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RELATING TO

THE TIDES AND WINDS IN THE GULF OF MEXICO.

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Notes on the Coast of the United States

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TABLES AND NOTES

RELATING TO

THE TIDES AND WINDS IN THE GULF OF MEXICO.

TIDES.

THE tides of ports in the Gulf of Mexico, west of Cape St. George, ebb and flow, as a rule, but once in twenty-four hours, or are single day tides. At particular parts of the month there are two small tides in the twenty-four hours. The rise and fall in all these ports is small. East of Cape St. George the rise and fall increases; there are two tides, as a rule, during the twenty-four hours, and the daily inequality is large.

PORTS EAST OF CAPE ST. GEORGE.

As is well known, the interval between the time of the moon's crossing the meridian (moon's transit) and the time of high water at a given place is nearly constant; that is, this interval varies between moderate limits, which can be assigned. The interval at full and change of the moon is known as the establishment of the port, and is ordinarily marked on the charts. As it is not generally the average of the interval during a month's tides, it is a less convenient and less accurate quantity for the use of the navigation than the average interval which is used on the Coast Survey charts, and is sometimes called the "mean" or "corrected establishment."

The following table gives the principal tidal quantities for the different ports named in the first column. The third column of the table gives the mean interval, in hours and minutes, between the moon's transit and the time of high water next after the transit; the fourth, the difference between the greatest and the least interval occurring in different parts of the month, (lunar.) A simple inspection of this column will show how important it is to determine these changes in many of the ports where they amount to more than half an hour, or to more than fifteen minutes from the average interval. The fifth, sixth, and seventh columns refer to the height of the tide. The fifth gives, in feet, the average rise and fall, or average difference between high and low water. The sixth gives the greatest difference, commonly known as the rise and fall of spring tides; and the seventh the least difference, known as the rise and fall of the neap tides.

The average duration of the flood or rising tide is given in the eighth column; of the ebb or falling tide in the ninth; and of the period during which the tide neither rises nor falls, or the "stand," in the tenth. The duration of the flood is measured from the middle of the stand at low water to the middle of the stand at high water; so that the whole duration from one high water to the next, or from one low water to the next, should be given by the sum of the numbers in the eighth and ninth columns:

TABLE I.

PORT.	STATE.	INTERVAL BETWEEN TIME OF MOON'S TRANSIT AND TIME OF HIGH WATER.		RISE AND FALL.			MEAN DURATION OF—		
		Mean interval.	Diff. between greatest and least int'val.	Mean.	Spring tides.	Neap tides.	Flood tide.	Ebb tide.	Sand.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
		h. m.	*h. m.*	*Feet.*	*Feet.*	*Feet.*	*h. m.*	*h. m.*	*h. m.*
Cape Florida	Florida	8 34	51	1.5	1.8	1.2	6 0	6 26	45
Indian key	....do	8 23	49	1.8	2.2	1.3	6 25	5 59	19
Sand key	....do	8 40	.....	1.2	2.0	0.6	6 31	5 55	13
Key West	....do	9 30	1 15	1.3	1.5	0.9	6 55	5 29	12
Tortugas	....do	9 56	1 32	1.2	1.5	0.6	6 43	5 40	.....
Charlotte harbor	....do	13 9	1 38	1.1	1.3	0.8	6 51	5 35	.....
Tampa Bay, (Egmont key)	....do	11 21	1 33	1.4	1.8	1.0	6 36	6 11	43
Cedar Keys, (Depot key)	....do	13 15	1 55	2.6	3.2	1.6	6 12	6 13	.....
St. Mark's	....do	13 38	2 0	2.2	2.9	1 4	6 12	6 11	.....

The foregoing Table I gives the means of determining, roughly, the time and height of high water at the several ports named. The hour of transit of the moon preceding the time of high water is to be taken from the Almanac, and the mean interval (col. 3) being added, the time of high water results. If the moon is near full or change the rise and fall will be that of spring tides, (col. 6 ;) if near the first or last quarter, it will be neap tides, (col. 7.) At intermediate times the mean rise and fall of col. 5 is to be used.

When greater accuracy is desired, the following rules and tables are to be used :

There are, as a general rule, one large and one small tide during the day, the height of the two successive high waters occurring one a. m., the other p. m., of the same twenty-four hours, and the intervals from the next preceding transit of the moon are very different. The inequalities depend upon the moon's declination ; they disappear near the time of the moon's declination being nothing, and are greatest about the time of its being greatest. The inequalities for low water are not the same as for high, though they disappear and have the greatest value at nearly the same times.

When the moon's declination is south, the highest of the two high tides of the twenty-four hours occurs at Key West, about nine hours after the moon's upper transit, (southing ;) and when the declination is north, the lowest of the two high tides occurs about that interval.

The lowest of the two low waters of the day is one which follows next the highest high water. The nature of these tides will probably appear more plainly from the annexed diagrams. In them the height of the tide is set off at the side on a scale of feet, and the hours of the day are at the top. At 12 noon, for example, the tide-gauge marked 6.7 feet.

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Joining all the heights observed in the twenty-four hours, we have a curve like that marked in the figure. The two high waters are *a* and *c*, and the two low waters *b* and *d*. If *a* is the high water, which occurs about nine hours after the transit of the moon, when the declination is north, the ebb *a b* is quite small, and the high water, *a*, is much lower than the next high water, *c*. If the moon's declination is south, it is the large high water, *a*, of the second diagram, which occurs next after the transit, and about nine hours from it. Tables II and III give the number to be added to the time of the moon's transit to find the time of high water. They are of double entry, the time of transit being placed in the first column. The number of days from the day at which the moon had the greatest declination is arranged at the top of the table. Entering the first column with the time of transit, and following the line horizontally until we come under the column containing the days from the greatest declination, we find the number to be added to the time of transit to give the time of high water. If the moon's declination is south, Table II is to be used; if north, Table III.

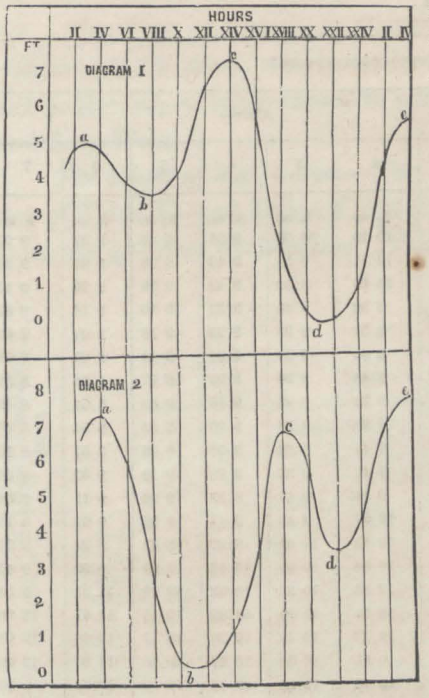

TABLE II.—KEY WEST.

Time of moon's transit.	SOUTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.														
	Before—								After—						
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7
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.
0 00	9 40	9 30	9 18	9 07	9 01	8 49	8 44	8 40	8 40	8 46	8 54	9 06	9 16	9 27	9 37
0 30	9 33	9 23	9 11	9 00	8 54	8 42	8 37	8 33	8 33	8 39	8 47	8 59	9 09	9 20	9 30
1 00	9 26	9 16	9 04	8 53	8 47	8 35	8 30	8 26	8 26	8 32	8 40	8 52	9 02	8 13	9 23
1 30	9 20	9 10	8 58	8 47	8 41	8 29	8 24	8 20	8 20	8 26	8 34	8 46	8 56	9 07	9 17
2 00	9 13	9 03	8 51	8 40	8 34	8 22	8 17	8 13	8 13	8 19	8 27	8 39	8 49	9 00	9 10
2 30	9 08	8 58	8 46	8 35	8 29	8 17	8 12	8 08	8 08	8 14	8 22	8 34	8 44	8 55	9 05
3 00	9 04	8 54	8 42	8 31	8 25	8 13	8 08	8 04	8 04	8 10	8 18	8 30	8 40	8 51	9 01
3 30	9 00	8 50	8 38	8 27	8 21	8 09	8 04	8 00	8 00	8 06	8 14	8 26	8 36	8 47	8 57
4 00	9 00	8 50	8 38	8 27	8 21	8 09	8 04	8 00	8 00	8 06	8 14	8 26	8 36	8 47	8 57
4 30	9 03	8 53	8 41	8 30	8 24	8 12	8 07	8 03	8 03	8 09	8 17	8 29	8 39	8 50	9 00
5 00	9 09	8 59	8 47	8 36	8 30	8 18	8 13	8 09	8 09	9 15	8 23	8 35	8 45	8 56	9 06
5 30	9 17	9 07	8 55	8 44	8 38	8 26	8 21	8 17	8 17	8 23	8 31	8 43	8 53	9 04	9 14
6 00	9 29	9 19	9 07	8 56	8 50	8 38	8 33	8 29	8 29	8 35	8 43	8 55	9 05	9 16	9 26
6 30	9 40	9 30	9 18	9 07	9 01	8 49	8 44	8 40	8 40	8 46	8 54	9 06	9 16	9 27	9 37
7 00	9 56	9 46	9 34	9 23	9 17	9 05	9 00	8 56	8 56	9 02	9 10	9 22	9 32	9 43	9 53
7 30	10 07	9 57	9 45	9 34	9 28	9 16	9 11	9 07	9 07	9 13	9 21	9 33	9 43	9 54	10 04
8 00	10 13	10 03	9 51	9 40	9 34	9 22	9 17	9 13	9 13	9 19	9 27	9 39	9 49	10 00	10 00
8 30	10 14	10 04	9 52	9 41	9 35	9 23	9 18	9 14	9 14	9 20	9 28	9 40	9 50	10 01	10 11
9 00	10 13	10 03	9 51	9 40	9 34	9 22	9 17	9 13	9 13	9 19	9 27	9 39	9 49	10 00	10 10
9 30	10 10	10 00	9 48	9 37	9 31	9 19	9 14	9 10	9 10	9 16	9 24	9 36	9 46	9 57	10 07
10 00	10 06	9 56	9 44	9 33	9 27	9 15	9 10	9 06	9 06	9 12	9 20	9 32	9 42	9 53	10 03
10 30	10 03	9 53	9 41	9 30	9 24	9 12	9 07	9 03	9 03	9 09	9 17	9 29	9 39	9 50	10 00
11 00	9 55	9 45	9 33	9 22	9 16	9 04	8 59	8 55	8 55	9 01	9 09	9 21	9 31	9 42	9 52
11 30	9 47	9 37	9 25	9 14	9 08	8 56	8 51	8 47	8 47	8 53	9 01	9 13	9 23	9 34	9 44

TABLE III.—KEY WEST.

Time of moon's transit.	NORTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.														
	Before—								After—						
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7
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.
0 0	9 29	9 36	9 43	9 53	10 06	10 16	10 22	10 22	10 22	10 18	10 06	9 56	9 43	9 34	9 27
0 30	9 22	9 29	9 36	9 46	9 59	10 09	10 15	10 15	10 15	10 11	9 59	9 49	9 36	9 27	9 20
1 0	9 15	9 22	9 29	9 39	9 52	10 02	10 08	10 08	10 08	10 04	9 52	9 42	9 29	9 20	9 13
1 30	9 09	9 16	9 23	9 33	9 46	9 56	10 02	10 02	10 02	9 58	9 46	9 36	9 23	9 14	9 07
2 0	9 02	9 09	9 16	9 26	9 39	9 49	9 55	9 55	9 55	9 51	9 39	9 29	9 16	9 07	9 00
2 30	8 57	9 04	9 11	9 21	9 34	9 44	9 50	9 50	9 50	9 46	9 34	9 24	9 11	9 02	8 55
3 0	8 53	9 00	9 07	9 17	9 30	9 40	9 46	9 46	9 46	9 42	9 30	9 20	9 07	8 58	8 51
3 30	8 49	8 56	9 03	9 13	9 26	9 36	9 42	9 42	9 42	9 38	9 26	9 16	9 03	8 54	8 47
4 0	8 49	8 56	9 03	9 13	9 26	9 36	9 42	9 42	9 42	9 38	9 26	9 16	9 03	8 54	8 47
4 30	8 52	8 59	9 06	9 16	9 29	9 39	9 45	9 45	9 45	9 41	9 39	9 29	9 06	8 57	8 50
5 0	8 58	9 05	9 12	9 22	9 35	9 45	9 51	9 51	9 51	9 47	9 35	9 25	9 12	9 03	8 56
5 30	9 06	9 13	9 20	9 30	9 43	9 53	9 59	9 59	9 59	9 55	9 43	9 33	9 20	9 11	9 04
6 0	9 18	9 25	9 32	9 42	9 55	10 05	10 11	10 11	10 11	10 07	9 55	9 45	9 32	9 23	9 16
6 30	9 29	9 36	9 43	9 53	10 06	10 16	10 22	10 22	10 22	10 18	10 06	9 56	9 43	9 34	9 27
7 0	9 45	9 52	9 59	10 09	10 22	10 32	10 38	10 38	10 38	10 34	10 22	10 12	9 59	9 50	9 43
7 30	9 56	10 03	10 10	10 20	10 33	10 43	10 49	10 49	10 49	10 45	10 33	10 23	10 10	10 01	9 54
8 0	10 02	10 09	10 16	10 26	10 39	10 49	10 55	10 55	10 55	10 51	10 39	10 29	10 16	10 07	10 00
8 30	10 03	10 10	10 17	10 27	10 40	10 50	10 56	10 56	10 56	10 52	10 40	10 30	10 17	10 08	10 01
9 0	10 02	10 09	10 16	10 26	10 39	10 49	10 55	10 55	10 55	10 51	10 39	10 29	10 16	10 07	10 00
9 30	9 59	10 06	10 13	10 23	10 36	10 46	10 52	10 52	10 52	10 48	10 36	10 26	10 13	10 04	9 57
10 0	9 55	10 02	10 09	10 19	10 32	10 42	10 48	10 48	10 48	10 44	10 32	10 22	10 09	10 00	9 53
10 30	9 52	9 59	10 06	10 16	10 29	10 39	10 45	10 45	10 45	10 41	10 29	10 19	10 06	9 57	9 50
11 0	9 44	9 51	9 58	10 08	10 21	10 31	10 37	10 37	10 37	10 33	10 21	10 11	9 58	9 49	9 42
11 30	9 36	9 43	9 50	10 00	10 13	10 23	10 29	10 29	10 29	10 25	10 13	10 03	9 50	9 41	9 34

Rule to find the time of high water.—Look in the Almanac for the time of the moon's transit (southing) for the day required. Look also if the declination is north or south, and how many days it is before or after the greatest. With the time of transit enter Table II or III (according as the declination is south or north) at the side, and at the top with the number of days before or after the moon's greatest declination. Take out of the table the number corresponding and add it to the time of moon's transit; the sum will be the time of high water.

Example I.—Required, the time of high water at Key West, Florida, for June 5, 1861. The American Nautical Almanac gives the time of the moon's upper transit at Washington on June 4 at 21*h.* 35*m.*, which is 9*h.* 35*m.* a. m. of the 5th, (page 330.) By referring to page 97 we find also that the moon's declination is north, and is greatest on the 8th; therefore on the 5th it is three days before the greatest. Entering Table III we find at the side 9*h.* 30*m.* of moon's transit, (the nearest number to 9*h.* 35*m.*,) and following the line horizontally until we come to the column headed three days before the moon's greatest declination we find 10*h.* 36*m.* To 9*h.* 35*m.*, time of transit of the moon at Key West June 5, add 10*h.* 36*m.*; the sum 20*h.* 11*m.*, or 8*h.* 11*m.* p. m., is the time of high water on that day. The declination being north, it is the small high water, *a*, of Diagram I. Rules will be given further on (Table VI) for obtaining in this case the time of the large high water.

If the moon's transit is taken in Greenwich time, as it would be if the British Nautical Almanac or the nautical part of the American Nautical Almanac is used, two minutes must be added for every hour of west longitude, or one minute for every half hour; for less than that the correction need not be taken into account. In the foregoing example, Key West being

5*h.* 27*m.* west of Greenwich, the correction for the five hours would be 10*m.* and for the 27*m.* 1*m.* The time of transit at Greenwich being 9*h.* 25*m.*, and adding 11*m.*, the time of transit obtained is 9*h.* 36*m.*, which would correspond with the transit used in the example if we had not neglected, as superfluous, to add 1*m.* for the difference of longitude between Washington and Key West.

The height of high water.—The height of high water is obtained in a similar manner by the use of Table IV and Table V, entering these in the same way with the time of transit and days from the greatest declination. Table IV is for south declination and Table V for north.

TABLE IV.—KEY WEST.

Time of moon's transit.	SOUTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.														
	Before—								After—						
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7
Hour.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	1 5	1.6	1.8	1.9	2.0	2.0	2.0	2.0	2.0	2.0	2 0	1.9	1.8	1.7	1.5
1	1.5	1.6	1.8	1.9	2.0	2.0	2.0	2 0	2.0	2 0	2.0	1.9	1.8	1.7	1.5
2	1.5	1.6	1.8	1.9	2.0	2 0	2.0	2.0	2.0	2.0	2.0	1.9	1.8	1.7	1.5
3	1.4	1.5	1.7	1.8	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.8	1.7	1 6	1.4
4	1.3	1.4	1.6	1.7	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.7	1 6	1.5	1.3
5	1.2	1.3	1.5	1 6	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.6	1.5	1.4	1.2
6	1.1	1.2	1.4	1.5	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.5	1.4	1.3	1.1
7	1.1	1.2	1.4	1.5	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.5	1.4	1.3	1.1
8	1.2	1.3	1.5	1.6	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.6	1.5	1.4	1.2
9	1.3	1.4	1.6	1.7	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.7	1.6	1.5	1.3
10	1.4	1.5	1.7	1.8	1.9	1.9	1.9	1.9	1.9	1.9	1 9	1.8	1.7	1.6	1.4
11	1.5	1.6	1.8	1.9	2.0	2.0	2.0	2.0	2.0	2.0	2.9	1.9	1.8	1.7	1.5

TABLE V.—KEY WEST.

Time of moon's transit.	NORTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.														
	Before—								After—						
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7
Hour.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	1.7	1.6	1.4	1.3	1.2	1.1	1.0	1 0	1.1	1.1	1.2	1.3	1.4	1.6	1.8
1	1.7	1.6	1.4	1.3	1.2	1 1	1.0	1.0	1.1	1.1	1.2	1.3	1.4	1.6	1.8
2	1.7	1.6	1.4	1 3	1.2	1.1	1.0	1.0	1.1	1.1	1.2	1.3	1.4	1.6	1.8
3	1.6	1.5	1.3	1.2	1.1	1.0	0.9	0.9	1.0	1.0	1.1	1.2	1.3	1.5	1.7
4	1.5	1.4	1.2	1.1	1.0	0.9	0.8	0.8	0.9	0.9	1.0	1.1	1.2	1.4	1.6
5	1 4	1.3	1.1	1.0	0.9	0.8	0.7	0.7	0.8	0.8	0.9	1.0	1.1	1.3	1.5
6	1.3	1.2	1.0	0.9	0.8	0.7	0.6	0.6	0.7	0.7	0.8	0.9	1.0	1.2	1.4
7	1.3	1.2	1.0	0.9	0.8	0.7	0.6	0.6	0.7	0.7	0.8	0.9	1 0	1.2	1.4
8	1.4	1.3	1.1	1.0	0.9	0.8	0.7	0.7	0.8	0.8	0.9	1.0	1.1	1.3	1.5
9	1.5	1.4	1.2	1 1	1.0	0.9	0.8	0.8	0.9	0.9	1.0	1.1	1.2	1.4	1 6
10	1.6	1.5	1.3	1.2	1.1	1.0	0.9	0.9	1.0	1.0	1.1	1.2	1.3	1.5	1.7
11	1.7	1.6	1.4	1.3	1.2	1.1	1.0	1.0	1.1	1.1	1.2	1 3	1.4	1.6	1.8

Example II.—To obtain the height of the tide for June 5, 1861, the time of which was found in Example I, the declination being north, we enter Table V with 10*h.* of transit (the nearest to 9*h.* 35*m.*) and three days before the moon's greatest declination, and we find that the tide will be 1.1 foot above the mean of the lowest low waters, or that 1.1 foot is to be added to the soundings of a chart reduced to the mean of the lowest low waters of each day. If the

soundings of the chart are given for mean low water the quantities in the table would be 0.2 foot too large, a difference which may be neglected.

The approximate time of the successive low and high waters of the day will be found by adding the numbers in Table VI to the time of the first high water already determined. The table gives the numbers for the different days from the greatest declination.

Tables containing numbers to be added to the time of high water found from Tables II and III, to obtain the successive high and low waters.

TABLE VI.—KEY WEST.

Days from moon's greatest declination.		SOUTH DECLINATION.			NORTH DECLINATION.			Days from moon's greatest declination.	
		Low water. (Large.)	High water. (Small.)	Low water. (Small.)	Low water. (Small.)	High water. (Large.)	Low water. (Large.)		
		h. m.	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*		
Before.	7	5 22	12 10	17 38	5 36	12 33	17 46	7	Before.
	6	5 42	12 31	17 40	5 18	12 18	17 50	6	
	5	6 05	12 55	17 41	4 58	12 03	17 56	5	
	4	6 24	13 17	17 44	4 35	11 44	17 59	4	
	3	6 39	13 28	17 39	4 11	11 18	17 58	3	
	2	7 02	13 52	17 40	3 50	10 58	17 58	2	
	1	7 13	14 01	17 39	3 39	10 46	17 56	1	
	0	7 18	14 10	17 42	3 37	10 46	17 59	0	
After.	1	7 12	14 10	17 48	3 44	10 46	17 52	1	After.
	2	6 57	13 58	17 51	3 57	10 54	17 47	2	
	3	6 39	13 41	17 53	4 21	11 19	17 48	3	
	4	6 15	13 18	17 53	4 43	11 38	17 45	4	
	5	5 57	12 59	17 53	5 09	12 03	17 44	5	
	6	5 32	12 36	17 54	5 26	12 22	17 46	6	
	7	5 13	12 16	17 53	5 40	12 36	17 46	7	

The days from the greatest declination are written in the first and last columns of the table. The second, third, and fourth columns refer to south declination, and fifth, sixth, and seventh to north. The second column gives the number which is to be added, according to the declination, to the time of high water, obtained by means of Tables II and III, to give the next low water, which is the large low water, *b*, of diagram 2. The third contains the numbers to be added to the same to give the second or small high water, *c*, of diagram 2. The fourth, the numbers to be added to the same to give the second or small low water, *d*, of diagram 2. The succeeding columns give the numbers to be used in the same way for north declination to obtain the low water, *b*, (small,) of diagram I; the high water, *c*, (large,) and the low water, *d*, (large,) of the same diagram. The rise and fall of the same successive tides may be obtained by inspection from Table VII, in which the first column at the side contains the time of transit, and the successive columns the numbers corresponding to that time and to the number of days from greatest declination. The arrangement of this table is like that already given.

The numbers for the small ebb tide, *a b*, of diagram I, or *c d*, of diagram II, are first given; then those for small low and large high waters, *b c*, of diagram I, and *d e*, of diagram II; next the large ebb tide, *c d*, of diagram I, or *a b*, of diagram II; and lastly, from the large low water to the small high water, *d e*, of diagram I, or *b c*, of diagram II.

TABLE VII.—KEY WEST.

Time of moon's transit.	SMALL EBB TIDE. Days from moon's greatest declination. Before—								After—							SMALL LOW WATER TO LARGE HIGH WATER. Days from moon's greatest declination. Before—								After—							Time of moon's transit.
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	
H.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	H.
0	1.6	1.4	1.1	1.0	0.8	0.7	0.7	0.7	0.7	0.8	0.9	1.1	1.2	1.5	1.8	1.4	1.4	1.5	1.6	1.6	1.7	1.7	1.7	1.7	1.6	1.7	1.7	1.6	1.5	1.4	0
1	1.6	1.4	1.1	1.0	0.8	0.7	0.7	0.7	0.7	0.8	0.9	1.1	1.2	1.5	1.8	1.4	1.4	1.5	1.6	1.6	1.7	1.7	1.7	1.7	1.6	1.7	1.7	1.6	1.5	1.4	1
2	1.6	1.4	1.1	1.0	0.8	0.7	0.7	0.7	0.7	0.8	0.9	1.1	1.2	1.5	1.8	1.4	1.4	1.5	1.6	1.6	1.7	1.7	1.7	1.7	1.6	1.7	1.7	1.6	1.5	1.4	2
3	1.5	1.3	1.0	0.9	0.7	0.6	0.6	0.6	0.6	0.7	0.8	1.0	1.1	1.4	1.7	1.3	1.3	1.4	1.5	1.5	1.6	1.6	1.6	1.6	1.5	1.6	1.6	1.5	1.4	1.3	3
4	1.3	1.1	0.8	0.7	0.5	0.4	0.4	0.4	0.4	0.5	0.6	0.8	0.9	1.2	1.5	1.1	1.1	1.2	1.3	1.3	1.4	1.4	1.4	1.4	1.3	1.4	1.4	1.3	1.2	1.1	4
5	1.1	0.9	0.6	0.5	0.3	0.2	0.2	0.2	0.2	0.3	0.4	0.6	0.7	1.0	1.3	0.9	0.9	1.0	1.1	1.1	1.2	1.2	1.2	1.2	1.1	1.2	1.2	1.1	1.0	0.9	5
6	1.0	0.8	0.5	0.4	0.2	0.1	0.1	0.1	0.1	0.2	0.3	0.5	0.6	0.9	1.2	0.8	0.8	0.9	1.0	1.0	1.1	1.1	1.1	1.1	1.0	1.1	1.1	1.0	0.9	0.8	6
7	1.0	0.8	0.5	0.4	0.2	0.1	0.1	0.1	0.1	0.2	0.3	0.5	0.6	0.9	1.2	0.8	0.8	0.9	1.0	1.0	1.1	1.1	1.1	1.1	1.0	1.1	1.1	1.0	0.9	0.8	7
8	1.1	0.9	0.6	0.5	0.3	0.2	0.2	0.2	0.2	0.3	0.4	0.6	0.7	1.0	1.3	0.9	0.9	1.0	1.1	1.1	1.2	1.2	1.2	1.2	1.1	1.2	1.2	1.1	1.0	0.9	8
9	1.3	1.1	0.8	0.7	0.5	0.4	0.4	0.4	0.4	0.5	0.6	0.8	0.9	1.2	1.5	1.1	1.1	1.2	1.3	1.3	1.4	1.4	1.4	1.4	1.3	1.4	1.4	1.3	1.2	1.1	9
10	1.5	1.3	1.0	0.9	0.7	0.6	0.6	0.6	0.6	0.7	0.8	1.0	1.1	1.4	1.7	1.3	1.3	1.4	1.5	1.5	1.6	1.6	1.6	1.6	1.5	1.6	1.6	1.5	1.4	1.3	10
11	1.6	1.4	1.1	1.0	0.8	0.7	0.7	0.7	0.7	0.8	0.9	1.1	1.2	1.5	1.8	1.4	1.4	1.5	1.6	1.6	1.7	1.7	1.7	1.7	1.6	1.7	1.7	1.6	1.5	1.4	11

TABLE VII.—KEY WEST—Continued.

Time of moon's transit.	LARGE EBB TIDE. Days from moon's greatest declination. Before—								After—							LARGE LOW WATER TO SMALL HIGH WATER. Days from moon's greatest declination. Before—								After—							Time of moon's transit.
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	7	6	5	4	3	2	1	0	1	2	3	4	5	9	7	
H.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	H.
0	1.4	1.6	1.9	2.0	2.2	2.3	2.3	2.3	2.3	2.2	2.1	1.9	1.8	1.5	1.2	1.6	1.5	1.5	1.4	1.4	1.3	1.3	1.3	1.3	1.4	1.3	1.3	1.4	1.5	1.6	0
1	1.4	1.6	1.9	2.0	2.2	2.3	2.3	2.3	2.3	2.2	2.1	1.9	1.8	1.5	1.2	1.6	1.5	1.5	1.4	1.4	1.3	1.3	1.3	1.3	1.4	1.3	1.3	1.4	1.5	1.6	1
2	1.4	1.6	1.9	2.0	2.2	2.3	2.3	2.3	2.3	2.2	2.1	1.9	1.8	1.5	1.2	1.6	1.5	1.5	1.4	1.4	1.3	1.3	1.3	1.3	1.4	1.3	1.3	1.4	1.5	1.6	2
3	1.3	1.5	1.8	1.9	2.1	2.2	2.2	2.2	2.2	2.1	2.0	1.8	1.7	1.4	1.1	1.5	1.4	1.4	1.3	1.3	1.2	1.2	1.2	1.2	1.3	1.2	1.2	1.3	1.4	1.5	3
4	1.1	1.3	1.6	1.7	1.9	2.0	2.0	2.0	2.0	1.9	1.8	1.6	1.5	1.2	0.9	1.3	1.2	1.2	1.1	1.1	1.0	1.0	1.0	1.0	1.1	1.0	1.0	1.1	1.2	1.3	4
5	0.9	1.1	1.4	1.5	1.7	1.8	1.8	1.8	1.8	1.7	1.6	1.4	1.3	1.0	0.7	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.8	0.8	0.9	0.8	0.8	0.9	1.0	1.1	5
6	0.8	1.0	1.3	1.4	1.6	1.7	1.7	1.7	1.7	1.6	1.5	1.3	1.2	0.9	0.6	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.7	0.7	0.8	0.7	0.7	0.8	0.9	1.0	6
7	0.8	1.0	1.3	1.4	1.6	1.7	1.7	1.7	1.7	1.6	1.5	1.3	1.2	0.9	0.6	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.7	0.7	0.8	0.7	0.7	0.8	0.9	1.0	7
8	0.9	1.1	1.4	1.5	1.7	1.8	1.8	1.8	1.8	1.7	1.6	1.4	1.3	1.0	0.7	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.8	0.8	0.9	0.8	0.8	0.9	1.0	1.1	8
9	1.1	1.3	1.6	1.7	1.9	2.0	2.0	2.0	2.0	1.9	1.8	1.6	1.5	1.2	0.9	1.3	1.2	1.2	1.1	1.1	1.0	1.0	1.0	1.0	1.1	1.0	1.0	1.1	1.2	1.3	9
10	1.3	1.5	1.8	1.9	2.1	2.2	2.2	2.2	2.2	2.1	2.0	1.8	1.7	1.4	1.1	1.5	1.4	1.4	1.3	1.3	1.2	1.2	1.2	1.2	1.3	1.2	1.2	1.3	1.4	1.5	10
11	1.4	1.6	1.9	2.0	2.2	2.3	2.3	2.3	2.3	2.2	2.1	1.9	1.8	1.5	1.2	1.6	1.5	1.5	1.4	1.4	1.3	1.3	1.3	1.3	1.4	1.3	1.3	1.4	1.5	1.6	11

Example III.—Thus, in Examples I and II, we had found that the high water of June 5, 1861, would happen at 8*h.* 11*m.* p. m., and would rise 1·1 feet above the mean of the lowest low waters. The moon's declination being north, we enter the 5th column of Table VI, and three days before the moon's greatest declination we find 4*h.* 11*m.*, which, added to 8*h.* 11*m.*, gives 12*h.* 22*m.*, or 0*h.* 22*m.* a. m. of June 6, as the time of the small low water. The next column gives 11*h.* 18*m.*, which, added to 8*h.* 11*m.*, gives 19*h.* 29*m.*, or 7*h.* 29*m.* a. m. June 6, as the time of the large high water. The 7th column would, in the same way, give the time of the large low water. It is evident that, if we had wanted the high and low waters of the forenoon of June 5, we ought to have begun by computing the time of high water for the evening of June 4. Table VII would have given us 0.7 feet as the fall from the high water of 8*h.* 11*m.* p. m. to the low water at 0*h.* 22*m.* a. m. June 6 ; then 1.5 feet as the rise from that low water

to the next or large high water at 7*h.* 29*m.*, next 2.1 feet as the fall from the large high water to the large low water.

It is easy to see how, in this way, the soundings of a chart can be reduced to what they would be approximately at all the successive high and low waters.

These tables being constructed for Key West, if the time is wanted at other places on the coast, compute first for Key West, as in the examples; then *subtract* 1*h.* 7*m.* for Indian key; *add* 26*m.* for Tortugas, 3*h.* 39*m.* for Charlotte harbor, 1*h.* 51*m.* for Egmont key, 3*h.* 45*m.* for Cedar keys, and 4*h.* 8*m.* for St. Mark's. For the heights add half a foot for Indian key, and use the tables as they are for Tortugas, Charlotte harbor, and Egmont key. For Cedar keys and St. Mark's the results could not be obtained with much accuracy in this way; still the tables will show which are the large and small high and low waters.

PORTS WEST OF CAPE ST. GEORGE.

Between St. Mark's and St. George's island, Apalachicola entrance, the tides change to the single day class, ebbing and flowing but once in the twenty-four (lunar) hours.

At St. George's island there are two tides a day, for three or four days, about the time of the moon's declination being zero. At other times there is but one tide a day, with a long stand at high water of from six to nine hours. From Cape St. Blas to and including the mouth of the Mississippi the single day tides are very regular, and the small and irregular double tides appear only for two or three days, (and frequently even not at all,) about the time of zero declination of the moon. The stand at high and low water is comparatively short, seldom exceeding an hour.

To the west of the mouth of the Mississippi the double tides reappear. At Isle Dernière they are distinct, though a little irregular for three or four days near the time of the moon's zero declination. At all other times the single day type prevails, the double tides modifying it, however, in the shape of a long stand of from six to ten hours at high water. This stand is shortest at the time of the moon's greatest declination, sometimes being reduced to but one hour. At Calcasieu the tides are distinctly double, but with a large daily inequality. The rise and fall being small, they would often present to the ordinary observer the same appearance as at Isle Dernière. At Galveston the double tides are plainly perceptible, though small, for five or six days at the time of the moon's zero declination. At other times they present the single day type, with the peculiarity that, after standing at high water for a short time, the water falls a small distance, and stands again at that height for several hours, then continues to fall to low water. Sometimes it falls very slowly for nine or ten hours following high water, and then acquires a more rapid rate at low water. At Aransas Pass and Brazos Santiago the single day tides prevail. Small, irregular, double tides are only perceived for two or three days at the moon's zero declination. At all other times there is but one high water in the day, with a long stand of from six to nine hours, during which there are often small, irregular fluctuations or a very slow fall. In the following table the mean rise and fall of tides at the above stations are given.

The highest high and the lowest low waters occur when the greatest declination of the moon happens at full or change; the least tide when the moon's declination is nothing at the first or last quarter. The rise and fall being so small, the times and heights are both much influenced by the winds, and are thus rendered quite irregular.

The accompanying plate of type-curves shows, in the manner of diagrams 1 and 2, page 5, the peculiarities of the tides at the different stations at the time of the moon's greatest and least declination. The full line represents the curve of observation; the dotted lines are the diurnal and semi-diurnal tides, which, by their combination, give to these tides their peculiar features, but which it would lead us too far to explain more fully in this article.

TABLE VIII.

Rise and fall at several stations on the Gulf of Mexico.

STATIONS.	MEAN RISE AND FALL OF TIDES.		
	Mean.	At moon's greatest declination.	At moon's least declination.
	Ft.	*Ft.*	*Ft.*
St. George's island, Florida	1.1	1.8	0.6
Pensacola, Florida	1.0	1.5	0.4
Fort Morgan, Mobile bay, Alabama	1.0	1.5	0.4
Cat island, Mississippi	1.3	1.9	0.6
Southwest Pass, Louisiana	1.1	1.4	0.5
Isle Dernière, Louisiana	1.4	2.2	0.7
Entrance to Lake Calcasieu, Louisiana	1.9	2.4	1.7
Galveston, Texas	1.1	1.6	0.8
Aransas Pass, Texas	1.1	1.8	0.6
Brazos Santiago, Texas	0.9	1.2	0.5

No very simple rule can be given for determining the time of the single day tides; but the following rough one will answer about the time of the moon's greatest declination, when the tides are highest. The stand being generally very long, errors are not of much importance. When the moon's declination is greatest and north it is high water about 20 hours after her transit (southing) at St. George's island, Fla., Southwest Pass of the Mississippi, Aransas Pass, and Brazos Santiago, Texas; 21 hours after at Pensacola, Fort Morgan, Dernière island, La., and Calcasieu, La.; 22 hours after at Cat island; and 23 hours after at Galveston. When the declination is greatest and south subtract 12 hours from the above quantities. This rule can be used for three or four days before or after the day of greatest declination. At other times the tides are small and irregular.

The mean level of the sea at Key West, and probably in the Gulf of Mexico, has a yearly fluctuation of about 0.8 of a foot; being highest in September and October, and lowest in January and February.

WINDS.

The prevailing winds during each month of the year at Key West, Fla., Fort Morgan, (entrance to Mobile bay, Ala.,) Cat island, La., and Galveston, Texas, are shown in the following table, deduced from the Coast Survey observations and their discussion. A column is given for each month, in which the prevailing wind is indicated at the top in large type. Under this, and in smaller type, are recorded the other winds prevailing during the month, but to a less degree; the order of succession indicates the relative quantity. When two winds are put down side by side on the same line, it indicates that the quantities of those two winds during that month are nearly equal. Thus, in February, at Key West, N. and N.NE. winds

prevail in about equal quantities—NE. less than either, SE. less than NE., and E. less than NE. Other winds than those were, of course, observed also during the month, but to so small an amount that no rule can be deduced from them.

Table showing the prevailing winds in the different months of the year in the Gulf of Mexico.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Key West, Fla.....	**N.**	**NNE. N.**	**SE. E.**	**WNW.**	**SE.**	**SE.**	**SE.**	**ESE.**	**ENE.**	**ENE.**	**NE.**	**NE.**
	NE.	NE.	NE.	SE.	ESE.	SSE.	ESE.	E.	E.	NE.	NNE.	ENE.
	NNE.	SE.	WNW.	NW.	NE.	ESE.	E.	SE.	NE.	E.	ENE.	N.
	ENE.	E.	.....	S.	.....	E.	.....	.....	.....	.....	E.	.....
Fort Morgan, Ala..	**N.**	**N.**	**N.**	**ESE.**	**ESE.**	**SW.**	**SW.**	**SW.**	**N.**	**N.**	**N.**	**N.**
	ESE.	NNE. NE.	ESE.	N.	N.	S.	E. S.	N.	NE.	NE.	ENE.	ESE.
	E.	ENE. ESE.	SSE.	WSW.	SW.	ESE.	W.	WSW.	ENE.	ENE.	SE.	E.
		SSE.	NNE SSW.	.....	.....	.....	.....	ESE.	.....	.....	.....	.....
Cat island, La	**NE.**	**NE.**	**SE.**	**SW.**	**SW.**	**SW.**	**SW.**	**SE.**	**NE.**	**NE.**	**NNE.**	**N.**
	N.	NNE. S	NNE.	SE.	S.	S. SE.	S.	SW.	NNE.	NNE	N.	ESE. NE.
	E.	SE.	N.	E. NNE	SE.	E.	SE.	NE.	N.	N.	SE. NE.	SE.
		N.	S.	.....	NE.	.....	.....	.....	.....	SW.	NW.	E.
Galveston, Tex....	**N.**	None prev't.	**SE.**	**NW.**	**S.**	**E.**	**SE.**	**SSE.**	**E.**	**N.**	**N.NW.**	**NW.N.**
	NW.	SE. NE. NW.	N. S.	SE.	SE.	N.	.....	SE.	NE.	NW. NE	SE.	E.
	NE.	Little wind.	SW.	N. S.	.....	S.	.....	.....	.....	.....	S.	NE.

In the two accompanying plates the quantities of wind are plotted on compass roses for every month and for the whole year, and also on the Cat island plate for the several meteorological seasons.