17737	98414	19452	98090	21161	97735	22863	97351	24559	96937	47
14	766	409	481	084	189	729	892	345	587	930	46
15	794	404	509	079	218	723	920	338	615	923	45
16	823	399	538	073	246	717	948	331	644	916	44
17	852	394	566	067	275	711	977	325	672	909	43
18	880	389	595	061	303	705	23005	318	700	902	42
19	27909	98383	19623	98056	21331	97698	23033	97311	24728	96894	41
20	937	378	652	050	360	692	062	304	756	887	40
21	966	373	680	044	388	686	090	298	784	880	39
22	995	368	709	039	417	680	118	291	813	873	38
23	18023	362	737	033	445	673	146	284	841	866	37
24	052	357	766	027	474	667	175	278	869	858	36
25	18081	98352	19794	98021	21502	97661	23203	97271	24897	96851	35
26	109	347	823	016	530	655	231	264	925	844	34
27	138	341	851	010	559	648	260	257	953	837	33
28	166	336	880	004	587	642	288	251	982	829	32
29	195	331	908	97998	616	636	316	244	25010	822	31
30	224	325	937	992	644	630	345	237	038	815	30
31	18252	98320	19965	97987	21672	97623	23373	97230	25066	96807	29
32	281	315	994	981	701	617	401	223	094	800	28
33	309	310	20022	975	729	611	429	217	122	793	27
34	338	304	051	969	758	604	458	210	151	786	26
35	367	299	079	963	786	598	486	203	179	778	25
36	395	294	108	958	814	592	514	196	207	771	24
37	18424	98288	20136	97952	21843	97585	23542	97189	25235	96764	23
38	452	283	165	946	871	579	571	182	263	756	22
39	481	277	193	940	899	573	599	176	291	749	21
40	509	272	222	934	928	566	627	169	320	742	20
41	538	267	250	928	956	560	656	162	348	734	19
42	567	261	279	922	985	553	684	155	376	727	18
43	18595	98256	20307	97916	22013	97547	23712	97148	25404	96719	17
44	624	250	336	910	041	541	740	141	432	712	16
45	652	245	364	905	070	534	769	134	460	705	15
46	681	240	393	899	098	528	797	127	488	697	14
47	710	234	421	893	126	521	825	120	516	690	13
48	738	229	450	887	155	515	853	113	545	682	12
49	18767	98223	20478	97881	22183	97508	23882	97106	25573	96675	11
50	795	218	507	875	212	502	910	100	601	667	10
51	824	212	535	869	24	496	938	093	629	660	9
52	852	207	563	863	268	489	966	086	657	653	8
53	881	201	592	857	297	483	995	079	685	645	7
54	910	196	620	851	325	476	24023	072	713	638	6
55	18938	98190	20649	97845	22353	97470	24051	97065	25741	96630	5
56	967	185	677	839	382	463	079	058	769	623	4
57	995	179	706	833	410	457	108	051	798	615	3
58	19024	174	734	827	438	450	136	044	826	608	2
59	052	168	763	821	467	444	164	037	854	600	1
M.	N cos	N sine	N cos	N sine	N cos	N sine	N cos	N sine	N cos	N sine	M.
	79°		78°		77°		76°		75°		

Table VIII. Of Natural Sines.

	15°		16°		17°		18°		19°		
M.	N sine	N cos.	N sine	N cos.	N sine	N cos	N sine	N cos	N sine	N cos.	M.
0	25882	96593	27564	96126	29237	95630	30902	95106	32557	94552	60
1	910	585	592	118	265	622	929	097	584	542	59
2	938	578	620	110	293	613	957	088	612	533	58
3	966	570	648	102	321	605	985	079	639	523	57
4	994	562	676	094	348	596	31012	070	667	514	56
5	26022	555	704	086	376	588	040	061	694	504	55
6	050	547	731	078	404	579	068	052	722	495	54
7	26079	96540	27759	96070	29432	95571	31095	95043	32749	94485	53
8	107	532	787	062	460	562	123	033	777	476	52
9	135	514	815	054	487	554	151	024	804	466	51
10	163	517	843	046	515	545	178	015	832	457	50
11	191	509	871	037	543	536	206	006	859	447	49
12	219	502	899	029	571	528	233	94997	887	438	48
13	26247	96494	27927	96021	29599	95519	31261	94988	32914	94428	47
14	275	486	959	013	626	511	289	979	942	418	46
15	303	479	983	005	654	502	316	970	969	409	45
16	331	471	28011	95997	682	493	344	961	997	399	44
17	359	463	039	989	710	485	372	952	33024	390	43
18	387	456	067	981	737	476	399	943	051	380	42
19	26415	96448	28095	95972	29765	95467	31427	94933	33079	94370	41
20	443	440	123	964	793	459	454	924	106	361	40
21	471	433	150	956	821	450	482	915	134	351	39
22	500	425	178	948	849	441	510	906	161	342	38
23	528	417	206	940	876	433	537	897	189	332	37
24	556	410	234	931	904	424	565	888	216	322	36
25	26584	96402	28262	95923	29932	95415	31593	94878	33244	94313	35
26	612	394	290	915	960	407	620	869	271	303	34
27	640	386	318	907	987	398	648	860	298	293	33
28	668	379	346	898	30015	389	675	851	326	284	32
29	696	371	374	890	043	380	703	842	353	274	31
30	724	363	402	882	071	372	730	832	381	264	30
31	26752	96355	28429	95874	30098	95363	31758	94823	33408	94254	29
32	780	347	457	865	126	354	786	814	436	245	28
33	808	340	485	857	154	345	813	805	463	235	27
34	836	332	513	849	182	337	841	795	490	225	26
35	864	324	541	841	209	328	868	786	518	215	25
36	892	316	569	832	237	319	896	777	545	206	24
37	26920	96308	28597	95824	30265	95310	31923	94768	33573	94196	23
38	948	301	625	816	292	301	951	758	600	186	22
39	976	293	652	807	320	293	979	749	627	176	21
40	27004	285	680	799	348	284	32006	740	655	167	20
41	032	277	708	791	376	275	034	730	682	157	19
42	060	269	736	782	403	266	061	721	710	147	18
43	27088	96261	28764	95774	30431	95257	32089	94712	33737	94137	17
44	116	253	792	766	459	248	116	702	764	127	16
45	144	246	820	757	486	240	144	693	792	118	15
46	172	238	847	749	514	231	171	684	819	108	14
47	200	230	875	740	542	222	199	674	846	098	13
48	228	222	903	732	570	213	227	665	874	088	12
49	27256	96214	28931	95724	30597	95204	32254	94656	33901	94078	11
50	284	206	959	715	625	195	282	646	929	068	10
51	312	198	987	707	653	186	309	637	956	058	9
52	340	190	29015	698	680	177	337	627	983	049	8
53	368	182	042	690	708	168	364	618	34011	039	7
54	396	174	070	681	736	159	392	609	038	029	6
55	27424	96166	29098	95673	30763	95150	32419	94599	34065	94019	5
56	452	158	126	664	791	142	447	590	093	009	4
57	480	150	154	656	819	133	474	580	120	93999	3
58	508	142	182	647	846	124	502	571	147	989	2
59	536	134	209	639	874	115	529	561	175	979	1
M.	N cos.	N sine	N cos.	N sine	N cos.	N sine	N cos.	N sine	N cos.	N sine	M.
	74°		73°		72°		71°		70°		

Table VIII. Of Natural Sines.

	20°		21°		22°		23°		24°		
M.	N.sine	N.cos.	N.sine	N.cos.	N.sine	N.cos.	N.sine	N.cos.	N.sine	N.cos.	M.
0	34202	93969	35837	93358	37461	92718	39073	92050	40674	91355	60
1	229	959	864	348	488	707	100	039	700	343	59
2	257	949	891	337	515	697	127	028	727	331	58
3	284	939	918	327	542	686	153	016	753	319	57
4	311	929	945	316	569	675	180	005	780	307	56
5	339	919	973	306	595	664	207	91994	806	295	55
6	366	909	36000	295	622	653	234	982	833	283	54
7	34393	93899	36027	93285	37649	92642	39260	91971	40860	91272	53
8	421	889	054	274	676	631	287	959	886	260	52
9	448	879	081	264	703	620	314	948	913	248	51
10	475	869	108	253	730	609	341	930	939	236	50
11	503	859	135	243	757	598	367	925	966	224	49
12	530	849	162	232	784	587	394	914	992	212	48
13	34557	93839	36190	93222	37811	92576	39421	91902	41019	91200	47
14	584	829	217	211	838	565	448	891	045	188	46
15	612	819	244	201	865	554	474	879	072	176	45
16	639	809	271	190	892	543	501	868	098	163	44
17	666	799	298	180	919	532	528	856	125	152	43
18	694	789	325	160	946	521	555	845	151	140	42
19	34721	93779	36352	93159	37973	92510	39581	91833	41178	91128	41
20	748	769	379	148	999	499	608	822	204	116	40
21	775	759	406	137	38026	488	635	810	231	104	39
22	803	748	434	127	053	477	661	799	257	092	38
23	830	738	461	116	080	466	688	787	284	080	37
24	857	728	488	106	107	455	715	775	310	068	36
25	34884	93718	36515	93095	38134	92444	39741	91764	41337	91056	35
26	912	708	542	084	161	432	768	752	363	044	34
27	939	698	569	074	188	421	795	741	390	032	33
28	966	688	596	063	215	410	822	729	416	020	32
29	993	677	623	052	241	399	848	718	443	008	31
30	35021	667	650	042	268	388	875	706	469	90996	30
31	35048	93657	36677	93031	38295	92377	39902	91694	41496	90984	29
32	075	647	704	020	322	366	928	683	522	972	28
33	102	637	731	010	349	355	955	671	549	960	27
34	130	626	758	92990	376	343	982	660	575	948	26
35	157	616	785	988	403	332	40008	648	602	936	25
36	184	606	812	978	430	321	035	636	628	924	24
37	35211	93596	36839	92967	38456	92310	40062	91625	43655	90911	23
38	239	585	867	956	483	299	088	613	681	899	22
39	266	575	894	945	510	287	115	601	507	887	21
40	293	565	921	935	537	276	141	590	734	875	20
41	320	555	948	924	564	265	168	578	760	863	19
42	347	544	975	913	591	254	195	566	787	851	18
43	35375	93534	37002	92902	38617	92243	40221	91555	41813	90839	17
44	402	524	029	892	644	231	248	543	840	826	16
45	429	514	056	881	671	220	275	531	866	814	15
46	456	503	083	870	698	209	301	519	892	802	14
47	484	493	110	859	725	198	328	508	919	790	13
48	511	483	137	849	752	186	355	496	945	778	12
49	35538	93472	37164	92838	38778	92275	40381	91484	41972	90766	11
50	565	462	191	827	805	164	408	472	998	753	10
51	592	452	218	816	832	152	434	461	42024	741	9
52	619	441	245	805	859	141	461	449	051	729	8
53	647	431	272	794	886	130	488	437	077	717	7
54	674	420	299	784	912	119	514	425	104	704	6
55	35701	93410	37326	92773	38939	92107	40541	91414	42130	90692	5
56	728	400	353	762	966	096	567	402	156	680	4
57	755	389	380	751	993	085	594	390	183	668	3
58	782	379	407	740	39020	073	621	378	209	655	2
59	810	368	434	729	046	062	647	366	235	643	1
M.	N.cos.	N.sine	N.cos.	N.sine	N.cos.	N.sine	N.cos.	N.sine	N.cos.	N.sine	M.
	69°		68°		67°		66°		65°		

Table VIII. Of Natural Sines.

	25°		26°		27°		28°		29°		
M.	N sine	N.cos.	N sine	N.cos.	N sine	N.cos.	N sine	N.cos.	N sine	N cos.	M.
0	42262	90631	43837	89879	45399	89101	46947	88295	48481	87462	60
1	288	618	863	867	425	087	973	281	506	448	59
2	315	606	889	854	451	074	999	267	532	434	58
3	341	594	916	841	477	061	47024	254	557	420	57
4	367	582	942	828	503	048	050	240	583	406	56
5	394	569	968	816	529	035	076	226	608	391	55
6	420	557	994	803	554	021	101	213	634	377	54
7	42446	90545	44020	89790	45580	89008	47127	88199	48659	87363	53
8	473	532	046	777	606	88995	153	185	684	349	52
9	499	520	072	764	632	981	178	172	710	335	51
10	525	507	098	752	658	968	204	158	735	321	50
11	552	495	124	739	684	955	229	144	761	306	49
12	578	483	151	726	710	942	255	130	786	292	48
13	42604	90470	44177	89713	45736	88928	47281	88117	48811	87278	47
14	631	458	203	700	762	915	306	103	837	264	46
15	657	446	229	687	787	902	332	089	862	250	45
16	683	433	255	674	813	888	358	075	888	235	44
17	709	421	281	662	839	875	383	062	913	221	43
18	736	408	307	649	865	862	409	048	938	207	42
19	42762	90396	44333	89636	45891	88848	47434	88034	48964	87193	41
20	788	383	359	623	917	835	460	020	989	178	40
21	815	371	385	610	942	822	486	006	49014	164	39
22	841	358	411	597	968	808	511	87993	040	150	38
23	867	346	437	584	994	795	537	979	065	136	37
24	894	334	464	571	46020	782	562	965	090	121	36
25	42920	90321	44490	89558	46046	88768	47588	87951	49116	87107	35
26	946	309	516	545	072	755	614	937	141	093	34
27	972	296	542	532	097	741	639	923	166	079	33
28	999	284	568	519	123	728	665	909	192	064	32
29	43025	271	594	506	149	715	690	896	217	050	31
30	051	259	620	493	175	701	716	882	242	036	30
31	43077	90246	44646	89480	46201	88688	47741	87868	49268	87021	29
32	104	233	672	467	226	674	767	854	293	007	28
33	130	221	698	454	252	661	793	840	318	86993	27
34	156	208	724	441	278	647	818	826	344	978	26
35	182	196	750	428	304	634	844	812	369	964	25
36	209	183	776	415	330	620	869	798	394	949	24
37	43235	90171	44802	89402	46355	88607	47895	87784	49419	86935	23
38	261	158	828	389	381	593	920	770	445	921	22
39	287	146	854	376	407	580	946	756	470	906	21
40	313	133	880	363	433	566	972	743	495	892	20
41	340	120	906	350	458	553	997	729	521	878	19
42	366	108	932	337	484	539	48022	715	546	863	18
43	43392	90095	44958	89324	46510	88526	48048	87701	49571	86849	17
44	418	082	984	311	536	512	073	687	596	834	16
45	445	070	45010	298	561	499	099	673	622	820	15
46	471	057	036	285	587	485	124	659	647	805	14
47	497	045	062	272	613	472	150	645	672	791	13
48	523	032	088	259	639	458	175	631	697	777	12
49	43549	90019	45114	89245	46664	88445	48201	87617	49723	86762	11
50	575	007	140	232	690	431	226	603	748	748	10
51	602	89994	166	219	716	417	252	589	773	733	9
52	628	981	192	206	742	404	277	575	798	719	8
53	654	968	218	193	767	390	303	561	824	704	7
54	680	956	243	180	793	377	328	546	849	690	6
55	43706	89943	45269	89167	46819	88363	48354	87532	49874	86675	5
56	732	930	295	153	844	349	379	518	899	661	4
57	759	918	321	140	870	336	405	504	924	646	3
58	785	905	347	127	896	322	430	490	950	632	2
59	811	892	373	114	921	308	456	476	975	617	1
M.	N.cos.	N sine	N.cos.	N sine	N.cos.	N sine	N.cos.	N sine	N.cos.	N sine	M.
	64°		63°		62°		61°		60°		

	30°		31°		32°		33°		34°		
M.	N sine	N.cos.	N sine	N.cos.	N sine	N.cos.	N. sine	N.cos.	N sine	N.cos.	M.
0	50000	86603	51504	85717	52992	84805	54464	83867	55919	82904	60
1	025	588	529	702	53017	789	488	851	943	887	59
2	050	573	554	687	041	774	513	835	968	871	58
3	076	559	579	672	066	759	537	819	992	855	57
4	101	544	604	657	091	743	561	804	56016	839	56
5	126	530	628	642	115	728	586	788	040	822	55
6	151	515	653	627	140	712	610	772	064	806	54
7	50176	86501	51678	85612	53164	84697	54635	83756	56088	82790	53
8	201	486	703	597	189	681	659	740	112	773	52
9	227	471	728	582	214	666	683	724	136	757	51
10	252	457	753	567	238	650	708	708	160	741	50
11	277	442	778	551	263	635	732	692	184	724	49
12	302	427	803	536	288	619	756	676	208	708	48
13	50327	86413	51828	85521	53312	84604	54781	83660	56232	82692	47
14	352	398	852	506	337	588	805	645	256	675	46
15	377	384	877	491	361	573	829	629	280	659	45
16	403	369	902	476	386	557	854	613	305	643	44
17	428	354	927	461	411	542	878	597	329	626	43
18	453	340	952	446	455	526	902	581	353	610	42
19	50478	86325	51977	85433	53460	84511	54927	83565	56377	82593	41
20	503	310	52002	416	484	495	951	549	401	577	40
21	528	295	026	401	509	480	975	533	425	561	39
22	553	281	051	385	534	464	999	517	449	544	38
23	578	266	076	370	558	448	55024	501	473	528	37
24	603	251	101	355	583	433	048	485	497	511	36
25	50628	86237	52126	85340	53607	84417	55072	83469	56521	82495	35
26	654	222	151	325	632	402	097	453	545	478	34
27	679	207	175	310	656	386	121	437	569	462	33
28	704	192	200	294	681	370	145	421	593	446	32
29	729	178	225	279	705	355	169	405	617	429	31
30	754	163	250	264	730	339	194	389	641	413	30
31	50775	86148	52275	85249	53754	84324	55218	83373	56665	82396	29
32	804	133	299	234	779	308	242	356	689	380	28
33	829	119	324	218	804	292	266	340	713	363	27
34	854	104	349	203	828	277	291	324	736	347	26
35	879	089	374	188	853	261	315	308	760	330	25
36	904	074	399	173	877	245	339	292	784	314	24
37	50929	86059	52423	85157	53902	84230	55363	83276	56808	82297	23
38	954	045	448	142	926	214	388	260	832	281	22
39	979	030	473	127	951	198	412	244	856	264	21
40	51004	015	498	112	975	182	436	228	880	248	20
41	029	000	522	096	54000	167	460	212	904	231	19
42	054	85985	547	081	024	151	484	195	928	214	18
43	51079	85970	52572	85066	54049	84135	55509	83179	56952	82198	17
44	104	956	597	051	073	120	533	163	976	181	16
45	129	941	621	035	097	104	557	147	57000	165	15
46	154	926	646	020	122	088	581	131	024	148	14
47	179	911	671	005	146	072	605	115	047	132	13
48	204	896	696	84989	171	057	630	098	071	115	12
49	51229	85881	52720	84974	54195	84041	55654	83082	57095	82098	11
50	254	866	745	959	220	025	678	066	119	082	10
51	279	851	770	943	244	009	702	050	143	065	9
52	304	836	794	928	269	83994	726	034	167	049	8
53	329	821	819	913	293	978	750	017	191	032	7
54	354	806	844	897	317	962	775	001	215	015	6
55	51379	85792	52869	84882	54342	83946	55799	82985	57238	81999	5
56	404	777	893	866	366	930	823	969	262	982	4
57	429	762	918	851	391	915	847	953	286	965	5
58	454	747	943	836	415	899	871	936	310	949	2
59	479	732	967	820	440	883	895	920	334	932	1
M.	N cos	N sine	N.cos.	N sine	N.cos.	N sine	N.cos.	N sine	N.cos.	N sine	M.
	59°		58°		57°		56°		55°		

Table VIII. Of Natural Sines.

	35°		36°		37°		38°		39°		
M.	N sine	N cos.	N sine	N cos.	N sine	N cos.	N sine	N cos.	N sine	N cos.	M.
0	57358	81915	58779	80902	60181	79864	61566	78801	62932	77715	60
1	381	899	802	885	205	846	589	783	955	696	59
2	405	882	826	867	228	829	612	765	977	678	58
3	429	865	849	850	251	811	635	747	63000	660	57
4	453	848	873	833	274	793	658	729	022	641	56
5	477	832	896	816	298	776	681	711	045	623	55
6	501	815	920	799	321	758	704	693	068	605	54
7	57524	81798	58943	80782	60344	79741	61726	78676	63090	77586	53
8	548	781	967	765	367	723	749	658	113	568	52
9	572	765	990	748	390	706	772	640	135	550	51
10	596	748	59014	730	414	698	795	622	158	531	50
11	619	731	037	713	437	671	818	604	180	513	49
12	643	714	061	696	460	653	841	586	203	494	48
13	57667	81698	59084	80679	60483	79635	61864	78568	63225	77476	47
14	691	681	107	662	506	618	887	550	248	458	46
15	715	664	131	644	529	600	909	532	271	439	45
16	738	647	154	627	553	583	932	514	293	421	44
17	762	631	178	610	576	565	955	496	316	402	43
18	786	614	201	593	599	547	978	478	338	384	42
19	57809	81597	59225	80576	60622	79530	62001	78460	63361	77366	41
20	833	580	248	558	645	512	024	442	383	347	40
21	857	563	272	541	668	494	046	424	406	329	39
22	881	546	295	524	691	477	069	405	428	310	38
23	904	530	318	507	714	459	092	387	451	292	37
24	928	513	342	489	738	441	115	369	473	273	36
25	57952	81496	59365	80472	60761	79424	62138	78351	63496	77255	35
26	976	479	389	455	784	406	160	333	518	236	34
27	999	462	412	438	807	388	183	315	540	218	33
28	58023	445	435	420	830	371	206	297	563	199	32
29	047	428	459	403	853	353	229	279	585	181	31
30	070	412	482	387	876	335	251	261	608	162	30
31	58094	81395	59506	80368	60899	79318	62274	78243	63630	77144	29
32	118	378	529	351	922	300	297	225	653	125	28
33	141	361	552	334	945	282	320	206	675	107	27
34	165	344	576	316	968	264	342	188	698	088	26
35	189	327	599	299	991	247	365	170	720	070	25
36	212	310	622	282	61015	229	388	152	742	051	24
37	58236	81293	59646	80264	61038	79211	62411	78134	63765	77033	23
38	260	276	669	247	061	193	433	116	787	014	22
39	283	259	693	230	084	176	456	098	810	76996	21
40	307	242	716	212	107	158	479	079	832	977	20
41	330	225	739	195	130	140	502	061	854	959	19
42	354	208	763	178	153	122	524	043	877	940	18
43	58378	81191	59786	80160	61176	79105	62547	78025	63899	76921	17
44	401	174	809	143	199	087	570	007	922	903	16
45	425	157	832	125	222	069	592	77988	944	884	15
46	449	140	856	108	245	051	615	970	966	866	14
47	472	123	879	091	268	033	638	952	989	847	13
48	496	106	902	073	291	015	660	934	64011	828	12
49	58519	81089	59926	80056	61314	78998	62683	77916	64033	76810	11
50	543	072	949	038	337	980	706	897	056	791	10
51	567	055	972	021	360	962	728	879	078	772	9
52	590	038	995	003	383	944	751	861	100	754	8
53	614	021	60019	79986	406	926	774	843	123	735	7
54	637	004	042	968	429	908	796	824	145	717	6
55	58661	80987	60065	79951	61451	78891	62819	77806	64167	76698	5
56	684	970	089	934	474	873	842	788	190	679	4
57	708	953	112	916	497	855	864	769	212	661	3
58	731	936	135	899	520	837	887	751	234	642	2
59	755	919	158	881	543	819	909	733	256	623	1
M.	N cos.	N sine	N cos.	N sine	N cos.	N sine	N cos.	N sine	N cos.	N sine	M.
	54°		53°		52°		51°		50°		

	40°		41°		42°		43°		44°		
M.	N sine	N cos.	N sine	N cos.	N sine	N cos.	N sine	N cos	N sine	N cos	M.
0	64279	76604	65606	75471	66913	74314	68200	73135	69466	71934	60
1	301	586	628	452	935	295	221	116	487	914	59
2	323	567	650	433	956	276	242	096	508	894	58
3	346	548	672	414	978	256	264	076	529	873	57
4	368	530	694	395	999	237	285	056	549	853	56
5	390	511	716	375	67021	217	306	036	570	833	55
6	412	492	738	356	043	198	327	016	591	813	54
7	64435	76473	65759	75337	67064	74178	68349	72996	69612	71792	53
8	457	455	781	318	086	159	370	976	633	772	52
9	479	436	803	299	107	139	391	957	654	752	51
10	501	417	825	280	129	120	412	937	675	732	40
11	524	398	847	261	151	100	433	917	696	711	49
12	546	380	869	241	172	080	455	897	717	691	48
13	64568	76361	65891	75222	67194	74061	68476	72877	69737	71671	47
14	590	342	913	203	215	041	497	857	758	650	46
15	612	323	935	184	237	022	518	837	779	630	45
16	635	304	956	165	258	002	539	817	800	610	44
17	657	286	978	146	280	73983	561	797	821	590	43
18	679	267	66000	126	301	963	582	777	842	569	42
19	64701	76248	66022	75107	67323	73944	68603	72757	69862	71549	41
20	723	229	044	088	344	924	624	737	883	529	40
21	746	210	066	069	366	904	645	717	904	508	39
22	768	192	088	050	387	885	666	697	925	488	38
23	790	173	109	030	409	865	688	677	946	468	37
24	812	154	131	011	430	846	709	657	966	447	36
25	64834	76135	66153	74992	67452	73826	68730	72637	69987	71427	35
26	856	116	175	973	473	806	751	617	70008	407	34
27	878	097	197	953	495	787	772	597	029	386	33
28	901	078	218	934	516	767	793	577	049	366	32
29	923	059	240	955	538	747	814	557	070	345	31
30	945	041	262	896	519	728	835	537	091	325	30
31	64967	76022	66284	74876	67580	73708	68857	72517	70112	71305	29
32	989	003	306	857	602	688	878	497	132	284	28
33	65011	75984	327	838	623	669	899	477	153	264	27
34	033	965	349	818	645	649	920	457	174	243	26
35	055	946	371	799	666	629	941	437	195	223	25
36	077	927	393	780	688	610	962	417	215	203	24
37	65099	75908	66414	74760	67709	73590	68983	72397	70236	71182	23
38	122	889	436	741	730	570	69004	377	257	162	22
39	144	870	458	722	751	551	025	357	277	141	21
40	166	851	480	703	773	531	046	337	298	121	20
41	188	832	501	683	795	511	067	317	319	100	19
42	210	813	523	664	816	491	088	297	339	080	18
43	65232	75794	66545	74644	67837	73472	69109	72277	70360	71059	17
44	254	775	566	625	859	452	130	257	381	039	16
45	276	756	588	606	880	432	151	236	401	019	15
46	298	738	610	586	901	412	172	216	422	70998	14
47	320	719	632	567	923	393	193	196	443	978	13
48	342	699	653	548	944	373	214	176	463	957	12
49	65364	75680	66675	74528	67965	73353	69235	72156	70484	70937	11
50	386	661	697	509	987	333	256	136	505	916	10
51	408	642	718	489	68008	314	277	116	525	896	9
52	430	623	740	470	029	294	298	095	546	875	8
53	452	604	762	451	051	274	319	075	567	855	7
54	474	685	783	431	072	254	340	055	587	834	6
55	65496	75566	66805	74412	68093	73234	69361	72035	70608	70813	5
56	518	547	827	392	115	215	382	015	628	793	4
57	540	528	848	373	136	195	403	71995	649	772	3
58	562	509	870	353	157	175	424	974	670	752	2
59	584	490	891	334	179	155	445	954	690	731	1
M.	N cos.	N sine	N cos	N sine	N cos.	N sine	N cos	N sine	N cos.	N sine	M.
	49°		48°		47°		46°		45°		

S.	h ′ 0° 0′	h ′ 0° 1′	h ′ 0° 2′	h ′ 0° 3′	h ′ 0° 4′	h ′ 0° 5′	h ′ 0° 6′	h 0° 7′	h ′ 0° 8′
0		2.2553	1.9542	1.7782	1.6532	1.5563	1.4771	1.4102	1.3522
1	4.0334	2481	9506	7757	6514	5548	4759	4091	3513
2	3.7324	2410	9470	7733	6496	5534	4747	4081	3504
3	3.5563	2341	9435	7710	6478	5520	4735	4071	3495
4	3.4313	2272	9400	7686	6460	5505	4723	4060	3486
5	3.3344	2205	9365	7662	6442	5491	4711	4050	3477
6	3.2553	2139	9331	7639	6425	5477	4699	4040	3468
7	3.1883	2073	9296	7616	6407	5463	4687	4030	3459
8	3.1303	2009	9262	7592	6390	5449	4676	4020	3450
9	3.0792	1946	9228	7570	6372	5435	4664	4010	3441
10	3.0334	2.1883	1.9195	1.7546	1.6355	1.5420	1.4652	1.3999	1.3432
11	2.9920	1821	9161	7524	6337	5306	4640	3989	3423
12	9542	1761	9128	7501	6320	5393	4629	3979	3415
13	9195	1701	9096	7478	6303	5379	4617	3969	3406
14	8873	1642	9063	7456	6286	5365	4605	3959	3397
15	8573	1584	9031	7434	6269	5351	4594	3949	3388
16	8293	1526	8999	7411	6252	5337	4582	3939	3379
17	8030	1469	8967	7389	6235	5323	4571	3929	3370
18	7782	1413	8935	7368	6218	5310	4559	3919	3362
19	7546	1358	8904	7345	6201	5296	4548	3909	3353
20	2.7324	2.1303	1.8873	1.7324	1.6184	1.5283	1.4536	1.3899	1.3344
21	7112	1249	8842	7302	6168	5269	4525	3890	3336
22	6910	1196	8811	7281	6151	5255	4513	3880	3327
23	6717	1143	8781	7259	6134	5242	4502	3870	3318
24	6532	1091	8751	7238	6118	5229	4491	3860	3310
25	6355	1040	8720	7216	6102	5215	4479	3850	3301
26	6184	0989	8690	7195	6085	5202	4468	3841	3293
27	6021	0939	8661	7175	6065	5189	4457	3831	3284
28	5862	0889	8631	7153	6053	5175	4446	3821	3275
29	5710	0840	8602	7133	6037	5162	4435	3812	3267
30	2.5563	2.0792	1.8573	1.7112	1.6021	1.5149	1.4424	1.3802	1.3259
31	5420	0744	8544	7091	6004	5136	4412	3792	3250
32	5283	0696	8516	7071	5988	5123	4401	3783	3241
33	5149	0649	8487	7050	5973	5110	4390	3773	3233
34	5019	0603	8459	7030	5957	5097	4379	3763	3224
35	4893	0557	8431	7010	5941	5084	4368	3754	3216
36	4771	0512	8403	6990	5925	5071	4357	3745	3208
37	4652	0466	8375	6969	5909	5058	4346	3735	3199
38	4536	0422	8347	6949	5894	5045	4335	3725	3191
39	4424	0378	8320	6930	5878	5032	4325	3716	3183
40	2.4313	2.0334	1.8293	1.6910	1.5862	1.5019	1.4313	1.3706	1.3174
41	4206	0291	8266	6890	5847	5006	4303	3697	3166
42	4102	0248	8239	6871	5832	4994	4292	3688	3158
43	3999	0206	8212	6851	5816	4981	4281	3678	3149
44	3899	0164	8186	6832	5801	4968	4270	3669	3141
45	3802	0122	8159	6812	5786	4956	4260	3660	3133
46	3706	0081	8133	6793	5770	4943	4249	3650	3124
47	3613	0040	8107	6774	5755	4931	4238	3641	3116
48	3522	0000	8081	6755	5740	4918	4228	3632	3108
49	3432	1.9960	8055	6736	5725	4906	4217	3622	3099
50	2.3344	1.9920	1.8030	1.6717	1.5710	1.4893	1.4206	1.3613	1.3091
51	3259	9881	8004	6698	5695	4881	4196	3604	3083
52	3174	9842	7979	6679	5680	4869	4185	3595	3075
53	3091	9803	7954	6660	5665	4856	4175	3585	3067
54	3010	9765	7929	6642	5651	4844	4165	3576	3059
55	2930	9727	7904	6623	5636	4832	4154	3567	3050
56	2852	9689	7879	6605	5621	4820	4143	3558	3042
57	2775	9652	7855	6587	5607	4808	4133	3549	3034
58	2700	9615	7830	6568	5592	4795	4122	3540	3026
59	2626	9579	7805	6550	5577	4783	4112	3531	3018
60	2.2553	1.9542	1.7782	1.6532	1.5563	1.4771	1.4102	1.3522	1.3010

Table IX. Proportional Logarithms.

S.	h ′ 0° 9′	h ′ 0° 10′	h ′ 0° 11′	h ′ 0° 12′	h ′ 0° 13′	h ′ 0° 14′	h ′ 0° 15′	h ′ 0° 16′	h ′ 0° 17′
0	1.3010	1.2553	1.2139	1.1761	1.1413	1.1091	1.0792	1.0512	1.0248
1	3002	2545	2132	1755	1408	1086	0787	0507	0244
2	2994	2538	2125	1749	1402	1081	0782	0502	0240
3	2986	2531	2119	1743	1397	1076	0777	0498	0235
4	2978	2524	2112	1737	1391	1071	0772	0493	0231
5	2970	2517	2106	1731	1385	1066	0768	0489	0227
6	2962	2510	2099	1725	1380	1061	0763	0484	0224
7	2954	2502	2093	1719	1374	1055	0758	0480	0218
8	2946	2495	2086	1713	1369	1050	0753	0475	0214
9	2939	2488	2080	1707	1363	1045	0749	0471	0210
10	1.2931	1.2481	1.2073	1.1701	1.1358	1.1040	1.0744	1.0466	1.0206
11	2923	2474	2067	1695	1352	1035	0739	0462	0201
12	2915	2467	2061	1689	1347	1030	0734	0458	0197
13	2907	2459	2054	1683	1341	1025	0729	0453	0193
14	2899	2452	2047	1677	1336	1020	0725	0448	0189
15	2891	2445	2041	1671	1331	1015	0720	0444	0185
16	2883	2438	2035	1665	1325	1009	0715	0440	0180
17	2875	2431	2028	1659	1319	1004	0710	0435	0176
18	2868	2424	2022	1654	1314	0990	0706	0431	0172
19	2860	2417	2015	1648	1309	0994	0701	0426	0168
20	1.2852	1.2410	1.2009	1.1642	1.1303	1.0989	1.0696	1.0422	1.0164
21	2845	2403	2003	1636	1298	0984	0692	0418	0160
22	2837	2396	1996	1630	1292	0979	0687	0413	0155
23	2829	2389	1990	1624	1287	0974	0682	0408	0151
24	2821	2382	1984	1619	1282	0969	0678	0404	0147
25	2814	2375	1977	1613	1276	0964	0673	0400	0143
26	2806	2368	1971	1607	1271	0959	0668	0395	0139
27	2798	2362	1965	1601	1266	0954	0663	0391	0135
28	2791	2355	1958	1595	1260	0949	0659	0386	0130
29	2783	2348	1952	1589	1255	0944	0654	0382	0126
30	1.2775	1.2341	1.1946	1.1584	1.1249	1.0939	1.0649	1.0378	1.0122
31	2768	2334	1939	1578	1244	0934	0645	0373	0118
32	2760	2327	1933	1572	1238	0929	0640	0369	0114
33	2753	2320	1927	1566	1233	0924	0635	0365	0110
34	2745	2313	1920	1560	1228	0919	0631	0360	0106
35	2737	2306	1914	1555	1222	0914	0626	0356	0102
36	2730	2300	1908	1549	1217	0909	0621	0352	0098
37	2722	2293	1902	1543	1212	0904	0617	0347	0093
38	2715	2286	1895	1537	1206	0899	0612	0343	0089
39	2707	2279	1889	1532	1201	0894	0608	0339	0085
40	1.2700	1.2272	1.1883	1.1526	1.1196	1.0889	1.0603	1.0334	1.0081
41	2692	2265	1877	1520	1191	0884	0598	0330	0077
42	2685	2259	1871	1515	1186	0880	0594	0326	0073
43	2677	2252	1864	1509	1180	0875	0589	0321	0069
44	2670	2245	1858	1503	1175	0870	0584	0317	0065
45	2663	2239	1852	1498	1170	0865	0580	0313	0061
46	2655	2232	1846	1492	1164	0860	0575	0308	0057
47	2648	2225	1840	1486	1159	0855	0571	0304	0053
48	2640	2218	1834	1481	1154	0850	0566	0300	0049
49	2633	2212	1828	1475	1148	0845	0561	0295	0044
50	1.2626	1.2205	1.1822	1.1469	1.1143	1.0840	1.0557	1.0291	1.0040
51	2618	2198	1816	1464	1138	0835	0552	0287	0036
52	2611	2192	1809	1458	1133	0830	0548	0282	0032
53	2603	2185	1803	1452	1128	0826	0543	0278	0028
54	2596	2178	1797	1447	1123	0821	0539	0274	0024
55	2589	2172	1791	1441	1117	0816	0534	0269	0020
56	2582	2165	1785	1435	1112	0811	0529	0265	0016
57	2574	2159	1779	1430	1107	0806	0525	0261	0012
58	2567	2152	1773	1424	1102	0801	0520	0257	0008
59	2560	2145	1767	1419	1096	0796	0516	0252	0004
60	1.2553	1.2139	1.1761	1.1413	1.1091	1.0792	1.0512	1.0248	1.0000

S.	h ′ 0° 18′	h ′ 0° 19′	h ′ 0° 20′	h ′ 0° 21′	h ′ 0° 22′	h ′ 0° 23′	h ′ 0° 24′	h ′ 0° 25′	h ′ 0° 26′	h ′ 0° 27′	h ′ 0° 28′	h ′ 0° 29′
0	10000	9765	9542	9331	9128	8935	8751	8573	8403	8239	8081	7929
1	9996	9761	9539	9327	9125	8932	8748	8570	8400	8236	8078	7926
2	9992	9757	9535	9323	9122	8929	8745	8567	8397	8234	8076	7924
3	9988	9754	9532	9320	9119	8926	8742	8565	8395	8231	8073	7921
4	9984	9750	9528	9317	9115	8923	8739	8562	8392	8228	8071	7919
5	9980	9746	9524	9313	9112	8920	8736	8559	8389	8225	8068	7916
6	9976	9742	9521	9310	9109	8917	8733	8556	8386	8223	8066	7914
7	9972	9738	9517	9306	9105	8913	8730	8553	8383	8220	8063	7911
8	9968	9735	9513	9303	9102	8910	8727	8550	8381	8217	8060	7909
9	9964	9731	9510	9300	9099	8907	8724	8547	8378	8215	8058	7906
10	9960	9727	9506	9296	9096	8904	8721	8544	8375	8212	8055	7904
11	9956	9723	9503	9293	9092	8901	8718	8541	8372	8209	8053	7901
12	9952	9720	9499	9289	9089	8898	8715	8539	8370	8207	8050	7899
13	9948	9716	9495	9286	9086	8895	8712	8536	8367	8204	8047	7896
14	9944	9712	9492	9282	9082	8891	8709	8533	8364	8202	8045	7894
15	9940	9708	9488	9279	9079	8888	8706	8530	8361	8199	8043	7891
16	9936	9704	9485	9276	9076	8885	8703	8527	8358	8196	8040	7889
17	9932	9701	9481	9272	9073	8882	8700	8524	8356	8194	8037	7886
18	9928	9697	9478	9269	9070	8879	8697	8522	8353	8191	8035	7884
19	9924	9693	9474	9265	9066	8876	8694	8519	8350	8188	8032	7881
20	9920	9689	9470	9262	9063	8873	8691	8516	8347	8186	8030	7879
21	9916	9686	9467	9259	9060	8870	8688	8513	8345	8183	8027	7877
22	9912	9682	9463	9255	9056	8867	8685	8510	8342	8180	8024	7874
23	9908	9678	9460	9252	9053	8864	8682	8507	8339	8178	8022	7872
24	9905	9675	9456	9249	9050	8861	8679	8504	8337	8175	8020	7869
25	9901	9671	9453	9245	9047	8857	8676	8501	8334	8172	8017	7867
26	9897	9667	9449	9242	9044	8854	8673	8498	8331	8170	8014	7864
27	9893	9664	9446	9238	9041	8851	8670	8496	8328	8167	8012	7862
28	9889	9660	9442	9233	9037	8848	8667	8493	8326	8164	8009	7859
29	9885	9656	9439	9231	9034	8845	8664	8490	8323	8162	8007	7857
30	9881	9652	9435	9228	9031	8842	8661	8487	8320	8159	8004	7855
31	9877	9648	9431	9225	9027	8839	8658	8484	8317	8157	8002	7852
32	9873	9645	9428	9221	9024	8836	8655	8481	8315	8154	7999	7849
33	9869	9641	9425	9218	9021	8833	8652	8479	8312	8152	7997	7847
34	9865	9637	9421	9215	9018	8830	8649	8476	8309	8149	7994	7844
35	9861	9634	9417	9211	9015	8827	8646	8473	8306	8146	7991	7842
36	9858	9630	9414	9208	9012	8824	8643	8470	8304	8144	7989	7840
37	9854	9626	9410	9205	9008	8820	8640	8467	8301	8141	7986	7837
38	9850	9623	9407	9201	9005	8817	8637	8464	8298	8138	7984	7835
39	9846	9619	9404	9198	9002	8814	8635	8462	8296	8136	7981	7832
40	9842	9615	9400	9195	8999	8811	8632	8459	8293	8133	7979	7830
41	9838	9612	9396	9191	8995	8808	8629	8456	8290	8130	7976	7827
42	9834	9608	9393	9188	8992	8805	8626	8453	8288	8128	7974	7825
43	9830	9604	9389	9185	8989	8802	8623	8450	8285	8125	7971	7823
44	9826	9601	9386	9181	8986	8799	8620	8448	8282	8122	7969	7820
45	9823	9597	9383	9178	8983	8796	8617	8445	8279	8120	7966	7818
46	9819	9593	9379	9175	8980	8793	8614	8442	8277	8117	7964	7815
47	9815	9590	9375	9171	8976	8790	8611	8439	8274	8115	7961	7813
48	9811	9586	9372	9168	8973	8787	8608	8437	8271	8112	7959	7811
49	9807	9582	9368	9165	8970	8784	8605	8434	8268	8109	7956	7808
50	9803	9579	9365	9161	8967	8781	8602	8431	8266	8107	7954	7805
51	9800	9575	9362	9158	8964	8778	8599	8428	8263	8104	7951	7803
52	9796	9571	9358	9155	8960	8775	8596	8425	8260	8102	7949	7801
53	9792	9568	9355	9151	8957	8472	8593	8422	8258	8099	7946	7798
54	9788	9564	9351	9148	8954	8769	8591	8420	8255	8097	7944	7796
55	9784	9560	9348	9145	8951	8766	8588	8417	8252	8094	7941	7793
56	9780	9557	9344	9141	8948	8763	8585	8414	8250	8091	7939	7791
57	9777	9553	9341	9138	8945	8760	8582	8411	8247	8089	7936	7789
58	9773	9549	9337	9135	8942	8757	8579	8408	8244	8086	7934	7786
59	9769	9546	9334	9132	8938	8754	8576	8406	8242	8084	7931	7784
60	9765	9542	9331	9128	8935	8751	8573	8403	8239	8081	7929	7782

Table IX. Proportional Logarithms.

S.	h ′ 0° 30′	h ′ 0° 31′	h ′ 0° 32′	h ′ 0° 33′	h ′ 0° 34′	h ′ 0° 35′	h ′ 0° 36′	h ′ 0° 37′	h ′ 0° 38′	h ′ 0° 39′	h ′ 0° 40′	h ′ 0° 41′
0	7782	7630	7501	7368	7238	7112	6990	6871	6755	6642	6532	6425
1	7779	7637	7499	7365	7236	7110	6988	6869	6753	6640	6530	6423
2	7776	7634	7496	7363	7234	7108	6986	6867	6751	6638	6528	6421
3	7774	7632	7494	7361	7232	7106	6984	6865	6749	6637	6527	6420
4	7772	7630	7492	7359	7229	7104	6982	6863	6747	6635	6525	6418
5	7769	7627	7490	7356	7227	7102	6980	6861	6745	6633	6523	6416
6	7767	7625	7488	7354	7225	7100	6978	6859	6743	6631	6521	6414
7	7764	7623	7485	7352	7223	7097	6976	6857	6741	6629	6519	6412
8	7762	7620	7483	7350	7221	7095	6974	6855	6739	6627	6517	6411
9	7760	7618	748	7348	7219	7093	6972	6853	6738	6625	6516	6409
10	7757	7616	7478	7345	7216	7091	6970	6851	6736	6623	6514	6407
11	7755	7613	7476	7343	7214	7089	6968	6849	6734	6621	6512	6405
12	7753	7611	7474	7341	7212	7087	6966	6847	6732	6620	6510	6404
13	7750	7609	7472	7339	7210	7085	6964	6845	6730	6618	6508	6402
14	7748	7606	7469	7337	7208	7083	6962	6843	6728	6616	6507	6400
15	7745	7604	7467	7335	7206	7081	6960	6841	6726	6614	6505	6398
16	7743	7602	7465	7332	7204	7079	6958	6839	6724	6612	6503	6397
17	7740	7599	7463	7330	7202	7077	6956	6837	6722	6610	6501	6395
18	7738	7597	7461	7328	7200	7075	6954	6836	6721	6609	6500	6393
19	7736	7595	7458	7326	7197	7073	6952	6834	6719	6607	6498	6391
20	7733	7592	7456	7324	7195	7071	6950	6832	6717	6605	6496	6390
21	7731	7590	7454	7322	7193	7069	6948	6830	6715	6603	6494	6388
22	7729	7588	7452	7319	7191	7067	6946	6828	6713	6601	6492	6386
23	7726	7586	7449	7317	7189	7065	6944	6826	6711	6599	6490	6384
24	7724	7583	7447	7315	7187	7063	6942	6824	6709	6598	6489	6383
25	7721	7581	7445	7313	7185	7061	6940	6822	6707	6596	6487	6381
26	7719	7579	7443	7311	7183	7059	6938	6820	6705	6594	6485	6379
27	7717	7577	7441	7309	7181	7057	6936	6818	6704	6592	6484	6377
28	7714	7574	7438	7306	7179	7054	6934	6816	6702	6590	6482	6376
29	7712	7572	7436	7304	7177	7052	6932	6814	6700	6588	6480	6374
30	7710	7570	7434	7302	7175	7050	6930	6812	6698	6587	6478	6372
31	7707	7567	7431	7300	7172	7048	6928	6810	6696	6585	6476	6370
32	7705	7565	7429	7298	7170	7046	6926	6808	6694	6583	6474	6369
33	7703	7563	7427	7296	7168	7044	6924	6807	6692	6581	6473	6367
34	7700	7560	7425	7293	7166	7042	6922	6805	6690	6579	6471	6365
35	7698	7558	7423	7291	7164	7040	6920	6803	6689	6577	6469	6363
36	7696	7556	7421	7289	7162	7038	6918	6801	6687	6576	6467	6362
37	7693	7553	7418	7287	7160	7036	6916	6799	6685	6574	6465	6360
38	7691	7551	7416	7285	7158	7034	6914	6797	6683	6572	6464	6358
39	7688	7549	7414	7283	7156	7032	6912	6795	6681	6570	6462	6357
40	7686	7546	7411	7281	7153	7030	6910	6793	6679	6568	6460	6355
41	7683	7544	7409	7278	7151	7028	6908	6791	6677	6566	6458	6353
42	7681	7542	7407	7276	7149	7026	6906	6789	6676	6565	6457	6351
43	7679	7540	7405	7274	7147	7024	6904	6787	6674	6563	6455	6349
44	7676	7537	7403	7272	7145	7022	6902	6785	6676	6561	6453	6348
45	7674	7535	7401	7270	7143	7020	6900	6784	6670	6559	6451	6346
46	7672	7533	7398	7268	7141	7018	6898	6782	6668	6557	6449	6344
47	7669	7531	7396	7266	7139	7016	6896	6780	6666	6556	6448	6342
48	7667	7528	7394	7264	7137	7014	6894	6778	6664	6554	6446	6341
49	7665	7526	7392	7261	7135	7012	6892	6776	6662	6552	6444	6339
50	7662	7524	7389	7259	7133	7010	6890	6774	6660	6550	6442	6337
51	7660	7522	7387	7257	7131	7008	6888	6772	6659	6548	6441	6336
52	7658	7519	7385	7255	7128	7006	6886	6770	6657	6546	6439	6334
53	7655	7517	7383	7253	7126	7004	6884	6768	6655	6545	6437	6332
54	7653	7515	7381	7251	7124	7002	6882	6766	6653	6543	6435	6331
55	7651	7512	7378	7248	7122	7000	6880	6764	6651	6541	6434	6329
56	7648	7510	7376	7246	7120	6998	6878	6762	6649	6539	6432	6327
57	7646	7508	7374	7244	7119	6996	6877	6761	6648	6538	6430	6325
58	7644	7506	7372	7242	7116	6994	6875	6759	6646	6536	6428	6323
59	7641	7503	7370	7240	7114	6992	6873	6757	6644	6534	6426	6322
60	7639	7501	7368	7238	7112	6990	6871	6755	6642	6532	6425	6320

Table IX. Proportional Logarithms.

S.	h ′ 0° 42′	h ′ 0° 43′	h ′ 0° 44′	h ′ 0° 45′	h ′ 0° 46′	h ′ 0° 47′	h ′ 0° 48′	h ′ 0° 49′	h ′ 0° 50′	h ′ 0° 51′	h ′ 0° 52′	h ′ 0° 53′
0	6320	6218	6118	6021	5925	5832	5740	5651	5563	5477	5393	5310
1	6318	6216	6116	6019	5923	5830	5739	5649	5561	5475	5391	5308
2	6317	6214	6115	6017	5922	5828	5737	5648	5560	5474	5390	5307
3	6315	6213	6113	6016	5920	5827	5736	5646	5559	5473	5389	5306
4	6313	6211	6111	6014	5919	5825	5734	5645	5557	5471	5387	5304
5	6311	6209	6110	6012	5917	5824	5733	5643	5556	5470	5386	5303
6	6310	6208	6108	6011	5916	5823	5731	5642	5554	5469	5384	5302
7	6308	6206	6106	6009	5914	5821	5730	5640	5553	5467	5383	5300
8	6306	6204	6105	6008	5912	5819	5728	5639	5551	5465	5381	5299
9	6305	6203	6103	6006	5911	5818	5727	5637	5550	5464	5380	5298
10	6303	6201	6102	6004	5909	5816	5725	5636	5548	5463	5379	5296
11	6301	6199	6100	6003	5908	5815	5724	5634	5547	5461	5377	5295
12	6300	6198	6099	6001	5906	5813	5722	5633	5546	5460	5376	5294
13	6298	6196	6097	6000	5905	5812	5721	5631	5544	5458	5374	5292
14	6296	6194	6095	5998	5903	5810	5719	5630	5543	5457	5373	5291
15	6294	6193	6094	5997	5902	5809	5718	5629	5541	5456	5372	5290
16	6293	6191	6092	5995	5900	5807	5716	5627	5540	5454	5370	5288
17	6291	6189	6090	5993	5898	5805	5715	5626	5538	5453	5369	5287
18	6289	6188	6089	5992	5897	5804	5713	5624	5537	5452	5368	5285
19	6287	6186	6087	5990	5895	5802	5712	5623	5535	5450	5366	5284
20	6286	6184	6086	5988	5894	5801	5710	5621	5534	5449	5365	5283
21	6284	6183	6084	5987	5892	5800	5709	5620	5533	5447	5364	5281
22	6282	6181	6082	5985	5890	5798	5707	5618	5531	5446	5362	5280
23	6281	6179	6080	5984	5889	5796	5706	5617	5530	5444	5361	5278
24	6279	6178	6079	5982	5888	5795	5704	5615	5528	5443	5359	5277
25	6277	6176	6077	5980	5886	5793	5703	5614	5527	5441	5358	5276
26	6275	6174	6075	5979	5884	5792	5701	5612	5525	5440	5356	5274
27	6274	6173	6074	5977	5883	5790	5700	5611	5524	5439	5355	5273
28	6272	6171	6072	5976	5881	5789	5698	5609	5522	5437	5354	5272
29	6270	6169	6071	5974	5880	5787	5697	5608	5521	5436	5352	5270
30	6269	6168	6069	5973	5878	5786	5695	5607	5520	5435	5351	5269
31	6267	6166	6067	5971	5876	5784	5694	5605	5519	5433	5350	5268
32	6265	6164	6066	5969	5875	5783	5693	5604	5517	5432	5348	5266
33	6264	6163	6064	5968	5874	5781	5691	5602	5516	5430	5347	5265
34	6262	6161	6062	5966	5872	5779	5689	5601	5514	5429	5345	5264
35	6260	6159	6061	5964	5870	5778	5688	5599	5512	5427	5344	5262
36	6259	6158	6059	5963	5869	5777	5686	5598	5511	5426	5343	5261
37	6257	6156	6058	5961	5867	5775	5685	5596	5510	5425	5341	5260
38	6255	6154	6056	5960	5866	5773	5683	5595	5508	5423	5340	5258
39	6254	6153	6055	5958	5864	5772	5682	5594	5507	5422	5339	5257
40	6252	6151	6053	5957	5862	5770	5680	5592	5505	5420	5337	5255
41	6250	6149	6051	5955	5861	5769	5679	5590	5504	5419	5336	5254
42	6248	6148	6050	5954	5860	5768	5677	5589	5503	5418	5335	5253
43	6247	6146	6048	5952	5858	5766	5676	5587	5501	5416	5333	5251
44	6245	6144	6046	5950	5856	5764	5674	5586	5500	5415	5332	5250
45	6243	6143	6045	5949	5855	5763	5673	5585	5498	5414	5331	5249
46	6241	6141	6043	5947	5853	5761	5671	5583	5497	5412	5329	5247
47	6240	6139	6041	5945	5852	5760	5670	5582	5495	5411	5328	5246
48	6238	6138	6040	5944	5850	5758	5669	5580	5494	5409	5326	5245
49	6236	6136	6038	5942	5849	5757	5667	5579	5492	5408	5325	5243
50	6235	6134	6037	5941	5847	5755	5665	5577	5490	5406	5323	5242
51	6233	6133	6035	5939	5846	5754	5664	5576	5491	5405	5322	5241
52	6231	6131	6033	5938	5844	5752	5662	5574	5488	5404	5321	5239
53	6230	6130	6032	5936	5842	5751	5661	5573	5487	5402	5319	5238
54	6228	6128	6030	5935	5841	5749	5660	5572	5486	5401	5318	5237
55	6226	6126	6028	5933	5839	5748	5658	5570	5484	5399	5317	5235
56	6225	6125	6027	5931	5838	5746	5656	5569	5482	5398	5315	5234
57	6223	6123	6025	5930	5836	5745	5655	5567	5481	5397	5314	5233
58	6221	6121	6024	5928	5835	5743	5654	5566	5480	5395	5312	5231
59	6220	6120	6022	5927	5833	5742	5652	5564	5478	5394	5311	5230
60	6218	6118	6021	5925	5832	5740	5651	5563	5477	9393	5310	5229

S.	h ′ 0° 54′	h ′ 0° 55′	h ′ 0° 56′	h ′ 0° 57′	h ′ 0° 58′	h ′ 0° 59′	h ′ 1° 0′	h ′ 1° 1′	h ′ 1° 2′	h ′ 1° 3′	h ′ 1° 4′	h ′ 1° 5′
0	5229	5149	5071	4994	4918	4844	4771	4699	4629	4559	4491	4424
1	5227	5148	5069	4992	4917	4843	4770	4698	4627	4558	4490	4422
2	5226	5146	5068	4991	4916	4842	4769	4697	4626	4557	4489	4421
3	5225	5145	5067	4990	4915	4841	4768	4696	4625	4556	4488	4420
4	5223	5144	5065	4989	4913	4839	4766	4694	4624	4555	4486	4419
5	5222	5142	5064	4987	4912	4838	4765	4693	4623	4553	4485	4418
6	5221	5141	5063	4986	4011	4837	4764	4692	4622	4552	4484	4417
7	5219	5140	5062	4985	4910	4835	4763	4691	4620	4551	4483	4416
8	5218	5138	5060	4984	4908	4834	4761	4690	4619	4550	4482	4415
9	5217	5137	5059	4983	4907	4833	4760	4689	4618	4549	4481	4414
10	5215	5136	5058	4981	4906	4832	4759	4687	4617	4548	4479	4412
11	5214	5134	5056	4980	4905	4831	4758	4686	4616	4547	4478	4411
12	5213	5133	5055	4979	4903	4830	4757	4685	4615	4546	4477	4410
13	5211	5132	5054	4977	4902	4828	4755	4684	4613	4544	4476	4409
14	5210	5130	5053	4976	4901	4827	4754	4683	4612	4543	4475	4408
15	5209	5129	5051	4975	4900	4826	4753	4682	4611	4542	4474	4407
16	5207	5128	5050	4973	4898	4824	4752	4680	4610	4541	4473	4406
17	5206	5127	5049	4972	4897	4823	4751	4679	4609	4540	4472	4405
18	5205	5125	5048	4971	4896	4822	4750	4678	4608	4539	4471	4404
19	5203	5124	5046	4970	4895	4821	4748	4677	4606	4537	4469	4402
20	5202	5123	5045	4968	4893	4820	4747	4676	4605	4536	4468	4401
21	5201	5122	5044	4967	4892	4819	4746	4675	4604	4535	4467	4400
22	5199	5120	5042	4966	4891	4817	4745	4673	4603	4534	4466	4399
23	5198	5119	5041	4965	4890	4816	4743	4672	4602	4533	4465	4398
24	5197	5118	5040	4964	4889	4815	4742	4671	4601	4532	4464	4397
25	5195	5116	5038	4962	4887	4813	4741	4670	4600	4530	4463	4396
26	5194	5115	5037	4961	4886	4812	4740	4669	4598	452	4461	4395
27	5193	5114	5036	4960	4885	4811	4739	4668	4597	4528	4460	439
28	5191	5112	5035	4958	4883	4810	4737	4666	4596	4527	4459	4392
29	5190	5111	5033	4957	4882	4809	4736	4665	4595	4526	4458	4391
30	5189	5110	5032	4956	4881	4808	4735	4664	4594	4525	4457	4390
31	5187	5108	5031	4955	4880	4806	4734	4663	4593	4524	4456	4389
32	5186	5107	5029	4953	4878	4805	4733	4661	4591	4523	4455	4388
33	5185	5106	5028	4952	4877	4804	4732	4660	4590	4522	4454	4387
34	5183	5104	5027	4951	4876	4802	4730	4659	4589	4520	4452	4386
35	5182	5103	5026	4950	4875	4801	4729	4658	4588	451	4451	438
36	5181	5102	5025	4949	4874	4800	4728	4657	4587	4518	4450	4384
37	5179	5100	5023	4947	4872	4799	4727	4656	4586	4517	4449	4383
38	5178	5099	5022	4946	4871	4798	4725	4654	4585	4516	4448	4381
39	5177	5098	5021	4945	4870	4797	4724	4653	4584	451	4447	438
40	5175	5097	5019	4943	4869	4795	4723	4652	4582	4513	4446	4379
41	5174	5095	5018	4942	4867	4794	4722	4651	4581	4512	4445	4378
42	5173	5094	5017	4941	4866	4793	4721	4650	4580	4511	4444	4377
43	5171	5093	5015	4940	4865	4792	4719	4648	4579	4510	4442	4376
44	5170	5091	5014	4938	4864	4790	4718	4647	4578	4509	4441	437
45	5169	5090	5013	4937	4863	4789	4717	4646	4577	4508	4440	4374
46	5167	5089	5012	4936	4861	4788	4716	4645	4575	4507	4439	4372
47	5166	5087	5010	4934	4860	4787	4715	4644	4574	4506	4438	4371
48	5165	5086	5009	4933	4859	4786	4714	4643	4573	4505	4437	4370
49	5163	5085	5008	4932	4858	4784	4712	4641	4572	4503	4436	436
50	5162	5084	5006	4931	4856	4783	4711	4640	4571	4502	4435	4368
51	5161	5082	5005	4930	4855	4782	4710	4639	4570	4501	4434	4367
52	5159	5081	5004	4928	4854	4781	4709	4638	4568	4500	4432	4366
53	5158	5080	5003	4927	4853	4779	4708	4637	4567	4499	4431	4365
54	5157	5079	5002	4926	4852	4778	4707	4636	4566	4498	4430	4364
55	5155	5076	5000	4924	4850	4777	4705	4634	4565	4497	4429	4363
56	5154	5076	4999	4923	4849	4776	4704	4633	4564	4495	4428	4362
57	5153	5075	4998	4922	4848	4775	4703	4632	4563	4494	4427	4361
58	5152	5073	4996	4921	4846	4773	4702	4631	4561	4493	4426	4359
59	5150	5072	4995	4919	4845	4772	4700	4630	4560	4492	4425	4358
00	5149	5071	4994	4918	4844	4771	4699	4629	4559	4491	4424	4357

Table IX. Proportional Logarithms.

S.	h ′ 1° 6′	h ′ 1° 7′	h ′ 1° 8′	h ′ 1° 9′	h ′ 1° 10′	h ′ 1° 11′	h ′ 1° 12′	h ′ 1° 13′	h ′ 1° 14′	h ′ 1° 15′	h ′ 1° 16′	h ′ 1° 17′
0	4357	4292	4228	4164	4102	4040	3979	3919	3860	3802	3745	3688
1	4356	4291	4226	4163	4101	4039	3978	3918	3859	3801	3744	3687
2	4355	4290	4225	4162	4100	4038	3977	3917	3858	3800	3743	3686
3	4354	4289	4224	4161	4099	4037	3976	3917	3857	3799	3742	3685
4	4353	4287	4222	4160	4098	4036	3975	3916	3856	3798	3741	3684
5	4352	4286	4222	4159	4097	4035	3974	3915	3855	3797	374	3683
6	4351	4285	4221	4158	4096	4034	3973	3914	3855	3796	373	3682
7	4349	4284	4220	4157	4094	4033	3972	3913	3854	3795	373	3681
8	4348	4283	4219	4156	4093	4032	3971	3912	3853	3794	373	3680
9	4347	4282	4218	4155	4092	4031	3970	3911	3852	3793	373	3679
10	4346	4281	4217	4154	4091	4030	3969	3910	3851	3792	3735	3678
11	4345	4280	4216	4153	4090	4029	3968	3909	3850	3791	3734	3677
12	4344	4279	4215	4152	4089	4028	3967	3908	3849	3791	3733	3677
13	4343	4278	4214	4151	4088	4027	3966	3907	3848	3790	3732	3676
14	4342	4277	4213	4150	4087	4026	3965	3906	3847	3789	3731	3675
15	4341	4276	4212	4149	4086	4025	3964	3905	3846	3788	3730	3674
16	4340	4275	4211	414	4085	4024	3963	3904	3845	3787	3729	3673
17	4339	4274	4210	4146	4084	4023	3962	3903	3844	3786	3728	3672
18	4338	4273	4209	4145	4083	4062	3961	3902	3843	3785	3727	3671
19	4336	4271	4207	4144	4082	4021	3960	3901	3842	3784	3726	3670
20	4335	4270	4206	4143	4081	4020	3959	3900	3841	3783	3725	3669
21	4334	4269	4205	4142	4080	4019	3958	3899	3840	3782	3725	3668
22	4333	4268	4204	4141	4079	4018	3957	3898	3839	3781	3724	3667
23	4332	4267	4203	4140	4078	4017	3956	3897	3838	3780	3723	3666
24	4331	4266	4202	4139	4077	4016	3955	3896	3837	3779	3722	3665
25	4330	4265	4201	4138	4076	4015	3954	3895	3836	3778	3721	3664
26	4329	4264	4200	4137	4075	4014	3953	3894	3835	3777	3720	3663
27	4328	4263	4199	4136	4074	4013	3952	3893	3834	3776	3719	3663
28	4327	4262	4198	4135	4073	4012	3951	3892	3833	3775	3718	3662
29	4326	4261	4197	4134	4072	4011	3950	3891	3832	3774	3717	3661
30	4325	4260	4196	4133	4071	4010	3949	3890	3831	3773	3716	3660
31	4323	4258	4195	4132	4070	4009	3948	3889	3830	3772	3715	3659
32	4322	4257	4194	4131	4069	4008	3947	3888	3829	3771	3714	3658
33	4321	4256	4193	4130	4068	4007	3946	3887	3828	3770	3713	3657
34	4320	4255	4191	4129	4067	4006	3945	3886	3827	3769	3712	3656
35	4319	4254	4190	4128	4066	4005	3944	3885	3826	3768	3711	3655
36	4318	4253	4189	4127	4065	4004	3943	3884	3825	3768	3710	3654
37	4317	4252	4188	4126	4064	4003	3942	3883	3824	3767	3709	3653
38	4316	4251	4187	4125	4063	4002	3941	3882	3823	3766	3708	3652
39	4315	4250	3186	4124	4062	4001	3940	3881	3822	3766	3708	3651
40	4313	4249	4185	4122	4061	4000	3939	3880	3821	3764	3707	3650
41	4312	4248	4184	4121	4060	3999	3938	3879	3820	3763	3706	3649
42	4311	4247	4183	4120	4059	3998	3937	3878	3820	3762	3705	3649
43	4310	4246	4182	4119	4057	3997	3936	3877	3819	3761	3704	3648
44	4309	4245	4181	4118	4056	3996	3935	3876	3818	3760	3703	3647
45	4308	4244	4180	4117	4055	3995	3934	3875	3817	3759	3702	3646
46	4307	4242	4179	4116	4054	3993	3933	3874	3816	3758	3701	3645
47	4306	4241	4178	4115	4053	3992	3932	3873	3815	3757	3700	3644
48	4305	4240	4177	4114	4052	3991	3931	3872	3814	3756	3699	3643
49	4304	4239	4176	4113	4051	3990	3930	3871	3813	3755	3698	3642
50	4303	4238	4175	4112	4050	3989	3929	3870	3812	3754	3697	3641
51	4302	4237	4174	4111	4049	3988	3928	3869	3811	3753	3696	3640
52	4300	4236	4173	4110	4048	3987	3927	3868	3810	3752	3695	3639
53	4299	4235	4172	4109	4047	3986	3926	3667	3809	3751	3694	3638
54	4298	4234	4171	4108	4046	3985	3925	3866	3808	3750	3693	3637
55	4297	4233	4169	4107	4045	3984	3924	3865	3807	3749	3692	3636
56	4296	4232	4168	4106	4044	3983	3923	3864	3806	3748	3691	3635
57	4295	4231	4167	4105	4043	3982	3922	3863	3805	3747	3691	3635
58	4294	4230	4166	4104	4042	3981	3921	3862	3804	3746	3690	3634
59	4293	4229	4165	4103	4041	3980	3920	3861	3803	3745	3689	3633
60	4292	4228	4164	4102	4040	3979	3919	3860	3802	3745	3688	3632

S.	h ′ 1° 18′	h ′ 1° 19′	h ′ 1° 20′	h ′ 1° 21′	h ′ 1° 22′	h ′ 1° 23′	h ′ 1° 24′	h ′ 1° 25′	h ′ 1° 26′	h ′ 1° 27′	h ′ 1° 28′	h ′ 1° 29′
0	3632	3576	3522	3468	3415	3362	3310	3259	3208	3158	3108	3059
1	3631	3575	3521	3467	3414	3361	3309	3258	3207	3157	3107	3058
2	3630	3574	3520	3466	3413	3360	3308	3257	3206	3156	3106	3057
3	3629	3574	3519	3465	3412	3359	3307	3256	3205	3155	3105	3056
4	3628	3573	3518	3464	3411	3358	3306	3255	3204	3154	3105	3056
5	3627	3572	3517	3463	3410	3358	3306	3254	3203	3153	3104	3055
6	3626	3571	3516	3463	3409	3357	3305	3253	3203	3153	3103	3054
7	3625	3570	3515	3462	3408	3356	3304	3253	3202	3152	3102	3053
8	3624	3569	3514	3461	3407	3355	3303	3252	3201	3151	3101	3052
9	3623	3568	3514	3460	3406	3354	3302	3251	3200	3150	3101	3052
10	3622	3567	3513	3459	3406	3353	3301	3250	3199	3149	3100	3051
11	3621	3566	3512	3458	3405	3352	3300	3249	3198	3148	3099	3050
12	3621	3565	3511	3457	3404	3351	3300	3248	3198	3148	3098	3049
13	3620	3564	3510	3456	3403	3351	3299	3247	3197	3147	3097	3048
14	3619	3563	3509	3455	3402	3350	3298	3247	3196	3146	3096	3047
15	3618	3563	3508	3454	3401	3349	3297	3246	3195	3145	3096	3047
16	3617	3562	3507	3454	3400	3348	3296	3245	3194	3144	3095	3046
17	3616	3561	3506	3453	3400	3347	3295	3244	3193	3143	3094	3045
18	3615	3560	3506	3452	3399	3346	3294	3243	3193	3143	3093	3044
19	3614	3559	3505	3451	3398	3345	3294	3242	3192	3142	3092	3043
20	3613	3558	3504	3450	3397	3344	3293	3241	3191	3141	3091	3043
21	3612	3557	3503	3449	3396	3344	3292	3241	3190	3140	3091	3042
22	3611	3556	3502	3448	3395	3343	3291	3240	3189	3139	3090	3041
23	3610	3555	3501	3447	3394	3342	3290	3239	3188	3138	3089	3040
24	3610	3555	3500	3446	3393	3341	3289	3238	3188	3138	3088	3039
25	3609	3554	3499	3445	3393	3340	3288	3237	3187	3137	3087	3038
26	3608	3553	3498	3445	3392	3339	3287	3236	3186	3136	3086	3038
27	3607	3552	3497	3444	3391	3338	3287	3236	3185	3135	3086	3037
28	3606	3551	3496	3443	3390	3338	3286	3235	3184	3134	3085	3036
29	3605	3550	3496	3442	3389	3337	3285	3234	3183	3133	3084	3035
30	3604	3549	3495	3441	3388	3336	3284	3233	3183	3133	3083	3034
31	3603	3548	3494	3440	3387	3335	3283	3232	3182	3132	3082	3034
32	3602	3547	3493	3439	3386	3334	3282	3231	3181	3131	3082	3033
33	3601	3546	3492	3438	3386	3333	3282	3231	3180	3130	3081	3032
34	3600	3545	3491	3438	3385	3332	3281	3230	3179	3129	3080	3031
35	3599	3544	3490	3437	3384	3331	3280	3229	3178	3128	3079	3030
36	3598	3544	3489	3436	3383	3331	3279	3228	3178	3128	3078	3030
37	3597	3543	3488	3435	3382	3330	3278	3227	3177	3127	3078	3029
38	3596	3542	3487	3434	3381	3329	3277	3226	3176	3126	3077	3028
39	3596	3541	3487	3433	3380	3328	3276	3225	3175	3125	3076	3027
40	3595	3540	3486	3433	3379	3327	3276	3225	3174	3124	3075	3026
41	3594	3539	3485	3431	3378	3326	3275	3224	3173	3123	3074	3026
42	3593	3538	3484	3431	3378	3325	3274	3223	3173	3123	3073	3025
43	3592	3537	3483	3430	3377	3325	327	3222	3172	3122	3073	3024
44	3591	3536	3482	3429	3376	3324	3272	3221	3171	3121	3072	3023
45	3590	3535	3481	3428	3375	3323	3271	3220	3170	3120	3071	3022
46	3589	3534	3480	3427	3374	3322	3270	3219	3169	3119	3070	3022
47	3588	3533	3479	3426	3373	3321	3270	3219	3168	3119	3069	3021
48	3587	3533	3479	3425	3372	3320	3269	3218	3168	3118	3069	3020
49	3586	3532	3478	3424	3371	3319	3268	3217	3167	3117	3068	3019
50	3585	3531	3477	3423	3371	3318	3267	3216	3166	3116	3067	3018
51	3585	3530	3476	3423	3370	3318	3266	3215	3165	3115	3066	3018
52	3584	3529	3475	3422	3369	3317	3265	3214	3164	3114	3065	3017
53	3583	3528	3474	3421	3368	3316	3264	3214	3163	3114	3064	3016
54	3582	3527	3473	3420	3367	3315	3264	3213	3163	3113	3064	3015
55	3581	3526	3472	3419	3366	3314	3263	3212	3162	3112	3063	3014
56	3580	3525	3471	3418	3365	3313	3262	3211	3161	3111	3062	3013
57	3579	3525	3471	3417	3365	3313	3261	3210	3160	3110	3061	3013
58	3578	3524	3470	3416	3364	3312	3260	3209	3159	3109	3060	3012
59	3577	3523	3469	3415	3363	3311	3259	3209	3158	3109	3060	3011
60	3576	3522	3468	3415	3362	3310	3259	3208	3158	3108	3059	3010

S.	h ′ 1° 30′	h ′ 1° 31′	h ′ 1° 32′	h ′ 1° 33′	h ′ 1° 34′	h ′ 1° 35′	h ′ 1° 36′	h ′ 1° 37′	h ′ 1° 38′	h ′ 1° 39′	h ′ 1° 40′	h ′ 1° 41′
0	3010	2962	2915	2868	2821	2775	2730	2685	2640	2596	2553	2510
1	3009	2961	2914	2867	2821	2775	2729	2684	2640	2596	2552	2509
2	3009	2961	2913	2866	2820	2774	2728	2683	2639	2595	2551	2508
3	3008	2960	2912	2866	2819	2773	2728	2683	2638	2594	2551	2507
4	3007	2959	2912	2865	2818	2772	2727	2682	2637	2593	2550	2507
5	3006	2958	2911	2864	2818	2772	2726	2681	2637	2593	2549	2506
6	3005	2958	2910	2863	2817	2771	2725	2681	2636	2592	2548	2505
7	3005	2957	2909	2862	2816	2770	2725	2680	2635	2591	2548	2504
8	3004	2956	2908	2862	2815	2769	2724	2679	2634	2590	2547	2504
9	3003	2955	2908	2861	2815	2769	2723	2678	2634	2590	2546	2503
10	3002	2954	2907	2860	2814	2768	2722	2678	2633	2589	2545	2502
11	3001	2954	2906	2859	2813	2767	2722	2677	2632	2588	2545	2502
12	3001	2953	2905	2859	2812	2766	2721	2676	2632	2588	2544	2501
13	3000	2952	2905	2858	2811	2766	2720	2675	2631	2587	2543	2500
14	2999	2951	2904	2857	2811	2765	2719	2675	2630	2586	2543	2499
15	2998	2950	2903	2856	2810	2764	2719	2674	2629	2585	2542	2499
16	2997	2950	2902	2855	2809	2763	2718	2673	2629	2585	2541	2498
17	2997	2949	2901	2855	2808	2762	2717	2672	2628	2584	2540	2497
18	2996	2948	2901	2854	2808	2762	2716	2672	2627	2583	2540	2497
19	2995	2947	2900	2853	2807	2761	2716	2671	2626	2582	2539	2496
20	2994	2946	2899	2852	2806	2760	2715	2670	2626	2582	2538	2495
21	2993	2946	2898	2852	2805	2760	2714	2669	2625	2581	2538	2494
22	2993	2945	2898	2851	2804	2759	2713	2669	2624	2580	2537	2494
23	2992	2944	2897	2850	2804	2758	2713	2668	2623	2580	2536	2493
24	2991	2943	2896	2849	2803	2757	2712	2667	2623	2579	2535	2492
25	2990	2942	2895	2848	2802	2756	2711	2666	2622	2578	2535	2492
26	2989	2942	2894	2848	2801	2756	2710	2666	2621	2577	2534	2491
27	2989	2941	2894	2847	2801	2755	2710	2665	2621	2577	2533	2490
28	2988	2940	2893	2846	2800	2754	2709	2664	2620	2576	2532	2489
29	2987	2939	2892	2845	2799	2753	2708	2663	2619	2575	2532	2489
30	2986	2939	2891	2845	2798	2753	2707	2663	2618	2574	2531	2488
31	2985	2938	2890	2844	2798	2752	2707	2662	2618	2574	2530	2487
32	2985	2937	2890	2843	2797	2751	2706	2661	2617	2573	2530	2487
33	2984	2936	2889	2842	2796	2750	2705	2660	2616	2572	2529	2486
34	2983	2935	2888	2841	2795	2750	2704	2660	2615	2572	2528	2485
35	2982	2934	2887	2841	2795	2749	2704	2659	2615	2571	2527	2484
36	2981	2934	2887	2840	2794	2748	2703	2658	2614	2570	2527	2484
37	2981	2933	2886	2839	2793	2747	2702	2657	2613	2569	2526	2483
38	2980	2932	2885	2838	2792	2747	2701	2657	2612	2569	2525	2482
39	2979	2931	2884	2838	2792	2746	2701	2656	2612	2568	2525	2482
40	2978	2931	2883	2837	2791	2745	2690	2655	2611	2567	2524	2481
41	2977	2930	2883	2836	2790	2744	2699	2654	2610	2566	2523	2480
42	2977	2929	2882	2835	2789	2744	2698	2654	2610	2566	2522	2480
43	2976	2928	2881	2834	2788	2743	2698	2653	2609	2565	2522	2479
44	2975	2927	2880	2834	2788	2742	2697	2652	2608	2564	2521	2478
45	2974	2927	2880	2833	2787	2741	2696	2652	2607	2564	2520	2477
46	2973	2926	2879	2832	2786	2741	2695	2651	2607	2563	2520	2477
47	2973	2925	2878	2831	2785	2740	2695	2650	2606	2562	2519	2476
48	2972	2924	2877	2831	2785	2739	2694	2649	2605	2561	2518	2475
49	2971	2923	2876	2830	2784	2738	2693	2649	2604	2561	2517	2474
50	2970	2923	2876	2829	2783	2737	2692	2648	2604	2560	2517	2474
51	2969	2922	2875	2828	2782	2737	2692	2647	2603	2559	2516	2473
52	2969	2921	2874	2828	2782	2736	2691	2646	2602	2558	2515	2472
53	2968	2920	2873	2827	2781	2735	2690	2646	2601	2558	2514	2472
54	2967	2920	2873	2826	2780	2735	2689	2645	2601	2557	2514	2471
55	2966	2919	2872	2825	2779	2734	2689	2644	2600	2556	2513	2470
56	2965	2918	2871	2824	2778	2733	2688	2643	2599	2556	2512	2470
57	2965	2917	2870	2824	2778	2732	2687	2643	2599	2555	2512	2469
58	2964	2916	2869	2823	2777	2731	2686	2642	2598	2554	2511	2468
59	2963	2916	2869	2822	2776	2731	2686	2641	2597	2553	2510	2467
60	2962	2915	2868	2821	2775	2730	2685	2640	2596	2553	2510	2467

Table IX. Proportional Logarithms.

S.	h ′ 1° 42′	h ′ 1° 43′	h ′ 1° 44′	h ′ 1° 45′	h ′ 1° 46′	h ′ 1° 47′	h ′ 1° 48′	h ′ 1° 49′	h ′ 1° 50′	h ′ 1° 51′	h ′ 1° 52′	h ′ 1° 53′
0	2467	2424	2382	2341	2300	2259	2218	2178	2139	2099	2061	2022
1	2466	2424	2382	2340	2299	2258	2218	2178	2138	2099	2060	2021
2	2465	2423	2381	2339	2298	2257	2217	2177	2137	2098	2059	2021
3	2465	2422	2380	2339	2298	2257	2216	2176	2137	2098	2059	2020
4	2464	2421	2380	2338	2297	2256	2216	2176	2136	2097	2058	2019
5	2463	2421	2379	2337	2296	2255	2215	2175	2135	2096	2057	2019
6	2462	2420	2378	2337	2296	2255	2214	2174	2135	2096	2057	2018
7	2462	2419	2378	2336	2295	2254	2214	2174	2134	2095	2056	2017
8	2461	2419	2377	2335	2294	2253	2213	2173	2133	2094	2055	2017
9	2460	2418	2376	2335	2294	2253	2212	2172	2133	2094	2055	2016
10	2460	2417	2375	2334	2293	2252	2212	2172	2132	2093	2054	2016
11	2459	2417	2375	2333	2292	2251	2211	2171	2132	2092	2053	2015
12	2458	2416	2374	2333	2291	2251	2210	2170	2131	2092	2053	2014
13	2457	2415	2373	2332	2291	2250	2210	2170	2130	2091	2052	2014
14	2457	2414	2373	2331	2290	2249	2209	2169	2130	2090	2051	2013
15	2456	2414	2372	2331	2289	2249	2208	2169	2129	2090	2051	2013
16	2455	2413	2371	2330	2289	2248	2208	2168	2128	2089	2050	2012
17	2455	2412	2371	2329	2288	2247	2207	2167	2128	2088	2050	2011
18	2454	2412	2370	2328	2287	2247	2206	2167	2127	2088	2049	2010
19	2453	2411	2369	2328	2287	2246	2206	2166	2126	2087	2048	2010
20	2452	2410	2368	2327	2286	2245	2205	2165	2126	2086	2048	2009
21	2452	2410	2368	2326	2285	2245	2204	2165	2125	2086	2047	2009
22	2451	2409	2367	2326	2285	2244	2204	2164	2124	2085	2046	2008
23	2450	2408	2366	2325	2284	2243	2203	2163	2124	2084	2046	2007
24	2450	2408	2366	2324	2283	2243	2202	2163	2123	2084	2045	2007
25	2449	2407	2365	2324	2283	2242	2202	2162	2122	2083	2044	2006
26	2448	2406	2364	2323	2282	2241	2201	2161	2122	2083	2044	2005
27	2448	2405	2364	2322	2281	2241	2200	2161	2121	2082	2043	2005
28	2447	2405	2363	2322	2281	2240	2200	2160	2120	2081	2042	2004
29	2446	2404	2362	2321	2280	2239	2199	2159	2120	2081	2042	2004
30	2445	2403	2362	2320	2279	2239	2198	2159	2119	2080	2041	2003
31	2445	2403	2361	2319	2279	2238	2198	2158	2118	2079	2041	2002
32	2444	2402	2360	2319	2278	2237	2197	2157	2118	2079	2040	2001
33	2443	2401	2359	2318	2277	2237	2196	2157	2117	2078	2039	2001
34	2443	2400	2359	2317	2276	2236	2196	2156	2116	2077	2039	2000
35	2442	2400	2358	2317	2276	2235	2195	2155	2116	2077	2038	2000
36	2441	2399	2357	2316	2275	2235	2194	2155	2115	2076	2037	1999
37	2440	2398	2357	2315	2274	2234	2194	2154	2114	2075	2037	1998
38	2440	2398	2356	2315	2274	2233	2193	2153	2114	2075	2036	1998
39	2439	2397	2355	2314	2273	2233	2192	2153	2113	2074	2035	1997
40	2438	2396	2355	2313	2272	2232	2192	2152	2113	2073	2035	1996
41	2438	2396	2354	2313	2272	2231	2191	2151	2112	2073	2034	1996
42	2437	2395	2353	2312	2271	2231	2190	2151	2111	2072	2033	1995
43	2436	2394	2353	2311	2270	2230	2190	2150	2111	2071	2033	1994
44	2436	2394	2352	2311	2270	2229	2189	2149	2110	2071	2032	1994
45	2435	2393	2351	2310	2269	2229	2188	2149	2109	2070	2032	1993
46	2434	2392	2350	2309	2268	2228	2188	2148	2109	2070	2031	1993
47	2433	2391	2350	2308	2268	2227	2187	2147	2108	2069	2030	1992
48	2433	2391	2349	2308	2267	2227	2186	2147	2107	2068	2030	1991
49	2432	2390	2348	2307	2266	2226	2186	2146	2107	2068	2029	1991
50	2431	2389	2348	2306	2266	2225	2185	2145	2106	2067	2028	1990
51	2431	2389	2347	2306	2265	2225	2184	2145	2105	2066	2028	1989
52	2430	2388	2346	2305	2264	2224	2184	2144	2105	2066	2027	1989
53	2429	2387	2346	2304	2264	2223	2183	2143	2104	2065	2026	1988
54	2429	2387	2345	2304	2263	2223	2182	2143	2103	2064	2026	1987
55	2428	2386	2344	2303	2262	2222	2182	2142	2103	2064	2025	1987
56	2427	2385	2344	2302	2262	2221	2181	2141	2102	2063	2024	1986
57	2426	2384	2343	2302	2261	2220	2180	2141	2101	2062	2024	1986
58	2426	2384	2342	2301	2260	2220	2180	2140	2101	2062	2023	1985
59	2425	2383	2341	2300	2260	2219	2179	2139	2100	2061	2023	1984
60	2424	2382	2341	2300	2259	2218	2178	2139	2099	2061	2022	1984

S.	h ′ 1° 54′	h ′ 1° 55′	h ′ 1° 56′	h ′ 1° 57′	h ′ 1° 58′	h ′ 1° 59	h ′ 2° 0′	h ′ 2° 1′	h ′ 2° 2′	h ′ 2° 3′	h ′ 2° 4′
0	1984	1946	1908	1871	1834	1797	1761	1725	1689	1654	1619
1	1983	1945	1907	1870	1833	1797	1760	1724	1688	1653	1618
2	1982	1944	1907	1870	1833	1796	1760	1724	1688	1652	1617
3	1982	1944	1906	1869	1832	1795	1759	1723	1687	1652	1617
4	1981	1943	1906	1868	1831	1795	1758	1722	1687	1651	1616
5	1980	1943	1905	1868	1831	1794	1758	1722	1686	1651	1616
6	1980	1942	1904	1867	1830	1794	1757	1721	1685	1650	1615
7	1979	1941	1904	1867	1830	1793	1756	1721	1685	1650	1614
8	1979	1941	1903	1866	1829	1792	1756	1720	1684	1649	1614
9	1978	1940	1903	1865	1828	1792	1755	1719	1684	1649	1613
10	1977	1939	1902	1865	1828	1791	1755	1719	1683	1648	1613
11	1977	1939	1901	1864	1827	1791	1754	1718	1683	1647	1612
12	1976	1938	1901	1863	1827	1790	1754	1718	1682	1647	1612
13	1975	1938	1900	1863	1826	1789	1753	1717	1681	1646	1611
14	1975	1937	1899	1862	1825	1789	1752	1716	1681	1645	1610
15	1974	1936	1899	1862	1825	1788	1752	1716	1680	1645	1610
16	1973	1936	1898	1861	1824	1787	1751	1715	1680	1644	1609
17	1973	1935	1898	1860	1823	1787	1751	1715	1679	1644	1609
18	1972	1934	1897	1860	1823	1786	1750	1714	1678	1643	1608
19	1972	1934	1896	1859	1822	1786	1749	1713	1678	1642	1607
20	1971	1933	1896	1858	1822	1785	1749	1713	1677	1642	1607
21	1970	1933	1895	1858	1821	1785	1748	1712	1677	1641	1606
22	1970	1932	1894	1857	1820	1784	1748	1712	1676	1641	1606
23	1969	1931	1894	1857	1820	1783	1747	1711	1675	1640	1605
24	1968	1931	1893	1856	1819	1783	1746	1711	1675	1640	1605
25	1968	1930	1893	1855	1819	1782	1746	1710	1674	1639	1604
26	1967	1929	1892	1855	1818	1781	1745	1709	1674	1638	1603
27	1967	1929	1891	1854	1817	1781	1745	1709	1673	1638	1603
28	1966	1928	1891	1854	1817	1780	1744	1708	1673	1637	1602
29	1965	1927	1890	1853	1816	1780	1743	1708	1672	1637	1602
30	1965	1927	1889	1852	1816	1779	1743	1707	1671	1636	1601
31	1964	1926	1889	1852	1815	1778	1742	1706	1671	1635	1600
32	1963	1926	1888	1851	1814	1778	1742	1706	1670	1635	1600
33	1963	1925	1888	1850	1814	1777	1741	1705	1670	1634	1599
34	1962	1924	1887	1850	1813	1777	1740	1705	1669	1634	1599
35	1961	1924	1886	1849	1812	1776	1740	1704	1668	1633	1598
36	1961	1923	1886	1849	1812	1775	1739	1703	1668	1633	1598
37	1960	1922	1885	1848	1811	1775	1739	1703	1667	1632	1597
38	1960	1922	1884	1847	1810	1774	1738	1702	1667	1631	1596
39	1959	1921	1884	1847	1810	1774	1737	1702	1666	1631	1596
40	1958	1921	1883	1846	1809	1773	1737	1701	1665	1630	1595
41	1958	1920	1883	1846	1809	1772	1736	1700	1665	1630	1595
42	1957	1919	1882	1845	1808	1772	1736	1700	1664	1629	1594
43	1956	1919	1881	1844	1808	1771	1735	1699	1664	1628	1593
44	1956	1918	1881	1844	1807	1771	1734	1699	1663	1628	1593
45	1955	1918	1880	1843	1806	1770	1734	1698	1663	1627	1592
46	1955	1917	1879	1842	1806	1769	1733	1697	1662	1627	1592
47	1954	1916	1879	1842	1805	1769	1733	1697	1661	1626	1591
48	1953	1916	1878	1841	1805	1768	1732	1696	1661	1626	1591
49	1953	1915	1878	1841	1804	1768	1731	1696	1660	1625	1590
50	1952	1914	1877	1840	1803	1767	1731	1695	1660	1624	1589
51	1951	1914	1876	1839	1803	1766	1730	1694	1659	1624	1589
52	1951	1913	1876	1839	1802	1766	1730	1694	1658	1623	1588
53	1950	1912	1875	1838	1801	1765	1729	1693	1658	1623	1588
54	1950	1912	1875	1838	1801	1765	1728	1693	1657	1622	1587
55	1949	1911	1874	1837	1800	1764	1728	1692	1657	1621	1587
56	1948	1911	1873	1836	1799	1763	1727	1691	1656	1621	1586
57	1948	1910	1873	1836	1799	1763	1727	1691	1655	1620	1586
58	1947	1910	1872	1835	1798	1762	1726	1690	1655	1620	1585
59	1946	1909	1871	1834	1798	1761	1725	1690	1654	1619	1584
60	1946	1908	1871	1834	1797	1761	1725	1689	1654	1619	1584

Table IX. Proportional Logarithms.

S.	h ′ 2° 5′	h ′ 2° 6′	h ′ 2° 7′	h ′ 2° 8′	h ′ 2° 9′	h ′ 2° 10′	h ′ 2° 11′	h ′ 2° 12′	h ′ 2° 13′	h ′ 2° 14′	h ′ 2° 15′
0	1584	1549	1515	1481	1447	1413	1380	1347	1314	1282	1249
1	1583	1548	1514	1480	1446	1413	1379	1346	1314	1281	1249
2	1582	1548	1514	1479	1446	1412	1379	1346	1313	1281	1248
3	1582	1547	1513	1479	1445	1412	1378	1345	1313	1280	1248
4	1581	1547	1512	1478	1445	1411	1378	1345	1312	1279	1247
5	1581	1546	1512	1478	1444	1410	1377	1344	1311	1279	1247
6	1580	1546	1511	1477	1443	1410	1377	1344	1311	1278	1246
7	1580	1545	1511	1477	1443	1409	1376	1343	1310	1278	1246
8	1579	1544	1510	1476	1442	1409	1376	1343	1310	1277	1245
9	1578	1544	1510	1476	1442	1408	1375	1342	1319	1277	1245
10	1578	1543	1509	1475	1441	1408	1374	1341	1309	1276	1244
11	1577	1543	1508	1474	1441	1407	1374	1341	1308	1276	1243
12	1577	1542	1508	1474	1440	1407	1373	1340	1308	1275	1243
13	1576	1542	1507	1473	1440	1406	1373	1340	1307	1275	1242
14	1575	1541	1507	1473	1439	1405	1372	1339	1307	1274	1242
15	1575	1540	1506	1472	1438	1405	1372	1339	1306	1274	1241
16	1574	1540	1506	1472	1438	1404	1371	1338	1305	1273	1241
17	1574	1539	1505	1471	1437	1404	1371	1338	1305	1273	1240
18	1573	1539	1504	1470	1437	1403	1370	1337	1304	1272	1240
19	1573	1538	1504	1470	1436	1403	1369	1337	1304	1271	1239
20	1572	1538	1503	1469	1436	1402	1369	1336	1303	1271	1239
21	1571	1537	1503	1469	1435	1402	1368	1335	1303	1270	1238
22	1571	1536	1502	1468	1434	1401	1368	1335	1302	1270	1238
23	1570	1536	1502	1468	1434	1400	1367	1334	1302	1269	1237
24	1570	1535	1501	1467	1433	1400	1367	1334	1301	1269	1237
25	1569	1535	1500	1466	1433	1399	1366	1333	1301	1268	1236
26	1569	1534	1500	1466	1432	1399	1366	1333	1300	1268	1235
27	1568	1534	1499	1465	1432	1398	1365	1332	1300	1267	1235
28	1567	1533	1499	1465	1431	1398	1365	1332	1299	1267	1234
29	1567	1532	1498	1464	1431	1397	1364	1331	1298	1266	1234
30	1566	1532	1498	1464	1430	1397	1363	1331	1298	1266	1233
31	1566	1531	1497	1463	1429	1396	1363	1330	1297	1265	1233
32	1565	1531	1496	1463	1429	1395	1362	1329	1297	1264	1232
33	1565	1530	1496	1462	1428	1395	1362	1329	1296	1264	1232
34	1564	1529	1495	1461	1428	1394	1361	1328	1296	1263	1231
35	1563	1529	1495	1461	1427	1394	1361	1328	1295	1263	1231
36	1563	1528	1494	1460	1427	1393	1360	1327	1295	1262	1230
37	1562	1528	1494	1460	1426	1393	1360	1327	1294	1262	1230
38	1562	1527	1493	1459	1426	1392	1359	1326	1294	1261	1229
39	1561	1527	1493	1458	1425	1392	1359	1326	1293	1261	1229
40	1560	1526	1492	1458	1424	1391	1358	1325	1292	1260	1228
41	1560	1525	1491	1457	1424	1390	1357	1325	1292	1260	1227
42	1559	1525	1491	1457	1423	1390	1357	1324	1291	1259	1227
43	1559	1524	1490	1456	1423	1389	1356	1323	1291	1258	1226
44	1558	1524	1490	1456	1422	1389	1356	1323	1290	1258	1226
45	1558	1523	1489	1455	1422	1388	1355	1322	1290	1257	1225
46	1557	1523	1489	1455	1421	1388	1355	1322	1289	1257	1225
47	1556	1522	1488	1454	1420	1387	1354	1321	1289	1256	1224
48	1556	1522	1487	1454	1420	1387	1354	1321	1288	1256	1224
49	1555	1521	1487	1453	1419	1386	1353	1320	1288	1255	1223
50	1555	1520	1486	1452	1419	1386	1352	1320	1287	1255	1223
51	1554	1520	1486	1452	1418	1385	1352	1319	1287	1254	1222
52	1554	1519	1485	1451	1418	1384	1351	1319	1286	1254	1222
53	1553	1519	1485	1451	1417	1384	1351	1318	1285	1253	1221
54	1552	1518	1484	1450	1417	1383	1350	1317	1285	1253	1221
55	1552	1518	1483	1450	1416	1383	1350	1317	1284	1252	1220
56	1551	1517	1483	1449	1415	1382	1349	1316	1284	1251	1219
57	1551	1516	1482	1449	1415	1382	1349	1316	1283	1251	1219
58	1550	1516	1482	1448	1414	1381	1348	1315	1283	1250	1218
59	1550	1515	1481	1447	1414	1381	1347	1315	1282	1250	1218
60	1549	1515	1481	1447	1413	1380	1347	1314	1282	1249	1217

S.	h ′ 2° 16′	h ′ 2° 17′	h ′ 2° 18′	h ′ 2° 19′	h ′ 2° 20′	h ′ 2° 21′	h ′ 2° 22′	h ′ 2° 23′	h ′ 2° 24′	h ′ 2° 25′	h ′ 2° 26′
0	1217	1186	1154	1123	1091	1061	1030	0999	0969	0939	0909
1	1217	1185	1153	1122	1091	1060	1029	999	969	939	909
2	1216	1184	1153	1121	1090	1059	1029	998	968	938	908
3	1216	1184	1152	1121	1090	1059	1028	998	968	938	908
4	1215	1183	1152	1120	1089	1058	1028	997	967	937	907
5	1215	1183	1151	1120	1089	1058	1027	997	967	937	907
6	1214	1182	1151	1119	1088	1057	1027	996	966	936	906
7	1214	1182	1150	1119	1088	1057	1026	996	966	936	906
8	1213	1181	1150	1118	1087	1056	1026	995	965	935	905
9	1213	1181	1149	1118	1087	1056	1025	995	965	935	905
10	1212	1180	1149	1117	1086	1055	1025	0994	0964	0934	0904
11	1211	1180	1148	1117	1086	1055	1024	994	964	934	904
12	1211	1179	1148	1116	1085	1054	1024	993	963	933	903
13	1210	1179	1147	1116	1085	1054	1023	993	963	933	903
14	1210	1178	1147	1115	1084	1053	1023	992	962	932	902
15	1209	1178	1146	1115	1084	1053	1022	992	962	932	902
16	1209	1177	1146	1114	1083	1052	1022	991	961	931	901
17	1208	1177	1145	1114	1083	1052	1021	991	961	931	901
18	1208	1176	1145	1113	1082	1051	1021	990	960	930	900
19	1207	1175	1144	1113	1082	1051	1020	990	960	930	900
20	1207	1175	1143	1112	1081	1050	1020	0989	0959	0929	0899
21	1206	1174	1143	1112	1081	1050	1019	989	959	929	899
22	1206	1174	1142	1111	1080	1049	1019	988	958	928	898
23	1205	1173	1142	1111	1080	1049	1018	988	958	928	898
24	1205	1173	1141	1110	1079	1048	1018	987	957	927	897
25	1204	1172	1141	1110	1079	1048	1017	987	957	927	897
26	1203	1172	1140	1109	1078	1047	1017	986	956	926	896
27	1203	1171	1140	1109	1078	1047	1016	986	956	926	896
28	1202	1171	1139	1108	1077	1046	1016	985	955	925	895
29	1202	1170	1139	1107	1076	1046	1015	985	955	925	895
30	1201	1170	1138	1107	1076	1045	1015	0984	0954	0924	0894
31	1201	1169	1138	1106	1075	1045	1014	984	954	924	894
32	1200	1169	1137	1106	1075	1044	1014	983	953	923	893
33	1200	1168	1137	1105	1074	1044	1013	983	953	923	893
34	1199	1168	1136	1105	1074	1043	1013	982	952	922	892
35	1199	1167	1136	1104	1073	1043	1012	982	952	922	892
36	1198	1167	1135	1104	1073	1042	1012	981	951	921	891
37	1198	1166	1135	1103	1072	1042	1011	981	951	921	891
38	1197	1165	1134	1103	1072	1041	1010	980	950	920	890
39	1197	1165	1134	1102	1071	1041	1010	980	950	920	890
40	1196	1164	1133	1102	1071	1040	1009	0979	0949	0919	0889
41	1196	1164	1132	1101	1070	1039	1009	979	949	919	889
42	1195	1163	1132	1101	1070	1039	1008	978	948	918	888
43	1194	1163	1131	1100	1069	1038	1008	978	948	918	888
44	1194	1162	1131	1100	1069	1038	1007	977	947	917	887
45	1193	1162	1130	1099	1068	1037	1007	977	947	917	887
46	1193	1161	1130	1099	1068	1037	1006	976	946	916	886
47	1192	1161	1129	1098	1067	1036	1006	976	946	916	886
48	1192	1160	1129	1098	1067	1036	1005	975	945	915	885
49	1191	1160	1128	1097	1066	1035	1005	975	945	915	885
50	1191	1159	1128	1097	1066	1035	1004	0974	0944	0914	0884
51	1190	1159	1127	1096	1065	1034	1004	974	944	914	884
52	1190	1158	1127	1096	1065	1034	1003	973	943	913	883
53	1189	1158	1126	1095	1064	1033	1003	973	943	913	883
54	1189	1157	1126	1095	1064	1033	1002	972	942	912	883
55	1188	1157	1125	1094	1063	1032	1002	972	942	912	882
56	1188	1156	1125	1093	1063	1032	1001	971	941	911	882
57	1187	1156	1124	1093	1062	1031	1001	971	941	911	881
58	1187	1155	1124	1092	1062	1031	1000	970	940	910	881
59	1186	1154	1123	1092	1061	1030	1000	970	940	910	880
60	1186	1154	1123	1091	1061	1030	0999	0969	0939	0909	0880

S.	h ′ 2° 27′	h ′ 2° 28′	h ′ 2° 29′	h ′ 2° 30′	h ′ 2° 31′	h ′ 2° 32′	h ′ 2° 33′	h ′ 2° 34′	h ′ 2° 35′	h ′ 2° 36′	h ′ 2° 37′
0	0880	0850	0821	0792	0763	0734	0706	0678	0649	0621	0594
1	879	850	820	791	762	734	705	677	649	621	593
2	879	849	820	791	762	733	705	677	648	621	593
3	878	849	819	790	762	733	704	676	648	620	592
4	878	848	819	790	761	732	704	676	648	620	592
5	877	848	818	789	761	732	703	675	64[illegible]	619	591
6	877	847	818	789	760	731	703	675	64[illegible]	619	591
7	876	847	817	788	760	731	702	674	646	618	590
8	876	846	817	788	759	730	702	674	646	618	590
9	875	846	816	787	759	730	702	673	645	617	590
10	0875	0845	0816	0787	0758	0729	0701	0673	0645	0617	0589
11	874	845	815	787	758	729	701	672	644	616	589
12	874	844	815	786	757	729	700	672	644	616	588
13	873	844	814	786	757	728	700	671	643	615	588
14	873	843	814	785	756	728	699	671	643	615	587
15	872	843	814	785	756	727	699	670	642	615	587
16	872	842	813	784	755	727	698	670	642	614	586
17	871	842	813	784	755	726	698	669	641	614	586
18	871	841	812	783	754	726	697	669	641	613	585
19	870	841	812	783	754	725	697	669	641	613	585
20	0870	0840	0811	0782	0753	0725	0696	0668	0640	0612	0584
21	869	840	811	782	753	724	696	668	640	612	584
22	869	839	810	781	752	724	695	667	639	611	584
23	868	839	810	781	752	723	695	667	639	611	583
24	868	838	809	780	751	723	694	666	638	610	583
25	867	838	809	780	751	722	694	666	638	610	582
26	867	837	808	779	750	722	693	665	637	609	582
27	866	837	808	779	750	721	693	665	637	609	581
28	866	836	807	778	750	721	693	664	636	608	581
29	865	836	807	778	749	720	692	664	636	608	580
30	0865	0835	0806	0777	0749	0720	0692	0663	0635	0608	0580
31	864	835	806	777	748	720	691	663	635	607	579
32	864	834	805	776	748	719	691	662	634	607	579
33	863	834	805	776	747	719	690	662	634	606	579
34	863	833	804	775	747	718	690	662	634	606	578
35	862	833	804	775	746	718	689	661	633	605	578
36	862	833	803	774	746	717	689	661	633	605	577
37	861	832	803	774	745	717	688	660	632	604	577
38	861	832	802	773	745	716	688	660	632	604	576
39	860	831	802	773	744	716	687	659	631	603	576
40	0860	0831	0801	0773	0744	0715	0687	0659	0631	0603	0575
41	859	830	801	772	743	715	686	658	630	602	575
42	859	830	801	772	743	714	686	658	630	602	574
43	858	829	800	771	742	714	685	657	629	602	574
44	858	829	800	771	742	713	685	657	629	601	573
45	857	828	799	770	741	713	685	656	628	601	573
46	857	828	799	770	741	712	684	656	628	600	573
47	856	827	798	769	740	712	684	655	627	600	572
48	856	827	798	769	740	711	683	655	627	599	572
49	855	826	797	768	739	711	683	655	627	599	571
50	0855	0826	0797	0768	0739	0711	0682	0654	0626	0598	0571
51	855	825	796	767	739	710	682	654	626	598	570
52	854	825	796	767	738	710	681	653	625	597	570
53	854	824	795	766	738	709	681	653	625	597	569
54	853	824	795	766	737	709	680	652	624	596	569
55	853	823	794	765	737	708	680	652	624	596	568
56	852	823	794	765	736	708	679	651	623	596	568
57	852	822	793	764	736	707	679	651	623	595	568
58	851	822	793	764	735	707	678	650	622	595	567
59	851	821	792	763	735	706	678	650	622	594	567
60	0850	0821	0792	0763	0734	0706	0678	0649	0621	0594	0566

S.	h ′ 2° 38′	h ′ 2° 39′	h ′ 2° 40′	h ′ 2° 41′	h ′ 2° 42′	h ′ 2° 43′	h ′ 2° 44′	h ′ 2° 45′	h ′ 2° 46′	h ′ 2° 47′	h ′ 2° 48′
0	0566	0539	0512	0484	0458	0431	0404	0378	0352	0326	0300
1	566	538	511	484	457	430	404	377	351	325	299
2	565	538	511	484	457	430	403	377	351	325	299
3	565	537	510	483	456	430	403	377	350	324	298
4	564	537	510	483	456	429	402	376	350	324	298
5	564	536	509	482	455	429	402	376	349	323	297
6	563	536	509	482	455	428	402	375	349	323	297
7	563	536	508	481	454	428	401	375	349	322	297
8	562	535	508	481	454	427	401	374	348	322	296
9	562	535	507	480	454	427	400	374	348	322	296
10	0562	0534	0507	0480	0453	0426	0400	0373	0347	0321	0295
11	561	534	507	479	453	426	399	373	347	321	295
12	561	533	506	479	452	426	399	372	346	320	294
13	560	533	506	479	451	425	399	372	346	320	294
14	560	532	505	478	451	425	398	372	346	319	294
15	559	532	505	478	451	424	398	371	345	319	293
16	559	531	504	477	450	424	397	371	345	319	293
17	558	531	504	477	450	423	397	370	344	318	292
18	558	531	503	476	450	423	396	370	344	318	292
19	557	530	503	476	449	422	396	370	343	317	291
20	0557	0530	0502	0475	0449	0422	0395	0369	0343	0317	0291
21	557	529	502	475	448	422	395	369	342	316	291
22	556	529	502	475	448	421	395	368	342	316	290
23	556	528	501	474	447	421	394	368	342	316	290
24	555	528	501	474	447	420	394	367	341	315	289
25	555	527	500	473	446	420	393	367	341	315	289
26	554	527	500	473	446	419	393	366	340	314	288
27	554	526	499	472	446	419	392	366	340	314	288
28	553	526	499	472	445	418	392	366	339	313	288
29	553	526	498	471	445	418	391	365	339	313	287
30	0552	0525	0498	0471	0444	0418	0391	0365	0339	0313	0287
31	552	525	497	471	444	417	391	364	338	312	286
32	551	524	497	470	443	417	390	364	338	312	286
33	551	524	497	470	443	416	390	363	337	311	285
34	550	523	496	469	442	416	389	363	337	311	285
35	550	523	496	469	442	415	389	363	336	310	285
36	550	522	495	468	442	415	388	362	336	310	284
37	549	522	495	468	441	414	388	362	336	310	284
38	549	521	494	467	441	414	388	361	335	309	283
39	548	521	494	467	440	414	387	361	335	309	283
40	0548	0521	0493	0466	0440	0413	0387	0360	0334	0308	0282
41	547	520	493	466	439	413	386	360	334	308	282
42	547	520	493	466	439	412	386	359	333	307	282
43	546	519	492	465	438	412	385	359	333	307	281
44	546	519	492	465	438	411	385	359	332	306	281
45	546	518	491	464	438	411	384	358	332	306	280
46	545	518	491	464	437	410	384	358	332	306	280
47	545	517	490	463	437	410	384	357	331	305	279
48	544	517	490	463	436	410	383	357	331	305	279
49	544	516	489	462	436	409	383	356	330	304	279
50	0543	0516	0489	0462	0435	0409	0382	0356	0330	0304	0278
51	543	516	489	462	435	408	382	356	329	304	278
52	542	515	488	461	434	408	381	355	329	303	277
53	542	515	488	461	434	407	381	355	329	303	277
54	541	514	487	460	434	407	381	354	328	302	276
55	541	514	487	460	433	406	380	354	328	302	276
56	541	513	486	459	433	406	380	353	327	301	276
57	540	513	486	459	432	406	379	353	327	301	275
58	540	512	485	458	432	405	379	352	326	300	275
59	539	512	485	458	431	405	378	352	326	300	274
60	0539	0512	0484	0458	0431	0404	0378	0352	0326	0300	0274

Table IX. Proportional Logarithms.

S.	h ′ 2° 49′	h ′ 2° 50′	h ′ 2° 51′	h ′ 2° 52′	h ′ 2° 53′	h ′ 2° 54′	h ′ 2° 55′	h ′ 2° 56′	h ′ 2° 57′	h ′ 2° 58′	h ′ 2° 59′
0	0274	0248	0223	0197	0172	0147	0122	0098	0073	0049	0024
1	273	248	222	197	172	147	122	97	73	48	24
2	273	247	222	197	171	146	121	97	72	48	23
3	273	247	221	196	171	146	121	96	72	47	23
4	272	246	221	196	171	146	121	96	71	47	23
5	272	246	221	195	170	145	120	96	71	46	22
6	271	246	220	195	170	145	120	95	71	46	22
7	271	245	220	194	169	144	119	95	70	46	21
8	270	245	219	194	169	144	119	94	70	45	21
9	270	244	219	194	169	143	119	94	69	45	21
10	0270	0244	0218	0193	0168	0143	0118	0093	0069	0044	0020
11	269	244	218	193	168	143	118	93	68	44	20
12	269	243	218	192	167	142	117	93	68	44	19
13	268	243	217	192	167	142	117	92	68	43	19
14	268	242	217	192	166	141	117	92	67	43	18
15	267	242	216	191	166	141	116	91	67	42	18
16	267	241	216	191	166	141	116	91	66	42	18
17	267	241	216	190	165	140	115	91	66	42	17
18	266	241	215	190	165	140	115	90	66	41	17
19	266	240	215	189	164	139	114	90	65	41	16
20	0265	0240	0214	0189	0164	0139	0114	0089	0065	0040	0016
21	265	239	214	189	163	139	114	89	64	40	16
22	264	239	213	188	163	138	113	89	64	40	15
23	264	238	213	188	163	138	113	88	64	39	15
24	264	238	213	187	162	137	112	88	63	39	15
25	263	238	212	187	162	137	112	87	63	38	14
26	263	237	212	186	161	136	112	87	62	38	14
27	262	237	211	186	161	136	111	87	62	38	13
28	262	236	211	186	161	136	111	86	62	37	13
29	261	236	210	185	160	135	110	86	61	37	12
30	0261	0235	0210	0185	0160	0135	0110	0085	0061	0036	0012
31	261	235	210	184	159	134	110	85	60	36	12
32	260	235	209	184	159	134	109	84	60	35	11
33	260	234	209	184	158	134	109	84	60	35	11
34	259	234	208	183	158	133	108	84	59	35	10
35	259	233	208	183	158	133	108	83	59	34	10
36	258	233	208	182	157	132	107	83	58	34	10
37	258	232	207	182	157	132	107	82	58	33	09
38	258	232	207	181	156	131	107	82	57	33	09
39	257	232	206	181	156	131	106	82	57	33	08
40	0257	0231	0206	0181	0156	0131	0106	0081	0057	0032	0008
41	256	231	205	180	155	130	105	81	56	32	8
42	256	230	205	180	155	130	105	80	56	31	7
43	255	230	205	179	154	129	105	80	56	31	7
44	255	230	204	179	154	129	104	80	55	31	6
45	255	229	204	179	153	129	104	79	55	30	6
46	254	229	203	178	153	128	103	79	54	30	6
47	254	228	203	178	153	128	103	78	54	29	5
48	253	228	202	177	152	127	103	78	53	29	5
49	253	227	202	177	152	127	102	77	53	29	4
50	0252	0227	0202	0176	0151	0126	0102	0077	0053	0028	0024
51	252	227	201	176	151	126	101	77	52	28	4
52	252	226	201	176	151	126	101	76	52	27	3
53	251	226	200	175	150	125	100	76	51	27	3
54	251	225	200	175	150	125	100	75	51	27	2
55	250	225	200	174	149	124	100	75	51	26	2
56	250	224	199	174	149	124	099	75	50	26	2
57	250	224	199	174	148	124	099	74	50	25	1
58	249	224	198	173	148	123	098	74	49	25	1
59	249	223	198	173	148	123	098	73	49	25	0
60	0248	0223	0197	0172	0148	0122	0098	0073	0049	0024	0000

TABLE X. For computing the Effects of Parallax on the Moon's Distance from the SUN or a STAR.

Apparent Distance.

Add the Difference of the two Numbers taken out of this Table, if the Apparent Distance is less than 90°, and subtract it if above.

Parallax in Altitude or Distance	10°	11°	12°	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	24°	25°
M	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″
5	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
8	3	3	2	2	2	2	2	2	2	2	1	1	1	1	1	1
10	5	5	4	4	4	3	3	3	3	2	2	2	2	2	2	2
11	6	5	5	4	4	4	4	3	3	3	3	3	3	3	2	2
12	7	6	6	5	5	4	4	4	4	3	3	3	3	3	3	3
13	8	8	7	6	6	5	5	5	5	4	4	4	3	3	3	3
14	10	9	8	7	7	6	6	6	6	5	5	4	4	4	4	4
15	11	10	9	8	8	7	7	6	6	6	5	5	5	4	4	4
16	13	11	10	9	9	8	8	7	7	6	6	6	6	5	5	5
17	14	13	12	11	10	9	9	8	8	7	7	6	6	6	5	5
18	16	14	13	12	11	10	10	9	9	8	8	7	7	6	6	6
19	18	16	15	14	13	12	11	10	10	9	8	8	8	7	7	7
20	20	18	16	15	14	13	12	11	11	10	9	9	9	8	8	7
21	22	20	18	17	15	14	13	12	12	11	10	10	10	9	9	8
22	24	22	20	18	17	16	15	14	13	12	12	11	11	10	10	9
23	26	24	22	20	18	17	16	15	14	14	13	12	11	11	10	10
24	29	26	24	22	20	19	18	17	16	15	14	13	12	11	11	10
25	31	28	26	24	22	21	19	18	17	16	15	14	13	12	12	11
26	34	31	28	26	24	22	21	19	18	17	16	15	14	13	13	12
27	36	33	30	28	26	24	22	21	19	18	17	16	15	15	14	13
28	39	35	32	30	28	26	24	22	21	20	19	18	17	16	15	14
29	42	38	34	32	30	28	25	24	22	21	20	19	18	17	16	15
30	45	41	37	34	32	29	27	25	24	22	21	20	19	18	17	16
31	48	44	39	37	34	31	29	27	25	24	23	22	21	19	18	18
32	51	46	42	39	36	33	31	29	27	25	24	23	22	21	20	19
33	54	49	44	41	38	35	33	31	29	27	25	24	23	22	21	20
34	57	52	47	44	41	38	35	33	31	29	27	25	24	23	22	21
35	60	55	50	46	43	40	37	35	33	31	29	27	25	24	23	23
36	64	58	53	49	45	42	40	37	35	33	31	29	27	26	25	24
37	67	61	56	52	48	45	42	39	37	35	32	31	29	28	26	25
38	71	65	59	55	51	47	44	41	39	36	34	32	31	29	28	27
39	75	68	62	58	53	50	46	43	41	38	36	34	32	31	29	28
40	79	72	66	61	56	52	49	46	43	40	38	36	34	32	31	30
41	83	76	69	64	59	55	51	48	45	42	40	38	36	34	33	32
42	87	80	73	67	62	58	54	50	47	44	42	40	38	36	35	33
43	91	84	76	70	64	60	56	53	49	47	44	42	39	38	36	35
44	96	88	80	73	67	63	59	55	52	49	46	43	41	39	38	36
45	100	92	83	77	70	66	61	58	54	51	48	46	43	41	40	38
46	105	96	87	80	74	69	64	60	57	54	51	48	45	43	42	40
47	109	100	91	84	77	72	67	63	59	56	53	49	47	45	43	42
48	114	104	95	87	80	75	70	65	61	58	55	52	50	47	45	43
49	119	109	99	91	83	78	73	69	64	61	57	55	52	49	46	45
50	124	113	103	95	87	81	76	71	67	63	60	57	44	51	48	46
51	129	117	107	98	91	85	79	74	69	66	62	59	56	53	50	49
52	134	121	111	102	95	89	83	77	72	68	65	61	58	55	53	51
53	139	126	115	106	98	92	86	80	74	71	67	64	60	58	55	53
54	144	131	120	110	102	95	89	83	77	73	70	66	63	60	57	54
55	149	136	124	114	106	99	92	86	80	76	72	69	65	62	59	57
56	155	141	129	119	110	103	96	89	83	79	75	71	68	65	62	59
57	160	146	133	123	114	107	99	93	86	82	77	74	70	67	64	61
58	166	151	138	127	118	110	103	96	90	85	80	76	73	69	66	63
59	172	156	142	133	123	115	106	100	93	88	83	79	75	72	68	65
60	178	162	148	137	128	119	110	103	97	91	86	82	78	74	70	67
61	184	167	153	141	131	122	113	107	100	94	89	85	80	76	72	69
62	190	173	158	145	135	125	117	110	103	97	92	87	83	79	75	72

Table X. For computing the Effects of Parallax on the Moon's Distance from the Sun or a Star.

Apparent Distance.

Add the Difference of the two Numbers taken out of this Table, if the Apparent Distance is less than 90°, and subtract it if above.

Parallax in Altitude or Distance M	26° ″	27° ″	28° ″	29° ″	30° ″	31° ″	32° ″	33° ″	34° ″	35° ″	36° ″	37° ″	38° ″
5	0	0	0	0	0	0	0	0	0	0	0	0	0
8	1	1	1	1	1	1	1	1	1	1	1	0	0
10	2	2	2	1	1	1	1	1	1	1	1	1	1
11	2	2	2	2	2	2	2	2	1	1	1	1	1
12	3	2	2	2	2	2	2	2	2	2	2	1	1
13	3	3	3	3	2	2	2	2	2	2	2	2	2
14	4	3	3	3	3	3	3	2	2	2	2	2	2
15	4	4	4	4	3	3	3	3	3	3	3	2	2
16	5	5	5	4	4	4	4	3	3	3	3	2	2
17	5	5	5	5	4	4	4	4	4	4	3	3	3
18	6	6	6	5	5	5	5	4	4	4	4	3	3
19	6	6	6	6	5	5	5	5	5	4	4	4	4
20	7	7	7	6	6	6	6	5	5	5	5	4	4
21	8	7	7	7	7	6	6	6	6	5	5	5	5
22	9	8	8	7	7	7	7	6	6	6	6	5	5
23	9	9	9	8	8	7	7	7	7	6	6	6	6
24	10	9	9	9	9	8	8	7	7	7	7	6	6
25	11	10	10	10	9	9	9	8	8	8	7	7	7
26	12	11	11	10	10	9	9	9	9	8	8	7	7
27	13	12	12	11	11	10	10	10	9	9	9	8	8
28	14	13	13	12	12	11	11	10	10	9	9	8	8
29	15	14	14	13	13	12	12	11	11	10	10	9	9
30	16	15	15	14	14	13	13	12	12	11	11	10	10
31	17	16	16	15	15	14	14	13	13	12	11	11	11
32	18	17	17	16	16	15	15	14	14	13	12	11	11
33	19	19	18	17	17	16	16	15	14	14	13	12	12
34	21	20	19	18	18	17	17	16	15	14	14	13	13
35	22	21	20	19	19	18	17	17	16	15	14	14	13
36	23	22	21	20	20	19	18	17	17	16	15	14	14
37	24	23	22	21	21	20	19	18	18	17	16	15	15
38	26	24	23	22	22	21	20	19	19	18	17	16	16
39	27	26	24	24	23	22	21	20	20	19	18	17	17
40	29	27	26	25	24	23	22	21	21	20	19	18	18
41	30	29	27	26	25	24	23	23	22	21	2	19	19
42	32	30	29	28	27	26	25	24	23	22	21	20	20
43	33	32	30	29	28	27	26	25	24	23	22	21	21
44	35	33	32	30	29	28	27	26	25	24	23	22	22
45	36	35	33	32	30	29	28	27	26	25	24	23	23
46	38	36	35	33	32	30	29	28	27	26	25	24	24
47	40	38	36	35	33	32	30	29	28	27	26	26	25
48	42	40	38	36	35	33	32	31	30	29	28	27	26
49	43	41	39	38	36	35	33	32	31	30	29	28	27
50	45	43	41	39	38	36	35	33	32	31	30	29	28
51	47	45	43	41	39	38	36	35	33	32	31	30	29
52	49	47	45	43	41	39	38	36	35	33	32	31	30
53	50	48	46	44	42	41	39	38	36	35	33	32	31
54	52	50	48	46	44	42	41	39	38	36	35	33	32
55	54	52	49	47	45	44	42	41	39	38	36	35	33
56	56	53	51	49	47	45	44	42	41	39	38	36	35
57	58	55	53	51	49	47	45	44	42	41	39	37	36
58	60	57	55	53	51	49	47	45	44	42	40	38	37
59	62	59	57	55	53	51	48	47	45	43	41	40	38
60	64	61	59	56	54	52	50	48	47	45	43	41	40
61	66	63	61	58	56	54	52	50	48	46	44	43	41
62	69	66	63	60	58	56	54	52	50	48	46	44	43

TABLE X. For computing the Effects of Parallax on the MOON's Distance from the SUN or a STAR.

Parallax in Altitude or Distance	Apparent Distance. Add the Difference of the two Numbers taken out of this Table, if the Apparent Distance is less than 90°, and subtract it if above.												
	39°	40°	41°	42°	43°	44°	45°	46°	47°	48°	49°	50°	51°
M	″	″	″	″	″	″	″	″	″	″	″	″	″
5	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0
10	1	1	1	1	1	1	1	1	1	1	1	0	0
11	1	1	1	1	1	1	1	1	1	1	1	0	0
12	1	1	1	1	1	1	1	1	1	1	1	0	0
13	2	2	2	2	2	1	1	1	1	1	1	1	1
14	2	2	2	2	2	2	2	1	1	1	1	1	1
15	2	2	2	2	2	2	2	2	2	1	1	1	1
16	2	2	2	2	2	2	2	2	2	2	2	2	1
17	3	3	3	3	3	3	2	2	2	2	2	2	2
18	3	3	3	3	3	3	3	3	3	2	2	2	2
19	4	3	3	3	3	3	3	3	3	3	3	3	3
20	4	4	4	4	3	3	3	3	3	3	3	3	3
21	5	4	4	4	4	4	4	4	4	3	3	3	3
22	5	5	5	5	4	4	4	4	4	3	3	3	3
23	6	5	5	5	5	5	4	4	4	4	4	3	3
24	6	6	6	6	5	5	5	5	5	4	4	4	4
25	7	6	6	6	6	6	5	5	5	5	5	4	4
26	7	7	7	7	6	6	6	6	6	5	5	5	5
27	8	7	7	7	7	6	6	6	6	5	5	5	5
28	8	8	8	8	7	7	7	7	7	6	6	6	6
29	9	9	9	8	8	7	7	7	7	6	6	6	6
30	9	9	9	9	8	8	8	8	7	7	6	6	6
31	10	10	10	9	9	8	8	8	8	7	7	7	6
32	10	10	10	10	9	9	9	9	8	8	7	7	6
33	11	11	11	10	10	10	9	9	8	8	7	7	7
34	12	11	11	11	10	10	10	10	9	9	8	8	7
35	13	12	12	11	11	11	10	10	9	9	8	8	8
36	13	13	13	12	11	11	11	11	10	10	9	9	9
37	14	13	13	12	12	11	11	11	10	10	10	10	10
38	15	14	14	13	13	12	12	12	12	11	11	11	11
39	16	15	15	14	14	13	13	13	13	12	12	11	11
40	17	16	16	15	15	14	14	14	13	13	12	12	12
41	18	17	17	16	15	15	14	14	14	13	13	12	12
42	19	18	18	17	16	15	15	15	14	14	13	13	13
43	20	18	18	17	16	16	15	15	14	14	13	13	13
44	20	19	19	18	17	16	16	16	15	15	14	13	13
45	21	20	20	19	18	17	17	16	15	15	14	14	14
46	22	21	20	20	19	18	18	17	16	16	15	14	14
47	23	22	22	21	20	20	19	18	17	16	15	15	15
48	24	23	23	22	22	21	20	19	18	17	16	16	16
49	26	24	24	24	23	22	21	20	19	18	17	17	17
50	27	26	26	25	24	23	22	21	20	19	18	18	18
51	28	27	26	25	24	23	22	22	21	20	19	18	18
52	29	28	27	26	25	24	23	22	21	20	19	19	18
53	30	29	28	27	26	25	24	23	22	21	20	19	19
54	31	30	29	28	27	26	25	24	23	22	21	20	19
55	32	31	30	29	28	27	26	25	24	23	22	21	20
56	33	32	31	30	29	28	27	26	25	24	23	22	21
57	35	33	32	31	30	29	28	27	26	25	24	23	22
58	36	35	33	32	31	30	29	28	27	26	25	24	23
59	37	36	34	33	32	31	30	29	28	27	26	25	24
60	38	37	35	34	33	32	31	30	29	28	27	26	25
61	40	38	36	35	34	33	32	31	30	29	28	27	26
62	41	40	38	36	35	34	33	32	31	30	29	28	27

TABLE X. For computing the Effects of Parallax on the MOON's Distance from the SUN or a STAR.

Apparent Distance.

Add the Difference of the two Numbers taken out of this Table, if the Apparent Distance is less than 90°, and subtract it if above.

Parallax in Altitude or Distance M	52°	53°	54°	55°	56°	57°	58°	59°	60° 120	65° 115	70° 110	75° 105	80° 100	85° 95	90° 90°
	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
14	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0
15	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0
16	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0
17	2	2	2	1	1	1	1	1	1	1	0	0	0	0	0
18	2	2	2	2	2	2	2	2	2	1	1	0	0	0	0
19	3	2	2	2	2	2	2	2	2	1	1	0	0	0	0
20	3	2	2	2	2	2	2	2	2	1	1	1	0	0	0
21	3	3	3	2	2	2	2	2	2	1	1	1	0	0	0
22	3	3	3	3	3	3	2	2	2	2	1	1	0	0	0
23	3	3	3	3	3	3	3	3	2	2	1	1	0	0	0
24	4	3	3	3	3	3	3	3	3	2	1	1	1	0	0
25	4	4	4	3	3	3	3	3	3	2	1	1	1	0	0
26	5	4	4	4	4	4	3	3	3	3	2	1	1	0	0
27	5	5	5	4	4	4	4	4	3	3	2	1	1	0	0
28	6	5	5	5	5	5	4	4	4	3	2	2	1	0	0
29	6	5	5	5	5	5	4	4	4	3	2	2	1	0	0
20	6	5	5	5	5	5	4	4	4	4	3	2	1	0	0
31	6	5	5	5	5	5	5	5	4	4	3	2	1	0	0
32	6	5	5	5	5	5	5	5	5	4	3	2	1	0	0
33	6	6	6	5	5	5	5	5	5	4	3	2	1	0	0
34	7	6	6	6	6	6	5	5	5	4	4	2	1	0	0
35	8	7	7	6	6	6	6	6	5	4	4	2	1	0	0
36	8	8	7	7	7	7	6	6	6	5	4	3	2	1	0
37	9	9	8	8	8	7	7	7	6	5	4	3	2	1	0
38	10	10	9	9	9	8	8	7	7	5	4	3	2	1	0
39	11	10	10	9	9	9	8	8	7	5	4	3	2	1	0
30	11	11	10	10	9	9	8	8	8	6	5	3	2	1	0
41	12	12	11	10	10	10	9	9	8	6	5	3	2	1	0
42	12	12	11	11	10	10	9	9	9	7	5	4	2	1	0
43	12	12	11	11	10	10	9	9	9	7	5	4	2	1	0
44	12	12	11	11	11	10	10	9	9	7	6	4	2	1	0
45	13	12	12	11	11	11	10	10	9	7	6	4	2	1	0
46	13	13	12	12	12	11	11	10	10	8	7	5	3	1	0
47	14	14	13	12	12	12	11	11	10	8	7	5	3	1	0
48	15	14	13	13	12	12	12	11	11	9	7	5	3	2	0
49	16	15	14	14	14	13	13	12	11	9	7	5	3	2	0
50	17	16	15	15	14	13	13	12	12	10	8	6	4	2	0
51	17	16	16	15	15	14	14	13	12	10	8	6	4	2	0
52	17	17	16	16	15	15	14	14	13	10	8	6	4	2	0
53	18	18	17	16	16	15	15	14	13	10	8	6	4	2	0
54	19	18	17	17	16	16	15	15	14	11	9	7	4	2	0
55	19	18	18	17	17	16	16	15	14	11	9	7	4	2	0
56	20	19	18	18	17	16	16	15	15	12	9	7	5	2	0
57	21	20	19	19	19	18	17	16	15	12	9	7	5	2	0
58	22	21	20	20	19	18	17	16	16	13	10	7	5	2	0
59	23	22	21	21	20	19	18	17	17	13	10	7	5	2	0
60	24	23	22	22	21	20	19	18	18	14	11	8	5	3	0
61	25	24	23	23	22	21	20	19	18	15	11	8	5	3	0
62	26	25	24	23	22	21	20	19	19	16	12	9	6	3	0

Table XI.

For turning Degrees and Minutes into Time, and the contrary.

D	H M	D	H M	D	H M	D	H M	D	H M	D	H M
M	M S	M	M S	M	M S	M	M S	M	M S	M	M S
1	0. 4	61	4. 4	121	8. 4	181	12. 4	241	16. 4	301	20. 4
2	0. 8	62	4. 8	122	8. 8	182	12. 8	242	16. 8	302	201.8
3	0.12	63	4.12	123	8.12	183	12.12	243	16.12	303	20.12
4	0.16	64	4.16	124	8.16	184	12.16	244	16.16	304	20.16
5	0.20	65	4.20	125	8.20	185	12.20	245	16.20	305	20.20
6	0.24	66	4.24	126	8.24	186	12.24	246	16.24	306	20.24
7	0.28	67	4.28	127	8.28	187	12.28	247	16.28	307	20.28
8	0.32	68	4.32	128	8.32	188	12.32	248	16.32	308	20.32
9	0.36	69	4.36	129	8.36	189	12.36	249	16.36	309	20.36
10	0.40	70	4.40	130	8.40	190	12.40	250	16.40	310	20.40
11	0.44	71	4.44	131	8.44	191	12.44	251	16.44	311	20.44
12	0.48	72	4.48	132	8.48	192	12.48	252	16.48	312	20.48
13	0.52	73	4.52	133	8.52	193	12.52	253	16.52	313	20.52
14	0.56	74	4.56	134	8.56	194	12.56	254	16.56	314	20.56
15	1. 0	75	5. 0	135	9. 0	195	13. 0	255	17 0	315	21. 0
16	1. 4	76	5. 4	136	9. 4	196	13. 4	256	17. 4	316	21. 4
17	1. 8	77	5. 8	137	9. 8	197	13. 8	257	17. 8	317	21. 8
18	1 12	78	5.12	138	9.12	198	13.12	258	17.12	318	21.12
19	1.16	79	5.16	139	9.16	199	13.16	259	17.16	319	21.16
20	1.20	80	5.20	140	9.20	200	13.20	260	17.20	320	21.20
21	1.24	81	5.24	141	9.24	201	13.24	261	17.24	321	21.24
22	1.28	82	5.28	142	9.28	202	13.28	262	17.28	322	21.28
23	1.32	83	5.32	143	9.32	203	13.32	263	17.32	323	21.32
24	1.36	84	5.36	144	9.36	204	13.36	264	17.36	324	21 36
25	1.40	85	5.40	145	9.40	205	13.40	265	17.40	325	21.40
26	1.44	86	5.44	146	9.44	206	13.44	266	17.44	320	21.44
27	1.48	87	5.48	147	9.48	207	13.48	267	17.48	327	21.48
28	1.52	88	5.52	148	9.52	208	13.52	268	17.52	328	21.52
29	1.56	89	5.56	149	9.56	209	13.56	269	17.56	329	21.56
30	2. 0	90	6. 0	150	10. 0	210	14. 0	270	18. 0	330	22. 0
31	2. 4	91	6. 4	151	10. 4	211	14. 4	271	18. 4	331	22. 4
32	2. 8	92	6. 8	152	10. 8	212	14. 8	272	18. 8	332	22. 8
33	2.12	93	6.12	153	10.12	213	14.12	273	18.12	333	22.12
34	2.16	94	6.16	154	10.16	214	14 16	274	18.16	334	22.16
35	2.20	95	6.20	155	10.20	215	14.20	275	18.20	335	22.20
36	2.24	96	6.24	156	10.24	216	14.24	276	18.24	336	22.24
37	2.28	97	6.28	157	10.28	217	14.28	277	18.28	337	22.28
38	2 32	98	6.32	158	10.32	218	14.32	278	18.32	338	22.32
39	2.36	99	6.36	159	10.36	219	14.36	279	18.36	339	22.36
40	2.40	100	6.40	160	10.40	220	14.40	280	18.40	340	22.40
41	2.44	101	6.44	161	10.44	221	14.44	281	18.44	341	22.44
42	2.48	102	6.48	162	10.48	222	14.48	282	18.48	342	22.48
43	2.52	103	6.52	163	10.52	223	14.52	283	18.52	343	22.52
44	2.56	104	6.56	164	10.36	224	14.56	284	18.56	344	22.56
45	3. 0	105	7. 0	165	11. 0	225	15. 0	285	19. 0	345	23. 0
46	3. 4	106	7. 4	166	11. 4	226	15. 4	286	19. 4	346	23. 4
47	3. 8	107	7. 8	167	11. 8	227	15. 8	287	19. 8	347	23. 8
48	3.12	108	7.12	168	11.12	228	15.12	288	19.12	348	23.12
49	3.16	109	7.16	169	11.16	229	15.16	289	19.16	349	23.16
50	3.20	110	7.20	170	11.20	230	15.20	290	19.20	350	23.20
51	3.24	111	7.24	171	11.24	231	15.24	291	19.24	351	23.24
52	3.28	112	7.28	172	11.28	232	15.28	292	19.28	352	23.28
53	3.32	113	7.32	173	11.32	233	15.32	293	19.32	353	23.32
54	3.36	114	7.36	174	11.36	234	15.36	294	19.36	354	23.36
55	3.40	115	7.40	175	11.40	235	15.40	295	19.40	355	23.40
56	3.44	116	7.44	176	11.44	236	15.44	296	19.44	356	23.44
57	3.48	117	7.48	177	11.48	237	15.48	297	19.48	357	23.48
58	3.52	118	7.52	178	11.52	238	15.52	298	19.52	358	23.52
59	3.56	119	7.56	179	11.56	239	15.56	299	19.56	359	23.56
60	4. 0	120	8. 0	180	12. 0	240	16. 0	300	20. 0	360	24. 0

TABLE XII. The Refraction of the Heavenly Bodies in Altitude.

App. Alt.	Ref.	App. Alt.	Ref.	App. Alt.	Ref.
D.M.	M. S.	D. M.	M.	D.	M.S.
0. 0	33. 0	6.30	7.51	30	1.38
0. 5	32.10	6.40	7.40	31	1.35
0.10	31.22	6.50	7.30	32	1.31
0.15	30.35	7. 0	7.20	33	1.28
0.20	29.50	7.10	7.11	34	1.24
0.25	29. 6	7.20	7. 2	35	1.21
0.30	28.22	7.30	6.53	36	1.18
0.35	27.41	7.40	6.45	37	1.16
0.40	27. 0	7.50	6.37	38	1.13
0.45	26.20	8. 0	6.29	39	1.10
0.50	25.42	8.10	6.22	40	1. 8
0.55	25. 5	8.20	6.15	41	1. 5
1. 0	24.27	8.30	6. 8	42	1. 3
1. 5	23.54	8.40	6. 1	43	1. 1
1.10	23.20	8.50	5.55	44	0.59
1.15	22.47	9. 0	5.48	45	0.57
1.20	22.15	9.10	5.42	46	0.55
1.25	21.44	9.20	5.36	47	0.53
1.30	21.15	9.30	5.31	48	0.51
1.35	20.46	9.40	5.25	49	0.4
1.40	20.18	9.50	5.20	50	0.48
1.45	19.51	10. 0	5.15	51	0.46
1.50	19.25	10.15	5. 7	52	0.44
1.55	19. 0	10.30	5. 0	53	0.43
2. 0	18.35	10.45	4.53	54	0.41
2. 5	18.11	11. 0	4.47	55	0.40
2.10	17.48	11.15	4.40	56	0.39
2.15	17.26	11.30	4.34	57	0.37
2.20	17. 4	11.45	4.29	58	0.35
2.25	16.44	12. 0	4.23	59	0.34
2.30	16.24	12.20	4.16	60	0.33
2.35	16. 4	12.40	4. 9	61	0.32
2.40	15.45	13. 0	4. 3	62	0.30
2.45	15.27	13.20	3.57	63	0.29
2.50	15. 9	13.40	3.51	64	0.28
2.55	14.52	14. 0	3.45	65	0.26
3. 0	14.36	14.20	3.40	66	0.25
3. 5	14.20	14.40	3.35	67	0.24
3.10	14. 4	15. 0	3.30	68	0.23
3.15	13.49	15.30	3.24	69	0.22
3.20	13.34	16. 0	3.17	70	0.21
3.25	13.20	16.30	3.10	71	0.19
3.30	13. 6	17. 0	3. 4	72	0.18
3.40	12.40	17.30	2.59	73	0.17
3.50	12.15	18. 0	2.54	74	0.16
4. 0	11.51	18.30	2.49	75	0.15
4.10	11.29	19. 0	2.44	76	0.14
4.20	11. 8	19.30	2.39	77	0.13
4.30	10.48	20. 0	2.35	78	0.12
4.40	10.29	20.30	2.31	79	0.11
4.50	10.11	21. 0	2.27	80	0.10
5. 0	9.54	21.30	2.24	81	0.9
5.10	9.38	22. 0	2.20	82	0.8
5.20	9.23	23. 0	2.14	83	0.7
5.30	9. 8	24. 0	2. 7	84	0.6
5.40	8.54	25. 0	2. 2	85	0.5
5.50	8.41	26. 0	1.56	86	0.4
5. 0	8.28	27. 0	1.51	87	0.3
6.10	8.15	28. 0	1.47	88	0.2
6.20	8. 3	29. 0	1.42	89	0.1

TABLE XIII. Depression or Dip of the Horizon of the Sea.

Height of the Eye.	Dip of the Horizon.
Feet.	M. S.
1	0.57
2	1.21
3	1.39
4	1.55
5	2. 8
6	2.20
7	2.31
8	2.42
9	2.52
10	3. 1
11	3.10
12	3.18
13	3.26
14	3.34
15	3.42
16	3.49
17	3.56
18	4. 3
19	4.10
20	4.16
21	4.22
22	4.28
23	4.34
24	4.40
26	4.52
28	5. 3
30	5.14
35	5.39
40	6. 2
45	6.24
50	6.44
60	7.23
70	7.59
80	8.32
90	9. 3
100	9.33

TABLE XIV. The Sun's Parallax in Altitude

Sun's Alt.	Sun's Parallax.
D.	S.
0	9
10	9
20	8
30	8
40	7
50	6
55	5
60	4
65	4
70	3
75	2
80	2
85	1
90	0

TABLE XV. Augmentation of the Moon's Semidiameter.

Moon's Alt.	Augmentation.
D.	S.
0	0
5	1
10	3
15	4
20	6
25	7
30	8
35	9
40	10
45	11
50	12
55	13
60	14
70	15
80&c.	16

TABLE XVI. Dip of the Land at different Distances from the Observer.

Dist. of the land in sea miles.	Height of the Eye above the Sea in Feet. 5	10	15	20	25	30	35	40
	Dip.	Dip.	Dip.	Dip.	Dip.	Dip.	Dip.	Dip.
	M.	M.	M.	M.	M.	M.	M.	M.
1/4	11	22	34	45	56	68	79	90
1/2	6	11	17	22	28	34	39	45
3/4	4	8	12	15	19	23	27	30
1	4	6	9	12	15	17	20	23
1 1/4	3	5	7	9	12	14	16	19
1 1/2	3	4	6	8	10	12	14	15
2	2	3	5	6	8	10	11	12
2 1/2	2	3	5	6	7	8	9	10
3	2	3	4	5	6	7	8	8
3 1/2	2	3	4	5	6	6	7	7
4	2	3	4	4	5	6	7	7
5	2	3	4	4	5	5	6	6
6	2	3	4	4	5	5	6	6

A TABLE

OF THE

SUN's DECLINATION,

For the YEARS 1791, 1795, 1799, 1803.

Each being the third after Leap-Year.

Days.	Jan.	Feb.	March	April	May	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	South	South	South	North	North	North	North	North	North	South	South	South
1	23. 0	17. 1	7. 28	4.39	15. 9	22. 6	23. 7	18. 0	8.14	3.16	14.38	21.52
2	22.54	16.43	7. 5	5. 2	15.27	22.16	23. 3	17.45	7.52	3.40	14.51	22. 1
3	22.49	16.26	6.42	5.25	15.45	22.21	22.58	17.29	7.30	4. 3	15. 10	22.10
4	22.42	16.08	6.19	5.48	16. 2	22.28	22.53	17.13	7. 8	4.26	15.28	22.18
5	22.36	15.50	5.56	6.11	16.19	22.35	22.48	16.57	6.45	4.49	15.47	22.26
6	22.28	15.31	5.33	6.33	16.36	22.41	22.42	16.41	6.23	5.12	16. 5	22.33
7	22.21	15.13	5.10	6.56	16.53	22.47	22.36	16.24	6.	5.36	16.25	22.40
8	22.13	14.54	4.46	7.18	17. 9	22.53	22.29	16. 7	5.38	5.59	16.40	22.46
9	22. 4	14.34	4.23	7.40	17.25	22.58	22.22	15.50	5.15	6.21	16.57	22.52
10	21.56	14.15	3.59	8. 3	17.41	23. 3	22.15	15.32	4.52	6.44	17.14	22.58
11	21.46	13.55	3.36	8.25	17.57	23. 7	22. 7	15.14	4.30	7. 7	17.31	23. 3
12	21.36	13.35	3.12	8.47	18.12	23.11	21.58	14.56	4. 7	7.30	17.47	23. 8
13	21.26	13.15	2.49	9. 8	18.27	23.15	21.50	14.38	3.44	7.52	18. 4	23.12
14	21.16	12.55	2.25	9.30	18.41	23.18	21.41	14.20	3.21	8.15	18.19	23.15
15	21. 5	12.34	2. 1	9.52	18.56	23.20	21.32	14. 1	2.57	8.37	18.35	23.19
16	20.53	12.13	1.38	10.13	19.10	23.23	21.22	13.42	2.34	8.59	18.50	23.21
17	20.41	11.52	1.14	10.34	19.23	23.24	21.12	13.23	2.11	9.21	19. 5	23.24
18	20.29	11.31	0.50	10.55	19.36	23.26	21. 1	13. 4	1.48	9.43	19.19	23.25
19	20.17	11.10	0.27	11.16	19.49	23.27	20.51	12.44	1.24	10.05	19.33	23.27
20	20. 4	10.48	0.03	11.36	20. 2	23.28	20.39	12.24	1. 1	10.26	19.47	23.27
21	19.50	10.27	0.21N.	11.57	20.14	23.28	20.28	12. 4	0.38	10.48	20.	23.28
22	19.37	10.05	0.45	12.17	20.26	23.28	20.16	11.44	0.14	11.09	20.13	23.28
23	19.23	9.43	1. 8	12.37	20.38	23.27	20. 4	11.24	0. 9S.	11.30	20.26	23.27
24	19. 8	9.21	1.32	12.57	20.49	23.26	19.51	11. 3	0.33	11.51	20.38	23.26
25	18.53	8.58	1.55	13.16	21.	23.26	19.39	10.43	0.56	12.12	20.50	23.25
26	18.38	8.36	2.19	13.36	21.10	23.23	19.25	10.22	1.20	12.33	21. 1	23.23
27	18.23	8.14	2.42	13.55	21.21	23.21	19.12	10. 1	1.43	12.53	21.12	23.20
28	18.07	7.51	3. 6	14.14	21.30	23.18	18.58	9.40	2. 6	13.13	21.23	23.17
29	17.51		3.29	14.33	21.40	23.15	18.44	9.18	2.30	13.33	21.33	23.14
30	17.34		3.52	14.51	21.49	23.11	18.30	8.57	2.53	13.53	21.43	23.10
31	17.18		4.16		21.58		18.15	8.35		14.12		23. 6

A TABLE

OF THE

SUN's DECLINATION,

For the YEARS 1792, 1796, 1800, 1804.

Each being Leap-Year.

Days.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	South	South	South	North	North	North	North	North	North	South	South	South
1	23. 1	17. 5	7.11	4.56	15.23	22.12	23. 4	17.48	7.57	3.34	14.46	21.59
2	22.56	16.48	6.48	5.19	15.40	22.19	23.	17.33	7.35	3.57	15. 5	22. 8
3	22.50	16.30	6.25	5.42	15.58	22.27	22.55	17.17	7.13	4.21	15.24	22.16
4	22.44	16.12	6. 2	6.05	16.15	22.34	22.49	17. 1	6.51	4.44	15.42	22.24
5	22.37	15.54	5.39	6.28	16.32	22.40	22.43	16.45	6.28	5. 7	16. 1	22.32
6	22.30	15.36	5.15	6.50	16.49	22.46	22.37	16.28	6. 6	5.30	16.18	22 39
7	22.23	15.17	4.52	7.13	17.05	22.52	22.31	16.11	5.43	5.53	16.36	22.45
8	22.15	14.58	4.29	7.35	17.22	22.57	22.24	15.54	5.21	6.16	16.53	22.51
9	22. 6	14.39	4. 5	7.57	17.37	23. 2	22.16	15.36	4.58	6.39	17.10	22.57
10	21.58	14.20	3.42	8.19	17.53	23. 6	22. 9	15.19	4.35	7. 2	17.27	23. 2
11	21.48	14. 0	3.18	8.41	18. 8	23.10	22. 0	15. 1	4.12	7.24	17.44	23. 7
12	21.39	13.40	2.54	9.03	18.23	23.14	21.52	14.43	3.49	7.47	18.	23.11
13	21.29	13.20	2.31	9.25	18.38	23.17	21.43	14.24	3.26	8. 9	18.15	23.15
14	21.18	13. 0	2.07	9.46	18.52	23.20	21.34	14. 6	3. 3	8.31	18.31	23.18
15	21. 7	12.39	1.43	10.08	19. 6	23.22	21.24	13.47	2.40	8.54	18.46	23.21
16	20.56	12.18	1.20	10.29	19.20	23.24	21.14	13.28	2.17	9.16	19. 1	23.23
17	20.44	11.58	0.56	10.50	19.33	23.26	21. 4	13. 8	1.53	9.38	19.16	23.25
18	20.32	11.36	0.32	11.11	19.46	23.27	20.53	12.49	1.30	9.59	19.30	23.26
19	20.20	11.15	0. 9	11.31	19.59	23.28	20.42	12.29	1. 7	10.21	19.43	23.27
20	20. 7	10.54	0.15N	11.52	20.11	23.28	20.31	12. 9	0.43	10.43	19.57	23.28
21	19.54	10.32	0.39	12.12	20.23	23.28	20.19	11.49	0.20	11. 4	20.10	23.28
22	19.42	10.10	1. 2	12.32	20.35	23.27	20. 7	11.29	0. 3S	11.25	20.23	23.27
23	19.26	9.48	1.26	12.52	20.46	23.26	19.55	11. 9	0.27	11.46	20.35	23.27
24	19.12	9.26	1.49	13.12	20.57	23.25	19.42	10.48	0.50	12. 7	20.47	23.25
25	18.57	9. 4	2.13	13.31	21.08	23.23	19.29	10.27	1.14	12.28	20.59	23.24
26	18.42	8.42	2.37	13.50	21.18	23.21	19.15	10. 6	1.37	12.48	21.10	23.21
27	18.27	8.19	3. 0	14. 9	21.28	23.18	19. 2	9.45	2. 1	13. 8	21.20	23.18
28	18.11	7.57	3.23	14.28	21.38	23.16	18.48	9.24	2.24	13.28	21.31	23 15
29	17.54	7.34	3.47	14.46	21.47	23.12	18.33	9. 2	3.47	13.48	21.41	23.11
30	17.39		4.10	15.05	21.55	23.08	18.19	8.41	3.11	14. 8	21.50	23. 7
31	17.22		4.33		22. 4		18. 4	8.19		14.27		23. 2

A TABLE

OF THE

SUN's DECLINATION,

For the YEAR 1797.

Being the first after Leap-Year.

Days.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	South	South	South	North	North	North	North	North	North	South	South	South
1	22.57	16.52	7.17	4.51	15.18	22.10	23. 5	17.53	8. 3	3.28	14.41	21.57
2	22.52	16.35	6.54	5.14	15.36	22.17	23. 1	17.37	7.41	3.51	15.	22. 6
3	22.45	16.17	6.31	5.36	15.53	22.25	22.56	17.21	7.19	4.15	15.19	22.14
4	22.39	15.59	6. 8	5.59	16.11	22.32	22.50	17. 5	6.57	4.38	15.37	22.22
5	22.32	15.41	5.44	6.22	16.28	22.38	22.45	16.49	6.34	5. 1	15.56	22.30
6	22.25	15.22	5.21	6.45	16.44	22.44	22.38	16.33	6.12	5.24	16.14	22.37
7	22.17	15. 3	4.58	7. 7	17. 1	22.50	22.32	16.16	5.49	5.47	16.31	22.45
8	22. 9	14.44	4.35	7.30	17.17	22.55	22.26	15.59	5.27	6.10	16.49	22.49
9	22. 0	14.24	4.11	7.52	17.33	23.	22.18	15.41	5. 4	6.33	17. 6	22.55
10	21.51	14. 5	3.48	8.14	17.49	23. 5	22.11	[illegible]	4.41	6 55	17.23	23.
11	21.41	13.45	3.24	8.36	18. 4	23. 9	22. 3	15. 6	4.18	7.18	17.39	23. 5
12	21.31	13.25	3. 0	8.58	18.19	23.13	21.54	14.48	3.55	7.41	17.56	23.10
13	21.21	13. 5	2.37	9.15	18.34	23.16	21.45	14.29	3.32	8. 3	18.11	23.14
14	21.10	12.45	2.13	9.41	18.48	23.19	21.30	14.11	3. 9	9.25	18.27	23.18
15	20.59	12.24	1.49	10. 2	19. 2	23.21	21.27	13.52	2.46	8.48	18.42	23.20
16	20.47	12. 3	1.26	10.23	19.16	23.23	21.17	13.33	2.23	9.10	18.57	23.22
17	20.35	11.42	1. 2	10.44	19.30	23.25	21. 7	13.14	2.	9.32	19.12	23.24
18	20.23	11.21	0.39	11. 5	19.42	23.27	20.56	12.54	1.36	9.54	19.26	23.26
19	20.10	10 59	0.15	11.26	19.56	23.27	20.45	12.34	1.13	10.15	19.40	23.27
20	19.57	10.38	0. 9N	11.46	20. 8	23.28	20.34	12.15	0.49	10.37	19.54	23.28
21	19.44	10.16	0.32	12. 6	20.20	23.28	20.22	11.55	0.26	10.58	20. 6	23.28
22	19.30	9.54	0.56	12.27	20.32	23.27	20.10	11.34	0. 3	11.22	20.19	23.27
23	19.15	9.32	1.20	12.47	20.43	23.27	19.58	11.14	0.21S.	11.40	20.32	23.27
24	19. 1	9.10	1.44	13. 6	20.54	23.25	19.45	10.53	0.44	12. 1	20.44	23.26
25	18.46	8.48	2. 7	13.26	21. 5	23.24	19.32	10.32	1. 7	12.22	20.55	23.24
26	18.31	8.25	2.31	13.45	21.15	23.22	19.19	10.12	1.31	12.43	21. 7	23.22
27	18.15	8 2	2.54	14. 5	21.25	23.19	19. 5	9.50	1.54	13. 3	21.18	23.19
28	17.59	7.40	3.17	14.23	21.35	23.16	18.51	9.29	2.18	13.23	21.28	23.16
29	17.43		3.41	14.41	21.44	23.13	18.37	9. 8	2.[illegible]	13.43	21.38	23.12
30	17.26		4. 4	15.	21.53	23. 9	18.23	8.46	3.[illegible]	14. 2	21.48	23. 8
31	17.10		4.27		22. 2		18. 8	8.24				23. 4

A TABLE

OF THE

SUN's DECLINATION

For the YEAR 1798.

Being the second after Leap-Year.

Days.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	South	South	South	North	North	North	North	North	North	South	South	South
1	22.58	16.57	7.23	4.44	15.14	22 8	23. 6	17.56	8. 8	3.22	14.37	21.55
2	22.53	16.39	7.	5. 7	15.31	22.16	23. 2	17.41	7.46	3.46	14.56	22. 4
3	22.47	16.21	6.37	5.30	15.49	22.23	22.57	17.25	7.24	4. 9	15.14	22.12
4	22.41	16. 3	6.14	5.53	16.06	22.30	22.52	17. 9	7. 2	4.32	15.33	22.20
5	22.34	15.45	5.51	6.16	16.24	22.37	22.46	16.53	6.40	4.55	15.51	22.28
6	22.27	15.27	5.27	6.39	16.40	22.43	22.41	16.37	6.17	5 18	16. 9	22.35
7	22.19	15. 8	5. 4	7. 1	16.57	22.49	22.34	16.20	5.55	5.41	16.27	22.42
8	22.11	14.49	4.40	7.24	17.13	22.54	22.27	16 3	5.32	6. 4	16.45	22.48
9	22. 2	14.30	4.17	7.4[illegible]	17.29	22.59	22.20	15.45	5. 9	6.27	17. 2	22.54
10	21.53	14.10	3.54	8. [illegible]	17.45	23. 4	22.13	15.28	4.47	6.50	17.19	22.59
11	21 44	13.50	3.30	8.30	18. 1	23. 8	22. 5	15.10	4.24	7.13	17.35	23. 4
12	21.34	13.30	3. 6	8.52	18.16	23.12	21.57	14.52	4. 1	7.35	17.51	23. 8
13	21.24	13.10	2.43	9.14	18.30	23.15	21.48	14.34	3 38	7.58	18. 7	23.13
14	21.13	12.50	2.19	9.35	18.45	23.18	21.39	14 15	3.15	8.20	18.23	23.16
15	21. 2	12.29	1.55	9.57	18.59	23.21	21.29	13.56	2.52	8.43	18.38	23.19
16	20.50	12. 8	1 32	10.19	19.13	23.23	21.20	13 37	2.28	9. 4	18.53	23.22
17	20.38	11.47	1. 8	10.39	19.26	23.25	21. 9	13.18	2. 6	9 26	19. 8	23.24
18	20.26	11.26	0.44	11. 0	19.40	23.26	20.59	12.59	1.42	9.48	19.22	23 26
19	20.13	11. 5	0.21	11.21	19.52	23.27	20.48	12.39	1.18	10.10	19.36	23.27
20	20. 1	10.43	0. 3N	11.41	20.05	23.28	20.37	12.20	0.55	10.32	19.50	23.28
21	19.47	10.21	0.27	12. 2	20.17	23.28	20.25	12.	0.32	10.53	20. 3	23.28
22	19.33	10.	0.50	12.22	20.29	23.28	20.13	11.40	0. 9	11.15	20.16	23.28
23	19.19	9.37	1.14	12.42	20.41	23.27	20. 1	11.19	0.15 S	11.36	20.29	23.27
24	19. 5	9.18	1.37	13. 2	20.52	23.26	19.48	10.58	0.39	11.56	20.41	23 25
25	18.50	8.53	2. 1	13.21	21. 3	23.24	19.36	10.38	1. 2	12.17	20.53	23.24
26	18.35	8.31	2.25	13.40	21.13	23.22	19.22	10.17	1.25	12.38	21. 4	23.22
27	18.19	8. 8	2.48	13.59	21.23	23.20	19. 9	9.56	1.49	12 58	21.15	23.20
28	18. 3	7.45	3.11	14.18	21.33	23.17	18.55	9.34	2.12	13.18	21.26	23 17
29	17.47		3. [illegible]	14.37	21 42	23.14	18.41	9.13	2 36	13 38	21.36	23.13
30	17.30		[illegible]	14.55	21.51	23 10	18.26	8.52	2.59	13.58	21.45	23. 9
31	17.14		[illegible]		22.		18.11	8.30		14.17		23. 5

to any other Time under that Merid. or to Noon under any other Merid.

Add after N. Sub. bef. N.	Sub. aft. N. Add. bef. N.	H. M. 0.20	H. M. 0.40	H. M. 1. 0	H. M. 1.20	H. M. 1.40	H. M. 2. 0	H. M. 2.20	H. M. 2.40	Add bef. N.	Sub. bef. N.
Add in W. Sub. in E.	Sub. in W Add in E	5 Deg	10 D.	15 D.	20 D.	25 D.	30 D.	35 D.	40 D.	Sub. in W Add in E	Add in W. Sub. in E.
Days.	Days.	M. S.	M. S	M. S	M. S	M. S.	M. S.	M. S.	M. S	Days.	Days.
December 21	Decem. 21	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	21 June	21 June
20	22	0. 0	0. 1	0. 1	0. 1	0. 2	0. 2	0. 2	0. 3	22	20
19	23	0. 0	0. 1	0. 2	0. 2	0. 3	0. 4	0. 5	0. 6	23	19
18	24	0. 1	0. 2	0. 3	0. 4	0. 6	0. 7	0. 8	0. 9	24	18
17	25	0. 1	0. 3	0. 4	0. 6	0. 7	0. 9	0.11	0.12	25	17
16	26	0. 2	0. 4	0. 5	0. 7	0. 9	0.11	0.13	0.15	26	16
15	27	0. 2	0. 5	0. 6	0. 8	0.11	0.13	0.15	0.18	27	15
14	28	0. 3	0. 6	0. 7	0.10	0.12	0.15	0.18	0.21	28	14
13	29	0. 3	0. 7	0. 9	0.12	0.15	0.18	0.21	0.24	29	13
12	30	0. 3	0. 7	0.10	0.13	0.17	0.20	0.23	0.27	30 June	12
11	Decem. 31	0. 4	0. 8	0.11	0.15	0.19	0.22	0.26	0.30	1 July	11
10	Jan. 1	0. 4	0. 8	0.12	0.16	0.20	0.24	0.28	0.32	2	10
9	2	0. 4	0. 8	0.13	0.17	0.21	0.26	0.30	0.35	3	9
8	3	0. 5	0. 9	0.14	0.19	0.24	0.29	0.33	0.38	4	8
7	4	0. 5	0.10	0.15	0.21	0.26	0.31	0.36	0.41	5	7
6	5	0. 5	0.11	0.16	0.22	0.28	0.33	0.38	0.44	6	6
5	6	0. 6	0.12	0.17	0.24	0.30	0.35	0.41	0.47	7	5
4	7	0. 6	0.12	0.18	0.25	0.31	0.37	0.43	0.49	8	4
3	8	0. 6	0.13	0.19	0.26	0.33	0.39	0.45	0.52	9	3
2	9	0. 7	0.14	0.20	0.27	0.34	0.41	0.48	0.55	10	2
Decem. N	10	0. 7	0.14	0.21	0.29	0.36	0.43	0.50	0.57	11	1 June
Novem. 30	11	0. 7	0.15	0.22	0.30	0.37	0.45	0.52	1. 0	12	31 May
29	12	0. 8	0.16	0.23	0.31	0.39	0.47	0.55	1. 2	13	30
28	13	0. 8	0.16	0.24	0.33	0.41	0.49	0.57	1. 6	14	29
27	14	0. 8	0.17	0.25	0.34	0.42	0.51	0.59	1. 8	15	28
26	15	0. 9	0.18	0.26	0.35	0.44	0.53	1. 2	1.11	16	27
25	16	0. 9	0.18	0.27	0.37	0.46	0.55	1. 4	1.13	17	26
24	17	0. 9	0.19	0.28	0.38	0.47	0.57	1. 6	1.16	18	25
23	18	0.10	0.20	0.29	0.39	0.49	0.58	1. 9	1.19	19	24
22	19	0.10	0.20	0.30	0.40	0.50	1. 0	1.10	1.20	20	23
21	20	0.10	0.21	0.31	0.41	0.51	1. 2	1.12	1.22	21	22
20	21	0.11	0.22	0.32	0.43	0.53	1. 4	1.14	1.25	22	21
19	22	0.11	0.22	0.33	0.44	0.55	1. 6	1.17	1.28	23	20
18	23	0.11	0.23	0.34	0.45	0.56	1. 7	1.19	1.30	24	19
17	24	0.12	0.23	0.34	0.46	0.57	1. 9	1.21	1.32	25	18
16	25	0.12	0.24	0.35	0.47	0.59	1.11	1.23	1.35	26	17
15	26	0.12	0.24	0.36	0.48	1. 0	1.12	1.24	1.36	27	16
14	27	0.12	0.25	0.37	0.49	1. 2	1.14	1.26	1.39	28	15
13	28	0.13	0.26	0.38	0.51	1. 4	1.16	1.28	1.41	29	14
12	Jan. 30	0.13	0.26	0.39	0.53	1. 6	1.19	1.32	1.45	31 July	12
9	Feb. 1	0.13	0.27	0.41	0.55	1. 9	1.22	1.36	1.50	2 August	10
7	3	0.14	0.28	0.42	0.57	1.11	1.25	1.39	1.53	4	8
5	5	0.14	0.29	0.43	0.58	1.13	1.27	1.42	1.56	6	6
3	7	0.15	0.30	0.45	1. 0	1.15	1.30	1.44	1.59	8	4
1	9	0.15	0.31	0.46	1. 2	1.17	1.32	1.47	2. 3	10	2 May
Nov. October 30	11	0.16	0.32	0.47	1. 3	1.19	1.35	1.50	2. 6	10	30 April
28	13	0.16	0.32	0.48	1. 5	1.21	1.37	1.53	2. 9	14	28
26	15	0.16	0.33	0.49	1. 6	1.22	1.39	1.56	2.12	16	26
24	17	0.17	0.34	0.50	1. 7	1.24	1.41	1.58	2.15	18	24
21	20	0.17	0.34	0.52	1. 9	1.27	1.44	2. 1	2.19	21	21
18	23	0.17	0.35	0.53	1.11	1.29	1.46	2. 4	2.22	24	18
15	Feb. 26	0.18	0.36	0.54	1.13	1.31	1.49	2. 7	2.25	27	15
12	March 1	0.18	0.37	0.55	1.14	1.32	1.51	2. 9	2.28	30 August	12
9	4	0.19	0.38	0.56	1.15	1.34	1.53	2.12	2.30	2 Sept.	9
6	7	0.19	0.38	0.57	1.16	1.35	1.54	2.13	2.32	5	6
October 3	10	0.19	0.38	0.57	1.17	1.36	1.55	2.14	2.34	8	3 April
Sept. 30	13	0.19	0.39	0.58	1.17	1.37	1.56	2.15	2.35	11	31 March
27	16	0.19	0.39	0.58	1.18	1.38	1.57	2.16	2.36	14	28
24	19	0.20	0.39	0.58	1.18	1.38	1.57	2.16	2.36	17	25
21	22	0.20	0.40	0.59	1.19	1.39	1.58	2.17	2.36	20	22

TAB. II. For reducing the Sun's Declin. as given in the N. A. for Noon at Greenwich to any other Time under that Merid. or to Noon under any other Merid.

Add aft. N Sub. bef. N		Sub. aft. N Add bef. N		H. M. 3. 0	H. M. 3. 20	H. M. 3. 40	H. M. 4. 0	H. M. 4. 20	H. M. 4. 40	H. M. 5. 0	Sub. aft N Add bef. N	Add aft N Sub. bef. N
Add in W Sub. in E		Sub. in W Add in E		45D.	50D.	55D.	60D.	65D.	70D.	75D.	Sub. in W Add in E	Add in W Sub. in E
Days.		Days.		M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	Days.	Days.
Decem.	21	Decem.	21	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	21 June	21 June
	20		22	0. 3	0. 3	0. 4	0. 4	0. 4	0. 5	0. 5	22	20
	19		23	0. 6	0. 7	0. 8	0. 9	0. 9	0 10	0 11	23	19
	18		24	0.10	0.11	0.12	0.13	0.14	0.15	0.16	24	18
	17		25	0.13	0.15	0.16	0.18	0.19	0.20	0.22	25	17
	16		26	0.16	0.18	0.20	0.22	0.24	0 26	0.27	26	16
	15		27	0.20	0.22	0.24	0.26	0.29	0.31	0.33	27	15
	14		28	0.25	0.25	0.28	0.31	0.34	0.36	0.38	28	14
	13		29	0.26	0.29	0.32	0.35	0.38	0.41	0.44	29	13
	12		30	0.30	0.33	0.36	0.40	0.43	0.46	0.50	30 June	12
	11	Dec.	31	0.33	0.37	0.40	0.44	0.48	0.51	0.55	1 July	11
	10	Jan.	1	0.36	0.40	0.44	0.48	0.53	0.57	1. 1	2	10
	9		2	0.39	0.44	0.48	0 53	0.57	1. 2	1. 6	3	9
	8		3	0.43	0.48	0.53	0.57	1. 2	1. 7	1.11	4	8
	7		4	0.46	0.41	0.56	1. 1	1. 7	1.12	1.17	5	7
	6		5	0.49	0.55	1. 0	1. 6	1.11	1.17	1 22	6	6
	5		6	0.52	0.58	1. 4	1.10	1.16	1.22	1.27	7	5
	4		7	0.55	1. 1	1. 7	1.14	1.20	1.26	1.32	8	4
	3		8	0.58	1. 5	1.11	1.18	1.24	1.31	1.37	9	3
	2		9	1. 1	1. 8	1.15	1.22	1.29	1.36	1.43	10	2
Decem.	1		10	1. 4	1.12	1.19	1.26	1.33	1.41	1.48	11	1 June
Nov.	30		11	1. 7	1.15	1.23	1.30	1.37	1.45	1.52	12	31
	29		12	1.10	1.18	1.26	1.34	1.42	1.50	1.57	13	30
	28		13	1.13	1.22	1.30	1.38	1 46	1.54	2. 2	14	29
	27		14	1.16	1.25	1.34	1.42	1.50	1.58	2. 7	15	28
	26		15	1.19	1.28	1.37	1.46	1.55	2. 3	2.12	16	27
	25		16	1.22	1.31	1.40	1.49	1.59	2. 8	2.17	17	26
	24		17	1.25	1.35	1.44	1.53	2. 3	2.12	2.21	18	25
	23		18	1.28	1.38	1.47	1.57	2. 7	2.16	2.26	19	24
	22		19	1.30	1.41	1.51	2. 1	2.11	2.21	2.31	20	22
	21		20	1.33	1.44	1.54	2. 4	2.15	2.25	2.35	21	22
	20		21	1.36	1.47	1.57	2. 8	2.19	2.29	2.40	22	21
	19		22	1.39	1.50	2 0	2 11	2.22	2.33	2.44	23	20
	18		23	1.41	1.53	2. 4	2.15	2.26	2.37	2.48	24	19
	17		24	1.43	1.55	2. 7	2.18	2.30	2.41	2.52	25	18
	16		25	1.46	1.58	2.10	2.21	2.33	2.45	2.56	26	17
	15		26	1.48	2. 1	2.13	2.25	2.37	2.49	3. 1	27	16
	14		27	1.51	2. 4	2 16	2.28	2.40	2.52	3. 5	28	15
	13		28	1.54	2. 7	2.19	2.31	2.44	2.56	3. 9	29	14
	11	Jan.	30	1.58	2.11	2.24	2.37	2.51	3. 4	3.17	31 July	12
	9	Feb.	1	2. 3	2.17	2.30	2.43	2.57	3.11	3.24	2 Aug.	10
	7		3	2. 7	2.21	2.35	2.49	3. 3	3.17	3.32	4	8
	5		5	2.11	2.25	2.40	2.54	3. 9	3.23	3.38	6	6
	3		7	2.14	2.29	2.44	2.59	3.14	3.29	3 44	8	4
Nov.	1		9	2.18	2.33	2.49	3. 4	3.19	3.35	3.50	10	2 May
Oct.	30		11	2.22	2.38	2.53	3. 9	3.25	3.41	3.56	12	30 April
	28		13	2.25	2.41	2.58	3.14	3.30	3.46	4. 3	14	28
	26		15	2.29	2.45	3. 2	3.18	3.35	3.51	4. 8	16	26
	24		17	2.32	2.49	3. 5	3.22	3.39	3.56	4.13	18	24
	21		20	2.36	2.53	3.11	3.28	3.45	4. 3	4.20	21	21
	18		23	2.40	2.58	3.15	3.33	3.51	4. 8	4 26	24	18
	15	Feb.	26	2.43	3. 1	3.20	3.38	3.56	4.14	4.32	27	15
	12	March	1	2.46	3. 5	3.23	3.42	4. 1	4.19	4 38	30 Aug.	12
	9		4	2.49	3. 8	3.26	3.45	4. 4	4.23	4.41	2 Sept.	9
	6		7	2.51	3.10	3.29	3.48	4. 7	4.26	4.45	5	6
Oct.	3		10	2.53	3.13	3.32	3.51	4.10	4.29	4 49	8	3 April
Sept.	30		13	2.55	3.14	3.33	3.53	4.13	4.32	4.51	11	31 March
	27		16	2.56	3.15	3.34	3.54	4.14	4.33	4.52	14	28
	24		19	2.56	3.15	3.35	3.55	4.15	4.33	4.52	17	25
	21		22	2.56	3.15	3.35	3.55	4 15	4.34	4.53	20	22

TAB. XVIII. For reducing the Sun's Decl. N. as given in the N. A. for Noon at Greenwich to any other Time under that Merid. or to Noon under any other Merid.

Add aft. N Sub. bef. N	Sub. aft. N Add bef. N	H. M. 5. 20	H. M. 5. 40	H. M. 6. 0	H. M. 6. 20	H. M. 6. 40	H. M. 7. 0	H. M. 7. 20	Sub. aft. N Add bef. N	Add aft. N Sub. bef. N
Add in W Sub. in E	Sub. in W Add in E	80D.	85D.	90D.	95D.	D 100	D 105	D. 110	Sub. in W Add in E	Add in W Sub in E
Days.	Days.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	Days.	Days.
Decem. 21	Decem. 21	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	21 June	21 June
20	22	0 5	0. 6	0. 6	0. 7	0. 8	0. 8	0. 8	22	20
19	23	0. 11	0. 12	0. 13	0. 14	0. 15	0. 15	0. 16	23	19
18	24	0. 17	0. 19	0. 20	0. 21	0. 22	0. 23	0. 24	24	18
17	25	0. 23	0. 25	0. 26	0. 28	0. 29	0. 31	0. 32	25	17
16	26	0. 29	0. 31	0. 32	0. 35	0. 37	0. 38	0. 40	26	16
15	27	0. 35	0. 38	0. 40	0. 42	0. 44	0. 46	0. 49	27	15
14	28	0. 41	0. 43	0. 46	0. 49	0. 51	0. 54	0. 57	28	14
13	29	0. 47	0. 50	0. 53	0. 56	0. 59	1. 2	1. 5	29	13
12	30	0 53	0. 56	0. 59	1. 3	1. 6	1. 9	1. 12	30 June	12
11	Decem. 31	0. 59	1. 2	1. 6	1. 10	1. 13	1. 17	1. 21	1 July	11
10	Jan. 1	1. 5	1. 9	1. 13	1. 17	1. 21	1. 25	1. 29	2	10
9	2	1. 11	1. 15	1. 19	1. 24	1. 28	1. 32	1. 37	3	9
8	3	1. 16	1. 21	1. 26	1. 31	1. 35	1. 40	1. 45	4	8
7	4	1. 22	1. 27	1. 32	1. 37	1. 42	1. 47	1. 53	5	7
6	5	1. 27	1. 33	1. 38	1. 44	1. 49	1. 54	2. 0	6	6
5	6	1. 33	1. 39	1. 45	1. 51	1. 57	2. 2	2. 8	7	5
4	7	1. 39	1. 45	1. 51	1. 57	2. 3	2. 9	2. 16	8	4
3	8	1. 44	1. 50	1. 57	2. 4	2. 12	2. 16	2. 23	9	3
2	9	1. 50	1. 56	2. 3	2. 10	2. 17	2. 23	2. 30	10	2
Decem. 1	10	1. 55	2. 2	2. 9	2. 16	2. 23	2. 30	2. 38	11	1 June
Nov. 30	11	2 0	2. 7	2. 15	2. 22	2. 30	2. 37	2. 45	12	31 May
29	12	2. 5	2. 13	2. 21	2. 29	2. 37	2. 44	2. 52	13	30
28	13	2. 10	2. 19	2. 27	2. 35	2. 43	2. 51	3. 0	14	29
27	14	2. 16	2. 25	2. 33	2. 42	2. 50	2. 58	3. 7	15	28
26	15	2 21	2. 30	2. 38	2. 47	2. 56	3. 5	3. 13	16	27
25	16	2. 26	2. 35	2. 44	2. 53	3. 2	3. 11	3. 21	17	26
24	17	2. 31	2. 40	2. 50	2. 59	3. 9	3 18	3. 28	18	25
23	18	2. 36	2. 46	2. 55	3. 5	3. 15	3. 24	3. 34	19	24
22	19	2. 41	2. 51	3. 1	3. 11	3. 21	3. 31	3. 41	20	23
21	20	2. 46	2. 56	3. 6	3. 17	3. 27	3. 37	3. 48	21	22
20	21	2. 50	3. 2	3. 12	3. 23	3. 33	3. 44	3 55	22	21
19	22	2. 55	3. 6	3. 17	3. 28	3. 39	3. 5	4. 1	23	20
18	23	3. 0	3. 11	3. 22	3. 33	3. 45	3. 56	4. 7	24	19
17	24	3. 4	3. 16	3. 27	3. 39	3. 50	4. 1	4. 13	25	18
16	25	3. 8	3. 20	3. 32	3. 44	3. 56	4 7	4. 19	6	17
15	29	3. 13	3. 25	3. 37	3. 49	4. 1	4. 13	4. 26	27	16
14	27	3. 17	3. 29	3. 42	3. 54	4. 6	4. 19	4. 31	28	15
13	28	3. 22	3. 34	3. 47	4. 0	4. 12	4. 25	4. 38	29	14
12	Jan. 30	3. 30	3. 43	3. 56	4. 9	4. 22	4. 36	4. 49	31 July	12
9	Feb. 1	3. 38	3. 51	4. 5	4. 18	4. 32	4. 46	4. 59	2 Aug.	10
7	3	3. 46	4. 0	4. 14	4. 28	4. 42	4. 56	5. 10	4	8
5	5	3 52	4. 6	4. 21	4. 36	4. 50	5. 5	5. 19	6	6
3	7	3. 59	4. 14	4. 29	4. 44	4. 59	5. 14	5. 29	8	4
Nov. 1	9	4. 5	4. 21	4. 36	4. 52	5. 7	5. 23	5. 38	10	2 May
Oct. 30	11	4. 12	4. 28	4. 44	5. 0	5. 16	5. 31	5. 47	12	30 April
28	13	4. 19	4. 35	4. 51	5. 7	5. 23	5. 40	5. 56	14	28
26	15	4. 24	4. 41	4. 57	5. 14	5. 30	5. 47	6. 3	15	26
24	17	4. 30	4. 47	5. 3	5. 21	5. 38	5. 55	6. 12	18	24
21	20	4. 37	4. 55	5. 12	5. 29	5. 47	6. 4	6. 21	21	21
18	23	4. 44	5. 2	5. 19	5. 37	5. 55	6. 13	6. 31	24	18
15	Feb. 26	4. 50	5. 8	5. 26	5. 44	6. 2	6. 20	6. 38	27	15
12	March 1	4. 56	5. 15	5. 33	5. 52	6. 10	6. 29	6. 47	30 Aug	12
9	4	5. 0	5. 19	5. 38	5. 57	6. 16	6. 34	6. 53	2 Sept.	9
6	7	5. 4	5. 20	5. 42	6. 1	6. 20	6. 39	6 58	5	6
Oct. 3	10	5. 18	5. 27	5. 46	6. 5	6. 25	6. 44	7. 3	8	3 April
Sept. 30	13	5. 11	5. 30	5. 49	6 8	6. 28	6. 47	7. 6	11	31 March
27	16	5. 12	5. 31	5 51	6. 11	6. 31	6. 50	7. 9	14	28
24	19	5. 12	5. 32	5. 52	6. 12	6 32	6. 51	7. 11	17	25
21	22	5 13	5. 33	5. 53	6. 13	6. 33	6. 52	7. 11	20	22

TAB. XVIII. For reducing the SUN's DECLIN. as given in the N. A. for Noon at GREENWICH to any other Time under that Merid. or to Noon under any other Merid.

Add. aft. N Sub. bef. N.	Sub. aft. N Add bef. N	H. M. 7. 40	H. M. 8. 0	H. M. 8. 20	H. M. 8. 40	H. M. 9. 0	H. M. 9. 20	H. M. 9. 40	Sub. aft. N Add bef. N	Add aft. N Sub. bef. N
Add in W Sub. in E.	Sub. in W. Add in E.	D. 115	D 120	D 125	D 130	D 135	D 140	D 145	Sub. in W Add in E.	Add in W Sub. in E.
Days.	Days.	M. S.	M. S.	M. S.	M. S	M. S	M. S	M. S.	Days.	Days.
Decem. 21	Decem 21	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	21 June	21 June
20	22	0. 9	0. 9	0. 9	0.10	0.10	0.10	0.10	22	20
19	23	0.17	0.18	0.18	0.19	0.19	0.20	0.21	23	19
18	24	0.25	0.26	0.27	0.28	0.29	0.30	0.31	24	18
17	25	0.34	0.35	0.36	0.38	0.39	0.41	0.43	25	17
16	26	0.42	0.44	0.46	0.48	0.49	0.51	0.53	26	16
15	27	0.51	0.53	0.55	0.57	0.59	1. 1	1. 3	27	15
14	28	0.59	1. 2	1. 5	1. 7	1. 9	1.12	1.14	28	14
13	29	1. 8	1.11	1.14	1.17	1.19	1.22	1.25	29	13
12	30	1.16	1.19	1.23	1.26	1.29	1.32	1.35	30 June	12
11	Decem 31	1.24	1.28	1.32	1.35	1.39	1.43	1.46	1 July	11
10	Jan. 1	1.33	1.37	1.41	1.45	1.49	1.53	1.57	2	10
9	2	1.42	1.46	1.51	1.55	1.59	2. 3	2. 7	3	9
8	3	1.49	1.54	1.59	2. 4	2. 9	2.13	2.18	4	8
7	4	1.58	2. 3	2. 8	2.13	2.19	2.23	2.28	5	7
6	5	2. 5	2.11	2.16	2.22	2.28	2.33	2.39	6	6
5	6	2.14	2.20	2.26	2.32	2.38	2.43	2.49	7	5
4	7	2.22	2.28	2.34	2.44	2.47	2.53	2.59	8	4
3	8	2.29	2.36	2.43	2.49	2.56	3. 3	3. 9	9	3
2	9	2.37	2.44	2.51	2.58	3. 5	3.12	3.19	10	2
Decem. 1	10	2.45	2.52	2.59	3. 6	3.14	3.21	3.28	11	1 June
Novem. 30	11	2.52	3. 0	3. 7	3.15	3.23	3.30	3.38	12	31 May
29	12	3. 0	3. 8	3.16	3.24	3.32	3.39	3.47	13	30
28	13	3. 8	3.16	3.24	3.32	3.40	3.49	3.57	14	29
27	14	3.15	3.24	3.32	3.41	3.40	3.58	4. 6	15	28
26	15	3.22	3.31	3.40	3.49	3.58	4. 7	4.16	16	27
25	16	3.30	3.39	3.48	3.57	4. 7	4.16	4.25	17	26
24	17	3.37	3.46	3.56	4. 6	4.16	4.24	4.34	18	25
23	18	3.44	3.54	4. 4	4.14	4.24	4.33	4.43	19	24
22	19	3.51	4. 1	4.11	4.21	4.31	4.41	4.51	20	23
21	20	3.58	4. 8	4.19	4.29	4.39	4.50	5. 0	21	22
20	21	4. 5	4.16	4.27	4.37	4.48	4.59	5. 9	22	21
19	22	4.12	4.23	4.34	4.45	4.56	5. 7	5.18	23	20
18	23	4.19	4.30	4.41	4.53	5. 4	5.15	5.26	24	19
17	24	4.25	4.36	4.48	5. 0	5.12	5.23	5.34	25	18
16	25	4.31	4.43	4.55	5. 7	5.19	5.30	5.42	26	17
15	26	4.38	4.50	5. 2	5.14	5.26	5.38	5.50	27	16
14	27	4.43	4.56	5. 8	5.21	5.33	5.46	5.58	28	15
13	28	4.50	5. 3	5.16	5.28	5.40	5.54	6. 6	29	14
12	Jan. 30	5. 2	5.15	5.28	5.41	5.54	6. 8	6.21	31 July	12
9	Feb. 1	5.13	5.27	5.40	5.54	6. 8	6.22	6.35	10 Aug.	4
7	2	5.24	5.38	5.52	6. 6	6.30	6.35	6.49	8	4
5	5	5.34	5.49	6. 4	6.18	6.33	6.47	7. 2	6	6
3	7	5.44	5.59	6.14	6.23	6.44	6.55	7.14	4	8
Novem. 1	9	5.53	6. 9	6.24	6.40	6.55	7.11	7.26	2	10 May
October 30	11	6. 3	6.18	6.34	6.50	7. 6	7.21	7.37	12	30 April
28	13	6.12	6.28	6.44	7. 0	7.16	7.32	7.48	14	28
26	15	6.20	6.36	6.53	7.10	7.26	7.42	7.58	16	26
24	17	6.29	6.46	7. 2	7.19	7.36	7.51	8. 9	18	24
22	20	6.38	6.56	7.11	7.31	7.48	8. 5	8.22	21	21
18	23	6.48	7. 6	7.24	7.41	8. 0	8.17	8.34	24	18
15	Feb. 26	6.57	7.15	7.34	7.52	8.10	8.28	8.46	27	15
12	March 1	7. 6	7.24	7.42	8. 1	8.20	8.38	8.57	30 Aug.	12
9	4	7.12	7.31	7.50	8. 9	8.28	8.46	9. 6	2 Septem.	9
6	7	7.17	7.36	7.55	8.14	8.33	8.53	9.12	5	6
October 3	10	7.23	7.42	8. 1	8.20	8.39	8.59	9.18	8	3 April
Sept. 30	13	7.26	7.46	8. 4	8.24	8.43	9. 3	9.22	11	31 March
27	16	7.29	7.48	8. 7	8.27	8.47	9. 6	9.25	14	28
24	19	7.30	7.50	8.10	8.29	8.49	9. 8	9.27	17	25
21	22	7.32	7.50	8.10	8.30	8.50	9. 9	9.28	20	22

TAB. XVIII. For reducing the SUN's DECLIN. as given in the N. A. for Noon at GREENWICH to any other Time under that Merid. or to Noon under any other Merid.

Add af. N Sub bef. N	Sub. af. N Add. bef. N	H. M. 10. 0	H. M. 10. 20	H. M. 10. 40	H. M. 11. 0	H. M. 11. 20	H. M. 11. 40	H. M. 12. 0	Sub. af. N Add bef. N	Add af. N Sub. bef. N
Add. in W Sub. in E	Sub. in W Add. in E	D 150	D 155	D 160	D 165	D 170	D 175	D 180	Sub. in W Add in E	Add in W Sub. in E
Days.	Days.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	Days.	Days.
Decem. 21	Decem. 21	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	21 June	21 June
20	22	0.11	0.11	0.12	0.12	0.12	0.13	0.13	22	20
19	23	0.22	0.23	0.24	0.24	0.25	0.26	0.26	23	19
18	24	0.33	0.34	0.35	0.36	0.37	0 38	0.39	24	18
17	25	0.44	0.46	0.47	0.48	0.50	0.51	0.53	25	17
16	26	0.55	0.57	0.58	1. 0	1. 2	1. 4	1. 6	26	16
15	27	1. 6	1. 8	1.11	1.13	1.15	1.17	1.19	27	15
14	28	1.17	1.20	1.23	1.25	1.27	1.30	1.32	28	14
13	29	1.28	1.30	1.34	1.37	1.40	1.43	1.46	29	13
12	30	1.39	1.42	1.45	1.49	1.52	1.55	1.59	30	12
11	Decem. 31	1.50	1.54	1.57	2. 1	2. 5	2. 8	2.12	1 July	11
10	Jan. 1	2. 1	2. 5	2. 9	2.13	2.17	2.21	2.25	2	10
9	2	2.12	2.16	2.20	2.25	2.30	2.34	2.38	3	9
8	3	2.23	2.27	2.32	2.37	2.42	2.47	2.51	4	8
7	4	2 34	2 39	2.44	2.49	2.54	2.59	3. 4	5	7
6	5	2.44	2.50	2.55	3. 0	3. 6	3.11	3.17	6	6
5	6	2.55	3. 1	3. 6	3.12	3.18	3.24	3.30	7	5
4	7	3. 5	3.11	3.17	3.23	3.29	3.36	3.42	8	4
3	8	3.15	3.21	3.28	3.34	3 41	3.48	3.54	9	3
2	9	3.26	3.32	3.38	3.45	3.52	3.59	4. 6	10	2
Novem. 1	10	3.35	3.42	3.49	3.56	4. 4	4.11	4.18	11	1 June
Decem. 30	11	3.45	3.52	3.59	4. 7	4.15	4.22	4.30	12	31 May
29	12	3.55	4. 3	4.10	4 18	4.26	4.34	4.42	13	30
28	13	4. 5	4.13	4.21	4.29	4.38	4.46	4.54	14	29
27	14	4.15	4.23	4.31	4.40	4.49	4.57	5. 5	15	28
26	15	4.24	4.33	4 41	4.50	4.59	5. 8	5.17	16	27
25	16	4.34	4.43	4.52	5. 1	5.10	5.19	5.28	17	26
24	17	4.43	4.53	5. 2	5.11	5.21	5.30	5.40	18	25
23	18	4.52	5. 2	5.12	5.22	5.32	5.41	5.51	19	24
22	19	5. 1	5.12	5.22	5.32	5.42	5.52	6. 2	20	23
21	20	5.10	5.21	5.31	5.42	5.53	6. 3	6.13	21	22
20	21	5 20	5.31	5 41	5.52	6. 3	6.14	6.24	22	21
19	22	5.29	5.40	5 51	6. 2	6.13	6.24	6.34	23	20
18	23	5.37	5.49	6. 0	6.11	6.23	6.34	6.44	24	19
17	24	5.45	5.57	6. 9	6.20	6.32	6.43	6.54	25	18
16	25	5.54	6. 6	6.17	6.29	6.41	6.53	7. 4	26	17
15	26	6. 2	6.14	6.26	6.38	6.51	7. 3	7.14	27	16
14	27	6.10	6.22	6.34	6.47	7. 0	7.12	7.24	28	15
13	28	6.19	6.31	6.43	6.56	7. 9	7.22	7.34	29	14
11	Jan. 30	6.34	6.47	7. 0	7.13	7.26	7.40	7.53	31 July	12
9	Feb. 1	6.49	7. 3	7.16	7.30	7.43	7.57	8.11	2 Aug.	10
7	3	7. 3	7.17	7.31	7.45	7.59	8.13	8.28	4	8
5	5	7.16	7.31	7.45	8. 0	8.14	8.28	8.43	6	6
3	7	7.29	7.44	7.59	8.14	8.28	8.43	8.58	8	4
Novem. 1	9	7.41	7.56	8.12	8.27	8.42	8.58	9.13	10	2 May
Oct. 30	11	7.53	8. 8	8.24	8.40	8.56	9.12	9.28	12	30 April
28	13	8. 4	8.20	8.36	8.53	9. 9	9.21	9.42	14	28
26	15	8.15	8.32	8.48	9. 5	9.21	9.38	9.54	16	26
24	17	8 26	8.43	9. 0	9.17	9.34	9.50	10. 7	18	24
21	20	8.40	8.57	9.14	9.32	9.49	10. 6	10.24	21	21
18	23	8.52	9.10	9.28	9.46	10. 3	10.21	10.39	24	18
15	Feb. 26	9. 4	9.22	9.40	9.58	10.16	10.34	10.53	27	15
12	March 1	9.15	9.33	9.51	10.10	10.29	10.47	11. 6	30 Aug.	12
9	4	9.24	9.43	10. 1	10.20	10.39	10.58	11.16	2 Sept.	9
6	7	9.30	9.50	10. 9	10.28	10.47	11. 6	11.24	5	6
Oct. 3	10	9.37	9.56	10.16	10.35	10.54	11.13	11.32	8	3 April
Sept. 30	13	9.41	10. 0	10.21	10.40	11.59	11.18	11.38	11	31 March
27	16	9.45	10. 4	10.24	10.44	11. 3	11.22	11.42	14	28
24	19	9.47	10. 6	10.26	10.46	11. 5	11.24	11.44	17	25
21	22	9.48	10. 7	10.27	10.47	11. 6	11.25	11.45	10	22

A TABLE

OF THE

SUN's RIGHT ASCENSION.

Days.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Days.
	South	South	South	North	North	North	North	North	North	South	South	South	
	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M	H. M.	H. M.	H. M.	H. M.	
1	18 48	21 0	22 49	0 43	2 34	4 36	6 41	8 46	10 42	12 30	14 26	16 30	1
2	18 52	21 4	22 53	0 46	2 38	4 41	6 45	8 49	10 45	12 33	14 30	16 34	2
3	18 57	21 8	22 57	0 50	2 41	4 45	6 49	8 53	10 49	12 37	14 34	16 39	3
4	19 1	21 12	23 1	0 53	2 45	4 49	6 57	8 57	10 52	12 41	14 38	16 43	4
5	19 6	21 16	23 4	0 57	2 49	4 53	6 57	9 1	10 56	12 44	14 42	16 47	5
6	19 10	21 20	23 8	1 1	2 53	4 56	7 1	9 5	11 0	12 48	14 46	16 52	6
7	19 14	21 24	23 11	1 4	2 57	5 1	7 5	9 9	11 3	12 52	14 50	16 56	7
8	19 19	21 28	23 15	1 8	3 1	5 5	7 10	9 12	11 7	12 55	14 54	17 0	8
9	19 23	21 32	23 19	1 12	3 5	5 9	7 14	9 16	11 11	12 59	14 58	17 5	9
10	19 27	21 36	23 22	1 15	3 8	5 13	7 18	9 20	11 14	13 3	15 2	17 9	10
11	19 32	21 40	23 26	1 19	3 12	5 18	7 22	9 24	11 18	13 6	15 6	17 14	11
12	19 36	21 44	23 30	1 23	3 16	5 22	7 26	9 28	11 21	13 10	15 10	17 18	12
13	19 40	21 48	23 33	1 26	3 20	5 26	7 30	9 31	11 25	13 14	15 14	17 23	13
14	19 45	21 52	23 37	1 30	3 24	5 30	7 34	9 35	11 28	13 17	15 18	17 27	14
15	19 49	21 56	23 41	1 34	3 28	5 34	7 38	9 39	11 32	13 21	15 22	17 31	15
16	19 53	22 0	23 44	1 37	3 32	5 38	7 42	9 43	11 36	13 25	15 26	17 36	16
17	19 58	22 4	23 48	1 41	3 36	5 43	7 46	9 46	11 39	13 29	15 31	17 40	17
18	20 2	22 7	23 52	1 45	3 40	5 47	7 50	9 50	11 43	13 32	15 35	17 45	18
19	20 6	22 11	23 55	1 49	3 44	5 51	7 54	9 54	11 46	13 36	15 39	17 49	19
20	20 10	22 15	23 59	1 52	3 48	5 55	7 58	9 58	11 50	13 40	15 43	17 54	20
21	20 14	22 19	0 3	1 56	3 52	5 59	8 2	10 1	11 54	13 44	15 47	17 58	21
22	20 19	22 23	0 6	2 0	3 56	6 3	8 6	10 5	11 57	13 47	15 52	18 2	22
23	20 23	22 26	0 10	2 3	4 0	6 7	8 10	10 9	12 1	13 51	15 56	18 7	23
24	20 27	22 30	0 13	2 7	4 4	6 12	8 14	10 12	12 4	13 55	16 0	18 11	24
25	20 31	22 34	0 17	2 11	4 8	6 16	8 18	10 16	12 8	13 59	16 4	18 16	25
26	20 35	22 38	0 21	2 15	4 12	6 20	8 22	10 20	12 12	14 3	16 9	18 20	26
27	20 40	22 42	0 24	2 19	4 16	6 24	8 26	10 23	12 15	14 7	16 13	18 25	27
28	20 44	22 45	0 28	2 22	4 20	6 28	8 30	10 27	12 19	14 10	16 17	18 29	28
29	20 48		0 32	2 26	4 24	6 32	8 34	10 31	12 22	14 14	16 21	18 34	29
30	20 52		0 35	2 30	4 28	6 37	8 38	10 34	12 26	14 18	16 26	18 38	30
31	20 56		0 39		4 32		8 42	10 38		14 22		18 42	31

This table is sufficiently exact for finding when any star comes to the meridian, in order to obtain the latitude; but in all calculations for determining the longitude by celestial observations, the sun's right ascension and declination must be taken out of the Nautical Almanac, as they are there calculated to a greater degree of accuracy.

A TABLE of the Right Ascension and Declination of some of the principal fixed Stars, adapted to the Year 1796, with their Annual Variation.

Names of the Stars.	Mag.	Right Ascension.	Annu. Vari.	Declination.	Annual Vari.
		H. M. S.	S. T.	° ′ ″	S. T.
Shedar, in the breast of Cassiopeia	3	0 28 51	+3.31	55 25 5N	19 91+
Abruccabar, pole star, tail of the Little Bear	2	0 50 24	10.05	88 13 13	19.69+
Mirach, in the girdle of Andromeda	2	0 58 22	3.30	34 32 7	19.45+
Almaach, in the foot of Andromeda	2	1 51 27	3.62	41 20 38	17.80+
Menkar, in the jaw of the Whale	2	2 51 38	3.13	3 16 52	14 80+
Algol, in the head of Medusa	2	2 54 57	3.85	40 9 31	14.63+
Algenib, the bright star in Perseus	2	3 9 50	4.20	49 7 23	13.72+
Pleiades, the bright star in Taurus	3	3 35 24	3.55	23 27 50	12.00+
Hyades, in Taurus	3	4 8 12	3.39	15 7 24	9.60+
Aldebaran, the Bull's south eye	1	4 24 14	3.43	16 5 19	8.32+
Capella, in the Goat	1	5 1 40	4.40	45 46 12	5.30+
Bellatrix, in the west shoulder of Orion	2	5 14 12	3.22	6 9 8	4.15+
Beteiguese, in the east shoulder of Orion	1	5 44 8	3.25	7 21 21	1.58+
Castor, the bright star in the head of Gemini	2	7 21 35	3.88	32 19 20	6.78—
Procyon, the bright star in the Little Dog	1	7 28 39	3.20	5 44 58	7.40—
* Pollux, in the head of Gemini	2	7 31 52	3.75	28 30 26	7.70—
Acubens, in the claw of Cancer	3	8 47 19	3.24	12 38 18	13.30—
Regulus, in the Lion's heart	1	9 57 31	3.24	12 57 32	17.16—
Dubhe, upper Pointer in the Great Bear	2	10 51 2	3.88	62 51 0	19.09—
Alioth, the first in the tail of the Great Bear	2	12 45 6	2.69	57 4 10	19.69—
Benetnach, last in the tail of the Great Bear	2	13 39 31	2.41	50 20 11	18 24—
Arcturus, in Bootes	1	14 6 25	2.82	20 16 5	17 16—
Mirach, in the thigh of Bootes	3	14 46 10	2.63	27 56 27	15.67—
Alphacca, the bright star in the Crown	2	15 26 4	2.54	27 24 39	12.60—
Ras. Algethi, in the head of Hercules	2	17 25 27	2.74	14 38 1	4.87—
Ras. Alhague, in the head of Ophiucus	2	17 5 22	2.75	12 43 18	3.15—
Rastaben, in the head of the Dragon	2	17 51 53	1.37	51 30 59	0.78—
Vega, the bright star in the Harp	1	18 30 1	2.02	38 35 54	2.52+
Atair, the bright star in the Eagle	2	19 40 48	2.90	8 20 7	8.40+
Deneb, in the tail of the Swan	2	20 37 29	2.05	44 33 26	12.44+
Aldermain, in the shoulder of Cepheus	3	21 13 42	1.44	61 43 31	14.95+
Scheat, in the thigh of Pegasus	2	22 53 54	2.88	26 58 8	19.18+
Marcab, in the wing of Pegasus	2	22 54 37	2.98	14 6 37S.	19 20+
Achernar, in the river Eridanus	1	1 30 7	2.25	58 16 39	18.56—
Rigel, in the foot of Orion	1	5 4 44	2.89	8 26 52	4.94—
Canopus, the bright star in Argo	1	6 19 26	1.34	52 35 23	1.60+
Sirius, the bright star in the Great Dog	1	6 36 11	2.69	16 25 58	3.10+
Alphard, in the heart of the female Hydra	2	9 17 34	2.90	7 46 53	15.13+
* Virgin's Spike, in the sheaf of Virgo	1	13 14 28	3.15	10 5 28	19.00+
Zubenesch, in the south scale of Libra	2	14 39 38	3.31	15 11 3	15 50+
Zubenelg, in the north scale of Libra	2	15 6 3	3.22	8 37 13	13.93+
Antares, in the heart of Scorpio	1	16 16 56	3.66	25 57 55	8.90+
Fomalhaut, bright star in the Southern Fish	1	22 46 20	3.33	30 41 52	18.97—
The foot of the Cross	1	12 15 24	3.22	61 57 50	20.01+
The bright star in the Oars	1	9 10 56	0.75	68 52 46	14.79+
The bright star in Centaur	1	14 26 12	4.21	59 59 37	16.26+

If the places of these stars are wanted for any time before the beginning of the year 1796, multiply the annual variation, both in right ascension and declination, by the number of years before 1796, and subtract the product from the right ascension standing in the table; but the product of the annual variation in declination must be added to, or subtracted from, the declination, according as the sign + or — follow it; but for any years after 1796, the variation in right ascension must be added to the right ascension in the table, and the variation in declination must be either added to, or subtracted from it, according as their signs are, to fit the declination to any succeeding year.—The annual variation is set down for seconds, and decimals of a second.

It is obvious, that by the sun's annual motion, he is perpetually changing his declination and right ascension, which is set down in the preceding table for the noon of every day at London; and may be reduced to any other time or meridian, as has been already shewn in finding the longitude.

By the precession of the equinoxes, the fixed stars are continually altering their longitudes, right ascensions, and declinations; the alteration in the longitude is about 50 seconds every year; the alteration in right ascension and declination of some of the principal fixed stars are set down in the preceding table for 1796; and their annual variation, which being applied to the right ascension and declination in the table, by addition or subtraction, gives the right ascension and declination for any succeeding years.

The right ascension of the sun, moon, or stars, is the number of degrees of the equinoctial that comes to the meridian with them, counted from the first point of Aries.

The use of the tables of the right ascension of the sun and stars is to find the time when any star culminates, or is upon the meridian on a given day.

RULE.

Look for the right ascension of the sun and star in the preceding tables, and subtract the sun's right ascension from the star's; but if the sun's right ascension be greatest, add 24 hours to the star's right ascension, and then subtract the sun's from it, the remainder will be the time of the star's coming to the meridian.

When the sun's right ascension is least, the star comes to the meridian in the afternoon, but before noon when the sun is greatest.

EXAMPLE I.

At what time will the star Arcturus be on the meridian of London, Dec. 1?

	H.	M.
Arcturus's right ascension -	14	6
	24	0
	38	6
Sun's right ascension —	16	31
After midnight —	21	35
	12	0
Morning — —	9	34

That is, the star Arcturus will be upon the meridian of London 35 minutes after nine o'clock in the morning.

EXAMPLE II.

At what time will the star Virgin's Spike be on the meridian of London, September 1?

	H.	M.
Spica Virginis's right ascension	13	14
Sun's right ascension —	10	42
The star culminates afternoon	2	32

So that the star Virgin's Spike comes to the meridian at London 32 minutes after two in the afternoon.

To find what Star will come upon the Meridian at any given Time.

RULE.

Add the time from noon to the right ascension of the sun, the sum will be the right ascension of the star required to be known; with which enter the table of the star's right ascension, and find what star's right ascension agrees with, or comes the nearest to it, and that is the star required.

EXAMPLE I.

I would know what star would be on the meridian of London about ten at night, January 25?

	H.	M.
Sun's right ascension January 25, at noon —	20	32
And for 10 hours more —	0	2
Given time 10 hours P. M.	10	0
	30	34
Sub.	24	0
Nearly answers to Sirius —	6	34

EXAMPLE II.

What star will be upon the meridian of London 20 minutes past four in the morning, May 10?

	H.	M.
Sun's right ascension May 9 at noon	3	5
And for 16 hours more —	0	3
Given time 16 hours, 30 minutes P.M. — —	16	30
Right ascension of mid. heaven	19	38

Answers nearly to Atair in the Eagle.

TABLE XXI. OF AMPLITUDES.

DECLINATION IN DEGREES.

Lat.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	23.29	Lat.
	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M	D.M	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	
1	1. 0	2. 0	3. 0	4. 0	5. 0	6. 0	7. 0	8. 0	9. 0	10. 0	11. 0	12. 0	13. 0	14. 0	15. 0	16. 0	17. 0	18. 0	19. 0	20. 0	21. 0	22. 0	23. 0	23.29	1
2	1. 0	2. 0	3. 0	4. 0	5. 0	6. 0	7. 0	8. 0	9. 0	10. 0	11. 0	12. 0	13. 0	14. 0	15. 0	16. 1	17. 1	18. 1	19. 1	20. 1	21. 1	22. 1	23. 1	23.30	2
3	1. 0	2. 0	3. 0	4. 0	5. 0	6. 0	7. 1	8. 1	9. 1	10. 1	11. 1	12. 1	13. 1	14. 1	15. 1	16. 1	17. 1	18. 1	19. 1	20. 2	21. 2	22. 2	23. 2	23.31	3
4	1. 0	2. 0	3. 0	4. 0	5. 0	6. 1	7. 1	8. 1	9. 1	10. 1	11. 2	12. 1	13. 2	14. 2	15. 2	16. 2	17. 2	18. 2	19. 3	20. 3	21. 3	22. 3	23. 3	23.33	4
5	1. 0	2. 0	3. 0	4. 1	5. 1	6. 1	7. 2	8. 2	9. 2	10. 2	11. 3	12. 3	13. 3	14. 3	15. 4	16. 4	17. 4	18. 4	19. 4	20. 5	21. 5	22. 5	23. 5	23.35	5
6	1. 0	2. 0	3. 1	4. 1	5. 1	6. 2	7. 2	8. 2	9. 3	10. 2	11. 3	12. 4	13. 4	14. 4	15. 5	16. 5	17. 5	18. 6	19. 6	20. 7	21. 7	22. 7	23. 8	23.38	6
7	1. 0	2. 1	3. 1	4. 2	5. 2	6. 2	7. 3	8. 3	9. 4	10. 4	11. 5	12. 5	13. 6	14. 6	15. 7	16. 8	17. 8	18. 8	19. 9	20. 9	21.10	22.10	23.11	23.40	7
8	1. 0	2. 1	3. 1	4. 2	5. 3	6. 3	7. 4	8. 4	9. 5	10. 5	11. 6	12. 7	13. 8	14. 8	15.10	16.10	17.10	18.11	19.11	20.12	21.13	22.13	23.14	23.44	8
9	1. 0	2. 1	3. 2	4. 3	5. 3	6. 4	7. 5	8. 6	9. 7	10. 7	11. 8	12. 9	13.10	14.10	15.11	16.12	17.13	18.14	19.15	20.16	21.17	22.17	23.18	23.49	9
10	1. 1	2. 2	3. 3	4. 4	5. 5	6. 6	7. 7	8. 8	9. 9	10.10	11.11	12.12	13.13	14.14	15.15	16.16	17.17	18 18	19.19	20.20	21.21	22.22	23.23	23.54	10
11	1. 1	2. 2	3. 3	4. 4	5. 5	6. 6	7. 7	8. 9	9.10	10.11	11.11	12.13	13.15	14.16	15.17	16.18	17.20	18.21	19.22	20.24	21.25	22.26	23.28	23.58	11
12	1. 1	2. 3	3. 4	4. 5	5. 7	6. 8	7. 9	8.11	9.12	10.13	11.15	12.16	13.18	14.19	15.21	16.22	17.23	18.25	19.26	20.28	21.29	22.31	23.33	24. 5	12
13	1. 2	2. 3	3. 5	4. 6	5. 8	6.10	7.11	8.12	9.14	10.15	11.17	12.19	13.21	14.22	15.24	16 26	17.28	18.30	19.31	20.33	21.35	22.37	23.38	24. 8	13
14	1. 2	2. 3	3. 5	4. 7	5. 9	6.11	7.13	8.15	9.17	10.18	11.20	12.22	13.24	14.26	15.28	16.30	17.32	18.34	19.36	20.38	21.41	22.43	23.45	24.15	14
15	1. 2	2. 4	3. 6	4. 8	5.11	6.13	7.15	8.17	9.19	10.21	11.23	12.25	13.28	14.30	15.33	16.35	17.37	18.40	19.42	20.44	21.46	22.49	23.51	24.22	15
16	1. 2	2. 5	3. 7	4.10	5.12	6.15	7.17	8.19	9.22	10.24	11.27	12.29	13.32	14.34	15.37	16.40	17.42	18.45	19.48	20.51	21.53	22.56	23.59	24.29	16
17	1. 2	2. 5	3. 8	4.11	5.13	6.16	7.19	8.22	9.25	10.27	11.30	12.33	13.36	14.39	15.42	16.45	17.48	18.51	19.54	20.57	22. 0	23. 4	24. 7	24.38	17
18	1. 3	2. 6	3. 9	4.12	5.15	6.19	7.22	8.25	9.28	10.30	11.34	12.38	13.41	14.44	15.46	16.51	17 54	18.57	20. 1	21. 5	22. 8	23.12	24 15	24.46	18
19	1. 3	2. 7	3.10	4.13	5.17	6.21	7.24	8.28	9.31	10.34	11.38	12.42	13.47	14.50	15.53	16.57	18. 1	19. 5	20. 8	21.12	22.16	23.20	24.24	24.56	19
20	1. 4	2. 8	3.12	4.15	5.19	6.23	7.27	8.31	9.35	10.38	11.43	12.47	13.51	14.55	16. 0	17. 4	18. 8	19.12	20.16	21.20	22.25	23.29	24.34	25. 5	20
21	1. 4	2. 8	3.13	4.17	5.21	6.26	7.30	8.34	9.39	10 43	11.48	12.52	13.57	15. 1	16. 5	17.10	18.15	19.20	20.24	21.29	22.34	23.39	24.44	25.16	21
22	1. 4	2. 9	3.14	4.19	5.23	6.28	7.33	8.38	9.43	10.47	11.53	12.58	14. 3	15. 8	16.13	17.18	18.23	19.28	20.33	21.39	22.44	23.50	24.55	25.27	22
23	1. 5	2.10	3.15	4.21	5.26	6.31	7.36	8.42	9.47	10.52	11.58	13. 3	14. 9	15.14	16.19	17.25	18.31	19.37	20.43	21.49	22.55	24. 1	25. 7	25.39	23
24	1. 5	2.11	3.17	4.23	5.28	6.34	7.40	8.45	9.51	10.57	12. 3	13. 9	14.17	15.21	16.27	17.34	18.40	19.46	20.52	21.59	23. 6	24.12	25.19	25.51	24
25	1. 6	2.12	3.18	4.25	5.31	6.37	7.43	8.50	9.56	11. 2	12. 9	13.16	14.23	15.29	16.35	17.42	18.49	19.56	21. 3	22.10	23.18	24.24	25.32	26. 5	25
26	1. 7	2.13	3 20	4.27	5.33	6.41	7.58	8.54	10. 1	11. 8	12.15	13.23	14.30	15.37	16.44	17.51	18.59	20. 6	21.14	22.22	23.30	24.38	25.46	26.19	26
27	1 7	2.14	3.22	4.29	5.36	6.44	7.51	8.59	10. 6	11.14	12.22	13.30	14.38	15.45	16 53	18. 1	19. 9	20.17	21.26	22.34	23.43	24.51	26. 0	26.34	27
28	1. 8	2.16	3.24	4.32	5.40	6.48	7.56	9. 4	10.12	11.20	12.29	13.37	14.46	15.54	17. 3	18.11	19.20	20.29	21.38	22.48	23.57	25. 6	26 16	26.49	28
29	1. 8	2.17	3 25	4.34	5.43	6.52	8. 0	9. 9	10.18	11.27	12.36	13.45	14.54	16. 3	17.12	18.22	19.31	20.41	21.51	23. 1	24.11	25.22	26.32	27. 6	29
30	1. 9	2.18	3.28	4 37	5.46	6.56	8. 5	9.15	10.24	11.33	12.42	13.53	15. 3	16.13	17.23	18.33	19.43	20.54	22. 5	23.16	24.27	25.38	26.49	27.23	30
31	1.10	2.20	3.30	4 40	5.50	7. 0	8.10	9.21	10.31	11.41	12.52	14. 2	15.13	16.23	17.34	18.45	19.56	21. 8	22.19	23.31	24.43	25.55	27. 7	27.42	31
32	1.10	2.21	3.32	4.43	5.54	7. 5	8.16	9.27	10.38	11.49	13. 0	14.11	15.23	16.34	17.46	18.58	20.10	21.22	22.34	23.47	25. 0	26.13	27.26	28. 1	32
33	1.11	2.23	3.35	4.46	[illegible]	7. 0	8.20	9.33	10.45	11.57	13. 9	14.21	15.33	16.45	17.58	19.11	20.24	21.37	22.50	24. 4	25.18	26.32	27.46	28.23	33

DECLINATION IN DEGREES.

Lat.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	23.29	Lat.
	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	D.M.	
34	1.12	2.25	3.37	4.50	6. 2	7.15	8.27	9.39	10.52	12. 5	13.18	14.32	15.44	16.57	18.11	19.25	20.39	21.53	23. 7	24.21	25.36	26.51	28. 7	28.44	34
35	1.13	2.27	3.40	4.53	6. 6	7.20	8.33	9.47	11. 0	12.14	13.28	14.42	15.55	17.11	18.25	19.40	20.55	22.10	23.25	24.40	25.56	27.13	28.29	29. 7	35
36	1.14	2.28	3.43	4.57	6.11	7.25	8.39	9.54	11. 9	12.23	13.38	14.53	16. 9	17.24	18.39	19.55	21.11	22.27	23.43	25. 0	26.18	27.35	28.53	29.30	36
37	1.15	2.30	3.45	5. 0	6.15	7.31	8.46	10. 2	11.17	12.33	13.49	15. 5	16.21	17.38	18.54	20.11	21.28	22.46	24. 3	25.21	26.39	27.58	29.17	29.56	37
38	1.16	2.32	3.48	5. 5	6.21	7.37	8.54	10.11	11.27	12.44	14. 1	15.18	16.35	17.53	19.10	20.28	21.46	23. 5	24.24	25.43	27. 3	28.23	29.43	30.23	38
39	1.17	2.34	3.51	5. 8	6.26	7.43	9. 1	10.19	11.37	12.54	14.12	15.31	16.49	18. 8	19.27	20.46	22. 6	23.26	24.46	26. 6	27.27	28.49	30.11	30.51	39
40	1.18	2.36	3.55	5.13	6.32	7.50	9. 9	10.28	11.47	13. 6	14.25	15.45	17. 5	18.24	19.44	21. 5	22.26	23.47	25. 9	26.31	27.53	29.16	30.40	31.22	40
41	1.19	2.39	3.58	5.18	6.38	7.57	9.17	10.37	11.57	13.18	14.39	16. 0	17.21	18.42	20. 4	21.26	22.48	24.10	25.33	26.56	28.21	29.46	31.11	31.53	41
42	1.21	2.41	4. 2	5.23	6.44	8. 5	9.26	10.47	12. 9	13.31	14.53	16.15	17.37	19. 0	20.23	21.46	23.10	24.34	25.58	27.24	28.50	30.16	31.43	32.26	42
43	1.22	2.44	4. 6	5.28	6.51	8.13	9.35	10.58	12.21	13.44	15. 7	16.31	17.55	19.19	20.43	22. 8	23.34	24.59	26.25	27.53	29.20	30.48	32.16	33. 0	43
44	1.23	2.47	4.10	5.34	6.58	8.21	9.45	11. 9	12.34	13.58	15.23	16.48	18.13	19.39	21. 5	22.32	23.59	25.26	26.54	28.23	29.53	31.22	32.51	33.37	44
45	1.25	2.50	4.15	5.40	7. 5	8.30	9.56	11.21	12.47	14.13	15.38	17. 6	18.33	20. 0	21.28	22.56	24.25	25.54	27.25	28.56	30.27	31.58	33.30	34.16	45
46	1.26	2.53	4.19	5.46	7.12	8.39	10. 6	11.34	13. 1	14.28	15.50	17.25	18.54	20.23	21.52	23.23	24.53	26.25	27.58	29.31	31. 3	32.37	34.12	35. 0	46
47	1.28	2.56	4.24	5.52	7.20	8.49	10.18	11.47	13.16	14.44	16.15	17.45	19.16	20.47	22.18	23.50	25.23	26.57	28.32	30. 7	31.42	33.18	34.56	35.46	47
48	1.29	2.59	4.29	5.59	7.29	8.59	10.30	12. 0	13.31	15. 2	16.34	18. 6	19.39	21.12	22.45	24.40	25.55	27.31	29. 7	30.45	32.23	34. 3	35.43	36.35	48
49	1.31	3. 3	4.34	6. 6	7.38	9.10	10.42	12.14	13.47	15.21	16.54	18.28	20. 3	21.38	23.14	24.51	26.28	28. 6	29.45	31.25	33. 6	34.48	36.33	37.26	49
50	1.33	3. 6	4.40	6.14	7.48	9.21	10.55	12.29	14. 5	15.40	17.16	18.52	20.29	22. 6	23.45	25.24	27. 3	28.43	30.25	32. 8	33.52	35.37	37.26	38.20	50
51	1.35	3.10	4.46	6.22	7.58	9.33	11. 9	12.46	14.24	16. 1	17.39	19.18	20.57	22.37	24.18	25.59	27.41	29.24	31. 8	32.54	34.41	36.30	38.23	39.19	51
52	1.37	3.15	4.52	6.30	8. 8	9.46	11.24	13. 3	14.43	16.23	18. 6	19.44	21.29	23. 8	24.52	26.36	28.21	30. 7	31.55	33.44	35.34	37.27	39.24	40.23	52
53	1.40	3.20	4.59	6.39	8.19	10. 0	11.40	13.21	15. 5	16.46	18.29	20.12	21.57	23.42	25.28	27.16	29. 4	30.53	32.45	34.38	36.33	38.29	40.29	41.29	53
54	1.42	3.24	5. 5	6.49	8.31	10.15	11.57	13.41	15.26	17.11	18.57	20.43	22.30	24.18	26. 7	27.58	29.50	31.42	33.38	35.35	37.32	39.16	41.45	42.45	54
55	1.45	3.29	5.14	6.59	8.44	10.30	12.15	14. 2	15.49	17.57	19.26	21.14	23. 5	24.56	26.49	28.43	30.39	32.35	34.35	36.36	38.39	40.47	42.56	44. 0	55
56	1.47	3.34	5.22	7.10	8.57	10.47	13.35	14.24	16.14	18. 5	19.56	21.49	23.43	25.37	27.34	29.32	31.31	33.33	35.36	37.42	39.51	42. 4	44.19	45.27	56
57	1.50	3.40	5.31	7.22	9.13	11. 4	12.50	14.45	16.45	18.33	20.29	22.25	24.23	26.21	28.22	30.24	32.27	34.34	36.46	38.53	41. 9	43.27	45.50	47. 2	57
58	1.53	3.46	5.40	7.34	9.26	11.22	13.18	15.14	17.10	19. 7	21. 4	23. 4	25. 0	27. 9	29.14	31.21	33.28	35.40	37.54	40.12	42.34	44.59	47.30	48.46	58
59	1.56	3.53	5.50	7.47	9.43	11.42	13.41	15.41	17.44	19.41	21.43	23.47	25.54	28. 1	30.12	32.22	34.12	36.53	39.13	41.37	44. 5	46.40	49.21	50.51	59
60	2. 0	4. 0	6. 0	8. 1	10. 2	12. 4	14. 6	16.10	18.14	20.18	22.21	24.34	26.46	28.55	31. 9	33.27	35.47	38. 9	40.36	43.10	45.48	48.31	51.24	52.51	60
61	2. 3	4. 8	6.12	8.17	10.21	12.27	14.34	16.40	18.46	20.57	23.13	25.23	27.39	29.56	32.16	34.39	37. 5	39.36	42.11	44.52	47.40	50.35	53.42	55.17	61
62	2. 7	4.15	6.24	8.32	10.41	12.52	15. 2	17.14	19.28	21.42	23.59	26.17	28.37	31. 1	33.27	35.57	38.31	41.10	43.54	46.46	49.46	52.56	56.20	58. 4	62
63	2.12	4.24	6.37	8.50	11. 4	13.19	15.34	17.51	20. 9	22.27	24.51	27.15	29.42	32.12	34.45	37.23	40. 5	42.54	45.49	48.55	52. 7	55.36	59.24	61.22	63
64	2.17	4.33	6.51	9. 9	11.28	13.47	16. 8	18.30	20.54	23.18	25.38	28.19	30.52	33.30	36.11	38.57	41.49	44.49	47.57	51.17	54.50	58.43	63. 2	65.22	64
65	2.22	4.44	7. 0	9.30	11.54	14.19	16.45	19.13	21.43	24.13	26.50	29.28	32. 9	34.55	37.46	40.42	43.46	46.59	50.43	54. 2	57.59	62.26	67.36	70.33	65
66	2.27	4.55	7.23	9.25	12.21	14.53	17.26	20. 0	22.37	25.14	27.58	30.44	33.34	36.29	39.31	42.40	45.58	49.26	53.11	57.14	61.47	67. 4	73.52	78.25	66

A TABLE *shewing the Time of the Sun, Moon, and Stars' Setting, when they have North Declination, or the Time of their Rising, when they have South Declination.*

DEGREES OF DECLINATION.

Lat.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	23 20	Lat.
	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	
1°	6.00	6.00	6.0	6.00	6.00	6.00	6.00	6.00	6.00	6.01	6.01	6.01	6.01	6.01	6.01	6.01	6.01	6.01	6.01	6.01	6.03	6.02	6.02	6.02	6.02	1°
2	6.00	6.00	6.0	6.00	6.00	6.00	6.01	6.01	6.01	6.01	6.01	6.01	6.02	6.02	6.02	6.02	6.02	6.02	6.03	6.03	6.03	6.03	6.03	6.03	6.04	2
3	6.00	6.00	6.0	6.00	6.01	6.01	6.01	6.01	6.02	6.02	6.02	6.02	6.02	6.03	6.03	6.03	6.03	6.04	6.04	6.04	6.04	6.05	6.05	6.05	6.05	3
4	6.00	6.00	6.0	6.01	6.01	6.01	6.02	6.02	6.02	6.03	6.03	6.03	6.03	6.04	6.04	6.04	6.05	6.05	6.05	6.05	6.06	6.06	6.06	6.07	6.07	4
5	6.00	6.00	6.01	6.01	6.01	6.02	6.02	6.02	6.03	6.03	6.04	6.04	6.04	6.05	6.05	6.05	6.06	6.06	6.07	6.07	6.07	6.08	6.08	6.09	6.09	5
6	6.00	6.00	6.01	6.01	6.02	6.02	6.03	6.03	6.03	6.04	6.04	6.05	6.05	6.06	6.06	6.06	6.07	6.07	6.08	6.08	6.09	6.09	6.10	6.10	6.11	6
7	6.00	6.00	6.01	6.01	6.02	6.02	6.03	6.03	6.04	6.04	6.05	6.06	6.06	6.06	6.07	6.08	6.08	6.09	6.09	6.10	6.10	6.11	6.11	6.12	6.12	7
8	6.00	6.00	6.01	6.02	6.02	6.03	6.03	6.04	6.04	6.05	6.06	6.07	6.07	6.07	6.08	6.09	6.09	6.10	6.10	6.11	6.12	6.12	6.13	6.14	6.14	8
9	6.00	6.1	6.01	6.02	6.02	6.03	6.04	6.04	6.05	6.06	6.06	6.08	6.08	6.08	6.09	6.10	6.10	6.11	6.12	6.13	6.14	6.14	6.15	6.15	6.16	9
10	6.00	6.1	6.01	6.02	6.03	6.04	6.04	6.05	6.06	6.06	6.07	6.08	6.09	6.09	6.10	6.11	6.12	6.12	6.13	6.14	6.15	6.16	6.16	6.17	6.17	10
11	6.00	6.1	6.02	6.02	6.03	6.04	6.05	6.05	6.06	6.07	6.08	6.09	6.09	6.10	6.11	6.12	6.13	6.14	6.14	6.15	6.16	6.17	6.18	6.19	6.19	11
12	6.00	6.1	6.02	6.03	6.04	6.04	6.05	6.06	6.07	6.08	6.09	6.09	6.10	6.11	6.12	6.13	6.14	6.15	6.16	6.17	6.18	6.19	6.20	6.21	6.21	12
13	6.00	6.1	6.02	6.03	6.04	6.05	6.06	6.06	6.07	6.08	6.09	6.10	6.11	6.12	6.13	6.14	6.15	6.16	6.17	6.18	6.19	6.20	6.21	6.22	6.23	13
14	6.00	6.1	6.02	6.03	6.04	6.05	6.06	6.07	6.08	6.09	6.10	6.11	6.12	6.13	6.14	6.15	6.16	6.17	6.19	6.20	6.21	6.22	6.23	6.24	6.25	14
15	6.00	6.1	6.02	6.03	6.04	6.05	6.06	6.07	6.09	6.10	6.11	6.12	6.13	6.14	6.15	6.16	6.18	6.19	6.20	6.21	6.22	6.24	6.25	6.26	6.27	15
16	6.00	6.1	6.02	6.03	6.05	6.06	6.07	6.08	6.09	6.10	6.12	6.13	6.14	6.15	6.16	6.18	6.19	6.20	6.21	6.23	6.24	6.25	6.27	6.28	6.29	16
17	6.00	6.1	6.02	6.04	6.05	6.06	6.07	6.09	6.10	6.12	6.12	6.13	6.15	6.16	6.17	6.19	6.20	6.21	6.23	6.24	6.25	6.27	6.28	6.30	6.31	17
18	6.00	6.1	6.02	6.04	6.05	6.06	6.08	6.09	6.10	6.13	6.13	6.14	6.16	6.17	6.19	6.20	6.21	6.22	6.24	6.26	6.27	6.29	6.30	6.32	6.33	18
19	6.00	6.1	6.03	6.04	6.05	6.07	6.08	6.10	6.11	6.13	6.14	6.15	6.17	6.18	6.20	6.21	6.23	6.24	6.26	6.27	6.28	6.30	6.31	6.33	6.34	19
20	6.00	6.1	6.03	6.04	6.06	6.07	6.09	6.10	6.12	6.14	6.15	6.16	6.18	6.19	6.21	6.22	6.23	6.25	6.27	6.29	6.30	6.32	6.33	6.35	6.36	20
21	6.00	6.1	6.03	6.05	6.06	6.08	6.09	6.11	6.12	6.14	6.16	6.17	6.19	6.20	6.22	6.24	6.25	6.27	6.29	6.30	6.32	6.34	6.35	6.37	6.38	21
22	6.00	6.2	6.03	6.05	6.06	6.08	6.10	6.11	6.13	6.15	6.16	6.18	6.20	6.21	6.23	6.25	6.27	6.28	6.30	6.32	6.34	6.36	6.37	6.39	6.40	22
23	6.00	6.2	6.03	6.05	6.07	6.09	6.10	6.12	6.14	6.15	6.17	6.19	6.21	6.23	6.24	6.26	6.28	6.30	6.32	6.34	6.36	6.37	6.39	6.41	6.42	23
24	6.00	6.2	6.03	6.05	6.07	6.09	6.11	6.13	6.14	6.16	6.18	6.20	6.22	6.24	6.25	6.27	6.29	6.31	6.33	6.35	6.37	6.39	6.41	6.43	6.44	24
25	6.00	6.2	6.04	6.06	6.07	6.09	6.11	6.13	6.15	6.17	6.19	6.21	6.23	6.25	6.27	6.29	6.31	6.32	6.35	6.37	6.39	6.41	6.43	6.46	6.47	25
26	6.00	6.2	6.04	6.06	6.08	6.10	6.12	6.14	6.16	6.18	6.20	6.22	6.24	6.26	6.28	6.30	6.32	6.34	6.36	6.39	6.41	6.43	6.45	6.48	6.49	26
27	6.00	6.2	6.04	6.06	6.08	6.10	6.12	6.14	6.16	6.19	6.21	6.23	6.25	6.27	6.29	6.31	6.34	6.36	6.38	6.40	6.43	6.45	6.48	6.50	6.51	27
28	6.00	6.2	6.04	6.06	6.09	6.11	6.13	6.15	6.17	6.19	6.22	6.24	6.26	6.28	6.30	6.33	6.35	6.37	6.40	6.42	6.45	6.47	6.50	6.52	6.53	28
29	6.00	6.2	6.04	6.07	6.09	6.11	6.13	6.16	6.18	6.20	6.23	6.25	6.27	6.29	6.32	6.34	6.37	6.39	6.42	6.44	6.47	6.49	6.52	6.54	6.55	29
30	6.00	6.2	6.05	6.07	6.09	6.12	6.14	6.16	6.19	6.21	6.23	6.26	6.28	6.31	6.33	6.36	6.38	6.41	6.43	6.46	6.48	6.51	6.54	6.57	6.58	30

A TABLE shewing the Time of the Sun, Moon, and Star's Setting, when they have North Declination, or the Time of their Rising, when they have South Declination.

DEGREES OF DECLINATION.

Lat.	0°		1		2		3		4		5		6		7		8		9		10		11		12		13		14		15		16		17		18		19		20		21		22		23		23½		Lat.
	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M	
31	6.	00	6.	02	6.	05	6.	07	6.	10	6.	12	6.	15	6.	17	6.	19	6.	22	6.	24	6.	27	6.	29	6.	32	6.	34	6.	37	6.	40	6.	42	6.	45	6.	48	6.	51	6.	53	6.	56	6.	59	7.	01	31°
32	6.	00	6.	02	6.	05	6.	08	6.	10	6.	13	6.	15	6.	18	6.	20	6.	23	6.	25	6.	28	6.	31	6.	33	6.	36	6.	39	6.	41	6.	44	6.	47	6.	50	6.	53	6.	56	6.	58	7.	01	7.	03	32
33	6.	00	6.	03	6.	05	6.	08	6.	10	6.	13	6.	16	6.	18	6.	21	6.	24	6.	26	6.	29	6.	32	6.	34	6.	37	6.	40	6.	43	6.	46	6.	49	6.	52	6.	55	6.	58	7.	01	7.	04	7.	06	33
34	6.	00	6.	03	6.	05	6.	08	6.	11	6.	14	6.	16	6.	19	6.	22	6.	25	6.	27	6.	30	6.	33	6.	36	6.	39	6.	42	6.	45	6.	48	6.	51	6.	54	6.	57	7.	00	7.	03	7.	06	7.	08	34
35	6.	00	6.	03	6.	06	6.	08	6.	11	6.	14	6.	17	6.	20	6.	23	6.	25	6.	28	6.	31	6.	34	6.	37	6.	40	6.	43	6.	46	6.	49	6.	53	6.	56	6.	59	7.	02	7.	06	7.	09	7.	11	35
36	6.	00	6.	03	6.	06	6.	09	6.	12	6.	15	6.	18	6.	20	6.	23	6.	26	6.	29	6.	32	6.	36	6.	39	6.	42	6.	45	6.	48	6.	52	6.	55	6.	58	7.	01	7.	05	7.	08	7.	12	7.	14	36
37	6.	00	6.	03	6.	06	6.	09	6.	12	6.	15	6.	18	6.	21	6.	24	6.	27	6.	31	6.	34	6.	37	6.	40	6.	43	6.	47	6.	50	6.	53	6.	57	7.	00	7.	04	7.	07	7.	11	7.	15	7.	17	37
38	6.	00	6.	03	6.	06	6.	09	6.	13	6.	16	6.	19	6.	22	6.	25	6.	28	6.	32	6.	35	6.	38	6.	42	6.	45	6.	48	6.	52	6.	55	6.	59	7.	02	7.	06	7.	10	7.	14	7.	17	7.	19	38
39	6.	00	6.	03	6.	06	6.	10	6.	13	6.	16	6.	20	6.	23	6.	26	6.	29	6.	33	6.	36	6.	40	6.	43	6.	47	6.	50	6.	54	6.	57	7.	01	7.	05	7.	0	7.	12	7.	16	7.	20	7.	22	39
40	6.	00	6.	03	6.	07	6.	10	6.	13	6.	17	6.	20	6.	24	6.	27	6.	31	6.	34	6.	38	6.	41	6.	45	6.	48	6.	52	6.	56	7.	00	7.	03	7.	07	7.	11	7.	15	7.	19	7.	23	7.	25	40
41	6.	00	6.	03	6.	07	6.	10	6.	14	6.	17	6.	21	6.	25	6.	28	6.	32	6.	35	6.	39	6.	43	6.	46	6.	50	6.	54	6.	58	7.	02	7.	06	7.	10	7.	14	7.	18	7.	22	7.	27	7.	29	41
42	6.	00	6.	04	6.	07	6.	11	6.	14	6.	18	6.	22	6.	25	6.	29	6.	33	6.	37	6.	40	6.	44	6.	48	6.	52	6.	56	7.	00	7.	04	7.	08	7.	12	7.	17	7.	21	7.	25	7.	30	7.	32	42
43	6.	00	6.	04	6.	07	6.	11	6.	15	6.	19	6.	22	6.	26	6.	30	6.	34	6.	38	6.	42	6.	46	6.	50	6.	54	6.	58	7.	02	7.	06	7.	11	7.	15	7.	19	7.	24	7.	28	7.	33	7.	36	43
44	6.	00	6.	04	6.	08	6.	12	6.	15	6.	19	6.	23	6.	27	6.	31	6.	35	6.	39	6.	43	6.	47	6.	52	6.	56	7.	00	7.	04	7.	09	7.	13	7.	18	7.	22	7.	27	7.	31	7.	36	7.	39	44
45	6.	00	6.	04	6.	08	6.	12	6.	16	6.	20	6.	24	6.	28	6.	32	6.	36	6.	41	6.	45	6.	49	6.	53	6.	58	7.	02	7.	07	7.	11	7.	16	7.	21	7.	25	7.	30	7.	35	7.	40	7.	43	45
46	6.	00	6.	04	6.	08	6.	12	6.	17	6.	21	6.	25	6.	29	6.	33	6.	36	6.	42	6.	46	6.	51	6.	55	7.	00	7.	04	7.	09	7.	14	7.	19	7.	24	7.	29	7.	34	7.	39	7.	44	7.	47	46
47	6.	00	6.	04	6.	09	6.	13	6.	17	6.	22	6.	26	6.	30	6.	35	6.	39	6.	43	6.	48	6.	53	6.	57	7.	02	7.	07	7.	12	7.	17	7.	22	7.	27	7.	32	7.	37	7.	43	7.	48	7.	51	47
48	6.	00	6.	04	6.	09	6.	13	6.	18	6.	22	6.	27	6.	31	6.	36	6.	41	6.	45	6.	50	6.	55	6.	59	7.	04	7.	09	7.	14	7.	19	7.	25	7.	30	7.	35	7.	41	7.	47	7.	53	7.	56	48
49	6.	00	6.	05	6.	09	6.	14	6.	18	6.	23	6.	28	6.	32	6.	37	6.	42	6.	47	6.	52	6.	57	7.	02	7.	07	7.	12	7.	17	7.	22	7.	28	7.	33	7.	39	7.	45	7.	51	7.	57	8.	00	49
50	6.	00	6.	05	6.	10	6.	14	6.	19	6.	24	6.	29	6.	34	6.	39	6.	44	6.	49	6.	54	6.	59	7.	04	7.	09	7.	14	7.	20	7.	25	7.	31	7.	37	7.	43	7.	49	7.	55	8.	02	8.	05	50
51	6.	00	6.	05	6.	10	6.	15	6.	20	6.	25	6.	30	6.	35	6.	40	6.	45	6.	50	6.	56	7.	01	7.	06	7.	12	7.	17	7.	23	7.	29	7.	35	7.	41	7.	47	7.	53	8.	00	8.	06	8.	10	51
52	6.	00	6.	05	6.	10	6.	15	6.	21	6.	26	6.	31	6.	36	6.	41	6.	47	6.	52	6.	58	7.	03	7.	09	7.	14	7.	20	7.	26	7.	32	7.	38	7.	45	7.	51	7.	58	8.	05	8.	12	8.	16	52
53	6.	00	6.	05	6.	11	6.	16	6.	22	6.	27	6.	32	6.	38	6.	43	6.	49	6.	54	7.	00	7.	06	7.	11	7.	17	7.	23	7.	29	7.	36	7.	42	7.	49	7.	56	8.	03	8.	10	8.	17	8.	21	53
54	6.	00	6.	06	6.	11	6.	17	6.	22	6.	28	6.	33	6.	39	6.	45	6.	50	6.	56	7.	02	7.	08	7.	14	7.	20	7.	27	7.	33	7.	40	7.	46	7.	53	8.	00	8.	08	8.	15	8.	23	8.	27	54
55	6.	00	6.	06	6.	11	6.	17	6.	23	6.	29	6.	35	6.	40	6.	46	6.	52	6.	58	7.	04	7.	11	7.	17	7.	23	7.	30	7.	37	7.	44	7.	51	7.	58	8.	05	8.	13	8.	21	8.	29	8.	33	55
56	6.	00	6.	06	6.	12	6.	18	6.	24	6.	30	6.	36	6.	42	6.	48	6.	54	7.	00	7.	07	7.	13	7.	20	7.	27	7.	34	7.	41	7.	48	7.	55	8.	03	8.	10	8.	19	8.	27	8.	36	8.	40	56
57	6.	00	6.	06	6.	12	6.	19	6.	25	6.	31	6.	37	6.	44	6.	50	6.	56	7.	03	7.	10	7.	16	7.	23	7.	30	7.	38	7.	45	7.	52	8.	00	8.	08	8.	16	8.	25	8.	34	8.	43	8.	48	57
58	6.	00	6.	06	6.	13	6.	19	6.	26	6.	32	6.	39	6.	45	6.	52	6.	58	7.	06	7.	13	7.	20	7.	27	7.	34	7.	42	7.	49	7.	57	8.	05	8.	14	8.	22	8.	32	8.	41	8.	51	8.	56	58
59	6.	00	6.	07	6.	13	6.	20	6.	27	6.	33	6.	40	6.	47	6.	54	7.	01	7.	08	7.	16	7.	23	7.	30	7.	38	7.	46	7.	54	8.	03	8.	11	8.	20	8.	29	8.	39	8.	49	9.	00	9.	05	59
60	6.	00	6.	07	6.	14	6.	21	6.	28	6.	35	6.	42	6.	49	6.	56	7.	03	7.	11	7.	19	7.	26	7.	34	7.	42	7.	51	7.	59	8.	08	8.	17	8.	26	8.	36	8.	47	8.	58	9.	09	9.	16	60

To find the Time of the Sun's Rising, Setting, and the Length of the Day and Night, by this Table.

First. Find the sun's declination at the top of the page (marked with the degrees of declination) and the latitudes in the right or left hand columns (marked lat.) and in the common angle of meeting is the time of sun setting, if the sun has north declination, but the time of sun rising, if the sun has south declination.

EXAMPLE I.

Let it be required to find the time of the sun's rising and setting, with the length of the day and night, in latitude 51° north, the 18th of July, 1796?

I first seek the sun's declination for the given day, and find it 20° 53′ north, which I here call 21°, then under the declination 21, and against the latitude 51°, stands 7 H. 53 M. the time the sun sets on the given day, in lat. 51 north, which being doubled, gives 15 H. 46 M. the length of the day; and if 7 H. 53 M. the time of the sun setting, be subtracted from 12 H. the remainder 4 H. 7 M. gives the time of the sun's rising, which being doubled, gives 8 H. 14 M. length of the night.

But, when the sun has 21° south declination in this latitude, the time of sun-setting becomes the time of sun-rising, and the length of the day will then become the length of the night.

Thus, the 25th of November, 1796, the sun's declination will be 20° 59′ south, or 21°, then the time of sun-rising is 7 H. 53 M. his setting 4 H. 7 M. and the length of the night 15 H. 46 M. and day 8 H. 14 M.

EXAMPLE II.

Let it be required to find the time of the sun's rising, setting, and length of the day and night, at Petersburg, the 21st June, 1796.

Under 23° 28′ N. the declination that day, and against 60° N. the latitude of Petersburg, — — 12 0

Stands the sun's setting —	9 16
The time of sun-rising —	2 44
Sun-setting doubled is the length of day	18 32
Sun-rising doubled is the length of night	5 28

EXAMPLE III.

Required the time of the sun's rising and setting, and length of day at the Cape of Good Hope, in lat. 34. 29 S. May 15th, 1796.

Under the declination 19° 6′ or 19° N. and against the lat. 34 S. - 12 0

Stands the sun's rising -	6 54
Time of sun's setting -	5 6
	2
The length of the day - -	10 12
And 6H. 54M. doub. is length of night	13 48

When a greater degree of accuracy is required, proportional parts may be taken for degrees and minutes of latitude and declination.

To find the Rising and Setting of the Stars.

By this table the rising and setting of any star may be found, whose declination does not exceed 23° 30′ north or south, in the following manner:

If you are in north lat. and the star has north declination, look for the declination at the top, and the lat. in the right or left hand columns, in the angle of meeting, is half the time of the star's continuance above the horizon, in that lat. or the time it takes in ascending from the eastern side of the horizon to the meridian, and descending from the meridian to the western part of the horizon.

Therefore, if these hours and minutes be subtracted from the time of the star's coming to the meridian, the remainder will be the time of the star's rising, and if added, the sum will be the time of the star's setting.

EXAMPLE I.

Required when the star Arcturus rises and sets December 1, in lat. 51 deg. N.

The time of the star's coming to the meridian, or southing in the morning	9 35
Then under star's declination 20° 16′ or 20° N. and against lat. 51 stands	7 47
Time of star's rising in the morning —	1 48
Added, gives the time of the star's setting —	17 22
	12
Star sets 22 minutes after 5 in the evening —	5 22

When the latitude is north, and the star has south declination, or the latitude south and the star has north declination, find the latitude in the side columns as before, against which, and under the degrees of declination, stands half the time

the star is under the horizon, which being subtracted from 12, the remainder will be half the time the star will be above the horizon in that latitude.

Example. *What time will the Dog Star, Sirius, rise and set at London, January 25?*

	12 0
Under the declination 16° 26′ S. and against lat. 51° 32′ or 52° stands	7 26
Half the time the star is above the horizon — —	4 34
The star comes to the meridian in the evening, at —	10 05
Which subtracted, shews that the star rises at 31 m. after 5 in the evening	5 31
Added, shews the time the star sets in the morning —	2 39

In like manner may the rising and setting of the planets be found when their declination does not exceed 23°½, and the time of their passage over the meridian is known.

Suppose it were required to know the time of Jupiter's rising and setting, in latitude 52 north, the 1st of August, 1796.

In the Nautical Almanack for 1796, I find that Jupiter passes over the meridian of Greenwich at 14 H. 3 M. that is, three minutes after two next morning, and his declination is 8° 27′ S.

Now, 12 H. added to 14 H. 3 M. is 26 H. 3 M. from which subtract 24 H. and the remainder 2 H. 3 M. is the time of his passing the meridian in the morning of that day, according to the civil account.

Under declination 8° 27′ or 8° and against latitude 52° stand 6 H. 41 M. half the time Jupiter is below the horizon; this doubled is 13 H. 22 M. the length of Jupiter's night, which subtracted from 24 H. gives 10 H. 38 M. the length of his day.

Again, 6 H. 41 M. added to his passing the meridian 2 H. 3 M. gives 8 H. 44 M. his rising in the evening, and 2 H. 3 M. added to 12 H. gives 14 H. 3 M. from this sum take 6 H. 41 M. and the remainder 7 H. 22 M. is the time of his setting in the morning.

Suppose it were required to find the moon's rising and setting August 13th, 1796, in latitude 52° north.

In the Nautical Almanack, (page 6th) I find that the moon passes the meridian of Greenwich at 8 H. 16 M. in the evening, and her declination at midnight is 22° 55′ South.

Then in the tables, under the declination 21° 32′ S. or 22°, and against the lat. 52° stands 8 H. 5 M. Half the time she is under the horizon doubled is 16 H. 10 M. the length of the lunar night, which subtracted from 24 H. leaves 7 H. 50 M. the lunar day. To the moon's southing or passage over the meridian, 8 H. 16 M. add half the lunar day, 3 H. 35 M. gives 11 H. 51 M. her setting at midnight, and from 8 H. 16 M. take 3, 35, the remainder 4 H. 41 M. is the time of her rising in the afternoon.

In like manner may be found the rising and setting of the other planets, only observing that the noon of the common day, and end of the sea day, is the beginning of the day in the Nautical Almanack.

As all the calculations here are made for the meridian of London, or Greenwich, care must be taken to reduce the time of their passages over the meridian of Greenwich to the meridian of the place of observation, by allowing 1 H. later for every 15° of west longitude, and 1 H. sooner for every 15° of east longitude.

It were to be wished, that gentlemen belonging to the sea would carry a celestial globe with them, upon which all the above may be found in an easy manner; for they would have nothing more to do but to set the globe north and south, raise the pole as many degrees above the horizon as the latitude is; bring the sun's place to the brazen meridian, and set the index to the upper 12; then turn the globe round, and note what stars come to the meridian, and the hour index will point to the time; when they come above the horizon, it will point to the time of their rising, and when they descend below the horizon, it will point to their setting; for as each star on the globe will point directly to one of the same name in the heavens, they may be viewed at any time of the night; or, if a planet, turn the globe until the index points to the time of their passage over the meridian, and make a mark on the globe with a pencil, under their declination, then turn the globe east until the mark comes to the horizon, and the index will point to the time of their rising; and turned westerly till it come to the horizon, the index will point to the time of their setting.

TABLE FOR FINDING THE DISTANCE OF TERRESTRIAL OBJECTS AT SEA.

Height in Feet	Dist. in Miles	Height in Feet	Dist. in Miles	Height in Feet	Dist. in Miles.	Height in Feet	Dist. in Miles	Height in Feet	Dist. in Miles
1	1.224	53	8.914	240	18.969	760	33.756	2250	58.083
2	1.732	56	9.163	245	19.165	780	34.197	2300	58.725
3	2.121	59	9.405	250	19.360	800	34.633	2350	59.360
4	2.449	62	9.641	255	19.553	820	35.063	2400	59.988
5	2.738	65	9.870	260	19.743	840	35.488	2450	60.609
6	2.999	68	10.097	265	19.932	860	35.908	2500	61.225
7	3.239	71	10.317	270	20 119	880	36.323	2550	61.834
8	3.463	74	10.533	275	20.305	900	36.734	2600	62.437
9	3.673	77	10.745	280	20.489	920	37.140	2650	63.035
10	3.872	80	10.952	285	20.671	940	37.546	2700	63.626
11	4.061	83	11.156	290	20.851	960	37.938	2750	64.213
12	4.242	86	11.355	295	21.030	980	38.332	2800	64.794
13	4.415	89	11.552	300	21.208	1000	38.721	2850	65.370
14	4.581	92	11.745	310	21.558	1030	39.297	2900	65.940
15	4.742	95	11.932	320	21.903	1060	39.886	2950	66.507
16	4.898	98	12.121	330	22.243	1090	40.426	3000	67.068
17	5.048	101	12.306	340	22.578	1120	40.978	3050	67.625
18	5.195	104	12.487	350	22.907	1150	41.524	3100	68.177
19	5.338	107	12.666	360	22.232	1180	42.062	3150	68.725
20	5.476	110	12.842	370	22.553	1210	42.593	3200	69.268
21	5.611	113	13.016	380	23.869	1240	43.118	3250	69.807
22	5.743	116	13.188	390	24.181	1270	43.636	3300	70.342
23	5.872	119	13.357	400	24.489	1300	44.149	3350	70.873
24	5.999	122	13.525	410	24.793	1330	44.659	3400	71.400
25	6.122	125	13.690	420	25.094	1360	45.156	3450	71.923
26	6.243	128	13.853	430	25.391	1390	45.651	3500	72.443
27	6.362	131	14.015	440	25.684	1420	46.140	3550	72.958
28	6.479	134	14.174	450	25.974	1450	46.629	3600	73.470
29	6.594	137	14.332	460	26.261	1480	47.106	3650	73.979
30	6.709	140	14.488	470	26.545	1510	47.581	3700	74.484
31	6.817	143	14.642	480	26.826	1540	48.052	3750	74.985
32	6.928	146	14.795	490	27 104	1570	48.517	3800	75.484
33	7.034	150	14.995	500	27.379	1600	48.979	3850	75.979
34	7.140	155	15.244	510	27.652	1630	49.436	3900	76.471
35	7.244	160	15.488	520	27.922	1660	49.889	3950	76.959
36	7.347	165	15.728	530	28.189	1690	50.339	4000	77.445
37	7.448	170	15.965	540	28.454	1720	50 782	4050	77.927
38	7.548	175	16.198	550	28.716	1750	51.223	4100	78.407
39	7.647	180	16.427	560	28 976	1780	51.661	4150	78.884
40	7.744	185	16.654	570	29.233	1810	52.094	4200	79.358
41	7.840	190	16.878	580	29.489	1840	52.524	4250	79.829
42	7.935	195	17.098	590	29.742	1870	52.951	4300	80.297
43	8.029	200	17.316	600	29.994	1900	53.374	4350	80.662
44	8.122	205	17.531	620	30 489	1930	53.793	4400	81.215
45	8 214	210	17.748	640	30.976	1960	54.219	4450	81.685
46	8.305	215	17.955	660	31.457	2000	54.761	4500	82.143
47	8.394	220	18.160	680	31.930	2050	55.441	4550	82.598
48	8.483	225	18.366	700	32.396	2100	56.113	4600	83.051
49	8.570	230	18.569	720	32.855	2150	56.777	4650	83.501
50	8.658	235	18.770	740	33.309	2200	57.434	4700	83.919

OF THE LATITUDES AND LONGITUDES

OF THE

PRINCIPAL HARBOURS AND CAPES IN THE WORLD;

With the TIMES of HIGH WATER where it is known.—The Longitude is reckoned from the Meridian of London.—Places marked thus *, are by Celestial Observations, others not so marked, are from the best Charts and Maps compared with these.

The Coast of England from London to the Land's End.

	Lat. D. M.	Long. D. M.	H. W. H.
* LONDON	51 32N.	0 0	2 46
* Green. Obs.	51 29	0 5E.	
Woolwich	51 30	0 9	
Purfleet	51 30	0 19	
Gravesend.....	51 27	0 28	
Rochester.....	51 23	0 38	
Nore.....	51 28	0 51	12 ½
N. Foreland light	51 25	1 32	11 ¾
S. Foreland lights	51 12	1 30	10 ½
* Dover	51 8	1 24	11 ¼
Dungeness.....	50 52	1 5	10 ½
Hastings	50 53	0 47	10 ¾
Beachy Head....	50 44	0 26	10 ¼
Shoreham	50 47	0 11W	9 ¼
Arundel	50 46	0 26	9 ¼
Selsey Bill	50 43	0 41	9 ½
Owers, S. E. Part	50 36	0 36	9 ¼
* Portsmouth Top	50 47	1 0	11 ¼
Isle of Wight.			
* Bembridge Ledge or Point	50 40	0 59	11 ¾
* Dunnose	50 33	1 10	9
* Saint Catherine's Point ..	50 30	1 14	9
* Needle's Lts.	50 41	1 24	9 ½
Pool Harbour ...	50 42	2 5	9
St. Alban's Head,	50 37	2 8	7 ¼
* Weymouth ...	50 37	2 30	6 ¼
Portland Lights	50 31	2 31	7 ¼
Exmouth Bar ...	50 37	3 18	6 ½
Torbay, Berry Head	50 22	3 22	6 ½
Dartmouth	50 18	3 33	6 ¼
* Start Point.....	50 9	3 40	6 ¾
Prawl ditto	50 8	3 47	6
* Eddystone Li.	50 8	4 18	5 ½
Hand Deeps	50 11	4 22	5 ½
Ram Head	50 18N.	4 15W	5 ¼
* Plymouth ..	50 22	4 10	6 ¼
Fowey	50 17	4 47	5 ½
* Deadman's Pt.	50 12	4 54	5 ¼
* Falmouth ...	50 8	5 5	5 ¼
Manacles Rocks	50 2	5 6	5
Black Head ...	50 5	5 [illegible]	5
* Lizard Point	49 57	5 14	5
Mount's Bay ..	50 8	5 37	5
Runnel Stone ..	50 2	5 48	5
Wolf Rock ...	49 56	6 30	4 ¾
Land's End ...	50 6	5 55	4 ½
Scilly Islands, S. part	49 52		
* St. Agnes Lts. Scilly	49 54	6 42	4 ¾
* St. Mary's, do.	49 57	6 36	4 ¾

The current in the mid. channel is N. E. about 1 H. 30 M. after high water; and it runs off Dungeness 4 H. to 4 and an half hours; in the Downs 4 hours; and east in the King's channel, 3 hours after high water.

The following table shews the time of high water at the principal headlands, &c. in the Channel, on full and change days, and the time the current runs after high water.

The current runs after H. W.

High Water.	H. M.	H. M.		H. M.
At the Lizard at	5 0	3 0	And the time the current has done running.	8
Off the Eddistone	5 30	3 0		8 30
Off the Start	6 10	2 30		8 30
Off Portland	7 15	3 0		10 15
Off I. of Wight	8 14	3 15		11 30
Off Arundel and Shoreham	9 15	1 15		10 30
Off Beachy	9 45	1 15		11
Off Dungeness	10 30	4 0		2 30

NOTE. H. W. stands for high water; R. for river; I. for island; P. for point, and C. for cape.

NOTE. The variation in the English, and St. George's channels, is 25° 30′, and on the east coast of England 25° west, and the Orkneys and Shetland islands about 2½ points, on the western coast of Ireland 2½ points west, and is found to vary between 11 and 12 minutes westerly every year, or a degree in 5½ years, therefore, by adding a degree for every 5½ years to the variation here given for 1795, you will have the variation nearly for any succeeding year.

From the North Foreland to Duncan's Bay Head.

	Lat. D. M.	Long. D. M.	H. W. H.
*North Foreland	51 25N.	1 32E.	11 ¾
Kentish Knock	51 43	1 45	11 ½
Long Sand Head	51 48	1 45	11 ½
Galloper N. P.	51 58	2 0	12
Ditto South P.	51 48	1 59	12
Shipwash N. P.	52 9	1 43	12
Ditto South P.	52 2	1 39	12
Gabbard	52 5	1 45	12
Orfordness ...	52 13	1 40	10 ½
Aldboro' knaps, South P. ...	52 15	1 49	9 ¾
Southwold	52 28	1 37	9
Leostaff Lights	52 38	1 49	9
*Yarmouth	52 39	1 45	8 ¼
Winterton Ness Lights	52 49	1 40	8 ¼
Smiths Knowl	52 57	2 20	
Haisborough Sand, S. P.	52 54	1 48	7 ½
Ditto, North P.	53 6	1 32	7 ½
Cromer Lights	53 3	1 16	9
Lemon and Ower, North P.	53 23	1 43	
Ditto, South P.	53 13	1 45	
Cromer Bank	53 21	1 30	
Dudgeon Lights	53 26	1 0	7 ½
Outer Dowfings	53 40	1 0	
Inner Dowfings	53 22	0 50	5 ½
Lynn Deeps ..	53 0	0 27	6
Spurn Lights ..	53 41	0 22	5 ¼
* Flamborough Head	54 10	0 7	4 ½
Filey Brig	54 17	0 5W	4 ½
Scarborough ..	54 21	0 13	4 ½
Robin Hood's Bay	54 30	0 22	3 ¾
Whitby	54 34	0 27	3 ¾
River Tees' Mouth, Stockton	54 41	0 59	3 ½
River Tyne's Mouth, Newcastle	55 2	1 9	3 ½
Coquet Island	55 22	1 21	2 ½
Staples Islands	55 39	1 40	2 ½
Holy Island	55 42	1 48	2 ½
Berwick	55 47	2 1	2 ¼
St. Abb's Head	55 57	2 6	4 ½
Dunbar ...	55 59	2 29	2
May I. Lights	56 11	2 32	4 ½
*EDINBURGH	55 58	3 9	2 ½
Fife Ness	56 15	2 33	4 ½
Mouth of Tay	56 27	2 38	3 ½
C. Rook, off do.	56 [illegible]	2 22	3 ½
Red Head ...	56 [illegible]	2 28	3
Montrose ...	56 44	2 24	1 ½
New Aberdeen	57 7	[illegible] 14	12 ¾
Peter Head	57 34	1 42	12
Buchan N[illegible]	57 31	1 42	12
Kinnaird's [illegible]	57 39	1 56	12
Bamff	57 38	2 27	11 ½

	Lat. D. M.	Long. D. M.	H. W. H.
Fort St. George	57 38N.	4 1W	11 ¼
Inverness ...	57 28	3 45	11 ¼
Cromartie ...	57 42	3 56	11 ¼
Tarbetness ...	57 54	3 44	11 ¼
Caithness ...	58 20	3 3	11
Nose Head ..	58 28	3 4	11
Duncansby Head	58 40	3 3	11 ¼

The Orkney Islands.

Pentland Skerries ...	58 45	2 57W	11 ½
Stromo ..	58 45N.	2 59	11 ½
South Renaldsha, South P.	58 47	2 52	11 ½
Copinsha ..	58 53	2 41	11 ½
Lambs Head, on Stronsal I.	59 4	2 29	11
North Ronaldsha, North P.	59 23	2 22	10 ½
Mould Head, on Patra Westra Island ..	59 21	2 52	9
Noup Head, on Westra I.	59 18	3 2	9
Marwick Head, on Pomona I.	59 6	3 16	10
Hoy Head, on Hoy Wells I.	58 55	3 18	10
Slue Skerry	59 3	3 24	10
Fair Island ..	59 30	1 42	4

The Shetland Islands.

Sumbug Head, South Point	59 52N.	1 15W	4
Rose or Hangliff	60 9	0 58	4
Brassa Sound Larwick	60 13	0 51	4
Out Skerries	60 25	0 18	4
Walfey Isle .	60 25	0 46	4
Unset, N. E. P.	60 47	0 15	4
Foul Island .	60 25	1 50	3

Ferro Islands.

The Munk Rock appears like a Ship under Sail	61 18N	6 47W	3
Fulae I. N. part of Ferro ..	62 12	6 27	4
East Point of Mygenes Isl. N.W. part of Ferro ...	62 3	7 32	4

From Duncan's Bay Head to the Land's-End.

Duncansby Head	58 40N.	3 3W	11 ¼
Dunnet Head	58 44	3 18	11 ¼
Faront Head	58 36	5 0	11 ¼
Cape Wrath, or Barre Head	58 36	5 20	7
A Rock seen at ½ Ebb ...	58 45	5 21	7

Table of Latitudes and Longitudes.

	Lat. D. M	Lon. D. M.	H. W. H.
Bata I.	58 54N	6 26W	
Rena Island ..	58 55	6 15	7
Rockal	57 28	13 32	
St. Kilda	57 51	8 56	
Butt of the Lewis	58 19	6 34	5 ½
Gallan Head	58 10	7 24	4 ¼
Flannan I. ..	58 13	7 50	4 ¼
Hiskere I. ...	57 23	7 58	5
Bara Head ...	56 56	7 44	5 ½
Rocks very dangerous	56 55	7 7	5 ½
Cana Islands ..	57 3	6 52	5 ½
Hyfker Islands	56 56	6 58	5 ½
Rum. I. West P.	56 59	6 46	5 ½
Tircey I. S. P.	56 30	7 12	5
Colt I. North P.	56 42	6 45	5
Bomfhly Rocks	56 9	7 5	5 ½
Skerryvore ...	56 17	7 22	5 ½
Ila I. S. W. P.	55 47	6 44	10 ½
Ditto, South P.	55 39	6 30	10 ½
Rachlan I. E. Part	55 17	6 17	9 ¼
Mull of Cantire Light-House	55 21	6 0	11
I. of Arran, S. E. Part	55 32	5 20	11
Cumray I. Entrance of Clyde	55 47	5 17	11
I lsa I.	55 26	5 24	11
rwin ...	55 36	5 0	11 ¾
Air	55 26	4 57	11 ¼
Loch Ryan ...	55 3	5 21	11 ½
Port Patrick Lts.	54 48	5 20	11
Mull of Galloway	54 37	5 8	11
Great Scar I.	54 40	4 57	11
Burrow Head ..	54 41	4 39	11
Solway Firth ..	54 47	4 30	11 ½
St. Bee's Head Light	54 30	3 50	11 ½
Whitehaven ..	54 32	3 47	11 ½
Selker Rock ..	54 16	3 39	11
Lancaster	54 3	3 3	11 ¼
Liverpool ...	53 27	3 12	11 ¼
Great Orms Hd.	53 20	4 3	10 ½
Skerries Light	53 25	4 50	9 ¼
Holyhead	53 19	4 52	9 ¼
Brachy Pool Hd.	52 47	4 57	7 ½
Bardsey I. ...	52 45	5 0	7 ½
Barmouth ...	52 48	4 12	8
Cardigan Harbour	52 12	4 47	7 ¼
Strumble Head	52 0	5 10	7
St. David's Head	51 55	5 20	6
Ramsay I.	51 48	5 22	6
Small's Light-House	51 48	5 36	9
St. Ann's ditto Milford Haven	51 44	5 10	5 ½
Worms Head	51 35	4 22	5 ½
Caldy I.	51 43	4 42	5 ¼
Lundy I. Entrance of Bristol Channel	51 15	4 44	5 5

	Lat. D. M.	Long. D. M.	H. W. H.
Mort P. S. Entrance of ditto	51 15N.	4 15W	5 ½
Hartland P.	51 4	4 38	5 ¼
Padstow	50 42	4 55	5 ¼
Towan Head ..	50 30	5 7	5 ¼
St. Ives Bay ..	50 17	5 34	4 ½
Cape Cornwall	50 10	5 55	4 ¼
The Seven Stones	50 6	6 23	4 ½
The Wolf Rock	49 57	6 2	4 ½
The Land's End	50 6	5 55	4 ½

The Isle of Man.

Calf of Man ..	54 1	5 3	10 ½
Douglas ...	54 7	4 42	
Ramsay Bay	54 17	4 38	10 ½
Point of Air ..	54 25	4 34	10 ½
Peel Hill	54 12	4 57	10 ½

Ireland.

Cape Clear ...	51 15N	9 50W	3
Fasnet Rock ..	51 13	9 55	3
Crookhaven ..	51 19	10 5	4
Mizen Head ...	51 18	10 13	3 ¾
Sheeps Head ...	51 24	10 15	3 ¾
Bantry Bay ...	51 26	10 10	3 ¾
Grellah Rocks	51 22	10 41	3
Dursey I. W. P.	51 26	10 45	3
Bull Rock	51 27	10 45	3
Cow Rock ...	51 27	10 48	3
Cod's Head ...	51 32	10 32	3
Kenmare Bay	51 35	10 50	3
Lamb Head ...	51 38	10 37	3 ½
Hog I.	51 37	10 49	3 ½
Hog's Head ...	51 41	10 48	3 ½
Bolus Head ..	51 41	10 55	3 ½
Skelling's Rocks	51 40	11 10	3 ¾
Lemon Rook ..	51 42	11 2	3 ¾
Bray Head ...	51 47	11 49	3 ¾
Dingle Bay ...	51 55	11 0	3 ½
Foze Rock ...	51 54	11 14	3 ½
Fretter's I. ...	51 56	11 22	3 ½
Tiraght Rocks	51 57	11 24	3 ¾
Great Blasket ..	51 57	11 9	3 ¾
Ennis Tuskan	52 0	11 23	3 ¾
Dunmore Head	51 59	10 55	3 ¾
Dunorling Head	52 5	10 57	3 ¾
Brandon Head	52 9	10 46	3 ¾
The Seven Hogs Rocks	52 11	10 37	3 ¾
Kerry Head, Entrance of Shannon Riv.	52 15	10 32	3 ¾
Loop Head, N. Entrance ditto	52 23	10 33	3 ¾
North Arran, or Killany ...	53 6	10 17	4
Galway Bay, ..	53 9	9 59	4
Sline Head ...	53 23	10 49	4
Ennis Shark I.	53 34	10 52	4
Ennis Turk I.	53 40	10 42	4
Clare Island ...	53 45	10 [illegible]6	4 ½
Achill Head ..	53 56	10 [illegible]	4 ½
Black Rock ..	54 2	10 33	5
Urris Head ...	54 18	10 37	5

	Lat. D. M.	Long. D. M.	H. W. H.
Broad Haven ..	54 15N.	10 29W	5
Stag Rocks, off Broad Haven	54 21	10 24	5
Down Patrick Head	54 18	9 58	5
Sligo Bay	54 15	9 18	5
Ennis Murray I.	54 24	9 18	[illegible]
Donegal Bay ..	54 30	9 6	5 ½
Tillon Head ..	54 38	9 25	5 ½
Arranmore	54 58	9 8	5 ½
Tory Island ...	55 15	8 48	4 ½
Lock Swilly ...	55 17	8 0	5
Malin Head ...	55 24	7 48	4
Enniſtrahul Rocks	55 29	7 35	4
Iniſhoan Head, Entrance of Londonderry	55 16	7 16	4
Bengore Head	55 18	6 44	4
Racklin I. Weſt Point	55 21	6 32	8
Fair Head	55 15	6 22	10 ½
The Maid's Rocks	54 55	5 46	10 ½
Belfaſt Loch ...	54 43	5 45	10 ½
Copeland Light	54 41	5 33	10 ½
St. John's P. ...	54 12	5 49	11
Dundrum	54 13	6 0	11
Carlingfordloch	54 0	6 12	10 ½
Dundalk	53 57	6 27	10 ½
Drogheda Bar ..	53 45	6 22	11
St. Patrick's I.	53 36	6 10	11
Lambay Iſland	53 31	6 7	11
DUBLIN	53 22	6 22	11 ¾
Wicklow Lights	52 59	6 7	10
Wexford	52 22	6 30	8 ½
Tuſker Rock	52 12	6 14	8 ½
Carnſore P. ...	52 11	6 23	8 ½
The Saltee Rocks	52 5	6 36	5 ½
Hook Lights, Waterford Harbour	52 3	7 3	4 ½
Dungarvon	51 59	7 36	5
Helwick Head	51 57	7 36	5
Youghall	51 50	7 53	5
Cork Harbour	51 41	8 23	4
Kinſale Harbour	51 34	8 42	4
Old Head of Kinſale	51 30	8 42	4
Seven Heads ..	51 27	8 52	4
Dundedy Head	51 25	9 8	4
The Stags, off Toe Head ...	51 19	9 23	4
Baltimore Harbour	51 20	9 46	4

From Calais to Scaw.

* Calais	50 57N.	1 57E.	
Gravelines	51 0	2 15	
* Dunkirk	51 2	2 28	
* Newport	51 8	2 51	
* Oſtend	51 14	3 2	
Walcheren I. Weſt P.	51 32	3 26	
Goree I	51 53N.	3 58E.	
Schoven I.	51 47	3 42	
* North Gatt ...	52 1	4 9	
* Rotterdam ...	51 56	4 34	
* AMSTERDAM ...	51 23	4 51	
Texel	53 10	4 52	
Bremen	53 23	10 28	
Elbe River, Entrance of	54 4	10 1	
Hillige Land Light	54 11	7 48	
Holmen	57 1	8 38	
Robſnout ...	57 30	8 42	
Scaw ...	57 42	10 3	

From the Scaw to St. Peterſburgh.

	Lat. D. M.	Long. D. M.
* Naze of Norway ...	57 59N.	6 42E.
Fer Light	59 5	10 8
Chriſtiana	59 50	10 20
Frederickſtad	59 10	10 35
Paternoſters	57 54	11 32
Marſtrand Light	57 54	11 40
Wingo Beacon	57 38	11 42
Gothenburgh	57 42	11 [illegible]
Leſſou I. Eaſt P.	57 20	11 [illegible]
Weſt P.	57 17	10 51
Trindelen Rock	57 28	11 15
Kummel Bank	57 27	11 21
Nidigen Light ...	57 18	12 1
Warberg	57 7	12 19
Falkenburgh	56 54	12 34
Halmſtad	56 40	12 56
Halland's I. Wadern	56 26	12 36
Koll Light	56 19	12 33
Anholt Light	56 44	11 36
Haſelo I.	56 12	11 48
Hielm I. ...	56 10	10 54
Cronenburgh Light ...	56 3	12 42
* Elſeneur	56 1	12 41
Huen I. North P. ...	55 55	12 44
* Lenſdſerone ...	56 8	12 5
* COPENHAGEN ..	55 41	12 41
Saltholm, North P. ..	55 41	12 51
Falſtrebo Light	55 21	12 53
Lubek	53 51	10 50
Dars Head	54 18	12 49
Bornholm I. N. E. P.	55 19	14 54
S. W. P. ..	54 57	15 17
* Dantzick	54 22	18 40
Oland, North P. ...	56 11	16 29
South P. ...	57 24	17 0
Gotland, North P. ...	56 55	18 16
South P.	57 55	19 37
Goltſke I.	58 16	19 27
Memel	55 42	21 [illegible]
Swaferort Lights ...	57 55	22 [illegible]
Domes Neſs Light ...	57 48	22 [illegible]
Runoe Light	57 49	23 [illegible]
Riga	57 2	23 45
Dogerort Light	58 56	22 3
Hengo Light	59 49	23 [illegible]
* STOCKHOLM ...	59 21	18 9
* St. Peterſburgh	59 56	30 25

From the Naze to Archangel.

	Lat. D. M.	Long. D. M.
* The Naze	47 59N.	6 41E.
Judder, or Walbert's Hd.	58 34	5 55
Lister Land	58 9	6 45
Rutt's I.	58 42	5 58
Great Wylingsoe Light-House	58 56	5 50
Stavanger	58 56	6 5
Ulster's I.	59 54	5 20
Bergen	60 12	5 50
Mus Sound	60 18	5 30
Sillewoog I.	60 36	5 21
Kate Nose	61 25	5 42
* Dronthemn, Var. 2 P. West	63 26	11 10
* Werro, I. Var. 1½ P. West	67 43	9 7
North Cape, Var. 1 P. West	71 10	26 10
Fishers I. Var. 1 P. W.	70 2	32 5
Kildume I. Var. ¾ P. West	69 18	33 45
* River Kola, Entrance, Var. ½ P. West ...	69 13	33 35
Sweetnose, Var. ½ P. W.	68 0	37 30
Orlogenose	67 0	39 23
Crois I. Var. ½ P. W.	66 19	38 50
Ponoy R. Var. ¼ P. W.	66 58	39 46
* Archangel, Var. ¼ P West	64 30	39 0
Catnose, or Blue Point	65 21	38 12
C. Bona Fortune	66 23	40 28
C. Candinose	68 22	41 25
Weigate's Straits	69 30	62 2
Nova Zembla ...	78 0	70 0

Coasts of France, Spain and Portugal, from Calais to Gibraltar.

	Lat. D. M.	Long. D. M.	H.W. H.	
* Calais ...	50 58N.	1 57E.		
Cape Griz Nez	50 58	1 40	3	¼
Boulogne	50 44	1 44		
Etaples	50 31	1 47		
St. Vallery ...	49 52	0 47		
* Dieppe	49 55	1 10	11	
Fechamp ...	49 50	0 30	11	
* Havre de Grace	49 29	0 12	9	
Mouth of the Seine ...	49 27	0 10W	9	
Caen ...	49 11	0 16	11	
Cape Barfleur Lights ...	49 44	1 7	10	½
Cherbourg ...	49 38	1 32	7	¼
C. St. Germain	49 46	1 52	9	
Alderney I. W. Point	49 48	2 12	9	
Casket Lights	49 48	2 25	10	
Guernsey I. W. Point ...	49 32	2 36		
Sark I. N. Point	48 28	2 17		
Jersey I. N. W. Point ...	49 16	2 17	6	
* Coutance ...	49 3	1 21	6	
* Granville ...	48 50	1 31	6	
* Avranche ..	48 41N.	1 17W	6	½
* St. Malo ...	48 39	1 56	6	½
Cape Frehel ...	48 48	2 22		
St. Brieux	48 32	2 48		
Brahat I.	48 52	2 52	7	½
Roche Blanche	48 59	3 52	7	½
* St. Anthony's Lights ...	48 40	4 24	6	
* Ushant, W. Pt	48 29	4 58	4	½
* Brest	48 23	4 25	3	¼
Point Raz	48 2	4 40		
Point L'Abbe	47 48	4 11		
Isles de Glenan	47 44	4 0		
L'Orient	47 44	3 21		
Isle de Groa ...	47 36	3 28		
Guiberon ...	47 34	3 5		
* Belle Isle ...	47 17	3 1	2	½
Houat Isle	47 20	2 57		
Dumet Isle ...	47 15	2 52		
* Nantes	47 13	1 25		
Nourmoustier I.	47 2	2 10		
Dieu Isle ...	46 42	2 16		
* Roche Bon	46 14	2 21	4	½
Ree Isle	46 15	1 28	3	½
* Rochelle ...	46 9	1 4	3	¼
* Rochfort ...	46 3	0 53		
Oleron Isle ...	46 3	1 19		
Cordovan Light House	45 36	1 6	4	½
* Bourdeaux ..	44 50	0 30	3	
C. Feret	44 43	1 10		
* Bayonne ...	43 29	1 24	3	½
C. Machicaco	43 31	3 15		
Bilboa ...	43 15	3 1	3	
C. de Lata ..	43 34	3 53		
C Penas	43 48	5 48	3	
* C. Ortegal ..	43 46	7 36	3	
C Prior	43 31	8 8	3	
Ferrol ...	43 30	8 0	3	
Corunna ...	43 17	8 12	3	
C. Belem	43 10	9 13	3	
C. Turiana ...	43 4	9 21	3	
* C. Finisterre	42 52	9 14	3	
Vigo Bay	42 14	8 34	3	½
C. Fallis ...	42 5	8 50	3	
* Oporto ...	41 20	8 21	3	
C. Mondego ...	40 5	8 46	3	
C. Fiseraon ...	39 24	9 10	3	
The Burlings	39 20	9 31	3	
* The Rock of Lisbon ...	38 45	9 31	3	
* Lisbon ...	38 42	9 7	3	¼
C. Epichel ...	38 21	9 15	3	
St. Ubes	38 29	9 0	3	
* C. St. Vincent	37 2	8 56	3	
C. St. Mary ...	37 0	7 55	3	
P. Avenisla ..	37 6	6 53	3	
* Cadiz	36 31	6 6	2	½
C. Trafalgar	36 10	5 56	3	
* Gibraltar ..	36 5	5 16	3	
Ceuta	35 50	5 12	3	½
* C. Spartel ..	35 48	5 48	3	

The North Coast of the Mediterranean Sea, from Gibraltar to Constantinople.

	Lat. D. M.	Long. D. M.
* Gibraltar	36 5N.	5 15W
Malaga	36 42	4 15
* Cape de Gatt	36 46	2 24
* Carthagena	37 37	1 2
* Cape Pallas	37 34	0 58
Alicant	38 25	0 9
Cape St. Martin	38 47	0 5E.
Gandia	39 1	0 0W
Valentia	39 30	0 32
Cape Oropeso	40 0	0 7
River Ebro	40 44	0 30E
* Barcelona	41 26	2 18
Cape Sebastian	41 48	3 15
Cape de Creux	42 18	3 23
Perpignan	42 30	2 57
Cette	43 24	3 46
Narbonne Road	43 0	2 55
Montpelier	43 37	3 49
Mountfort	43 39	5 0
* Marseilles	43 18	5 28
* Toulon	43 7	6 3
Cape Taillar	43 4	6 56
Cape de Oropes	43 29	7 21
Villa France	43 42	7 25
Cape de Mille	43 54	7 56
* Genoa	44 25	8 41
Point de Fino	44 16	9 0
* Leghorn	43 27	10 27
Cape M. Nero	43 18	10 0
Vada	43 15	10 35
Piombino	43 0	10 33
Point Ercore	42 29	11 1
* Civita Vecchia	42 5	11 52
* Rome	41 54	12 35
Cape Dazzia	41 38	12 35
* Naples	40 51	14 20
Cape Polonado	40 3	15 28
Policastro	41 17	15 53
Cape Batican	38 47	16 35
Cape Grofe	38 17	16 16
Cape Spartevento	38 6	16 57
Cape Collonia	39 0	18 8
Tarento	40 14	18 2
Galipoli	39 56	18 36
Cape St. Mary, the Entrance to the Gulf of Venice	39 40	19 14
Brinici	40 38	18 45
Barry	41 4	17 18
Manfredonia	41 40	16 10
Cape Vestio	41 43	16 34
Pescara	43 13	14 30
* Ancona	43 38	13 37
Comago	44 25	12 0
* Venice	45 26	12 10
Trieste	46 0	13 34
Rovigno	45 11	13 48
St. Maria	45 23	14 25
Pescera	44 42	15 40
Cape Sesto	43 45	16 25
Rosaro	42 48N.	17 40
Patero	42 23	19 15
Dorazo	41 40	18 45
La Vallona	40 55	20 8
Cape Liqueta	40 [illegible]	19 50
Pageni	39 19	21 28
Larta	38 55	22 3
Cape de Larta	38 40	21 44
Lepanto	38 15	22 54
Cape Gallo	36 40	21 49
Cape Mantapan	36 35	22 37
Cape St. Angele	36 37	23 44
Cape Mala	37 34	24 13
Corinth	38 10	23 35
* Athens	38 4	23 58
Negropont	38 28	24 10
Cape Doro	38 0	25 0
Cape St. George	39 10	23 44
* Salonica or Salonique	40 41	23 14
Cape Ballouri	39 43	23 55
Cape Pellice	39 57	24 25
Cape Monte Santo	40 10	24 57
Adrianople	40 44	27 5
Galipoli	40 25	27 11
*CONSTANTINOPLE	41 1	29 0

The South Coast of the Mediterranean Sea.

Ceuta	35 50N.	5 14W
C. Tetuan	35 28	5 44
C. Negril	35 25	4 24
* C. 3 Forcas	35 38	2 45
C. Fegalle	36 46	1 2
* C. Falcon	36 6	0 44
C. Ferrat	36 4	0 5
C. Tenois	36 35	1 12
* Algiers	36 49	2 19
C. Matifor	36 52	3 3
* C. Carbon	36 53	4 15
C. Tenes	37 4	5 44
C. Fyel	36 58	6 37
C. Ferro	37 4	7 33
Bona	36 45	7 53
Tabarca	37 8	8 55
C. Serra	37 25	9 35
C. Blanc	37 30	9 35
Tunis	36 45	10 10
C. Bon	37 9	11 8
Sufa	35 44	10 50
C. Paul	35 5	11 15
Cape de Zoara	33 30	11 24
* Tripoli	32 54	13 12
Magra	32 29	15 0
C. Menfurato	32 24	15 39
C. Lorat	31 0	16 30
C. Studico	31 43	17 37
Santotes	30 17	18 40
C. Linconta	30 57	18 10
C. Sarabion	31 28	19 1
Zoara	31 12	19 0
C. Bengaza	32 28	20 8
C. Razat	33. 7	22 20
Derne	32 59	22 [illegible]
C. Razatin	32 45	22 57

	Lat. D. M.	Long. D. M.
C. Lucca	32 15N.	25 25E
C. Soliman	31 40	25 45
P. Ramitan	31 25	26 27
C. Lagofego	31 13	27 19
C. Capopero	31 3	28 49
C. Rose	31 0	29 40
* Alexandria	31 11	30 22
C. Brule	31 44	31 34
Domiata	31 36	32 1
Berella	31 20	32 47
C. Gallo	31 34	33 55
Jafa	32 5	35 10
M. Carmel	32 50	35 16
C. Vardo	34 18	35 57
Tripoly	36 46	36 24
Tortosa	35 20	36 25
C. Saudin	36 0	36 0
C. Canzin	36 24	35 47
* Alexandretta, or Scanderoon	36 35	36 26
Aleppo	35 45	37 26
C. Urico	36 35	34 20
P. Cavelero	36 33	33 17
C. Dranmont	36 23	32 7
Satalia	36 58	30 35
C. Blanc	36 21	30 21
C. Seven Capes	36 31	28 54
C. Baibe	36 44	28 10
C. Crio	36 45	27 34
C. Petrera	37 10	27 30
C. St. Mary	37 45	27 20
C. Blanc	38 16	26 32
* Smyrna	38 28	27 27
C. Baba	39 24	26 20
C. Janesari	39 53	26 32
C. Capitani	40 13	28 0
Prusias	40 35	29 4

Islands within the Straits.

	Lat. D. M.	Long. D. M.
* Alboran	36 1N.	2 48
Zaffarine Islands	35 23	2 8
Formentera, W. Point	38 41	0 49E.
Ditto, E. ditto	38 39	1 10
Ivica, S. ditto	38 48	0 51
Ditto, N. E. ditto	39 10	1 11
Salina	38 50	0 40
Carbera, S. Point	39 10	2 23
Majorca, S. Point	39 18	2 30
Ditto, N. ditto	40 45	2 40
Ditto, W. ditto	39 40	1 51
Ditto, E. ditto	39 42	3 2
Minorca, S. ditto	39 43	3 50
* Minorca, St. Philip's Fort	39 51	3 54
Ditto, N. ditto Point	40 16	3 21
Sardinia, S. W. Point	39 4	8 18
Ditto, S. E. ditto	39 0	9 54
Ditto, N. ditto	41 15	8 55
Ditto, N. W. ditto	40 57	8 2
Corsica, N. Point	41 13	8 6
St. Peter	39 0	8 5
Toro	38 40	8 20
Galite	37 50	8 55
Elba	42 48	9 50

	Lat. D. M.	Long D. M.
Planoso	42 34N	9 45E.
Capraia	43 10	9 35
Gorgona	43 24	9 21
Pouza	42 32	9 55
Lustereo	38 53	13 35
Strombolo	38 57	15 52
Lonaze	58 10	12 20
Marefimo	38 0	12 11
Faugnana	37 56	12 26
Sicily, W. Point	38 11	12 40
Ditto, S. ditto	36 45	15 36
Meffina in ditto	38 15	15 59
Panteloria	36 54	12 0
Linosa	35 55	12 38
Pidnisia	35 40	12 40
Malta, N. Point	36 0	14 22
Ditto, S. ditto	35 39	14 35
* The Harbour in Malta	36 0	14 34
Gozo, N. Point	36 12	14 50
Corfu, S. E. Point	39 31	20 50
Fano, Entrance of the Gulf of Venice	40 8	21 6
Pelegosa	42 14	16 30
Piani	42 9	16 13
Tremilli	42 10	15 50
Lilla	42 47	16 27
Pomo	43 2	15 55
Longa, S. E. Part	43 55	15 52
Scio, S. Point	38 14	26 32
Cerigo, S. Point	36 22	23 21
Cerigotte	35 55	24 43
Milo	36 41	25 6
Martelene, W. Point	39 15	27 12
Goze	35 2	24 5
Candia: S. W. Point	35 17	23 56
Candia: Cape Spada	35 45	24 18
Candia: S. E. Point	35 21	23 55
Candia: N. E. Point	35 35	27 6
Rhodes, S. E. Point	35 27	18 45
Cyprus, W. Point	35 0	31 55
E. Point	35 40	35 0
S. Point	34 30	33 16

The Coast of Africa from Cape Spartel to Cape Verd.

	Lat. D. M.	Long. D. M.
* Cape Spartel	35 48N.	5 47W
* Larash	35 11	6 8
* New Sale	32 35	6 38
* Mazagan	33 15	8 11
* Cape Blanco	33 5	8 20
* Cape Cantin	32 35	9 0
* Sama Fay	32 20	8 40
* Mogadore Island	31 27	9 25
* Cape Geer	30 28	9 47
Santa Cruz	30 29	9 34
Cape Nun	28 40	11 10
* Cape Bajador	26 29	14 20
* Cape das Barbas	22 15	16 34
* Cape Blanco	20 41	16 52
Arguin	20 22	16 22
Cape Miric	19 15	16 16
Portendic	18 6	16 58
Senegal Bar	15 51	16 9
* Cape Verd	14 46	17 47

The Western Isles.

	Lat. D. M.	Long. D. M.
* Corvo	39 42N.	31 0W
* Flores	39 34	29 54
* Fayal, the Town	38 32	28 37
* Pico	38 29	28 20
Tercera	38 54	28 15
St. George	38 33	27 55
Graciosa	39 2	28 4
* St. Michael, E. Point	37 47	25 48
Ditto, W. Point	37 50	26 48
* St. Mary	37 0	25 6

The Madeiras.

* Porto Santo	32 58N.	16 20W
Rock E. of ditto, under water	33 30	16 2
Madeira, East P.	32 50	16 46
Ditto, West P.	32 30	17 26
* Funchal	32 38	17 5
The Salvages Islands	30 8	16 4

The Canaries.

* Manzarote, North P.	29 25N	13 26W
* Ditto, South P.	28 51	13 41
Forteventura, West P.	28 4	14 26
Ditto, East P.	28 40	13 40
* Canaria, N. E. P.	28 13	15 33
* Ditto, South P.	27 42	15 54
* The Peak of Teneriffe	28 13	16 26
* Ditto, North P.	28 39	16 0
* Orotavia in ditto	28 23	16 30
Santa Cruz in ditto	28 27	16 18
Palma, North P.	28 36	17 32
Tazicote in ditto	28 6	17 3
Ditto, South P.	28 18	17 37
Gomera, at the Port	28 6	17 4
* Ferro, the Town	27 47	17 40
* Ditto, East P.	27 50	17 37
Ditto, West P.	27 46	17 52

Cape Verd Islands.

St. Anthony	17 9N	24 48W
St. Vincent	16 50	24 36
St. Lucia	16 44	24 31
St. Nicholas	16 32	24 16
* Sal	16 38	22 50
* Bonavista	16 6	22 41
* Mayo	15 10	23 0
St. Jago, North P.	14 54	23 27
Ditto, South P.	14 17	23 25
Brava	14 50	24 39
* Fogo	14 57	24 22

From Cape Verd to the Cape of Good Hope.

	Lat. D. M.	Long. D. M.
* Cape de Verde	14 46N.	17 47W
* Goree Isle	14 36	17 37
Cape Naze	14 24	17 48
Cape St. Mary, Entrance to the River Gambia	13 17	16 56
Cape Roxo	12 23	17 30
Cape Vergue	9 52	14 56
Delos Isles	9 29	14 7
* Cape Sierra Leon	8 29	13 48
* Cape Ann	7 7	13 27
* Cape Mount	6 46	11 42
* Cape Mezurado	6 [illegible]	11 17
Cape Baxos	5 28	10 7
Sestos River	5 27	9 47
Cape Formosa	5 8	9 39
* Cape Palmas	4 26	8 15
St. Andrew's River	4 58	6 30
Cape Mabo	5 12	5 [illegible]
* Cape Appollonia	4 59	3 [illegible]
* Axim	4 52	2 36
* Cape Three Points	4 40	2 38
* Dix Cove	4 48	2 22
* Sakondee	5 0	1 59
* Elmina	5 10	1 [illegible]
* Cape Corse Castle	5 12	[illegible]
* Devil's Hill	5 24	[illegible]
* Anamaboe Fort	5 10	1 7
* Acra	5 30	[illegible]
* Barracoe	5 53	[illegible]
River Volta	5 53	[illegible]
Cape St. Paul	5 52	[illegible]
Whidah	6 25	[illegible]
Formosa River	5 33	[illegible]
Cape Formosa	4 30	6 40
New Callabar River	4 23	8 0
Cameron River	3 20	10 0
Cape St. John	1 15	[illegible]
Gabon River	0 0	9 29
C. de Lopas Gonsalvez	0 47S.	9 12
Setto River	2 16	9 35
Alvary Bay	3 27	10 40
Congo River	4 35	11 5
Ambris River	5 45	12 0
Cape Ledo	9 50	12 3
St. Philip de Benguela	12 18	12 35
* Cape Negro, appears like black hommocks	16 27	[illegible]
* Tiger's Island	16 30	[illegible]
Cape Frio	18 40	[illegible]
* Elizabeth's Bay	26 12	[illegible]
Cape Rostro de Pedro	23 0	14 [illegible]
* Angra Pequena	26 35	15 40
Cape das Voltas	29 0	16 45
* Walwick Bay, N. W. Point	23 0	14 0
Cape Defeada	32 20	15 24
* St. Helen's Bay, C. St. Martin's	32 45	17 45
* Saldanah Bay	33 [illegible]	18 [illegible]
* Cape of Good Hope	34 [illegible]	18 [illegible]

Islands between Cape Verd, the Cape of Good Hope, and Cape Horn.

	Lat. D. M.	Long. D. M.
St. Paul's	0 54N.	26 40W
* Ferdinand Noronha	3 56S.	32 32
St. Matthew	1 33	7 30
Fernand de Po, N. P.	3 23N	8 50E.
Princes I.	1 44	8 0
* St. Thomas, Man of War's Bay	0 27	7 0
* Ditto, South P.	0 5	6 50
* Annabona	1 28S.	5 52
* Trinidad	20 15	30 30W
* Ascension	7 56	14 16
* St. Helena, James Town	15 55	5 46
Saxemburgh	30 41	19 15
* Tristau da Cunha	37 10	13 20
Diego Alvarez	39 20	11 2
* Gough's Island	40 3	2 30
Falkland I. N. E. P.	51 50	63 30
Ditto, S. W. Point	51 0	66 5
* Island of Georgia	54 30	37 30

From the Cape of Good Hope to Canton in China.

	Lat. D. M.	Long. D. M.
* Cape of Good Hope	34 29S.	18 20E
False Cape	34 16	18 50
Cape Aguillis	34 44	20 15
* False Bay	34 10	18 39
Bay St. Braze	34 28	21 59
Cape Talbado	33 27	24 7
* Algoa Bay	33 30	26 35
Cape Delgado, Mufele B.	33 38	24 10
* First P. of Natal	32 11	28 51
* Middle P. Natal	30 45	30 20
Port Natal	29 50	30 57
Smoaky Cape	27 7	32 15
Cape St. Mary, Entrance of Delagoa Bay	25 51	33 16
Cape Corientes	23 37	36 35
Cape St. Sebastian	21 35	36 25
Sofalo	20 15	35 32
Angoza	16 11	39 27
Judda	21 29	39 26
* Mozenbique	14 56	42 29
Cape Delgado	10 6	41 15
Giuloa	8 41	39 40
Mombas	3 34	41 30
Melinda	2 45	41 47
* Magadosha	2 20N.	46 25
Cape Bassas	4 50	49 2
* Cape Orful	10 27	51 38
* Cape Guardafui	11 47	51 35
* Cape Babelmandel, Entrance of the Red Sea.	12 38	43 47
* Cape Fartash	15 29	52 5
* Cape Aden	12 45	45 17
Cape Morebet	17 16	54 19
* Socotra I. East Point	12 18	54 23
Ditto, West Point	12 45	53 2
* Cape Pedro	17 54	55 27
* Moka in the Red Sea	13. 17	43 17
Cape Isoclette	19 4N.	57 18E.
Great Mazeira I.	20 15	58 31
Cape Roselgate	22 36	59 54
Muscat	23 30	58 16
Cape Jask	25 57	57 15
C. Museldon, Entrance to the Gulf of Persia	26 17	56 17
Cape Birdistan	28 0	51 8
Gambaroon	27 18	56 6
Cape Monze	25 0	66 18
* Bassora	30 31	47 32
* Point Gigat	23 30	68 35
Diu Point	20 44	69 50
Cambaye	23 36	72 17
Surat	21 10	72 26
Cape St. John	20 6	72 34
* Bombay	18 57	72 43
Dabul	18 0	73 29
* Goa	15 31	73 55
Barcelore	13 53	75 2
Mangalore	13 0	75 35
Mount Dilly	12 5	75 35
* Cochin	9 53	76 27
* Cape Comorin	7 57	77 32
Dondra Head, South P. of Ceylon	5 47	81 2
* Trincomaley B.	8 35	81 27
Point Pedro	9 57	80 39
Point Calymere	10 13	79 54
* Negapatnam	10 32	79 53
* Pondicherry	11 42	79 59
* Fort St. David's	11 29	79 54
* Madras	13 5	80 35
Point Divy	16 2	81 29
* Masulipatnam	16 16	81 24
* Coringa Bay	16 58	82 30
* Point Gordeware	16 45	82 37
* Visagapatam	17 46	83 35
* Gamjam	19 25	85 7
* Jagernaut Pagoda	19 48	85 57
* Black Pagoda	19 51	86 10
False Point	20 17	86 51
* Point Palmyras	20 44	87 10
* Kadgiree	21 48	88 56
* Balasore	21 21	87 21
* Ingellee	21 50	88 11
* Calcutta	22 34	88 33
* Chandernagor	22 51	88 35
* Illamabad	22 20	91 52
Aracau River	20 17	93 0
Cheduba Isle	18 45	93 37
* C. Negrais	16 8	94 9
* Gulf of Martaban	15 37	96 30
* Tavay Point	13 37	97 44
* Junkseylon	8 15	98 2
* Malacca	2 12	102 11
* Cape Romania	1 15	104 5
* Siam, in the Gulf of Siam	14 18	100 55
* Cambaja Point	8 45	103 45
Avarella Point	12 54	107 50
* Pulo Canton	15 15	107 15
C. Nord or Turon	16 4	116 30
* Macao	22 13	113 52
* Canton	22 8	113 8

Islands lying between the Cape of Good Hope and Cape Cameron.

	Lat. D. M.	Long. D. M.
St. Paul's Island	37 31 S	77 56 E.
Amsterdam	38 15	78 0
* South P. Cape St. Mary's (Madagascar)	25 33	44 55
North P. C. Ambro or Natal (Madagascar)	12 2	50 19
* St. Auguſtin's B. (Madagascar)	23 35	43 30
C. St. Vincent (Madagascar)	21 46	43 37
C. St. Andrew's (Madagascar)	16 6	45 32
C. St. Sebaſtian (Madagascar)	12 30	49 44
Bay Antongil (Madagascar)	16 0	50 38
I. St. Mary (Madagascar)	16 54	50 36
* Foul Point (Madagascar)	17 41	49 59
* Fort Dauphin (Madagascar)	25 0	47 5
Baſſas de India	22 20	41 30
Europa Rocks	21 30	40 17
Juan de Nova	17 15	43 7
Suſſex Rocks	21 29	42 26
Bazaruto Rocks	21 16	36 30
Engliſh Bank	17 30	39 27
Cheſterfield ſhoal	16 17	44 8
* Mayotto I.	12 47	45 30
* Mohilla I	12 30	43 55
* Johanna I.	12 15	44 35
* Comoro	11 32	43 30
Portugueſe ſhoals	12 33	46 55
John Martin's I.	10 9	43 15
Aldabra Iſlands	9 40	46 45
Aſſumption I.	9 40	47 37
Coſmoledo I.	9 46	48 38
S. Peter's I.	9 34	50 47
Natal I.	8 30	47 15
Sandy I.	9 16	48 12
Zanzibar I.	6 10	40 45
Amirante I N.W.P	5 10	53 45
S.E.P.	6 30	55 0
Mahe I. N.W.P.	3 50 N.	54 5
S.E.P.	5 20 S.	56 30
* Iſle Bourbon	20 52	55 36
* Mauritius	20 10	57 35
* Diego Rais, or Rodrigue	19 40	63 10
* St. Brandon	16 34	62 50
Nazareth Bank, S. W. Point	16 45	60 0
N. E. Point	13 35	61 44
Sandy Iſland	15 10	55 5
* South Requepiz	10 30	64 32
John de Nova	10 15	53 30
Providence I.	9 15	53 32
St. Francis Iſles	7 10	56 30
Peros Banhos	5 30	72 20
* Diego Garcia	7 30	72 35
Candu Iſles	6 0 N.	76 35
Adu Iſles	5 30	76 20
Maldive Iſles, S. E. P.	0 40 S.	74 55
N.W.P.	7 15 N	73 40
Malique Iſlands	8 15	73 29
Laccadive Iſles, S.E.P.	10 0 S.	72 45
N.W.P.	12 36 N.	72 25

Iſles Eaſt of Cape Comorin.

	Lat. D. M.	Long. D. M.
* Ceylon, S. Point	5 47 N.	81 2 E
* N. Point	9 57	80 39
* Trincomaley in ditto	8 35	81 27
Bale of Cotton Rock	5 28	86 15
Preparis I.	14 50	93 35
Cocos I. North P.	14 21	93 10
* Great Andaman I. North P.	13 30	92 30
South P.	11 21	92 35
Little Andaman, S. P.	10 15	92 45
Nicobar Iſles, N. P.	9 25	93 7
South P	6 51	94 17
Seyers I.	7 35	95 30
Hog I.	2 30	95 45
Pulo Nyas	0 57	97 2
Po Mintaon	0 25 S.	97 45
Good Fortune I. S. P.	1 57	99 49
Engona	5 20	101 54
Poggy or Naſſau, S. P.	3 15	100 25
Trompeuſe	5 33	102 30
* Prince's I. Straits of Sunda	6 24	104 48
Bearings of a Rock on which the Indoſtan ſtruck in the Straits of Sunda.		
Zeeclip Weſt 5° North		
Pk. on Crocatoe S. 15° W.		
Peak on Tamarind I. N 6° W.		
Captain M'Intoſh rowed round the Rock in a Circle of ten Fathoms, and the Boat was never in leſs than ten Fathom Water.		
* Chriſtmas I.	10 30	104 27
Coco Iſland	21 45	98 30
* Java Head, or W. P.	6 45	104 55
* Eaſt P.	8 37	104 37
North Iſland	5 41	105 50
Peak on Crocatoa I.	6 8	105 14
Peak on Tamarin I.	6 54	105 38
Zeeclip	6 5	105 12
* Batavia in ditto	6 10	106 59
* Bally Straits, South Entrance	8 45	114 42
* Bally I. South Point	8 56	115 23
Lombock Straits	9 10	115 37
Straits of Maſs	9 0	116 56
Straits of Saby	8 30	119 34
Sandal Wood I.	9 45	120 6
Rotto I.	11 15	123 7
Timor I. Weſt Point	10 15	123 43
* Pulo Runda	5 50	95 39
* Pulo Way	5 [illegible]	95 33
* Pulo Braſſe	5 [illegible]	95 21
* Pumatra, Weſt Point	5 [illegible]	95 34
* Achen, in ditto	5 [illegible]	95 40
* Bencooien, in ditto	3 49 S.	102 [illegible]
* Eaſt Point	3 53	104 [illegible]

Islands in the China Seas to the Eastward of Java.

	Lat. D. M.	Long. D. M.
* Banca, North P.	1 33S.	116 0E.
South P.	3 4	106 17
* Lucepara, S. Entrance to the Straits of Banca	3 12	106 10
Monopin Hill	2 0	105 8
Billiton, S. E. Point	3 6	108 15
Bintang, E. Entrance to the Straits of Sincapore	0 18	105 15
Spirit Island	0 7N.	106 30
St. Julian's Island	0 45	106 38
Timelan Island	1 0	107 15
Victory Island	1 28	105 55
Wood I.	1 34	105 47
Saddle Island	2 17	105 44
Anambas Island	2 47	106 15
Natunas I.	4 5	108 10
* Pulo Tinoy I.	2 30	105 52
* Pulo Aroe I.	2 30	104 42
* Pulo Timon I. S. P.	2 49	104 24
* Pulo Brata	4 45	103 30
Pulo Lazen	7 17	102 30
Kidang I.	6 20	102 37
* Pulo Uby	8 30	103 45
* Pulo Way	10 0	102 34
Two Brothers	8 32	105 37
* Pulo Condor	8 41	106 10
* Pulo Sapata	10 4	108 42
Elephant	11 0	113 10
Pitt's I.	10 55	114 35
South Sea Castle I.	11 30	112 17
Paracels I. North P.	16 30	110 0
South P.	11 37	109 30
Macclesfield Bank, N. Point	16 6	114 10
South Point	15 15	114 20
Scarborough Rocks	15 0	117 12
Hainan North Point	20 2	110 15
South Point	18 12	109 20
* Formosa, South P.	27 47	120 52
Pratas Rocks	20 30	116 15
Triangles Rocks, N. P.	17 0	111 0
S. P.	16 0	111 32
* Borneo, S. W. Point	2 45S.	109 28
* S. E. Point	4 15	114 25
* W. Point	0 0	108 45
* E. Point	5 15N.	118 50
* N. Point	7 0	116 45
* Balambangan, Entrance to the Sooloo Sea	7 30	117 2
Banguey	7 17	117 30
Palawan, S. Point	8 28	117 30
N. Point	11 20	119 46
* Sooloo I. E. Point	5 57	121 21
Celebes, S. Point	5 42S.	120 6
N. Point	2 0N.	124 0
Luconia, N. Point	18 45	120 45
* Manilla in Luconia	14 36	120 59
* Karkalang I. S. P.	3 52	126 14
N. E. P.	4 29	126 26
* Moratay I.	2 28	127 30
* Gilolo I. N. Point	2 17N	127 20E.
* W. Point	1 8	127 1
* Heri I.	0 59	126 54
* Tirnate I.	0 57	126 53
* Mariene I.	0 21S.	126 40
* Sutta Manpal I.	1 48	126 17
* Burro I. West P.	3 3	125 43
* Sutta Bassie I.	2 36	125 41
* N. End of a dangerous Shoal off Bouton I.	5 25	122 8
* Bouton I. S. P.	5 42	121 11
* Toncca Bassie I.	5 35	123 15
* Balataya I.	5 55	122 37
* Cambona I.	5 29	121 26
* Salayer Straits	5 44	120 6
* Celebes I. S. P.	5 42	120 6
N. P.		
N. W. P.		
Tonyn I.	5 27	118 2
Lucifiva I.		
Paternosters in the Straits of Macassar		
Pulo Laut, S. P.		
* Great Solombo	5 28	113 8
* Lubeck I.	5 47	112 12
* Carimon Java I.	5 48	110 10
Pulo Rachel I.	5 53	108 3

NOTE. In these Seas there are many thousand Islands, so that it would be of no Use to lay them down here. Recourse must be had to the best Chart.

New Holland.

S. W. Cape	43 42S.	146 5E
S. E. Cape	43 46	147 5
* St. Maria's Isles	43 20	148 10
* St. Patrick's Head	41 44	148 20
* Cape Howe	37 24	149 54
* Cape Dromedary	36 21	150 4
* Botany Bay	34 0	151 20
* Port Jackson	33 47	151 21
* Cape Hawke	32 13	152 28
* Smoaky Cape	30 49	153 7
* Cape Danger	28 7	152 28
* Cape Morton	26 57	153 22
* Sandy Cape	24 45	153 2
* Keppel Bay	23 30	150 40
* Cumberland I.	20 30	148 45
* Cape Cleveland	19 10	148 5
* Cape Flattery	14 52	245 10
* Cape Conway	20 44	148 30
* Cape York	10 44	141 37
Van Diemen's Bay	10 30	130 15

New Guinea.

* Cape False	8 40S.	136 30
East Point	6 20	148 0
* Louisiade Isles, E. P.	10 35	154 0
West Point	1 30	148 30
* New Britain, East P.	4 53	153 9
West Point	6 0	149 20
* New Ireland, East P.	5 0	152 30
West Point	2 20	148 20

Rocks and Shoals lying West of New Holland.

	Lat. D. M.	Long. D. M.
A Rock above Water	28 17S.	98 30E.
Cloats Islands	21 45	93 27
Tryal Rocks	20 40	104 30
Rosemary I.	20 30	110 45
Abrolhos Shoals	28 30	111 45
Kerguellen's Land	28 41	96 4

Islands in the Pacific Ocean, lying between New Holland and Cape Horn.

Formosa, South P.	22 5N	120 50E.
North P.	25 15	122 13
* Tayoan in Formosa	22 40	120 20
Great Liqueo, S. P.	25 15	128 30
North P.	28 0	128 30
Xuno I. South P.	31 30	131 50
North P.	34 45	131 30
Niphon, South P.	33 30	135 0
North P.	41 0	142 0
Matoosmaee	42 30	140 30
* Kamtscatka on the Main, South P.	51 0	156 30
Beering's I. South P.	54 0	161 30
Ladrone Isles, Northernmost	21 0	114 6
Southernmost	8 0	114 6
* Pescadore Isles	10 30	164 0
Huahine I.	16 44S.	151 0W
St. Bartholemi	14 20N.	156 30
I. St. Pierre	11 0	178 45
Sandwich Isles	17 41S.	168 39E.
Northernmost	22 0	159 30W
* Owhyhee, South P.	20 0	155 30
* Queen Charlotte I.	19 18	138 4
* New Hebrides,		
Quiros C.	14 56	167 26E.
Northernmost	14 30	166 45
Southernmost	20 30	169 30
* Ballabea I.	20 7	164 48
* New Caledonia Pudgona	20 18	164 47
* C. Colenet	20 30	165 2
* Charlotte's Foreland	22 15	167 29
North P.	20 0	158 30
* C. Coronation	22 5	167 14
* Friendly Isles, Northernmost	19 30	174 15W
Southernmost	21 30	175 10
* Society Isles, N. W. end	17 30	152 0
* Otaheite, Oaitipeha B.	17 46	149 8
* Hood's I.	9 26	138 46
New Zealand.		
* Dusky Bay	45 47	166 24 E
* Pallifer's C.	41 38	175 24
* C. Farewell	40 37	172 47
* Turnagain C.	40 26	178 3
* North C.	34 10	167 10
* South C.	37 20	167 30

	Lat. D. M.	Long. D. M.
* Sandwich Land, N. P.	57 30S.	27 30W
* South ditto	60 0	27 27
South Georgia.		
C. Butler	53 58	37 40
C. Charlotte	54 32	36 11
C. Disappointment	54 58	36 15
C. George	54 17	36 32
C. North	54 4	38 15
Sandwich Bay	54 42	36 12
Saunders Island	54 6	36 58
Wallis's Isles	54 0	38 29

The Coast of Iceland.

Reikness C.	63 55N.	22 40W
Westman's I.	63 2	21 4
Palrixfiord	65 36	24 4
* Straumness	65 40	24 26
North Cape	66 34	23 5
Grims I.	67 0	21 41
* Rikesiord	67 0	17 30
Long Nose	66 45	12 14
Balaness	66 2	12 16
Enchuison I.	65 0	10 0
Engelhoast	64 32	12 14
Wreeland I.	64 5	13 14
C. Hekla	63 22	16 49

The Coast of Greenland.

* John or Manen's I.	71 10N.	9 44W
Gael Hamkes Bay	75 0	6 45
Bontekoe I.	73 27	9 30
Charn P.	70 5	22 17
Dangey I.	67 23	27 19
Herjons Ness	65 3	30 19
Whales I.	62 30	39 [illegible]
C. Discord	60 50	39 55
C. Prince Christian	59 55	41 30
* C. Farewell	59 38	42 38
C. Desolation	62 0	46 [illegible]

Davis's Straits.

C. Resolution	62 40N.	46 [illegible]
C. Comfort	62 45	47 [illegible]
Hope Harbour	63 55	47 [illegible]
Gilbert's Sound	64 15	47 53
Cooken Sound	64 50	47 58
K. Christian's River	66 7	47 8
Musketto Cove	64 55	52 51
Romel Port	67 22	45 53
Disco I. S. W. Point	69 6	44 38
Waygate I.	70 40	44 8
James's I. C. Pedford	68 30	50 8
Cumberland I. S. P.	66 0	60 30
Bay of Good Fortune	64 20	61 20
C. Elizabeth	62 5	64 30
Resolution I. C. Warwick	61 4	64 10

Hudson's Bay.

Button's Isles	60 47N.	65 16W
Lowe's Savage I.	61 48	66 20
Terra Nieva	62 4	[illegible]

	Lat. D. M.	Long. D. M.
Saddle Back I.	62 10N.	68 10W
Great Bear I.	54 4	79 56
Ice Cove	62 0	69 0
Baker's Dozen	57 0	
Great Savage I.	62 25	70 0
North Bluff	62 26	71 10
God's Mercies	62 28	70 48
Salisbury I.	63 30	76 50
Nottingham, E. End	63 35	76 45
C. Charles, East End	62 50	74 15
West End	62 40	76 0
Burgeo Isles	47 36	57 36
C. Walsingham	62 40	78 0
C. Diggs	62 45	78 48
Mansfield, North End	62 40	78 0
South End	61 35	81 30
Sleepers I.	60 10	81 30
Great ditto	58 35	81 30
C. Pembroke	62 57	82 10
Large Swan's Nest	62 20	83 30
C. Southampton	62 10	86 10
Churchill River	58 47	94 7
Charlton I.	52 3	79 5
Nelson's Shoals	57 35	92 30
Bay River	57 10	93 0

From Hudson's Bay to Quebec.

Button's Islands	60 47N.	65 16W
Black Head	59 50	63 32
Little Black Head	59 20	69 14
Cardinals I.	58 50	62 55
Steyles	58 7	61 45
Isle I.	57 45	61 15
Seal Islands	57 13	60 45
Sherred Cape	56 40	60 50
St. Peter's Harbour	56 28	60 45
St. Hardison	54 54	56 45
Great Bay of Elkimaux	54 20	57 30
C. Charles	52 13	55 25
Yell Point	51 57	55 52
Bay Bay	51 44	61 25
Bay	61 40	56 42
Cliffs	51 33	56 45
Bay	51 30	56 55
Point	51 24	57 12
Bonaventure Bay	51 28	57 45
Bay	50 52	59 2
Great Mecatina P.	50 42	59 8
Little Mecatina Islands	50 28	59 27
Mount Joli	50 5	61 30
Esquimaux Islands	50 12	63 0
Mingan I.	50 16	63 15
Grand Bay, St. John's	50 22	64 0
The Seven Island Bay	50 7	65 45
Trinity Bay	49 37	66 27
St. Nicholas's Bay	49 28	67 0
Laval Bay	48 55	68 0
Bay of Rocks	48 5	68 38
St. Paul's Bay	47 30	69 10
Quebec	46 55	69 46

Newfoundland.

	Lat. D. M.	Long. D. M.
Belle Isle, Var, 20° 30′ West	51 55N.	55 25W
Quirpon Harbour	51 40	55 34
St. Anthony's Cape	51 17	55 39
Hare Bay	51 15	55 56
Groais I.	50 55	55 40
Green I.	50 47	55 30
Hooping Harbour	50 46	56 13
White Bay	50 15	56 20
Horse Islands	56 21	56 46
C. St. *John*	56 10	55 33
Bay of Notre Dame	50 0	55 30
Twillingate *Islands*	50 3	54 35
Fogo I	50 0	53 49
Gander Bay	49 40	54 10
Wadham Islands	49 54	53 25
C. Freels	49 34	52 55
Funck I.	50 1	52 12
Barrow Harbour	48 50	53 0
C. *Bonavista*	48 52	52 35
Trinity Bay	48 30	53 0
P. of Grates	48 22	52 30
C. St. Francis	47 54	52 25
* St. John's Harbour	47 32	52 20
Great Burgeo I.	47 36	57 30
C. Spear	47 30	52 15
Bay of Bulls	47 21	52 24
C. Broyle	47 3	52 30
C. Ballard	46 49	52 37
C. Race	46 30	52 44
Virgin-Rocks	46 30	50 18
C. Pine	46 40	53 15
St. Mary's Bay	46 50	53 30
C. St. Mary's	46 52	54 2
Bay of Placentia	47 0	54 30
Chapcan Rouge	46 52	55 17
St. Peter's I.	46 36	56 6
Langley I.	46 42	56 15
Great Miquelon	46 55	56 16
Burnet	47 15	55 56
Fortune Bay	47 16	55 30
Penguin's Islands	47 24	57 0
Rumney I.	47 32	57 25
Great Barrisway	47 37	57 40
* *Burges I.*	47 32	57 37
C. Ray, Var 20° West	47 37	59 10
Cod Roy I.	47 52	59 18
C. St. George, Var. 19° W.	48 30	59 8
South Head	49 7	58 21
C. St. Gregory, Var. 22° 40′ West	49 22	58 12
Bay St. Paul	49 50	57 50
Ingornachoix Bay	50 38	57 22
St. John's I.	50 50	57 18
Point Ferolle	57 3	57 6
Bay St. Barbe	51 15	56 48
C. Norman	51 40	55 57
Limits of the Great Bank of Newfoundland, North P.	50 15	59 45
South P.	41 0	52 0
Outer Bank	47 0	45 0

The Gulf of St. Lawrence.

	Lat. D. M.	Long. D. M.
St. Paul's I.	47 11N.	59 55W
Bird Islands	47 55	60 36
Brion I.	47 52	60 55
Magdalen I. N. E. P.	47 41	60 55
S. W. ditto	47 12	61 36
Entry I.	47 15	61 15
Deadman's I.	47 15	61 48
I. of Anticosta, E. P.	49 8	61 34
S. W. ditto	49 22	63 18
West ditto	49 48	64 18
North ditto	49 53	63 58
I. de Bik, in the R. St. Lawrence ...	48 52	67 50
Mount Camille ...	48 37	67 15
C. St. Ann ...	49 3	66 0
Magdalen R. ...	49 13	65 18
C. Rozier ...	48 47	63 56
C. Gaspe and Bay ..	48 42	63 53
Flat P.	45 34	63 53
I. Bonaventure ..	48 28	63 53
C. Despair ...	48 24	64 1
Miscou I. Entrance of Chaleur Bay ...	48 0	64 16
P. Escuminac ...	47 1	64 39
St. John's I. N. Cape	47 2	63 49
West Point	46 34	64 11
East ditto	46 27	61 48
Bear Cape .	46 0	62 13
Hillsborough Bay	46 6	62 55
C. St. George, or St. Lewis ...	45 51	61 44
Gut of Canso, North Entrance, ..	45 42	61 22
Justan Corp I. ...	45 56	61 22
Port Hood ...	45 57	61 20
C. North, I. off Cape Breton ...	47 1	60 10
Port Dauphin, ditto .	46 23	60 13
Spanish Bay, ditto	46 18	59 57
Flint I. ...	46 11	59 33
Scatari I. ...	46 2	59 27
C. Breton ..	45 57	59 39
Louisburg ...	45 54	59 49
C. Hinchinbroke ..	45 34	60 24
I. Madam ...	45 29	60 44
Gut of Canso, South Entrance ...	46 28	60 46
Chedabucto Bay ..	46 23	60 46

From Cape Canso in Nova-Scotia to Cape Florida.

	Lat. D. M.	Long. D. M.
Sable I. East Point	44 8N.	59 55W
West ditto	44 4	60 30
C. Canso, Var. 15° W.	45 16	60 50
Port Howe ..	45 13	61 0
Torbay ..	45 12	61 11
Sandwich Bay ..	45 8	61 31
Port Stephens ..	45 0	61 53
Halifax Harbour .	44 36	63 23
C. Sambro Light-House	44 30	63 27
Charlotte Bay, Var. 14° West ...	44 34N.	63 50W
Port Jackson ..	44 13	64 22
Isle of Hope ..	43 53	64 39
Port Roseway .	43 40	65 12
C. Sable, Var. 11° 15′ West ...	43 27	65 30
Seal Isles ...	43 27	65 55
C. Forchu ...	43 52	66 4
St. Mary's Cape, Var. 11° 45′ West ...	44 10	66 7
Breyer's I. Var. 11° 15′ West ...	44 19	66 20
Anapolis Royal ..	44 47	65 43
Hauto I. ...	45 19	64 47
C. Chignecto, Entrance Bason of Mines	45 44	65 44
C. Spencer ..	45 17	65 50
Mocgone's I. Entrance of St. John's River	45 18	65 59
Wolf I. . .	45 3	66 40
Grand Manan I. South Point . .	64 43	[illegible] 50
Western Seal Islands	44 37	66 47
Machois Bay ...	44 44	67 15
Gouldsborough Harbour	44 34	67 56
Mount Desert Rock	44 3	67 30
C. Ann Light-House	42 51	70 4
Boston Harbour ...	42 25	70 31
C. Cod .	42 5	69 41
Cashes Ledge, North P.	43 23	69 0
South P.	42 58	[illegible]
St. George's Bank, N. W. Part ...	41 42	68 5
Nantucket I. ...	41 1	69 30
Ditto Shoals, S.W.P	40 42	69 20
Martha's Vineyard I.	41 18	70 20
Noman's Land I.	41 14	[illegible]
Rhode I. Harbour	41 [illegible]	[illegible] 6
Block I. Middle	41 [illegible]	[illegible]
Montuck Point, Long I.	41 [illegible]	[illegible]
* Sandy Hook ...	40 25	74 [illegible]
* New York Harbour	40 43	74 [illegible]
* C. May ...	38 55	74 [illegible]
* C. Henlopen, Var. 6° West ..	38 46	75 [illegible]
Philadelphia ...	39 57	75 [illegible]
False Cape ...	38 30	75 6
C. Charles ...	37 12	75 9
C. Henry ..	36 57	76 4
C. Hatteras ...	35 16	75 [illegible]
Ditto Shoals, S.W.P.	34 [illegible]	[illegible]
C. Lookout ...	34 22	[illegible]
Shoals off ditto, S. Poin	34 14	[illegible]
C. Fear ...	33 51	78 [illegible]
Frying-pan Shoals, off ditto, S. E. Part	33 36	78 17
George Town ...	33 27	79 24
Shoals off ditto .	33 5	79 13
C. Roman ...	33 4	79 30
Charles-Town Light-House .	32 42	79 10
Savannah . .	32 3	81 34
Tybee Light	32 0	81 40

	Lat. D.M.	Long. D.M.
Port Royal	32 12N.	80 54W
River St. John, Entrance	30 18	81 30
Augustine Bay	29 47	81 21
C. Caneveral	28 20	80 45
Shoals off ditto	28 20	80 40
C. Florida	25 44	80 44
I. of Bermudas, Saint George's Town	32 45	63 30
N.W. Point	32 25	60 25
S.W. Point	32 11	63 40

NOTE. This Island is surrounded with dangerous Rocks at six or seven miles distance, especially on the North side.

From Cape Florida to Cape Horn.

* C. Florida	25 44N	80 44W
* Dry Tortugas Shoals, S.W. Point	24 32	83 40
C. Sable	24 57	81 52
C. Roma[illegible]	25 42	82 36
* Charlotte Harbour	26 43	82 24
* *Spiritu Santo Bay*	27 36	82 54
Bay of Apalache	29 40	85 0
C. St. Blaze	29 35	85 44
Pensacola Bar	30 15	87 34
Mobile Point	30 11	88 35
* New Orleans	29 58	89 53
Mouth of R. Mississippi	29 13	89 27
Mouth of Rio Brava	26 7	90 49
New St. Anton	23 46	90 27
C. Roxo	21 57	99 42
* Vera Cruz	19 12	97 24
Campeche	19 41	92 54
Pocales Shoals, N.P.	23 50	88 54
* C. Catoche	21 38	87 26
* Logerhead Key	21 38	87 14
False C.	21 28	87 14
Cozumel I. S. Point	20 3	87 34
North Triangles, S. P.	18 25	87 26
N. Point	19 5	87 17
Key Bokel	16 27	88 14
Glover's Reef, N. Part	16 52	87 47
S. ditto	16 33	88 17
Utila, E. Point	16 11	87 27
Ratan I. E. Point	16 25	86 30
Bonacca I. N.E. Point	16 29	85 55
C. Honduras	16 1	86 9
C. *Cameron*	16 0	85 9
Black River	15 56	85 4
C. Dias Gracias	15 1	82 50
Triangles, S. Part	16 30	79 55
N. ditto	17 0	80 53
Sand Key, N. Part	16 30	78 20
St. Andrew's I.	12 32	80 50
Corn Islands, N. Part	12 10	82 2
* St. John's Point	10 33	82 50
* Porto Bello	9 33	79 44
Gulf of Darien	8 40	76 40
* Carthagena	10 27	75 21
* St. Martha	11 27	73 59
C. de la Vela	11 10	71 53
Monjes Islands	12 23N.	71 21W
C. Coquibacao	12 5	71 21
Aruba I. E. Point	12 9	69 25
Curaco I. N. Point	12 25	69 7
C. St. Roman	11 30	69 30
* Point Cabello	10 31	67 26
* Aves I. S. Part	11 54	67 13
Roca I.	11 45	66 17
Orchilla I. S. Part	11 44	66 3
Salt Tortuga, E. ditto	11 0	64 44
Blanca I. N. ditto	11 40	63 56
Margarita I. N.E. P.	11 10	63 13
N.W. ditto	11 3	63 46
C. Three Points	10 19	62 25
Orononoco River	8 25	59 26
Essequebo River	6 30	58 30
Surinam River	5 52	55 2
* Cayenne	4 56	52 10
C. North	1 48	49 57
Mouth of R. Amazon	0 18	51 30
St. Louis de Maranham	2 15S.	46 34
C. Baras	3 0	42 26
C. St. Roque	5 1	36 17
Pernambuca or Plende	8 0	35 0
C. St. Augustine	8 32	35 0
St. Francisco River	11 0	36 15
St. Salvadore	12 46	38 38
Porto Seguro	16 36	39 30
Abrolhos Banks	18 0	38 30
Espirituo Santo	20 0	39 45
C. St. Thome	21 51	40 20
C. Frio	22 35	41 15
* Rio Janeiro	22 54	42 38
Grande I.	23 15	43 30
Santos	24 4	45 30
St. Catherine's I.	27 15	49 0
Porto St. Pedro	31 44	55 17
* C. St. Mary, North Entrance to R. Plate	34 35	54 42
* C. St. Anthony, S. Entrance to ditto	36 25	56 27
* Buenos Ayres in ditto River, 14° Var. E.	34 35	58 25
C. La Matas	45 0	65 45
* C. Blanco	47 20	64 36
Bay St. Julian	49 10	68 38
Straits of Magellan	52 35	67 45
* C. Success	55 1	65 21
C. St Diego	54 34	65 15
C. St. Anthony	54 47	64 53
C. St. Bartholomew	54 58	64 51
C. St. John	54 7	63 51
* C. Horn	55 8	67 20

The West Coast of America from Cape Horn to Behring's Straits.

* Cape Horn	55 58S.	67 20W
* Barnwell's I.	55 49	66 52
* C. Diego	54 33	64 6
* Juan Fernandez I.	33 30	71 22
* Arica	18 29	77 5
* Conception Bay	36 43	72 34

	Lat. D. M.	Long. D. M.
* Lima	12 1S.	76 43W
Gallapagos Isles, Mid. Lat.	0 00	85 0
* Panama	8 48N.	80 15
Aquapulco	17 10	101 40
C. Corientes	22 20	107 0
California, South Point	23 30	109 30
C. de Touche	45 24	125 5
C. Fitzhugh	51 0	128 57
C. St. James ...	52 0	131 34
C. Caldwell	54 18	133 31
C. Edgecumbe	57 3	135 47
* Nootka, or Saint George's Sound	49 36	126 42
* Pr. William's Sound	61 5	147 15
* Cook's River ...	59 0	152 0
C. Grevill	57 30	153 0
Alaska, S. Point ...	54 45	163 11
* Shallow-Water P.	63 0	162 45
C. Stephens	64 21	162 15
* Norton Sound ...	64 15	162 0
* C. Rodney	64 35	164 24
* C. Prince of Wales	65 45	168 13

Islands in the West Indies.

Trinidada, N. E. P ...	10 45N.	60 36W
Tobago, N. E. ditto ..	11 29	59 57
S. W. ditto	11 5	60 49
Grenada, N. E. P. ...	12 14	61 49
S. W. ditto	11 57	62 19
Grenada Bank, Middle	11 55	62 45
Barbadoes, S. Point	13 7	59 45
E. ditto	13 12	59 37
Bridge Town ...	13 9	59 51
N. W. Point	13 22	59 52
St. Vincent, N. Point	13 12	61 16
S. ditto	13 4	61 15
St. Lucia, S. Point ...	13 30	61 0
N. ditto	13 56	60 46
Martinico, S. E. Point	14 24	60 57
Dimond ditto ...	14 24	61 1
Port Royal	14 36	61 4
W. Point	14 25	61 14
N. E. ditto	14 58	61 0
Dominica, S. Point ..	15 15	61 20
N. ditto	15 29	61 25
Marigalante, N. E. P.	16 4	61 0
S. E. ditto ...	15 53	60 59
Guadaloupe, S. Point	15 54	61 43
N. ditto	16 30	61 42
Grandeterre, S. E. P.	16 15	61 4
N. ditto ...	16 41	61 25
Deserada, N. E. Point	16 24	60 56
S. W. ditto	16 18	61 3
Antigua, E. Point	17 3	61 45
Montserrat, N. E. P.	16 47	62 12
S. W. ditto	16 40	62 15
Redondo I.	17 3	62 20
Nevis	17 17	62 28
St. Christopher's, S. E. Point	17 16	62 31
N. W. ditto ..	17 26	62 42

	Lat. D. M.	Long. D. M.
St. Eustatia, the Town	17 29N.	63 4W
Saba	17 39	63 8
Aves I.	15 33	63 35
Berbuda, S. E. Point	17 50	61 45
St. Bartholomew, E. P.	17 56	62 34
W. ditto	17 54	62 51
St. Martin's, E. Point	18 3	62 50
W. ditto ..	18 40	63 7
Anguilla, N. E. Point	18 22	62 46
S. W. ditto ...	18 9	63 5
Prickley Pear	18 20	63 10
Sambero	18 26	63 21
Anegado, E. Point ...	18 36	63 50
W. ditto ...	18 41	64 1
St. Croix, E. Point	17 36	63 40
W. ditto ...	17 44	64 25
Virgin Gorda, E. Point	18 18	63 40
The Fort ...	18 18	63 54
Tortola, E. Point	18 21	64 27
W. ditto	18 18	64 39
St. John's, S. Point	18 5	64 40
St. Thomas, S. ditto	18 25	64 41
The Town	18 22	64 46
Porto Rico, N. E. Point	18 39	65 39
S. E. ditto ...	18 10	65 38
N. W. ditto ...	18 41	67 46
S. W. ditto ...	18 11	67 45
La Mona I.	18 10	68 24

Hispaniola, or St. Domingo.

Cape Enganno	18 27	68 35
Soona I. E. Point	17 55	68 48
* Altavila Rock, off ditto	17 28	71 35
Abacou Point ...	18 2	73 48
* Port au Prince	18 40	72 10
C. Tiberon ...	18 20	74 31
* Fort St. Louis	18 19	73 15
Navaza I.	18 24	74 59
C. Dona Maria	18 38	74 22
* Petit Grove	18 27	72 49
C. Nicholas	19 50	73 25
* The Mole	19 49	73 25
Tortudos, E. Point	20 2	73 32
W ditto ...	20 5	72 56
Monte Christo	19 56	71 39
* Old C. Francois	19 40	69 57
* C. Pamana ...	19 15	69 10
C. Raphael	18 56	69 0

Island of Jamaica.

Morant, S. E. End	17 58	76 10
* Port Royal	18 0	76 48
Portland Point	17 42	77 2
Carlisle Bay ...	17 50	77 15
Pedro Bluffs ...	17 52	77 35
Black River	18 5	77 40
Savannah la Mer	18 15	78 6
Negril Point ..	18 27	78 32
Montego Bay	18 33	77 52
St. Ann's Harbour	18 39	76 56
Porta Maria	18 32	76 35
Port Anthony ...	18 25	76 5

Islands and Shoals lying off Jamaica	Lat. D.	Lat. M.	Long. D.	Long. M.
Morant Keys N.E.P.	17	26N.	75	55W
S. W. ditto	17	24	75	48
Formogas	18	31	75	39
Pedro Shoals, E. P.	17	20	77	1
Little Cayman, S. W. ditto	19	32	80	10
Great Cayman, S. W. ditto	19	11	81	8
N. ditto	19	18		
Swan I. S.W. ditto	17	12	83	30
Mesteriosa Shoal	18	0	83	50
A dry Bank ...	18	36	73	15
Pracel Shoal ...	18	50	84	20
Island of Cuba.				
C. Mayze	20	16	74	4
St. Jago	20	12	75	35
Cumberland Harbour	19	53	75	13
Cabo de Cruz ...	19	42	77	52
I. of Pines, S. W. Point	21	20	83	12
C. Corientes	21	46	84	57
Middle Cape ..	21	44	84	34
Cape Antonio ...	21	49	85	15
Colorados Rocks N.W.P.	22	30	85	14
Havannah	23	12	82	12
Matanzas	23	12	81	15
Islands and Shoals North of Cuba and Jamaica				
Last Reef	20	12	68	43
North Reef S.E. Point	20	15	69	29
W. ditto ...	20	51	70	1
The Triangle ...	20	40	69	48
Square Handkerchief, N. E. Point	21	17	70	20
S.W. ditto ...	20	53	70	57
Grand Turk's I. N.E. ditto	21	32	71	5
Sand Key	21	11	71	19
The Great Cayos, S.P.	21	8	71	45
E. ditto ...	21	43	71	26
N.W. ditto ...	21	57	72	6
Heneaga, N.E. Point	21	20N.	72	59W
W. ditto ...	21	0	73	40
Little Heneaga, W. P.	21	30	73	8
N. ditto	21	34	74	0
Hogstye's, the Middle ..	21	41	73	50
Mayaguana, S. Point ...	22	20	72	33
N. ditto	22	29	72	53
S. W. ditto ...	22	22	72	55
French Keys	22	42	73	27
Miraperoos Keys, S. P.	22	7	74	18
Cattle I. or South Key	22	8	74	0
North Key, Crooked I.	22	49	74	2
Atwood's Key, N.E. P.	23	13	73	25
Key Verde, S.W. ditto	22	12	75	10
The Brothers	22	38	75	0
Long I. S.E. Point ..	22	50	74	45
N. ditto	23	30	75	28
Rum Key	23	33	74	57
Watland's I. S. Part ..	23	57	74	35
Little I. its Centre ...	24	4	74	30
Cat I. S. Part	24	4	74	44
N. ditto	24	39	75	12
Exuma, E. ditto	23	34	75	10
Eleuthera, Powel's Pt. or S. Part	24	45	76	10
Egg I. or W. Part	25	35	77	10
New Providence, W. P.	21	56	78	5
* Nassau Town in ditto	25	4	77	45
W. P. of ditto	24	57	78	3
Andros I. S. Point ...	24	5	78	0
N. Point	25	15	78	30
Frozen Key	25	22	78	0
The Hole in the Wall	26	10	77	40
Little Bank of Bahama N. W. Point	27	45	79	44
Sandy Key	26	33	79	34
Great Isaac	26	0	79	47
Little ditto	26	5	79	11
Cat Keys Harbour	25	10	79	36
Orange Key	24	43	79	36
Double-headed Shot Keys, W. Point	24	0	80	10
Key Sal	23	31	80	3
Anguilla, E. Part ...	23	22	78	43

Though this Table is more extensive, and nearer the Truth than any published, it being deduced from many Thousand Observations, and these compared with the best Sea Charts extant, yet in the Nature of Things it neither now is, nor ever can be absolutely correct. For, let two Observers be on board the same Ship with different Instruments, they will frequently not agree in their Observations; add to this, that many Observers make no Allowance for the Dip, Refraction, and Difference of the Meridians, respecting the Sun's Declination.

Mr. Dalrymple observed to me, that although he had the inspecting of the Journals of the Officers in the East India Company's Service, yet there were but few Places whose Longitude he could determine with any degree of Precision.

FINIS.

EXTRACTS from a Letter written to JAMES BOGLE FRENCH, *Esq. Foreman of the Special Jury who tried the Cause in the* King's Bench, *at* Guildhall, *between Messrs.* SAYER *and* BENNET, *Plaintiffs, and Mr.* JOHN HAMILTON MOORE, *Defendant, by Mr.* JOHN STEVENSON, *one of Mr.* MOORE'S *Witnesses.*

THE Action was brought for copying of certain Charts, the property of the Plaintiffs, and the damages were laid at Ten Thousand Pounds: *Mr.* Stevenson's Letter was written in consequence of a paragraph in the Public Ledger of March 12, 1785, and a copy of it was published in that paper on the 28th of the same month.

"Upon my being asked by Counsellor Cooper whether I had seen Mr. Sayer's Charts, and those of Mr. Moore's, which were said to be copied from them? I answered in the affirmative, adding, that I had not only seen, but carefully examined them. Being then asked, whether I thought Mr. Moore's Charts were exact copies of Mr. Sayer's? I answered, 'No; I think they are essentially different:' Being desired to give the Court an account of that difference, I answered in substance as follows: That the Charts of Newfoundland, and the adjacent Coasts, four in number, (three particular and one general) were constructed upon very different principles: Mr. Moore's were constructed upon the true principles of Mercator's-sailing; but Mr. Sayer's were neither Plane nor Mercator's Charts: they were contrary to every received principle of geography and navigation, and consequently erroneous. That although the taking of the latitudes and longitudes of the principal places from the same authorities, had occasioned their positive situation to be nearly alike in both sets; yet Mr. Sayer's Charts, being constructed upon erroneous principles, the relative situation of places partook of that error, and consequently the course and distance from place to place, were erroneous.

"That the Charts of the Gulf of Florida and the West Indies, were on both sides on the Mercator's projection, but that Mr. Moore's differed materially from Mr. Sayer's in the situation of the principal places; that I found no less than twenty-four of those places to differ either from ten to eighteen miles in latitude, or from ten to thirty-three miles in longitude.

"Admiral Campbell, F. R. S. and the Governor of Newfoundland, declared to the Court, that Mr. Moore's Charts, so far from being considered in the light of exact copies, were really a very meritorious and happy improvement on Charts, (Mr. Sayer's) which he reprobated as erroneous and dangerous, to such a degree, that when he first examined them, on his station at Newfoundland, he was grieved for the honour of his country, that such a publication should originate in England, and often wished to have had the power of suppressing it entirely, by burning all the Charts, and destroying the plates.

Mr. Wales, F. R. S. and Mathematical Master of Christ's Hospital, (who circumnavigated as astronomer with Captain Cook) confirmed what had been said by Admiral Campbell, and Mr. Stevenson, concerning Mr. Sayer's Charts of Newfoundland and the adjacent coasts; namely, that they were neither upon the Plane, nor Mercator's projection, and, consequently, erroneous. With respect to the West Indies, he found that Mr. Moore's Charts differed materially from Mr. Sayer's in the latitudes and longitudes of some principal places.

"The late Lord Mansfield on summing up the evidence, observed, that the act of the 17th of his present Majesty was made to guard the property of ingenious men against copying, with only some colourable alterations; but never was intended to prevent the making of useful and important improvements. He stated what was said of the four Charts of Newfoundland, and the adjacent Coasts; and with respect to the West Indies, he related what had been said concerning the latitudes and longitudes of twenty-four of the principal places in that quarter. His Lordship also observed, that the situation of places was certainly an important object in the construction of Charts: and he enforced his observations by saying, that whether the Isle of Wight was exhibited in Charts where it really stands, or placed in the middle of the British Channel, was certainly a matter of great importance to every interested navigator.

The Jury gave a Verdict for Mr. MOORE.

Extract from the Sunday Gazette of the 8th of March, 1789.

"ON Wednesday last a cause was tried, before Lord Kenyon and a Special Jury of London Merchants, between *Mr. David Steele, Bookseller, Union-row, Tower-hill*, Plaintiff, and Mr. John Hamilton Moore, Teacher of Navigation, on Tower-hill, Defendant. The action was to recover 3000*l.* damages, *alledged by the Plaintiff to have been* sustained by him on account of the Defendant having published 'A Chart of the East Coast of England, including the Navigation from the South Foreland to Flamborough Head,' *from the* 'latest Observations and Surveys,' which Mr. Steele contended to have been pirated from two Charts of his, published by him in 1782, drawn by John Chandler; *when it appeared by the evidence of Mr. John Stevenson, and Mr. Porteus*, pilot to the squadron in the North Sea, during the last war, that there are a great many very material errors in Mr. Steele's Charts, which are corrected *in Mr. Moore's*. Mr. Stevenson *pointed* out one hundred and six places, in which Mr. Moore's differed materially from Mr. Steele's, besides many others of less note.——The Jury were prepared to give a *verdict in favour of Mr. Moore*, but were prevented by Mr. Steele's Counsel submitting to a nonsuit, which subjects Mr. Steele to pay Mr. Moore his costs of suit. Lord Kenyon declared he *heartily concurred with the Jury*, and expressed his indignation that such erroneous Charts as Mr. Steele's should be published. Mr. Moore was prepared, had it been necessary, with three other masters of the *Royal yachts, besides many experienced navigators, to prove* the correctness of his Chart, and the erroneousness of Mr. Steele's."

Mr. Stevenson observed, that the Isle of Grain in *Mr. Steele's Chart* was placed almost its whole breadth too far back from the entrance of the Thames; and that in his particular Draft of the Thames, which was on a larger scale, and therefore admitted of greater accuracy, there did not appear to be any Island at all. That the latter appeared to be an exact copy of Mr. Dixon's Draft of the Thames, excepting that the lower part of the river was *somewhat more lengthened*, which might have been owing to the stretching of the paper in tracing, from the upper part downwards.

When Mr. Stevenson was prevented *by the Plaintiff's Counsel from mentioning all the* 106 places in which Mr. Moore's Charts differed materially from Mr. Steele's, he proposed to enumerate 13 only, which differed either from 3 to $7\frac{1}{2}$ points *in bearing, or from* 4 to 9 miles in distance, but was again prevented; he then proposed to speak of one place only, but even in that he was also prevented! The place meant by Mr. Stevenson was the Mouse and West Barrow Sands, which were afterwards adverted to by Mr. Porteus. Mr. Chandler (who drew the Plaintiff's Charts) instead of making the Buoy on the Shivering-Sand, that *on the east end of the Ooze, and the Buoy of the west end of the Mouse*, lie nearly in a line with each other in his Chart, has placed the Mouse and the West Barrow Sands above 4 miles farther to the westward than they *ought to have been; he has also thought fit to* make the Shoe-Beacon follow the Mouse to the westward. The consequences are, instead of the buoy on the Mouse lying 2 miles N. N. W. from the east buoy of the *Ooze, he makes* it to bear W. $\frac{1}{2}$ N. distance 5 miles, and, instead of laying the Mouse buoy 7 miles E.N.E. from the West buoy of the Ooze, and 5 miles E. by S. $\frac{1}{2}$ S. from the Black Tail Beacon, *he makes it to lie* $2\frac{3}{4}$ *miles* N.E. $\frac{3}{4}$ E. from the former, and 2 miles E. by S. $\frac{3}{4}$ S. from the latter. Instead of the Shoe-Beacon bearing N. by E. from ships when in the Fairway, *between the Nob and the Ooze buoys, Mr. Chandler has placed the Beacon so far to the* westward, as to make it bear N. W. and instead of the buoy on the Mouse being seen from ships in the aforesaid situation, bearing N. W. by N. *Mr. Chandler*, by placing the west end of the West Barrow in that line of bearing, has directed them to look no less than $4\frac{1}{2}$ points more to the westward for the buoy, on the Mouse! Mr. Chandler dedicates his Chart, by permission, to the Elder Brethren of the Trinity House; but the mis-placing of the Ooze-sand is so glaring, that those Elder Brethren, who are so well acquainted with *the Nob Channel, must have discovered it* at first view; and, if they granted permission without examination, they may be deemed, if possible, more highly culpable. The most rational supposition is, that *Mr. Chandler has laboured under something, which, to say the least, appears very like a mistake!*

Mr. Stevenson desired Mr. Champion, one of the Jury, to compare the *northernmost part of* the Plaintiff's first Chart, with the southernmost part of his second Chart, and he would see a very considerable difference in the form and situation of those sands which are *exhibited in both: which difference*, Mr. Stevenson said, amounted to a clear proof, that both Charts had been copied, and copied from different authorities. In the small space which is *comprehended in both Charts, the relative position of no* less than 13 places in the second Chart differ from those of the same places in the first Chart, from $\frac{1}{2}$ to $4\frac{1}{2}$ points of the compass.

A Catalogue of New Charts, Pilots, and Sea Books, published by JOHN HAMILTON MOORE, *Hydrographer to His Royal Highness the Duke of Clarence, and Chart-seller to Her Serene Highness the Empress of Russia.*

	£.	s.	d.
PILOTS.			
THE Complete British Pilot, including the whole of the Navigation from London, round Great Britain, Ireland, the Shetland and Orkney Islands, on a large scale	2	12	6
The English Pilot, extending round England and Scotland, including the adjacent Islands, drawn from actual Surveys and Observations	2	2	0
The Irish Pilot, including the whole Coast of Ireland, with St. George's Channel, deduced from the most accurate Surveys	1	1	0
The American Pilot, including the Coast of America, from Cape Catouch to St. John's in the Bay of Funday	1	11	6
The West India Pilot, including the Bay of Honduras, &c. on a large scale	1	11	6
The Mediterranean Pilot, extending from London to Constantinople	1	11	6
The Baltic Pilot, extending from London to St. Petersburgh	1	1	0
The African Pilot, comprehending the whole of the Navigation from London to the Cape of Good Hope	1	11	6
The East India Pilot, comprehending the Navigation from England, round New Holland to Canton in China, regulated by the Best Observations	5	5	0
CHARTS OF ENGLAND, IRELAND AND SCOTLAND.			
The British Channel, including that of Bristol and the South-West Coast of Ireland, as far as the River Shannon, constructed upon the true Principles of Mercator's Sailing, containing particular Charts of the Downs, Portsmouth, Dartmouth, Plymouth, and Falmouth, with a printed Book of Directions	0	7	6
The Mouth of the Thames, shewing the Sands, Buoys, Soundings from the Nore, to the South Foreland and Orfordness, with Part of the River Thames	0	3	0
A Chart of the East Coast of England, on Three large Sheets, extending from the South Foreland to Flamborough Head, including the Nore, and a Chart of the River Thames to London, with all the Buoys, Beacons, Light Houses, and the Appearances of the Land, as laid down by the Elder Brethren of the Trinity House, with a Book of Sailing Directions	0	7	6
The East Coast of England and Scotland, from Yarmouth to Duncansby Head, Cape Wrath, the Orkney and Shetland Islands. With particular Plans of Tinmouth Bar, Stockton, Sunderland Roads, Holy Islands, Berwick, Montrose, and the Frith of Forth, with a Book of Sailing Directions	0	7	6
The Orkney Islands, extending from Duncansby Head to Cape Wrath, with Pentland Forth, shewing the Variation, Setting of the Tides, with their Velocity, and their Rise and Fall of Spring and Neap, together with all the Tracts going through the different Islands	0	6	0
The West Coast and Islands of Scotland, from Cape Wrath to the Mull of Cantire, and Part of Ireland; reduced to Mercator's			

	£.	s.	d.
Projection, with the Latitude and Longitude, laid down by Celestial Observations	0	7	6
St. George's and Bristol Channels, extending from the Mull of Cantire to Hartland Point, and the Coast of Ireland, from Rachlin Island to the Tusker Rock, being a Reduction of M'Kenzie's and other Surveys, reduced to a Mercator's Projection, shewing the Times of High-water, and the Rise of Spring and Neap Tides at the principal Harbours, with their different Velocities	0	7	6
North-west Coast of Ireland, from Belfast to Sligo Bay	0	3	0
West Coast of Ireland, from Sligo Bay to the River Shannon	0	3	6
South-west Coast of Ireland, from the River Shannon to Caldy Island	0	5	6
The Coast of Ireland, from Waterford to Dublin, on a very large Scale	0	5	6
The Coast of Wales, from great Orms Head to Swansea Bay, including the Isle of Anglesea, on a large Scale	0	5	6
Dartmouth Harbour, being an actual Survey of J. Dessiou's	0	3	0
Isle of Wight, Spithead, and Portsmouth, shewing all the Shoals, Buoys, Sea-marks, Soundings, Anchoring Places, &c. on a large Scale from actual Surveys	0	6	0
The Downs and Margate Roads, on a large Scale	0	3	0

FRANCE, SPAIN, PORTUGAL, AFRICA, AND THE MEDITERRANEAN.

A Chart of the Coasts of France, Spain, and Portugal, extending from Ushant to Gibraltar, including the Bay of Biscay, and particular Plans of twenty of the principal Harbours, on a large Scale	0	5	6
A Chart from Cape St. Vincent to Malaga, including the Straits of Gibraltar and Cadiz Bay, on a large Scale	0	3	0
The Mediterranean Sea, including the Coasts of Spain, Portugal, and France, with Sea Coasts up to Constantinople, with twenty-two Plans of the particular Harbours, on a large Scale	0	8	0
The Coasts from Lisbon to Sierra Leon, including the Madeiras, Canaries and Cape De Verd Islands, on a large Scale	0	8	0
A Chart of the Coast of Africa from Senegal to Sherbro' River, including Sierra Leon, and the Delos Islands	6	7	6
The Coasts of Africa, from Sierra Leon, to the Cape of Good Hope, with particular Plans of the Principal Harbours, &c. with the Princes', St. Thomas's, and Annabona Islands, on a large Scale	0	10	6
The Coasts of Ireland, France, Spain, Portugal, and Africa, including the Western Madeiras, Canary, and Cape De Verd Islands	0	6	6
A Chart of the Indian and Pacific Oceans, from the Cape of Good Hope, round New Holland to Canton in China, deduced from the latest Surveys and most accurate Observations	0	8	0
A General Chart of Europe, extending from Spain to the North Cape of Lapland, Petersburgh, exhibiting the Coasts of Britain, Ireland, Holland, and the adjacent Islands	0	3	0

NORTHERN NAVIGATION.

	£.	s.	d.
A New and Correct Chart of the North Sea, on a large Scale, including a Plan of Heilgeland, the whole of the Navigation from Dungeness to the Shetland Islands, and from Calais to the Scaw, with the Entrance of the Rivers Weser, Elbe, and Eyder, from Heilgeland Light, upon a very large Scale, with a printed Book of Directions — —	0	6	
The Coasts of England and Holland, from the South Foreland to Lynn Deeps, and from Calais to the Texel, on a Scale of Thirteen Inches to a Degree, with a printed Book of Directions — — — — —	0	6	0
The Cattegat Sound, and Belts from the Scaw to the Isle of Rugen, including particular Plans of the Sound, Marstrand Haven, Gotenburgh, and Malo, drawn from the Danish and Swedish Surveys, with a printed Book of Directions	0	6	0
The Baltic or East Sea, including Plans of the principal Harbours, on a large Scale, from the Sound to Stockholm and Dago Rort, deduced from the Russian and Swedish Surveys. The Latitudes and Longitudes determined by Celestial Observations, with a Book of Directions — —	0	7	6
The Gulf of Finland, on a large Scale, drawn from the Russian Atlas, and Swedish late Surveys, with a Book of Directions	0	6	6
White Sea, comprehending the Navigation from the North Cape to Archangel and Onega, with Plans of all the principal Harbours, on a large Scale — — —	0	6	6

AMERICA AND THE WEST-INDIES.

The Straits of Bellisle to Cape Cod, containing Newfoundland, Gulf and River St. Lawrence, Nova Scotia, Sable Island, and Bay of Funday, on a large Scale, drawn from the latest Marine Journals and Surveys — — —	0	10	6
Nova Scotia, the Bay of Fundy, and Island of St. John's, &c. on a Scale of six inches to a Degree, from des Barry's Survey	0	7	6
The Coast of America, from Cape Sable to Philadelphia, including Boston, New York, and Delaware Bay, on a very large Scale, from a late Survey — —	0	7	6
The Coast of America, from Philadelphia to the Gulf of Florida, including Delaware Bay, the Chesapeak, Charles Town and Savannah, on a very large Scale, from a late Survey —	0	7	6
The Gulf of Florida and Bahamas, including the Navigation from Cape Carnaveral to Cape Catouch, the Isle of Providence and Part of Cuba — — —	0	7	6
The Windward Passage, upon a very large Scale, including Jamaica, St. Domingo, Part of Cuba, Heneaga, &c. drawn from the late French Surveys, and the Observations of several experienced Mariners; the Latitudes and Longitudes are laid down by Celestial Observations — — —	0	7	6
The Coast of America, from Cape Cod to the Havannah, including Cash's Ledge, St. George's Bank, Nantucket Shoals, the Floridas, &c. &c. — — —	0	7	6
The West Indies, from the East Part of Hispaniola round West End of Cuba, including the Gulf and Windward Passages, Shoals and shewing the Rocks, Keys, &c. on four Sheets	0	10	6

CHARTS, &c.

	£.	s.	d.
The Caribbee or Windward Islands, from the Island of Hispaniola to Barbadoes, with Part of the Spanish Main, on a large Scale — — — — —	0	3	6
The Bay of Honduras, including the Swan Islands, and Musquitto Shore, with Plans of the particular Harbours, on a large Scale, drawn from a late Survey, with a printed Book of Directions — — — —	0	4	6
A New General Chart of America, from Hudson's Straits to the Island of Trinidada, including the whole of the West India Islands and Gulf of Florida — —	0	3	6
A new large Atlantic and Southern Oceans, from Davis's Straits to the Cape of Good Hope, Cape Horn and South America, including South Georgia, Falkland Islands, and the Galliapagos Isles, drawn from the latest Surveys ———	0	10	6
The Atlantic and Southern Oceans, extending from Greenland to Cape Horn and the Cape of Good Hope, shewing the Winds, and Variations of the Compass, &c. &c. ———	0	6	0
The Western Ocean, upon a very large Scale — —	0	6	0
A new Chart of the Gulph of Mexico, including the Navigation from the West End of Jamaica to the Bay of Honduras and the Gulph Passage — — — —	0	10	6
The Islands of Jersey and Guernsey, with the adjacent Coasts of France — — — —	0	3	0

NAVIGATION BOOKS.

	£.	s.	d.
The New Practical Navigator, being the Twelfth Edition for 1796 -	0	7	0
The New Daily Assistant, or Mariner's Compass - - -	0	3	6
The Coastg's Companion - - - -	0	3	0
Sailing Directions for the English and Bristol Channels, and the S. W. Coast of Ireland - - - - - -	0	2	6
Sailing Directions for St. George's Channel, and the Coast of Ireland -	0	2	6
Sailing Directions for the Coast of America, Gulf of Florida, Jamaica and Windward Passage - - - - -	0	2	6
Cargo Books - - - - - -	0	2	6

Journals, plain, printed, and ruled, at Various Prices.

Also may be had, on the most reasonable Terms, Hadley's Quadrants, and Sextants, warranted good; likewise Compasses, Telescopes, Cases of Instruments, Scales, &c. with all Kinds of Stationary useful at Sea.

Mr. MOORE acquaints Mariners in general, that he sells no Sea-Books, Charts, or Instruments, but such as may be depended on; consequently he excludes all those old, inaccurate and erroneous publications, the depending upon which, has often proved fatal to Shipping and seamen.

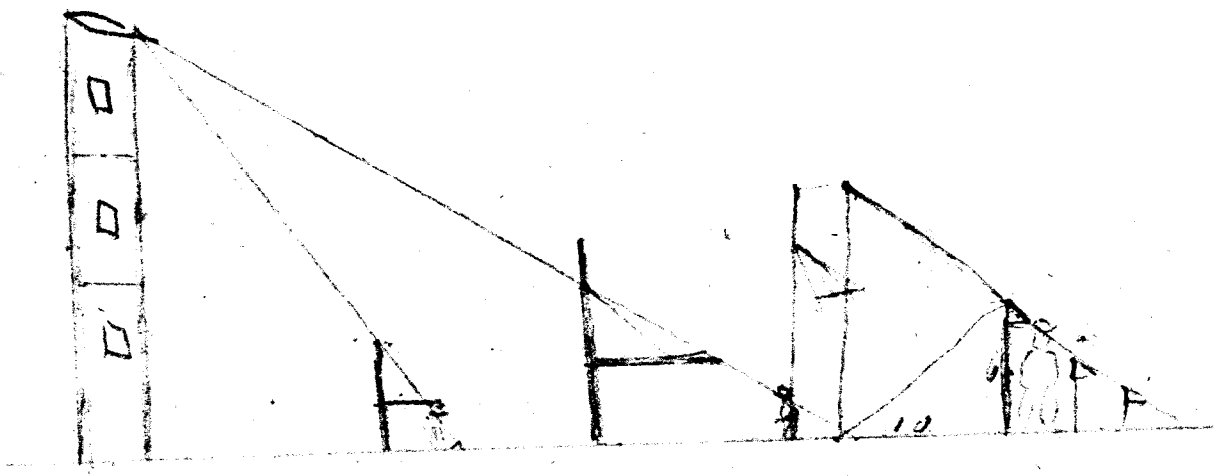
He also Teaches NAVIGATION;—the methods of finding the Latitude by double Altitudes of the Sun, and by the Meridian Altitude of the Moon or fixed Stars; also the method of determining the Longitude at Sea, by the Moon's distance from the Sun or a fixed Star, according to the latest and most approved methods: and the use of the Globes, Sea Instruments and Charts, in a few weeks.

	£.	s.	d.
For Teaching Navigation complete - - - -	5	5	0
——— a short and easy method of keeping a Journal at Sea,	3	3	0
——— the double Altitudes and Lunar Observations -	2	2	0

N. B. As the money is paid at entrance, those who cannot stay to be completed may return as often as they please till they are so, without any additional Expence.

Board and Lodging in the House, if required.

*** JOHN HAMILTON MOORE will be happy to receive information from every judicious seamen, respecting the different places they visit, in order to complete his plan of publishing the most correct Charts of all parts of the known World, on *true principles*, which has never yet been done.



I would know what Star will be on the Mer. of Philad.a at 10 o Clock 25 of Aug.st 1833

	h m	h
⊙ R.A for noon at Green	10.16	10
For 5 hours add	0.3	75 = 5
		15
⊙.s R.A at Green at 15 m	= 10.19	
~~[illegible]~~	=	
+ Time from noon	.10	
R.A of the sought Star	= 20.19	which

answers nearly to Deneb, a Star of the 2d. mag. in the tail of the Swan

Obs.n. Having calculated for the 25th instead of the 24th I found Deneb to be a little W of the Mer. at 10 o Clock, & a Star of the 1st. mag. (according to Keith) instead of the 2d mag as given in the Ta