

record of the temperature as indicated by a ventilated thermometer and of the pressure as recorded by a sensitive and carefully calibrated barograph. These two elements, in combination with the surface temperature and pressure will enable one to compute the altitude of the balloon and thus check its altitude against that indicated by the altimeter. A camera will probably be carried also, and photographs of clouds obtained whenever opportunity affords.

#### A METHOD FOR LOCATING THE DECIMAL POINT IN SLIDE-RULE COMPUTATION.

55/.501

By NELSON W. HAAS.

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The slide rule has come to be, in rapid computations in the field and elsewhere, what logarithms are in more refined computations. In several branches of the work of the United States Weather Bureau the slide rule is used extensively, particularly in the Aerological Division in the work of which the slide rule is used exclusively for many purposes; in the computation work of single and double theodolite observations, the computation of mean wind velocities and directions at various altitudes above sea level, in the reduction of the aerological data from kite flights to various levels, etc. Twenty-inch slide rules are used chiefly for such computations. The slide rule is particularly well adapted to this work, for the 20-inch rule yields three figures accurately and the fourth approximately. Four figures represent the maximum accuracy that is readily attainable in meteorological observations, and consequently the 20-inch rule is entirely satisfactory for this work, and it is very expeditious.

In many of these computations the approximate magnitude of the result is already known. This still further expedites the computations, but in the general use of the slide rule, especially when there are several factors involved in the computation, difficulty or delay is often encountered in locating the position of the decimal point in the result.

The usual method of locating the position of the decimal point in a result obtained on the slide rule is by guessing at it, or by a mental approximation. The derivation of the various rules given in slide-rule manuals for this purpose is not immediately obvious, and so these rules must be retained by sheer memory. To my knowledge they are never used. The method outlined below I have found to be the quickest and to involve the least mental effort of any I have tried. The method is very simple to use, but the derivation of it is somewhat tedious.

To multiply two numbers together, their logarithms are added, and the characteristic of the logarithm of the product will equal the sum of the characteristics of the logarithms of the factors unless the sum of the mantissas is greater than 1, in which case 1 will be carried over from the mantissa of the sum to the characteristic. Likewise, in dividing one number by another, the characteristic of the logarithm of the quotient will equal the characteristic of the logarithm of the dividend minus the characteristic of the logarithm of the divisor unless the mantissa corresponding to the divisor is greater than the mantissa corresponding to the dividend, in which case 1 will be borrowed from the characteristic corresponding to the dividend. It is thus evident that the characteristic corresponding to a product is equal either to the sum of the characteristics corresponding to the factors, or to this sum plus 1; and that the characteristic corresponding to a quotient is equal either to the difference

*Conclusion.*—This short discussion indicates briefly what it is hoped to accomplish during the balloon flights. While it is believed that this program can be quite closely adhered to, it should not be forgotten that in undertakings of this character unanticipated difficulties may arise to interfere more or less with the orderly prosecution of the work. The final report of the flights will indicate the degree of success enjoyed in this attempt at scientific ballooning.

of the characteristics corresponding to the factors, or equal to this difference minus 1.

On the slide rule, the ratio to the length of the scale, of the distance of any number on the scale from the left-hand index, is equal to the mantissa of the logarithm of the number. It will be evident from a moment's study of the rule, that when the left-hand index is involved in multiplication, this corresponds to the addition of logarithms in which the sum of the mantissas is less than 1; and that when the left hand index is involved in division, this corresponds to the subtraction of logarithms in which the mantissa of the logarithm of the divisor is less than the mantissa of the logarithm of the dividend. It is important to visualize the lengths of the scale as mantissas of the corresponding numbers. Further study of the rule will show that when the right-hand index is involved in any operation, this indicates, in multiplication, the addition of logarithms in which the sum of the mantissas is greater than 1; or in division, the subtraction of logarithms in which the mantissa corresponding to the divisor is greater than that corresponding to the dividend. See (1) below.

The significance of these statements is that when the left-hand index is involved in an operation, the algebraic sum of the characteristics corresponding to the factors has not been affected—neither increased nor decreased; but when the right-hand index is involved, the algebraic sum of the characteristics corresponding to the factors has been affected, increased by 1 in multiplication or decreased by 1 in division. This statement may be extended as follows:

When the left-hand index only is involved in a series of operations, the characteristic of the logarithm of the result is equal to the algebraic sum of the characteristics of the logarithms of the factors, but whenever the right-hand index is involved in an operation, the characteristic of the logarithm of the result is equal to this algebraic sum plus or minus 1 for each operation in which this index is involved.

This correction (1 for each operation in which the right-hand index is involved) is always applied in the same way as the logarithm of the second factor would be, added in multiplication and subtracted in division. See (2) below.

In performing a series of operations, nothing is regarded except the correction to be applied to the algebraic sum of the characteristics of the logarithms of the factors. These corrections are added cumulatively at each operation, and only the accumulated sum is retained in the mind. We may call this accumulated sum the "accumulated characteristic correction." It is usually very small. We then have the following rule: The characteristic of the logarithm of the result is equal

to the algebraic sum of the characteristics corresponding to all the factors plus the accumulated characteristic correction. See (3) below.

To locate the decimal point, the characteristic for each factor is found as when working with common logarithms, and from the algebraic sum of these and the correction, the decimal point is located as when working with common logarithms.

The unavoidable prolixity of this explanation really disguises the simplicity of the method. The entire process is done mentally, quickly, and with ease.

The rule as stated above is true for all direct scales, but the method can be applied to all scales by visualizing the scale lengths as mantissas. This is really the important part of the process.

(1) It is customary to consider the use of the right-hand indices of scales as involving cologarithms. It may be found helpful in learning to locate the decimal point, to think only of the logarithms of the numbers, and to make all settings always using the left-hand index first.

This will show that whenever the characteristic corresponding to a factor is involved, the result would lie on another scale identical with that being used, and lying immediately to the right or left of it. Crossing the index in this way, of course, indicates a change in the characteristic. This can be shown by squaring and cubing numbers on the fixed scales if it is not immediately obvious.

(2) The position of the slide always indicates whether the characteristic is being affected or not, but the necessity of noticing this can be eliminated by printing at the right-hand index the expression  $\frac{+1}{-1}$ . This will indicate that when that index is involved in multiplication the correction is +1 as is indicated by this being in the numerator, and for division the correction is -1 as is indicated by this being in the denominator.

(3) This rule is true only when these operations are performed in the usual way, where the result is always read on the fixed scale.

MONTHLY NORMALS OF SEA-LEVEL PRESSURE FOR THE UNITED STATES, CANADA, ALASKA, AND THE WEST INDIES.

551.54 (71)(73)(724)(798)

By P. C. DAY, Meteorologist.

[Weather Bureau, Washington, D. C., Mar 3, 1924.]

The tables presented below show the averages of pressure reduced to sea level, at 8 a. m. and 8 p. m., 75th meridian time, respectively, for the regular Weather Bureau stations in the United States, and for the same hours at Canadian stations; also similar normals for points in Alaska, Hawaii, and the West Indies, at the special hours of observation.

The hours in Hawaii have been 8 a. m. and 8 p. m., standard time of the Territory, which is that of the meridian of 157° 30' west, or 5½ hours behind 75th meridian time. The hours at stations in the West Indies have been in most instances 7 a. m. and 7 p. m., 75th meridian time, but these have varied in certain cases to secure better cable facilities. At the Alaskan stations a number of different hours have been used to promote better handling of reports; but the most usual hours have been 8 a. m. and 8 p. m., 135th meridian time, which is four hours behind 75th meridian time.

These values are based upon a period of 20 years' observations, 1901 to 1920, inclusive, and are published for the use of Weather Bureau forecasters and others interested in studies of barometric pressure.

The method of reduction from the observed station pressure, corrected for standard gravity and to a temperature of 32° F., to that of the sea level, is described by Prof. Frank H. Bigelow in the MONTHLY WEATHER REVIEW, January, 1902, 30:13-16.

At stations having records covering less than 20 years, approximate corrections have been made to reduce them to the full period. In cases where only one observation is made daily, data for the other hour have been interpolated by comparison with near-by stations.

In printing the data the first figure of the whole number of inches has been omitted and only the last figure and the decimal are shown, the whole inches being either 30 or 29.

The data for the Canadian stations were furnished through the courtesy of the director of that service, Sir Frederick Stupart; those for Cuba were extracted from the meteorological reports for that island.

Pressure at sea level, 8 a. m. and 8 p. m., 75th meridian time.

| Stations.             | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. |
|-----------------------|----------|-----------|--------|--------|------|-------|-------|---------|------------|----------|-----------|-----------|
| UNITED STATES.        |          |           |        |        |      |       |       |         |            |          |           |           |
| Abilene, Tex.:        |          |           |        |        |      |       |       |         |            |          |           |           |
| 8 a. m. ....          | 0.14     | 0.11      | 0.03   | 9.96   | 9.90 | 9.82  | 9.96  | 9.96    | 0.00       | 0.06     | 0.13      | 0.14      |
| 8 p. m. ....          | 0.11     | 0.06      | 9.96   | 9.88   | 9.82 | 0.04  | 9.98  | 9.88    | 9.93       | 0.01     | 0.09      | 0.10      |
| Albany, N. Y.:        |          |           |        |        |      |       |       |         |            |          |           |           |
| 8 a. m. ....          | 0.10     | 0.05      | 0.07   | 0.00   | 0.00 | 0.00  | 9.98  | 0.03    | 0.10       | 0.11     | 0.07      | 0.03      |
| 8 p. m. ....          | 0.09     | 0.08      | 0.04   | 9.96   | 9.96 | 9.95  | 9.94  | 9.99    | 0.06       | 0.07     | 0.05      | 0.07      |
| Albuquerque, N. Mex.: |          |           |        |        |      |       |       |         |            |          |           |           |
| 8 a. m. ....          | 0.10     | 0.04      | 9.96   | 9.88   | 9.82 | 9.84  | 9.90  | 9.82    | 9.94       | 0.01     | 0.10      | 0.12      |
| 8 p. m. ....          | 0.10     | 0.01      | 9.92   | 9.83   | 9.75 | 9.76  | 9.84  | 9.86    | 9.88       | 9.97     | 0.07      | 0.09      |
| Alpena, Mich.:        |          |           |        |        |      |       |       |         |            |          |           |           |
| 8 a. m. ....          | 0.05     | 0.07      | 0.05   | 0.01   | 0.01 | 0.00  | 9.99  | 0.02    | 0.07       | 0.06     | 0.02      | 0.03      |
| 8 p. m. ....          | 0.04     | 0.06      | 0.03   | 9.99   | 9.97 | 9.96  | 9.96  | 0.00    | 0.04       | 0.04     | 0.02      | 0.03      |
| Amarillo, Tex.:       |          |           |        |        |      |       |       |         |            |          |           |           |
| 8 a. m. ....          | 0.10     | 0.03      | 0.00   | 9.94   | 9.89 | 9.82  | 9.97  | 9.88    | 0.00       | 0.05     | 0.11      | 0.10      |
| 8 p. m. ....          | 0.08     | 0.04      | 9.96   | 9.88   | 9.81 | 9.84  | 9.89  | 9.90    | 9.94       | 0.01     | 0.08      | 0.08      |
| Anniston, Ala.:       |          |           |        |        |      |       |       |         |            |          |           |           |
| 8 a. m. ....          | 0.19     | 0.17      | 0.13   | 0.08   | 0.06 | 0.04  | 0.07  | 0.07    | 0.10       | 0.14     | 0.19      | 0.18      |
| 8 p. m. ....          | 0.16     | 0.13      | 0.08   | 0.01   | 9.99 | 9.98  | 0.01  | 0.01    | 0.04       | 0.09     | 0.15      | 0.15      |
| Apalachicola, Fla.:   |          |           |        |        |      |       |       |         |            |          |           |           |
| 8 a. m. ....          | 0.17     | 0.14      | 0.12   | 0.06   | 0.02 | 0.02  | 0.06  | 0.04    | 0.02       | 0.07     | 0.14      | 0.15      |
| 8 p. m. ....          | 0.14     | 0.10      | 0.08   | 0.01   | 9.98 | 9.98  | 0.01  | 0.01    | 0.00       | 0.04     | 0.12      | 0.12      |
| Asheville, N. C.:     |          |           |        |        |      |       |       |         |            |          |           |           |
| 8 a. m. ....          | 0.16     | 0.15      | 0.12   | 0.05   | 0.05 | 0.04  | 0.06  | 0.07    | 0.12       | 0.15     | 0.19      | 0.17      |
| 8 p. m. ....          | 0.15     | 0.13      | 0.09   | 0.00   | 0.00 | 9.99  | 0.01  | 0.02    | 0.08       | 0.12     | 0.16      | 0.15      |
| Atlanta, Ga.:         |          |           |        |        |      |       |       |         |            |          |           |           |
| 8 a. m. ....          | 0.16     | 0.14      | 0.11   | 0.06   | 0.04 | 0.04  | 0.06  | 0.06    | 0.09       | 0.13     | 0.17      | 0.15      |
| 8 p. m. ....          | 0.15     | 0.12      | 0.08   | 0.01   | 9.99 | 9.98  | 0.01  | 0.02    | 0.05       | 0.10     | 0.14      | 0.14      |
| Atlantic City, N. J.: |          |           |        |        |      |       |       |         |            |          |           |           |
| 8 a. m. ....          | 0.12     | 0.10      | 0.09   | 0.02   | 0.03 | 0.02  | 0.01  | 0.03    | 0.10       | 0.12     | 0.11      | 0.11      |
| 8 p. m. ....          | 0.11     | 0.07      | 0.06   | 9.98   | 9.98 | 9.98  | 9.98  | 0.01    | 0.08       | 0.09     | 0.08      | 0.10      |
| Augusta, Ga.:         |          |           |        |        |      |       |       |         |            |          |           |           |
| 8 a. m. ....          | 0.13     | 0.14      | 0.12   | 0.06   | 0.04 | 0.03  | 0.05  | 0.04    | 0.08       | 0.12     | 0.17      | 0.16      |
| 8 p. m. ....          | 0.14     | 0.10      | 0.06   | 9.99   | 9.97 | 9.97  | 9.99  | 9.99    | 0.03       | 0.07     | 0.12      | 0.14      |
| Baker, Oreg.:         |          |           |        |        |      |       |       |         |            |          |           |           |
| 8 a. m. ....          | 0.15     | 0.12      | 0.04   | 0.04   | 9.99 | 0.01  | 0.01  | 0.01    | 0.04       | 0.12     | 0.16      | 0.19      |
| 8 p. m. ....          | 0.13     | 0.10      | 0.01   | 9.98   | 9.93 | 9.94  | 9.93  | 9.94    | 9.98       | 0.09     | 0.14      | 0.18      |
| Baltimore, Md.:       |          |           |        |        |      |       |       |         |            |          |           |           |
| 8 a. m. ....          | 0.14     | 0.12      | 0.10   | 0.02   | 0.03 | 0.02  | 0.01  | 0.04    | 0.11       | 0.13     | 0.12      | 0.13      |
| 8 p. m. ....          | 0.12     | 0.09      | 0.06   | 9.97   | 9.98 | 9.97  | 9.96  | 0.00    | 0.07       | 0.09     | 0.09      | 0.11      |
| Bentonville, Ark.:    |          |           |        |        |      |       |       |         |            |          |           |           |
| 8 a. m. ....          | 0.13     | 0.12      | 0.06   | 0.00   | 9.97 | 9.98  | 0.01  | 0.01    | 0.06       | 0.10     | 0.13      | 0.14      |
| 8 p. m. ....          | 0.12     | 0.10      | 0.01   | 9.94   | 9.90 | 9.90  | 9.94  | 9.94    | 9.98       | 0.05     | 0.10      | 0.11      |
| Billings, Mont.:      |          |           |        |        |      |       |       |         |            |          |           |           |
| 8 a. m. ....          | 0.13     | 0.16      | 0.07   | 0.01   | 9.94 | 9.94  | 9.99  | 9.99    | 0.03       | 0.10     | 0.14      | 0.14      |
| 8 p. m. ....          | 0.12     | 0.12      | 0.03   | 9.95   | 9.90 | 9.88  | 9.91  | 9.91    | 9.97       | 0.07     | 0.13      | 0.14      |
| Binghamton, N. Y.:    |          |           |        |        |      |       |       |         |            |          |           |           |
| 8 a. m. ....          | 0.08     | 0.07      | 0.06   | 0.00   | 0.01 | 0.01  | 0.00  | 0.01    | 0.12       | 0.12     | 0.08      | 0.07      |
| 8 p. m. ....          | 0.08     | 0.07      | 0.04   | 9.97   | 9.97 | 9.96  | 9.96  | 0.00    | 0.07       | 0.08     | 0.06      | 0.07      |
| Birmingham, Ala.:     |          |           |        |        |      |       |       |         |            |          |           |           |
| 8 a. m. ....          | 0.19     | 0.17      | 0.13   | 0.07   | 0.05 | 0.04  | 0.07  | 0.07    | 0.09       | 0.13     | 0.19      | 0.18      |
| 8 p. m. ....          | 0.10     | 0.13      | 0.08   | 0.01   | 9.97 | 9.98  | 0.01  | 0.01    | 0.03       | 0.09     | 0.16      | 0.16      |

\* Values interpolated.