AUXILIARY TABLES

TO FACILITATE THE CALCULATIONS

OF THE

SURVEY OF INDIA.

THIRD EDITION.

REVISED AND EXTENDED UNDER THE DIRECTION OF

LIEUT.-COLONEL H. R. THUILLIER, R.E.,

SURVEYOR GENERAL OF INDIA

BY

COLONEL C. T. HAIG, R.E.,

DEPUTY SURVEYOR GENERAL IN CHARGE OF THE TRIGONOMETRICAL BRANCH OF THE SURVEY OF INDIA.

Dehra Dun:

PRINTED AT THE OFFICE OF THE TRIGONOMETRICAL BRANCH, SURVEY OF INDIA.

B. V. HUGHES.

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PREFACE.

Thirty-six years have elapsed since the publication of the first edition of the Auxiliary Tables of this Department, which was issued in 1851 under the title "Tables "to facilitate the computations of a trigonometrical survey and the projection of maps "for India. Computed and arranged by Babu Radhanath Sikdhar, Chief Computer in the "Surveyor General's Office." This edition contained but seventeen tables, two of which consisted of symbols, formulæ and constants. In 1868 this was "revised and extended "under the direction of Lieut.-Colonel J. T. Walker, R.E., F.R.S., &c., Superintendent "of the Great Trigonometrical Survey of India, by J. B. N. Hennessey, Esq., F.R.A.S., "Deputy Superintendent 1st Grade, Great Trigonometrical Survey, in charge Computing "Office," and issued as a second edition under the title of "Auxiliary Tables to facilitate "the calculations of the Survey Department of India." This edition contained twenty-six tables which were also, like those of the first edition, confined to the requirements of a trigonometrical survey and the projection of maps. Since 1868, however, ten other tables were from time to time added, which were generally numbered in continuation of the twenty-six as they were brought out, and now that the 1868 edition has been exhausted a new issue is imperatively called for, which of necessity requires a new arrangement of the old tables, grouping those together which relate to the same subjects; so that it has been impossible to retain the old familiar numbering by which many a table was popularly designated in the department. The present issue is moreover somewhat enlarged in scope and includes tables that will be useful to geographical explorers and save them the trouble of carrying other and perhaps cumbersome compilations, while at the same time it includes some new tables within the old scope which will also be found useful. The range of latitude—where it is the argument—has been somewhat enlarged, and now extends in all cases from the equator to 40°, except in Tables XXIX, XXX and XXXVI to XLI inclusive in which it extends to 46°.

This edition contains sixty-three tables of which the following numbers were to be found in the previous editions with the less extended range of latitude:—I, II, III, V to XIV, XXIV to XXX, XXXII, XXXIII, XXXV to XL and XLIX to LI. Four concise tables, XLV to XLVIII, occupying but one opening now take the place of the more voluminous table of Mile Equivalents in Feet and Links.

A set of four Star Charts containing all the stars of the first, second and third magnitudes, originally published by General Walker in 1873 for the use of geographical explorers, has been reduced to a suitable scale and inserted in this edition.

For the assistance of the ordinary computer the Tables are preceded by the usual explanations regarding their use, and these are now supplemented by additional explanations in smaller type, shewing how the tables themselves or the formulæ on which they are based have been obtained: with these the ordinary computer need have no concern.

To assist officers employed beyond the Frontier in reducing the astronomical observations that may require to be taken, a few examples of such calculations are added in an Appendix.

The preparation and printing of these Tables have been accomplished under the superintendence of Mr. W. H. Cole, M.A., Deputy Superintendent in charge of the Computing and Printing Offices, but my acknowledgments are also due to Mr. J. Eccles, M.A., Assistant Superintendent, for the preparation of the explanations and appendix and for the trouble he has taken to make them as complete as possible.

July 1887.

C. T. HAIG, COLONEL, R.E.,

Deputy Surveyor General,

In charge of Trigonometrical Surveys.

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TABLES AND THEIR EXPLANATION.

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SYMBOLS AND FORMULÆ.

a = Equatorial radius of the earth.

b = Polar radius " "

λ = Geodetic latitude.

c = Compression or ellipticity $= \frac{a-b}{a}$.

e = Eccentricity $= \left\{\frac{a^2-b^2}{a^2}\right\}^{\frac{1}{2}}$.

ν = Normal to the meridian at λ terminated by the minor axis

$$= \frac{a}{(1 - e^2 \sin^2 \lambda)^{\frac{1}{2}}}.$$

ρ = Radius of curvature to the meridian at λ

$$= \frac{a\,(1 - e^2)}{(1 - e^2 \sin^2 \lambda)^{\frac{3}{2}}}.$$

ρ_1 = Radius of curvature of an oblique section at an azimuth of A in latitude λ

$$= \frac{\rho\,\nu}{\rho \sin^2 A + \nu \cos^2 A}.$$

CONSTANTS EMPLOYED IN THE CALCULATION OF THE TABLES.

EVEREST'S CONSTANTS, 1ST SET.

See *Account of the Measurement of an Arc of the Meridian between the parallels of* 18° 3′ *and* 24° 7′, A.D. 1830, page 115.

a =	20922931·80 feet	$\log a = 7{\cdot}320\ 6225\ 395$
b =	20853374·58 "	$\log b = 7{\cdot}319\ 1763\ 443$
c =	$0{\cdot}003324449014 = \frac{1}{300{\cdot}8}$	$\log c = \bar{3}{\cdot}521\ 7196\ 767$
e^2 =	0·00663784607	$\log e^2 = \bar{3}{\cdot}822\ 0271\ 770$
$(1 - e^2)$ =	0·99336215393	$\log (1 - e^2) = \bar{1}{\cdot}997\ 1076\ 098$

AUXILIARY TABLES

TO FACILITATE THE CALCULATIONS

OF THE

SURVEY OF INDIA.

EXPLANATION OF THE TABLES.

TABLE I.—*Normals terminated by the Minor Axis, and their Logarithms.*

The Normals are given for every 10′ of latitude between the parallels of 0° and 40° to the nearest tenth of a foot, and their logarithms to nine places of decimals.

The formula by which they have been computed, *viz.*,

$$\nu = \frac{a}{(1 - e^2 \sin^2 \lambda)^{\frac{1}{2}}},$$

follows at once from the simple geometry of the ellipse, a being the semi-axis major of the ellipse, e the eccentricity and ν the normal at a point whose latitude is λ.

The argument with which to enter the table is the given latitude, and the corresponding Normal must be found by interpolation either in the ordinary way or, where extreme accuracy is required, according to the method exhibited in the foot note on the next page.

EXAMPLE.—To find the Normal at a point in latitude 9° 15′ 25″·7.

1°. Approximately.

In latitude 9° 10′	Normal	=	20924694·4 feet
(Difference = 64·1) × 5′·43		=	+ 34·8 „
Therefore in latitude 9° 15′ 25″·7	Normal	=	20924729·2 feet

2°. Rigorously*

If F = the value of the Normal corresponding to 9° 10′ 0″

and $F^{(n)}$ = „ „ „ 9 15 25·7

where n = 5′ 25″·7 reduced to the decimal of 10′

= ·543

the formula in the Note gives

$$F^{(n)} = F + n\,a + \frac{n\,(n-1)}{1.\,2}\,b + \frac{n\,(n-1)\,(n-2)}{1.\,2.\,3}\,c + \&c.,$$

---

* NOTE.—*On Interpolation by Differences of any order.*

(See Chauvenet's Astronomy Vol. I.)

Let it be required to determine intermediate values of a function from tabulated values corresponding to equidistant values of the variable on which they depend.

Let T, $T + w$, $T + 2\,w$, $T + 3\,w$, &c., express equidistant values of the variable, F, $F(^1)$, $F(^2)$, $F(^3)$, &c., corresponding values of the given function, and let the differences of the first, second and following orders be formed as expressed in the following table:—

Argument.	Function.	1st Diff.	2nd Diff.	3rd Diff.	4th Diff.	5th Diff.	6th Diff.
T	F						
		a					
$T + w$	$F(^1)$		b				
		$a(^1)$		c			
$T + 2\,w$	$F(^2)$		$b(^1)$		d		
		$a(^2)$		$c(^1)$		e	
$T + 3\,w$	$F(^3)$		$b(^2)$		$d(^1)$		f
		$a(^3)$		$c(^2)$		$e(^1)$	
$T + 4\,w$	$F(^4)$		$b(^3)$		$d(^2)$		
		$a(^4)$		$c(^3)$			
$T + 5\,w$	$F(^5)$		$b(^4)$				
		$a(^5)$					
$T + 6\,w$	$F(^6)$						

These differences are found by subtracting each number from the one below it and the proper algebraical signs must be prefixed. The differences of any order are found from those of the preceding order in the same manner as the first differences are found from the given functions.

The even differences (2nd, 4th, &c.,) fall in the same lines as the arguments and functions and the odd differences (1st, 3rd, &c.,) between these lines.

Now, denoting the value of the function corresponding to a value of the argument $T + nw$ by $F^{(n)}$ we have by algebra

$$F^{(n)} = F + n\,a + \frac{n\,(n-1)}{1.\,2}\,b + \frac{n\,(n-1)\,(n-2)}{1.\,2.\,3}\,c + \frac{n\,(n-1)\,(n-2)\,(n-3)}{1.\,2.\,3.\,4}\,d + \&c.,$$

in which the coefficients are those of the nth power of a binomial. If n be taken successively 0, 1, 2, 3, &c., we shall obtain the function F, $F(^1)$, $F(^2)$, $F(^3)$, &c., and intermediate values are found by using fractional values of n.

The formula is usually applied only to interpolating between the function from which we set out and the next following one, in which case n is less than unity.

To find the proper value of n in each case let $T + t$ be the value of the argument for which we wish to interpolate a value of the function: then

$$n\,w = t \quad \text{and} \quad n = \frac{t}{w}$$

that is, n is the value of t reduced to a fraction of the interval w.

EXAMPLE.—Suppose that, instead of being given for every hour as it is, the Moon's Right Ascension had been given in the Nautical Almanac for every twelfth hour as follows:—

where the 1st, 2nd, and 3rd differences, a, b, c, are found from the following data given in the table:

			Differences. 1st	2nd	3rd
In latitude	9° 10′ . . .	Normal = 20924694·4			
			+ 64·1		
„	9° 20′ . . .	„ = 20924758·5		+ 1·1	
			+ 65·2		0·0
„	9° 30′ . . .	„ = 20924823·7		+ 1·1	
			+ 66·3		
„	9° 40′ . . .	„ = 20924890·0			

So that $a = +\,64\cdot1,\quad b = +\,1\cdot1,\quad c = 0\cdot0,$

therefore

$$F^{(n)} = 20924694\cdot4 + 34\cdot81 - 0\cdot14,$$

$$= 20924729\cdot1.$$

Hence the Normal at a point in latitude 9° 15′ 25″·7 is 20924729·1 feet.

---

	h	☽'s R. A. h m s	1st Diff. m s	2nd Diff. s	3rd Diff. s	4th Diff. s	5th Diff. s
1886, May 28,	0	0 20 54·74					
			+ 23 29·98				
„ 28,	12	0 44 24·72		+20·88			
			23 50·86		+5·05		
„ 29,	0	1 8 15·58		25·93		−0·29	
			24 16·79		4·76		−0·22
„ 29,	12	1 32 32·37		30·69		0·51	
			24 47·48		4·25		
„ 30,	0	1 57 19·85		34·94			
			25 22·42				
„ 30,	12	2 22 42·27					

Required the Moon's Right Ascension on May 28, at 6^h.

Here T = May 28, 0^h; $t = 6^h$; $w = 12^h$, $\therefore n = \frac{6^h}{12^h} = \frac{1}{2}$; and if we denote the coefficients of a, b, c, d, e by A, B, C, D, E, we have

$$F = 0^h\ 20^m\ 54^s\cdot74$$

$a = +\ 23^m\ 29^s\cdot98,$	$A = n = +\frac{1}{2},$	$Aa = +\ 11\ 44\cdot99$
$b = +\ 20\cdot88,$	$B = A\,\frac{n-1}{2} = -\frac{1}{8},$	$Bb = -\ 2\cdot61$
$c = +\ 5\cdot05,$	$C = B\,\frac{n-2}{3} = +\frac{1}{16},$	$Cc = +\ 0\cdot32$
$d = -\ 0\cdot29,$	$D = C\,\frac{n-3}{4} = -\frac{5}{128},$	$Dd = +\ 0\cdot01$
$e = -\ 0\cdot22,$	$E = D\,\frac{n-4}{5} = +\frac{7}{256},$	$Ee = -\ 0\cdot01$

Therefore

☽'s Right Ascension on May 28, 1886, at $6^h = F^{(\frac{1}{2})} = 0\ 32\ 37\cdot44$

which is the value given in the Nautical Almanac for that hour.

TABLE II.—*Radii of Curvature to the Meridian, and their Logarithms.*

The Radii of Curvature are given in feet for every 10′ of latitude between the parallels 0° and 40° to the nearest tenth of a foot, and their logarithms to nine places of decimals.

The formula by which they have been computed, *viz.*,

$$\rho = \frac{a\,(1 - e^2)}{(1 - e^2 \sin^2 \lambda)^{\frac{3}{2}}},$$

follows very simply from that given for ν on page 9, ρ being the Radius of Curvature to the meridian at a point whose latitude is λ.

The argument with which to enter the table is the given latitude, and the corresponding Radius of Curvature must be found by interpolation in exactly the same way that the normal is found from Table I.

TABLE III.—*Logarithms of the Factor* $\frac{(\rho + \nu)^2 \operatorname{cosec} 1''}{8\rho^2 \nu^2}$ *for computing the Spherical Excess of a Triangle.*

The Spherical Excess of a triangle *ABC* may be found with all necessary accuracy from any one of the formulæ

$$e'' = a\,b \sin C \times \frac{\operatorname{cosec} 1''}{2\,(\text{radius})^2};$$

$$e'' = \frac{c^2 \sin A \sin B}{\sin C} \times \frac{\operatorname{cosec} 1''}{2\,(\text{radius})^2};$$

$$e'' = 2 \text{ area of triangle} \times \frac{\operatorname{cosec} 1''}{2\,(\text{radius})^2};$$

where e'' is the Spherical Excess in seconds.

The factor $\frac{\operatorname{cosec} 1''}{2\,(\text{radius})^2}$ has been computed with a radius $= \frac{\rho\,\nu}{\rho \cos^2 45 + \nu \sin^2 45} = \frac{2\,\rho\,\nu}{\rho + \nu}$, the radius of curvature of an oblique section passing through the centre of the spheroid and having an azimuth of 45°, where ρ is the radius of curvature of the meridian and ν the normal terminated by the minor axis, for the mean latitude of the triangle, ρ and ν being taken in feet. The factor thus becomes $\frac{(\rho + \nu)^2 \operatorname{cosec} 1''}{8\,\rho^2\,\nu^2}$, and its logarithm is given in the table to five places of decimals for each degree of latitude from 0° to 40°.

EXAMPLE.—For a triangle of which the mean latitude is 24°·28 :—

Given	log a in feet	=	4·97554
	log b ,,	=	4·98531
	log sin C	=	$\bar{1}$·97054
Tabular log for lat. 24°·28		=	$\overline{10}$·37407
$e'' = 2''·020$	log	=	0·30546

The Spherical Excess of each angle of the triangle may be considered $= \frac{e''}{3}$ when the lengths of the sides do not exceed 100 miles.

TABLE IV.—*For determining the Spherical Excess in Secondary Operations.*

This table* is intended to be used only in Secondary Operations where the Spherical Excess is not required with greater accuracy than the nearest tenth of a second, or in observations to distant snow peaks when the nearest second of Spherical Excess is sufficient.

In using the table the area of the triangle will be found with sufficient accuracy by measuring the base and perpendicular with a pair of compasses from a working chart and taking their lengths from a scale.

Having obtained the area, enter the table with it as the argument, and the Spherical Excess will be found in the column corresponding to the mean latitude of the triangle which need not be known with greater accuracy than the nearest 5°.

EXAMPLE.—To find the Spherical Excess of a triangle whose area is 545 square miles in mean latitude of 26°.

For area of	500	square miles	...	Spherical Excess	=	6″·60
,,	40	,,	...	,,	=	·53
,,	5	,,	...	,,	=	·07
For area of	545	square miles	...	Spherical Excess	=	7·20.

Therefore

Spherical Excess of the triangle = 7″·2.

---

* The table is further useful in readily calculating with fair approximation the effect of neglecting spherical excess in a triangulation of some magnitude.

Suppose that a triangulation of an average width of 5 miles proceeds, at any azimuth, for a distance of 200 miles, then the spherical excess applicable is 13″ of which one half or say 7″ may be applied to each flank.

The computations being made with plane angles will give erroneous values of the azimuth of the terminal side, that obtained from the {left / right} flank being too {great / small} by half the spherical excess (= 7″), while the difference in latitudes and longitudes will depend on the direction in which the series runs.

1st.—For a Meridional Series.

The latitudes of the two extremities of the terminal side will be insensibly affected.

The longitude of the {eastern / western} extremity will be {too small / ,, great} by the subtense of $\frac{7''}{2}$ at 200 miles, *i.e.* by 17¼ feet or 0″·19.

2nd.—For a Longitudinal Series.

The longitudes of the two extremities would be practically unaffected.

The latitude of the {northern / southern} extremity would be {too small / ,, great} by the subtense of $\frac{7''}{2}$ at 200 miles, *i.e.* by 17¼ feet or 0″·17.

3rd.—For a series in a direction whose azimuth is A.

In this case, for each extremity of the terminal side the subtense of 17¼ feet will be divided up between the latitude and longitude in the proportion of sin A : cos A.

It must also be noted that if the length of the terminal side were computed from the latitudes and longitudes, it would be 35 feet in defect of that given by the triangular calculations.

TABLE V.—*Reciprocals of Numbers to facilitate the Computation of Weights of Observed Angles.*

This table has been prepared for use in the calculation of 'weights of observed angles' which are employed in the reduction of geodetical figures by the 'method of least squares'.

The table has been so constructed that each number in the second column is the reciprocal, to two places of decimals, of all quantities between the corresponding upper and lower numbers in the first column.

Thus the reciprocal of		8·000	being	·125
„	„	7·407	„	·135
„	„	6·897	„	·145

any number between 8·000 and 7·407 has a reciprocal between ·125 and ·135 *i.e.* ·13 to two places of decimals; and any number between 7·407 and 6·897 has a reciprocal ·14.

TABLE VI.—*Logarithms for facilitating the Computation of Terrestrial Latitudes, Longitudes and Reverse Azimuths.*

This table gives the logarithms of the quantities P, Q, R, S, T, U, V, W, X, Y, Z used in the forms employed in this Department for the computation of terrestrial Latitudes, Longitudes and Reverse Azimuths.

The formulæ on which the calculations are based are due to Puissant and are demonstrated in the "Measurement of the Meridional Arc of India, 1847" by Colonel Everest and also in Vol. II of the *Account of the Operations of the G. T. Survey of India.*

Suppose that **A** and **B** are two stations and that the latitude and longitude of **A** and the azimuth of **B** from **A** are given, together with the distance at the mean sea level between the two stations, and it is required to compute the latitude and longitude of **B** and the azimuth of **A** from **B**.

We have given :—

λ = latitude of **A**,

L = longitude of **A**,

A = azimuth of **B** from **A** measured from S. by W. round the horizon,

c = distance at mean sea level between **A** and **B**,

and we require :—

λ' = latitude of **B**,

L' = longitude of **B**,

B = azimuth of **A** from **B** measured in the same way,

If we put

$$\lambda' = \lambda + \Delta\lambda; \qquad L' = L + \Delta L; \qquad \text{and } B = \overline{\pi + A} + \Delta A;$$

It will be seen that we require the differences

$$\Delta\lambda, \ \Delta L \text{ and } \Delta A.$$

each of which consists of four parts :—

$$\delta_1\lambda,\quad \delta_2\lambda,\quad \delta_3\lambda,\quad \delta_4\lambda,$$

$$\delta_1 L,\quad \delta_2 L,\quad \delta_3 L,\quad \delta_4 L,$$

$$\delta_1 A,\quad \delta_2 A,\quad \delta_3 A,\quad \delta_4 A.$$

The formulæ for $\Delta\lambda$, ΔL and ΔA as given in Vol. II of the *Account of the Operations &c.*, pages 116 to 118, are as follows :—

$$\Delta\lambda = \text{in seconds of arc}\left\{\begin{array}{l} -\frac{c}{\rho}\cos A \operatorname{cosec} 1'' \\ -\frac{1}{1.2}\frac{c^2}{\rho.\nu}\sin^2 A\tan\lambda\operatorname{cosec} 1'' \\ -\frac{3}{4}\frac{c^2}{\rho.\nu}\frac{e^2}{1-e^2}\cos^2 A\sin 2\lambda\operatorname{cosec} 1'' \\ +\frac{1}{1.2.3}\frac{c^3}{\rho.\nu^2}\sin^2 A\cos A(1+3\tan^2\lambda)\operatorname{cosec} 1'' \end{array}\right\} = \left\{\begin{array}{l} +\delta_1\lambda \\ +\delta_2\lambda \\ +\delta_3\lambda \\ +\delta_4\lambda \end{array}\right\}$$

$$\Delta L = \text{in seconds of arc}\left\{\begin{array}{l} -\frac{c}{\nu}\frac{\sin A}{\cos\lambda}\operatorname{cosec} 1'' \\ +\frac{1}{1.2}\frac{c^2}{\nu^2}\frac{\sin 2A\tan\lambda}{\cos\lambda}\operatorname{cosec} 1'' \\ -\frac{1}{1.2.3}\frac{c^3}{\nu^3}\frac{(1+3\tan^2\lambda)\sin 2A\cos A}{\cos\lambda}\operatorname{cosec} 1'' \\ +\frac{1}{1.2.3}\frac{c^3}{\nu^3}\frac{2\sin^3 A\tan^2\lambda}{\cos\lambda}\operatorname{cosec} 1'' \end{array}\right\} = \left\{\begin{array}{l} +\delta_1 L \\ +\delta_2 L \\ +\delta_3 L \\ +\delta_4 L \end{array}\right\}$$

$$\Delta A = \text{in seconds of arc}\left\{\begin{array}{l} -\frac{c}{\nu}\sin A\tan\lambda\operatorname{cosec} 1'' \\ +\frac{1}{4}\frac{c^2}{\nu^2}\left(1+2\tan^2\lambda+\frac{e^2\cos^2\lambda}{1-e^2}\right)\sin 2A\operatorname{cosec} 1'' \\ -\frac{c^3}{\nu^3}\left(\frac{5}{6}+\tan^2\lambda\right)\frac{\tan\lambda}{2}\sin 2A\cos A\operatorname{cosec} 1'' \\ +\frac{1}{2.3}\frac{c^3}{\nu^3}\sin^3 A\tan\lambda(1+2\tan^2\lambda)\operatorname{cosec} 1'' \end{array}\right\} = \left\{\begin{array}{l} +\delta_1 A \\ +\delta_2 A \\ +\delta_3 A \\ +\delta_4 A \end{array}\right\}$$

where ρ is the radius of curvature of the meridian and ν the normal terminated by the minor axis, both at **A**, and e the eccentricity of the ellipse.*

In these formulæ put,

$$P = \frac{\operatorname{cosec} 1''}{\rho};\quad Q = \frac{\rho}{\nu};\quad R = \frac{1}{2\rho};\quad S = 2\sec\lambda\frac{\rho}{\nu};\quad T = \left(2\tan^2\lambda+\frac{\nu}{\rho}\right)\frac{\cot\lambda\cos\lambda}{2};$$

$$U = \left(\frac{1}{3}+\tan^2\lambda\right)\sec^2\lambda\operatorname{cosec}\lambda\,\frac{\rho}{\nu^3}\,\frac{2(1-e^2)}{3e^2};\quad V = \frac{\sin\lambda\cos\lambda}{\left(2\tan^2\lambda+\frac{\nu}{\rho}\right)}\,\frac{\nu}{\rho}\,\frac{3e^2}{1-e^2};$$

$$W = \frac{\frac{5}{6}+\tan^2\lambda}{\frac{1}{3}+\tan^2\lambda}\sin\lambda;\quad X = \frac{\frac{1}{6}+\frac{1}{2}\tan^2\lambda}{\frac{5}{6}+\tan^2\lambda}\cot\lambda\,\frac{\nu}{\rho};\quad Y = \frac{2\tan^2\lambda\sec\lambda}{1+3\tan^2\lambda}\,\frac{\rho}{\nu};\quad Z = \frac{\frac{1}{2}+\tan^2\lambda}{\tan\lambda\sec\lambda}.$$

---

* The above values of $\Delta\lambda$, ΔL, and ΔA are only the first three terms of infinite series in which each of them may be expanded. The magnitudes of the neglected terms depend on c and λ. In the operations of this Survey c averages about 30 miles in hilly tracts and 11 miles in the plains: a very few of the sides of principal triangles exceed 60 miles but not one is as great as 70 miles: the latitude λ ranges in the Tables from 0° to 40°. If then we take $c = 70$ miles and $\lambda = 40°$ and compute the maximum values of the terms in $\frac{c^4}{\nu^4}$ (from the formulæ as given in Vol. II, page 119) we find that they and the azimuths on which they occur are as follows :—in $\Delta\lambda$, 0″·0024 on azimuth 40° 25′; in ΔL, 0″·0079 on azimuth 23° 50′; in ΔA, 0″·0087 on azimuth 24° 21′, which are within the limits of instrumental errors.

The terms $\delta_1 \lambda$, &c., $\delta_1 L$, &c., $\delta_1 A$, &c., assume the forms:—

$\delta_1 \lambda = \mathrm{P} \,.\, \cos A \,.\, c$; $\delta_1 L = \delta_1 \lambda \,.\, \mathrm{Q} \,.\, \sec \lambda \tan A$; $\delta_1 A = \delta_1 L \sin \lambda$;

$\delta_2 \lambda = \delta_1 A \,.\, \mathrm{R} \,.\, \sin A \,.\, c$; $\delta_2 L = \delta_2 \lambda \,.\, \mathrm{S} \,.\, \cot A$; $\delta_2 A = \delta_2 L \,.\, \mathrm{T}$;

$\delta_3 \lambda = \delta_2 A \,.\, \mathrm{V} \,.\, \cot A$; $\delta_3 L = \delta_3 \lambda \,.\, \mathrm{U} \,.\, \sin A \,.\, c$; $\delta_3 A = \delta_3 L \,.\, \mathrm{W}$;

$\delta_4 \lambda = \delta_3 A \,.\, \mathrm{X} \,.\, \tan A$; $\delta_4 L = \delta_4 \lambda \,.\, \mathrm{Y} \,.\, \tan A$; $\delta_4 A = \delta_4 L \,.\, \mathrm{Z}$;

which are the expressions used in the form for computation. It will be noticed that by this method the terms are found consecutively each from the preceding one. The proper signs to be given to the quantities will be found in Table VII.

Each of the quantities P, Q is given in logarithms to 7 places of decimals
„ „ R, S, T „ 5 „ „
„ „ U, V, W, X, Y, Z „ 3 „ „
} for every 10′ of latitude from 0° to 40°.

For latitudes other than those given in the table the quantities must be found by interpolation.

Example.—To find P for latitude 24° 8′ 3″·723 or 24° 8′·062

From the table, P for 24° 0′ = $\bar{3}$·9959792

Tab. difference for 10′ = − 94

Therefore „ 8′·062 = − 8·062 × 9·4 = − 76

Therefore P for 24° 8′ 3″·723 = $\bar{3}$·9959716

The other quantities must be treated in a similar way.

To illustrate the use of this table we will now give examples of computations of latitude, longitude and reverse azimuth both of a principal and of a secondary station.

Example 1.—Principal Triangulation. Given

Stations.	Spherical Angles.	Log Sides opposite Angles.
	° ′ ″	Feet.
Bhaorása H.S.	56 22 7·472	4·9853089
Párdho H.S.	69 8 3·472	5·0354039
Handiapáro H.S.	54 29 51·076	4·9755350

Latitude of Bhaorása = 24° 8′ 3″·728, of Párdho = 24° 16′ 17″·867

Longitude „ = 78° 3′ 7″·913, „ = 77° 48′ 40″·557

Azimuth of Handiapáro at Bhaorása = 178° 15′ 53″·888

„ „ Párdho = 232° 39′ 47″·353

To find the latitude and longitude of Handiapáro and the azimuths of Bhaorása and Párdho at Handiapáro.

Computation of Latitudes, Longitudes and Azimuths of Principal Stations.

Stn. **A**, Bhaorása H.S. λ = 24° 8′ 3″·728, L = 78 3 7·913 — Stn. **B**, Handiapáro H.S. A = 178° 16′ 53″·888, Log c = 5·0354039

P	$\bar{3}$·9959716	λ = 24 8 3·728
Cos A	$\bar{1}$·9998009	Δλ = + 17 54·404
c	5·0354039	λ′ = 24 25 58·132
(δ_1 λ)	3·0311764	+ 1074·4257
Q	$\bar{1}$·9975898	L = 78 3 7·913
Sec λ	0·0397247	ΔL = − 35·549
Tan A	$\bar{2}$·4813174	L′ = 78 2 32·364
(δ_1 L)	1·5498083	− 35·4657
Sin λ	$\bar{1}$·6115937	
(δ_1 A)	1·1614020	− 14·5011
R	$\bar{8}$·38051	π + A = 358 15 53·888
Sin A	$\bar{2}$·48112	ΔA = − 14·619
c	5·03540	B = 358 15 39·269
(δ_2 λ)	$\bar{3}$·05843	− ·0011
S	0·33835	
Cot A	1·51868	
(δ_2 L)	$\bar{2}$·91546	− ·0823
T	0·15624	
(δ_2 A)	$\bar{1}$·07170	− ·1180
V	$\bar{3}$·728	
Cot A	1·519	
(δ_3 λ)	$\bar{2}$·319	− ·0208
U	$\bar{6}$·869	
Sin A	$\bar{2}$·481	
c	5·035	
(δ_3 L)	$\bar{4}$·704	− ·0005
W	$\bar{1}$·899	
(δ_3 A)	$\bar{4}$·603	− ·0004
X	$\bar{1}$·763	
Tan A	$\bar{2}$·481	
(δ_4 λ)	$\bar{6}$·847	− ·0000
Y	$\bar{1}$·436	
Tan A	$\bar{2}$·481	
(δ_4 L)	$\bar{8}$·764	+ ·0000
Z	0·154	
(δ_4 A)	$\bar{8}$·918	+ ·0000

Fixed Station A.	Deduced Station B, Handiapáro H.S. Latitude.	Longitude.	Azimuth.
	° ′ ″	° ′ ″	° ′ ″
Bhaorása H.S.	24 25 58·132	78 2 32·364	358 15 39·269
Párdho H.S.	·131	·364	·269
Mean	24 25 58·132	78 2 32·364	358 15 39·269

Stn. **A**, Párdho H.S. λ = 24° 16′ 17″·867, L = 77 48 40·557 — Stn. **B**, Handiapáro H.S. A = 232° 39′ 47″·353, Log c = 4·9853089

P	$\bar{3}$·9959639	λ = 24 16 17·867
Cos A	$\bar{1}$·7828307	Δλ = + 9 40·264
c	4·9853089	λ′ = 24 25 58·131
(δ_1 λ)	2·7641035	+ 580·9028
Q	$\bar{1}$·9975950	L = 77 48 40·557
Sec λ	0·0401924	ΔL = + 13 51·807
Tan A	0·1175821	L′ = 78 2 32·364
(δ_1 L)	2·9194730	+ 830·7551
Sin λ	$\bar{1}$·6139084	
(δ_1 A)	2·5333814	+ 341·4927
R	$\bar{8}$·38051	π + A = 52 39 47·353
Sin A	$\bar{1}$·90041	ΔA = + 5 42·992
c	4·98531	B = 52 45 30·345
(δ_2 λ)	$\bar{1}$·79961	− ·6304
S	0·33882	
Cot A	$\bar{1}$·88242	
(δ_2 L)	0·02085	+ 1·0492
T	0·15458	
(δ_2 A)	0·17543	+ 1·4977
V	$\bar{3}$·728	
Cot A	$\bar{1}$·882	
(δ_3 λ)	$\bar{3}$·785	− ·0061
U	$\bar{6}$·870	
Sin A	$\bar{1}$·900	
c	4·985	
(δ_3 L)	$\bar{3}$·540	+ ·0035
W	$\bar{1}$·900	
(δ_3 A)	$\bar{3}$·440	+ ·0028
X	$\bar{1}$·762	
Tan A	0·118	
(δ_4 λ)	$\bar{3}$·320	− ·0021
Y	$\bar{1}$·440	
Tan A	0·118	
(δ_4 L)	$\bar{4}$·878	− ·0008
Z	0·153	
(δ_4 A)	$\bar{3}$·031	− ·0011

Fixed Station A.	Deduced Station B, Handiapáro H.S. Latitude.	Longitude.	Azimuth.
			° ′ ″
Párdho H.S.	...	...	52 45 30·345
Bhaorása H.S.	...	...	·345
Mean	...	...	52 45 30·345

EXAMPLE 2.—Secondary Triangulation. Given:—

Stations.	Angles.	Log Sides opposite Angles.
	° ′ ″	*Feet.*
Shadau s.	62 53 15	4·8399742
Maláni „	56 52 30	4·8135035
Kingriáli h.s.	60 14 15	4·8290939

Latitude of Shadau s. = 32° 3′ 34″·03, of Maláni s. = 32° 7′ 22″·66
Longitude „ „ = 71 3 29·80, „ „ = 71 15 46·72

Azimuth of Kingriáli h.s. at Shadau s. = 187° 2′ 0″
„ „ „ Maláni „ = 126 54 15

To find the latitude and longitude of Kingriáli h.s. and the azimuths of Shadau s. and Maláni s. at Kingriáli h.s.

COMPUTATION OF LATITUDES, LONGITUDES AND AZIMUTHS OF SECONDARY STATIONS.

Stn. **A**, Shadau s. λ = 32° 3′ 34″·03 L = 71 3 29 ·80		Stn. **B**, Kingriáli h.s. A = 187° 2′ 0″ Log c = 4·8135035	Stn. **A**, Maláni s. λ = 32° 7′ 22″·66 L = 71 15 46 ·72		Stn. **B**, Kingriáli h.s. A = 126° 54′ 15″ Log c = 4·8399742
P	$\bar{3}$·9954755	λ = 32 3 34·03	P	$\bar{3}$·9954712	λ = 32 7 22·66
Cos A	$\bar{1}$·9967196	$\Delta\lambda$ = + 10 39·28	Cos A	$\bar{1}$·7784974	$\Delta\lambda$ = + 6 50·64
c	4·8135035	λ' = 32 14 13·31	c	4·8399742	λ' = 32 14 13·30
$(\delta_1 \lambda)$	2·8056986	+ 639·291	$(\delta_1 \lambda)$	2·6139428	+ 411·096
Q	$\bar{1}$·9979206	L = 71 3 29·80	Q	$\bar{1}$·9979235	L = 71 15 46·72
Sec λ	0·0718614	ΔL = + 1 32·80	Sec λ	0·0721633	ΔL = − 10 44·12
Tan A	$\bar{1}$·0912277	L' = 71 5 2·60	Tan A	0·1243977	L' = 71 5 2·60
$(\delta_1 L)$	1·9667083	+ 92·621	$(\delta_1 L)$	2·8084273	− 643·320
Sin λ	$\bar{1}$·7249301		Sin λ	$\bar{1}$·7256978	
$(\delta_1 A)$	1·6916384	+ 49·2	$(\delta_1 A)$	2·5341251	− 342·1
R	$\bar{8}$·38002	$\pi + A$ = 7 2 0	R	$\bar{8}$·38001	$\pi + A$ = 306 54 15
Sin A	$\bar{1}$·08795	ΔA = + 49	Sin A	$\bar{1}$·90290	ΔA = − 5 43
c	4·81350	B = 7 2 49	c	4·83997	B = 306 48 32
$(\delta_2 \lambda)$	$\bar{3}$·97311	− ·009	$(\delta_2 \lambda)$	$\bar{1}$·65701	− ·454
S	0·37082		S	0·37112	
Cot A	0·90877		Cot A	$\bar{1}$·87560	
$(\delta_2 L)$	$\bar{1}$·25270	+ ·179	$(\delta_2 L)$	$\bar{1}$·90373	− ·801
T	0·08301		T	0·08258	
$(\delta_2 A)$	$\bar{1}$·33571	+ ·2	$(\delta_2 A)$	$\bar{1}$·98631	− 1·0

RESULTS OF THE FOREGOING COMPUTATION.

Mean Latitude of Kingriáli h.s. ... ... = 32° 14′ 13″·31
„ Longitude of „ „ ... ... = 71 5 2 ·60
„ Azimuth at Kingriáli h.s. of Shadau s. ... = 7 2 48
„ „ „ „ of Maláni „ ... = 306 48 33

TABLE VII.—*Directions for applying the Signs to the Terms of the Latitude, Longitude and Azimuth Formulæ.*

This table is to be used in conjunction with the preceding one and gives the proper signs to be applied to the terms $\delta_1\lambda$, &c., $\delta_1 L$, &c., and $\delta_1 A$, &c., in the computations of Latitude, Longitude and Reverse Azimuths.

TABLE VIII.—*For Calculating Azimuths and Distances of Points of which the Latitudes and Longitudes are known.*

When the latitudes and longitudes of two Stations **A** and **B** are known and we require the distance between them and the azimuth of each station at the other, this table is to be used for finding the quantities R′, S′, T′, U′, V′, W′, X′, Y′, Z′ employed in the forms for calculation.

The formulæ on which the calculations are based are those given under Table VI, and the treatment is as follows:—

Taking the formulæ for $\Delta\lambda$, ΔL, and ΔA and remembering that

$$\left.\begin{aligned} \delta_1\lambda &= -\frac{c}{\rho}\cos A \operatorname{cosec} 1'' \\ \delta_1 L &= -\frac{c}{\nu}\frac{\sin A}{\cos\lambda}\operatorname{cosec} 1'' \end{aligned}\right\}$$

we get by eliminating A from each term in succession

$$\Delta\lambda = \text{in seconds of arc}\left\{\begin{array}{l} +\delta_1\lambda \\ -\mathrm{R}'\,\delta_1 L^2 \\ -\mathrm{V}'\,\delta_1\lambda^2 \\ -\mathrm{X}'\,\delta_1\lambda\,\delta_1 L^2 \end{array}\right\} = \left\{\begin{array}{l} +\delta_1\lambda \\ +\delta_2\lambda \\ +\delta_3\lambda \\ +\delta_4\lambda \end{array}\right\} \text{ of Table VI, page 15.}$$

$$\Delta L = \text{in seconds of arc}\left\{\begin{array}{l} +\delta_1 L \\ +\mathrm{S}'\,\delta_1\lambda\,\delta_1 L \\ +\mathrm{U}'\,\delta_1\lambda^2\,\delta_1 L \\ -\mathrm{Y}'\,\delta_1 L^3 \end{array}\right\} = \left\{\begin{array}{l} +\delta_1 L \\ +\delta_2 L \\ +\delta_3 L \\ +\delta_4 L \end{array}\right\} \quad \text{,,} \quad \text{,,}$$

$$\Delta A = \text{in seconds of arc}\left\{\begin{array}{l} +\sin\lambda\,\delta_1 L \\ +\mathrm{T}'\,\delta_1\lambda\,\delta_1 L \\ +\mathrm{W}'\,\delta_1\lambda^2\,\delta_1 L \\ -\mathrm{Z}'\,\delta_1 L^3 \end{array}\right\} = \left\{\begin{array}{l} +\delta_1 A \\ +\delta_2 A \\ +\delta_3 A \\ +\delta_4 A \end{array}\right\} \quad \text{,,} \quad \text{,,}$$

where R′, S′, T′, &c., have the following values:—

$\mathrm{R}' = \frac{\nu}{4\rho}\sin 2\lambda \sin 1''$; $\mathrm{S}' = \frac{\rho}{\nu}\tan\lambda\sin 1''$; $\mathrm{T}' = \frac{1}{2}\left(1 + \frac{2\rho}{\nu}\tan^2\lambda\right)\cos\lambda\sin 1''$;

$\mathrm{U}' = \frac{1}{3}\frac{\rho^2}{\nu^2}\left(\frac{2-\cos 2\lambda}{\cos^2\lambda}\right)\sin^2 1''$; $\mathrm{V}' = \frac{3}{4}\frac{\rho}{\nu}\frac{e^2}{1-e^2}\sin 2\lambda\sin 1''$; $\mathrm{W}' = \frac{1}{12}\frac{\rho^2}{\nu^2}\frac{\sin\lambda}{\cos^2\lambda}(11-\cos 2\lambda)\sin^2 1''$;

$\mathrm{X}' = \frac{1}{6}(2-\cos 2\lambda)\sin^2 1''$; $\mathrm{Y}' = \frac{1}{3}\sin^2\lambda\sin^2 1''$; $\mathrm{Z}' = \frac{1}{12}\sin\lambda\,(3-\cos 2\lambda)\sin^2 1''$.

It thus appears that $\delta_1\lambda$ and $\delta_1 L$ are found by the first pair of equations, and then $\Delta\lambda$ and ΔL depend only on these and the quantities given in the table; and ΔA only needs in addition $\sin\lambda$.

Again in the reverse process, if $\Delta\lambda$ and ΔL are given, we have the 3rd and 4th equations for finding $\delta_1\lambda$ and $\delta_1 L$ and then the first pair of equations will give A and c; and ΔA will be found as before.

The differences $\Delta\lambda$, ΔL and ΔA in the explanation to Table VI may be computed as follows:—

Station **A**, Bhaorésa H.S.		Station **B**, Handiapáro H.S.
λ = 24° 8′ 3″·728 L = 78 3 7·913		A = 178° 15′ 53″·888 Log c = 5·0354039
c = 5·0354039 Cos A = $\bar{1}$·9998009 $\frac{1}{\rho}$ = 8·6815465 cosec 1″ = 5·3144251 $\delta_1 \lambda$ = 3·0311764 = +1074″·4257	c = 5·0354039 Sin A = $\bar{2}$·4811183 Sec λ = 0·0397247 $\frac{1}{\nu}$ = 8·6791363 cosec 1″ = 5·3144251 $\delta_1 L$ = 1·5498083 = −35″·4657	Sin λ = $\bar{1}$·6115937 $\delta_1 L$ = 1·5498083 $\delta_1 A$ = 1·1614020 = −14″·5011
R′ = $\bar{7}$·95882 $\delta_1 L^2$ = 3·09962 $\delta_2 \lambda$ = $\bar{3}$·05844 = − ·0011	S′ = $\bar{6}$·33448 $\delta_1 \lambda$ = 3·03118 $\delta_1 L$ = 1·54981 $\delta_2 L$ = $\bar{2}$·91547 = − ·0823	T′ = $\bar{6}$·49072 $\delta_1 \lambda$ = 3·03118 $\delta_1 L$ = 1·54981 $\delta_2 A$ = $\bar{1}$·07171 = − ·1180
V′ = $\bar{8}$·256 $\delta_1 \lambda^2$ = 6·062 $\delta_3 \lambda$ = $\bar{2}$·318 = − ·0208	U′ = $\bar{11}$·094 $\delta_1 \lambda^2$ = 6·062 $\delta_1 L$ = 1·550 $\delta_3 L$ = $\bar{4}$·706 = − ·0005	W′ = $\bar{12}$·992 $\delta_1 \lambda^2$ = 6·062 $\delta_1 L$ = 1·550 $\delta_3 A$ = $\bar{4}$·604 = − ·0004
X′ = $\bar{12}$·718 $\delta_1 \lambda$ = 3·031 $\delta_1 L^2$ = 3·100 $\delta_4 \lambda$ = $\bar{6}$·849 = ·0000	Y′ = $\bar{12}$·117 $\delta_1 L^3$ = 4·649 $\delta_4 L$ = $\bar{8}$·766 = ·0000	Z′ = $\bar{12}$·272 $\delta_1 L^3$ = 4·649 $\delta_4 A$ = $\bar{8}$·921 = ·0000
$\Delta\lambda$ . . . . . = +1074″·4038 = 17′ 54″·4038	ΔL . . . . . = −35″·5485	ΔA . . . . . = −14″·6195

NOTE.—Some slight abbreviation may be introduced into this calculation by employing P from Table VI for $\frac{1}{\rho}$ cosec 1″ and the co-log from Table XXVII for $\frac{1}{\nu}$ sec λ cosec 1″.

It remains now to explain how, having given $\Delta\lambda$ and ΔL, we can obtain $\delta_1 \lambda$ and $\delta_1 L$, the quantities required for finding A, c and ΔA.

We have

$$\Delta\lambda = \delta_1 \lambda - R' \delta_1 L^2 - V' \delta_1 \lambda^2 - X' \delta_1 \lambda \, \delta_1 L^2, \quad \ldots \quad (1)$$

$$\Delta L = \delta_1 L + S' \delta_1 \lambda \, \delta_1 L + U' \delta_1 \lambda^2 \delta_1 L - Y' \delta_1 L^3, \quad \ldots \quad (2)$$

and the terms involving U′, V′, X′, Y′ are very small compared with those involving R′, S′; therefore, omitting the last two terms of $\Delta\lambda$ and putting ΔL for $\delta_1 L$, we get as a first approximation

$$\delta_1 \lambda_a = \Delta\lambda + R' \Delta L^2. \quad \ldots \quad (3)$$

Substitute this for $\delta_1 \lambda$ in (2) and we get

$$\delta_1 L = \Delta L \div \left\{ 1 + S' \delta_1 \lambda_a + U' \delta_1 \lambda_a^2 - Y' \Delta L^2 \right\} \quad \ldots \quad (4)$$

where we have put ΔL^2 for $\delta_1 L^2$ in the last term, which we may safely do considering the magnitude of Y′.

Returning now to (1) and putting $\delta_1 \lambda_a$ for $\delta_1 \lambda$ in the third and fourth terms, we get a more accurate value of $\delta_1 \lambda$, *viz.*,

$$\delta_1 \lambda = \Delta\lambda + R' \delta_1 L^2 + V' \delta_1 \lambda_a^2 + X' \delta_1 \lambda_a \, \delta_1 L^2 \quad \ldots \quad (5)$$

In the practical application of these formulæ it will be sufficient to use 5 places of decimals of logarithms in the terms involving R′, S′, T′, and 3 places in the terms involving U′, V′, W′, X′, Y′, Z′. Hence in the great majority of cases the values of $\delta_1 \lambda$ and $\delta_1 L$, obtained from equations (5) and (4) will be as accurate as can be desired: and this accuracy can be tested by comparing $\delta_1 \lambda$ from (5) with $\delta_1 \lambda_a$ used in (4), and $\delta_1 L$ from (4) with ΔL employed in (4), and should the differences be sensible another approximation can be made.

The method just described is applicable to principal triangulation where great accuracy is required. In the case of secondary triangulation and for topographical purposes we may neglect the last two terms in each of the equations (1) and (2).

We shall then have

$$\delta_1\lambda = \Delta\lambda + R' \Delta L^2, \quad \ldots \quad (6)$$

$$\delta_1 L = \Delta L \div \left\{ 1 + S' \delta_1\lambda \right\}. \quad \ldots \quad (7)$$

If necessary we can further approximate by using this value of $\delta_1 L$ for ΔL in (6) and the new value of $\delta_1\lambda$ in (7), but this will rarely be required.

Having now obtained $\delta_1\lambda$ and $\delta_1 L$ we find A and c from the formulæ :—

$$\left.\begin{aligned} \delta_1\lambda &= -\frac{c}{\rho}\cos A \operatorname{cosec} 1'', \\ \delta_1 L &= -\frac{c}{\nu}\frac{\sin A}{\cos\lambda}\operatorname{cosec} 1''. \end{aligned}\right\}$$

From which

$$\cot A = \frac{\rho}{\nu}\sec\lambda\,\frac{\delta_1\lambda}{\delta_1 L},$$

$$c = -\delta_1\lambda \sec A\,\rho \sin 1'';$$

and finally ΔA will be found as before.

The signs of $\delta_1\lambda$ and $\delta_1 L$ will define the quadrant in which A lies ; see Table VII.

The quantities R′, S′, T′ are given in logs to 5 places and U′, V′, W′, X′, Y′, Z′ to 3 places of decimals, the former for every 10′ and the latter for every 1° of latitude from 0° to 40°.

The method of computing will then be as follows :—

1*st*. Principal Triangulation :—

Subtract the latitude and longitude of **A** from those of **B**, and we get $\Delta\lambda$ and ΔL with their proper signs.

Find $\delta_1\lambda_a$, an approximate value of $\delta_1\lambda$, from the formula

$$\delta_1\lambda_a = \Delta\lambda + R' \Delta L^2,$$

and find the quantity a from the formula

$$a = 1 + S' \delta_1\lambda_a + U' \delta_1\lambda_a^2 - Y' \Delta L^2;$$

then

$$\left.\begin{aligned} \delta_1 L &= \Delta L \div a, \\ \text{and} \quad \delta_1\lambda &= \Delta\lambda + R' \delta_1 L^2 + V' \delta_1\lambda_a^2 + X' \delta_1\lambda_a \delta_1 L^2. \end{aligned}\right\}$$

With these values of $\delta_1\lambda$ and $\delta_1 L$ find A, c and ΔA from the equations :—

$$\left.\begin{aligned} \cot A &= Q \sec\lambda\,\frac{\delta_1\lambda}{\delta_1 L}, \\ c &= -\frac{\delta_1\lambda \sec A}{P}, \\ \text{and} \quad \Delta A &= \sin\lambda\,\delta_1 L + T' \delta_1\lambda\,\delta_1 L + W' \delta_1\lambda^2 \delta_1 L - Z' \delta_1 L^3, \end{aligned}\right\}$$

in which P and Q are obtained from Table VI.

The signs of $\delta_1\lambda$ and $\delta_1 L$ will determine in which quadrant A lies according to Table VII.

EXAMPLE.

Station **A**, Párdho.	Station **B**, Handiapáro.
λ = 24° 16′ 17″·867	λ = 24° 25′ 58″·132
L = 77 48 40 ·557	L = 78 2 32 ·364

To find A, c and B.

		° ′ ″
Station **A**,	λ	24 16 17·867
„ **B**,	λ	24 25 58·132
B − A,	$\Delta\lambda$	+ 9 40·265

	° ′ ″
L	77 48 40·557
L	78 2 32·364
ΔL	+ 13 51·807

	Logarithms.		*Nat. Nos.* ″
$\Delta\lambda$		*+	580·265
R′	$\bar{7}$·96066		
ΔL^2	5·84005		
	$\bar{1}$·80071	+	·632
$\delta_1\lambda_a$		+	580·897

	Logarithms.
Q	$\bar{1}$·9975950
Sec λ	0·0401924
$\delta_1\lambda$	2·7641041
Co-log $\delta_1 L$	$\bar{3}$·0805269
Cot A	$\bar{1}$·8824184

†A = 232° 39′ 47″·233

			1·000000
S′	$\bar{6}$·33727		
$\delta_1\lambda_a$	2·76410		
	$\bar{3}$·10137	*+	·001263
U′	$\overline{11}$·096		
$\delta_1\lambda_a^2$	5·528		
	$\bar{6}$·624	+	·000004
Y′	$\overline{12}$·122		
ΔL^2	5·840		
	$\bar{7}$·962	−	·000001
a	0·0005494	+	1·001266
ΔL	2·9200225		
$\delta_1 L = \Delta L - a$	2·9194731		

$\delta_1\lambda$	2·7641041
Co-log P	2·0040361
Sec A	0·2171690
c	4·9853092

			Nat. Nos.
$\delta_1 L$	2·9194731		
Sin λ	$\bar{1}$·6139084		″
	2·5333815	*+	341·4928
T′	$\bar{6}$·49185		
$\delta_1\lambda$	2·76410		
$\delta_1 L$	2·91947		
	0·17542	*+	1·4977
W′	$\overline{12}$·996		
$\delta_1\lambda^2$	5·528		
$\delta_1 L$	2·919		
	$\bar{3}$·443	*+	·0028
Z′	$\overline{12}$·275		
$\delta_1 L^3$	8·758		
	$\bar{3}$·033	‡−	·0011
ΔA		+	342·9922

$\Delta\lambda$		*+	580·265
R′	$\bar{7}$·96066		
$\delta_1 L^2$	5·83895		
	$\bar{1}$·79961	+	·6304
V′	$\bar{8}$·258		
$\delta_1\lambda_a^2$	5·528		
	$\bar{3}$·786	+	·0061
X′	$\overline{12}$·719		
$\delta_1\lambda_a$	2·764		
$\delta_1 L^2$	5·839		
	$\bar{3}$·322	*+	·0021
$\delta_1\lambda$		+	580·9036

	° ′ ″
$\pi + A$ =	52 39 47·233
ΔA =	+ 5 42·992
B =	52 45 30·225

* *Plus* or *minus* as the case may be.

† A is in

	1st	2nd	3rd	4th	Quadrant,
when $\frac{\delta_1\lambda}{\delta_1 L}$	$\frac{-}{-}$	$\frac{+}{-}$	$\frac{+}{+}$	$\frac{-}{+}$	

‡ This term is + when $\delta_1 L$ is −, and − when $\delta_1 L$ is +.

2nd. Secondary Triangulation :—

In this case it is sufficient to take

$$\delta_1\lambda = \Delta\lambda + \text{R}'\,\Delta L^2,$$

$$\delta_1 L = \Delta L \div \left\{ 1 + \text{S}'\,\delta_1\lambda \right\};$$

with these find A and c as on page 21, and then

$$\Delta A = \delta_1 A + \delta_2 A,$$

where $\delta_1 A = \sin\lambda\ \delta_1 L$, and $\delta_2 A = \text{T}'\ \delta_1\lambda\ \delta_1 L$.

EXAMPLE.

Station **A**, Shadau s.	°	′	″	Station **B**, Kingriáli h.s.	°	′	″
λ	32	3	34·03	λ	32	14	13·31
L	71	3	29·80	L	71	5	2·60

To find A, c and B.

		Station **A**	Shadau s.
		,, **B**	Kingriáli h.s.
			° ′ ″
		λ_A	32 3 34·03
		λ_B	32 14 13·31
		L_A	71 3 29·80
		L_B	71 5 2·60
		$\lambda_B - \lambda_A = \Delta\lambda$	+ 10 39·28
		$L_B - L_A = \Delta L$	+ 1 32·80
$\delta_1\lambda$	Logs.	R′	$\bar{6}$·03969
		ΔL^2	3·93510
		R′ ΔL^2	$\bar{3}$·97479
	Nat. Nos.	,,	+ 0·009
		$\Delta\lambda$	+ 639·28
		Sum = $\delta_1\lambda$	+ 639·289
$\delta_1 L$	Logs.	S′	$\bar{6}$·48029
		$\delta_1\lambda$	2·80570
		S′ $\delta_1\lambda$	$\bar{3}$·28599
	Nat. Nos.	,,	+ 0·00193
		1 + S′ $\delta_1\lambda$	1·00193
	Logs.	,, (*a*)	0·0008374
		ΔL (*b*)	1·9675480
		(*b*) − (*a*) = $\delta_1 L$	1·9667106

A	Logs.	$\delta_1\lambda$	2·8056972
		Q	$\bar{1}$·9979206
		Sec λ	0·0718614
		Co-log $\delta_1 L$	$\bar{2}$·0332894
		Sum = Cot A	0·9087686
		†A	187° 2′ 0″·2
c	Logs.	$\delta_1\lambda$	2·8056972
		Co-log P	2·0045245
		Sec A	0·0032804
		Sum = c	4·8135021
B	Logs.	Sin λ	$\bar{1}$·7249301
		$\delta_1 L$	1·9667106
		Sum = $\delta_1 A$	1·6916407
		T′	$\bar{6}$·56330
		$\delta_1\lambda$	2·80570
		$\delta_1 L$	1·96671
		Sum = $\delta_2 A$	$\bar{1}$·33571
			° ′ ″
	Nat. Nos.	$\delta_1 A$	+ 49·2
		$\delta_2 A$	+ 0·2
		Sum = ΔA	+ 49·4
		$\pi + A$	7 2 0·2
		$B = \pi + A + \Delta A$	7 2 49·6

† See note to page 22.

TABLE IX.—*Computation of Heights.—Reduction of Log. Distance in Feet between two Stations* **A** *and* **B** *to reduce to the Level of Station* **A**.

In the computation of the difference of height of two stations it is necessary to find the distance between them at the level of the station whose height is known.

The sides of the triangles are the distances at the level of the sea, and this table gives the corrections in the 7th place to be added to their logarithms so as to get the values at any required height.

The correction is determined as follows:—

Let c = length of side at the sea level,

c' = ,, at height of station **A**,

h = height of **A** above sea level,

R = radius of earth,

$$\text{then } \frac{c'}{c} = \frac{R+h}{R}.$$

Therefore

$\log c' = \log c + \log \frac{R+h}{R}$, and R is taken equal to $\frac{2\rho\nu}{\rho+\nu}$, see page 12 of explanation of Table III.

EXAMPLE.—Let h = 1000 feet in latitude 20°.

From Table II	ρ = 20808279·7	$\log \rho$ =	7·318236178
,, I	ν = 20931059·7	$\log \nu$ =	7·320791216
		$\log 2$ =	0·301029996
		$\log 2\rho\nu$ =	14·94005739
	$\rho + \nu$ = 41739339·4	$\log \overline{\rho+\nu}$ =	7·62054557
	R = 20869489·2	$\log R$ =	7·31951182
	$R + h$ = 20870489·2 . . .	$\log \overline{R+h}$ =	7·31953263
		$\log \frac{R+h}{R}$ =	·00002081

so that the correction to the 7th place of logs = 208·1 as in the table.

The table gives the correction for every thousand feet from one to ten, and for each degree of latitude from 0° to 40°.

For other heights and latitudes the correction must be found by interpolation.

EXAMPLE.—To find the log distance in feet between **A** and **B** in lat. 30° when the height of **A** is 5,679 feet above sea level.

From the table the correction for	5,000 feet is	1039·6
,, ,,	600 ,,	124·8
,, ,,	70 ,,	14·6
,, ,,	9 ,,	1·9
Therefore the correction for	5,679 feet is	1181

Thus if the log distance between **A** and **B** at sea level = 4·9826056

Then the log distance between **A** and **B** at level of **A** = 4·9827237

If the difference of height between **A** and **B** is less than 5,000 feet, five-place logarithms are sufficient. In this case the small table at the foot of the page, which is the same for all latitudes, may be employed.

EXAMPLE.—To find the log distance in feet between **A** and **B** when the height of **A** is 4679 feet above sea level.

From the table the correction for	4,000	feet	is	8
,, ,,	600	,,		1
,, ,,	79	,,		0
Therefore the correction for	4,679	feet	is	9

Thus if the log distance between **A** and **B** at sea level = 4·67015

Then the log distance between **A** and **B** at level of **A** = 4·67024

TABLE X.—*Computation of Heights.—For converting Geodetic Distance in Miles into Seconds of Contained Arc.*

In the computation of difference of height it is necessary for the calculation of terrestrial refraction to convert the distance between the two stations into Seconds of Contained Arc, and this table is to be used for the purpose when the distance is given in miles.

Seconds of Contained Arc are determined as follows:—

Let c = the distance in miles,

and c'' = the corresponding contained arc in seconds;

then $c'' = c \times 5280 \times \dfrac{\text{cosec } 1''}{\text{radius in feet}}$,

and the radius is taken $= \dfrac{2\rho\nu}{\rho + \nu}$ as in Table III, page 12.

EXAMPLE.—Suppose c = 10 miles in latitude 20°.

$$\begin{aligned} \log 52800 &= 4\cdot7226339 \\ \log \text{cosec } 1'' &= 5\cdot3144251 \\ \text{sum} &= 10\cdot0370590 \\ \log \text{radius} &= 7\cdot3195118, \text{ see page 24.} \\ \log c'' &= 2\cdot7175472 \end{aligned}$$

Therefore the contained arc or c'' = 521″·9 as in the table.

The table gives the Contained Arc in seconds for geodetic distances ranging in length from 10 miles to 90 miles, for each degree of latitude from 0° to 40°, and also for two places of decimals of a mile, the latter part of the table being independent of the latitude.

EXAMPLE.—To convert 42·58 miles in latitude 24° into Seconds of Contained Arc.

From the upper table,	40 miles	=	2086″·7
,, ,, ,,	2	=	104·3
,, lower ,,	·58	=	30·3
Therefore the Contained Arc in Seconds		=	2221·3

TABLE XI.—*Computation of Heights.—For converting Geodetic Distance in Feet into Seconds of Contained Arc.*

This table is to be used instead of Table X, when the distance is given in feet.

It is calculated as follows:—

$$\text{Let } c = \text{distance in feet;}$$

then, from the last table, we have for latitude 20°

$$\log c'' = \log c + \bar{3}\cdot9949133;$$

therefore

$$c'' = c \times 0\cdot009884 = \frac{c}{100}\left\{1 - \cdot0116\right\}$$

$$= \frac{c}{100} - \frac{c}{1000} \times 0\cdot116$$

The quantity $-\frac{c}{1000} \times 0\cdot116$ is tabulated.

The table is constructed for geodetic distances in feet reckoned from 1000 feet to 9000 feet for each degree of latitude from 0° to 40°, but a sufficient number of decimal places is given to admit of its being used for distances up to 500,000 feet.

To find the Contained Arc proceed by the following rule:—

Rule.—Divide the number of feet in the geodetic distance by 100 and diminish the quotient by the quantity in the table corresponding to the number of feet reckoned by thousands and the result gives the number of Seconds of Contained Arc.

Example.—To convert 224,822 feet in latitude 24° into Seconds of Contained Arc.

224,822 feet = 225,000 feet approximately.

For 200,000 feet the table gives						− 23·9″
	20,000	,,	,,	,,		− 2·4
	5,000	,,	,,	,,		− 0·6
Therefore for	225,000	,,	,,	,,		− 26·9
	224,822	divided by 100			=	2248·2
Therefore the Contained Arc in Seconds					=	2221·3

TABLE XII.—*Computation of Heights.—Log. Secant of Observed Angle at Station* **B**.

The formulæ for computation of Difference of Height and of Terrestrial Refraction between two stations are deduced as follows:—(see *Account of the Operations of the Great Trigonometrical Survey of India*, Vol. II).

Let **A** and **B** be two stations at which reciprocal vertical observations have been taken, the height of **A** above see level being known it is required to find that of **B**.

Let H = the height of **A** in feet,

$H + h$ = ,, **B** ,,

c = the distance between the normals of **A** and **B** at the level of the sea,

c' = ,, ,, ,, ,, ,, of **A**,

obtained with the aid of Table IX.

Also let κ = the chord of the arc c',

R = the mean radius of curvature;

then

$$\kappa = 2R\sin\frac{c'}{2R} = c' - \frac{c'^3}{24R^2}.$$

Now $$c' = c\left(1 + \frac{H}{R}\right).$$

Therefore $$\kappa = c\left(1 + \frac{H}{R} - \frac{c^2}{24\,R^2}\right);$$

or neglecting the third term which is inappreciable, *1st*, in principal triangulation on account of the smallness of the side, *2nd*, in high secondary points or distant snow peaks in comparison with the uncertainty in refraction;—

$$\kappa = c\left(1 + \frac{H}{R}\right) = c'.$$

Let D_1 and D_2 be the vertical angles, both assumed to be depressions, which would be observed at **A** and **B** if there was no refraction and the heights of the signal and instrument were equal;

then $$h = \kappa \frac{\sin \frac{1}{2}(D_2 - D_1)}{\cos D_2}$$

$$= c' \sin \tfrac{1}{2}(D_2 - D_1) \sec D_2.$$

Let i_a, i_b = the heights in feet of the instruments at **A** and **B** respectively,

g_a, g_b = „ „ signals „ „

$\delta = g_a - g_b + i_a - i_b$,

r_a, r_b = the refractious in the vertical angles at **A** and **B** respectively, assumed to be the same and $= r''$

D_a, D_b = the observed vertical angles at **A** and **B** respectively, both assumed to be depressions,

also let S' = the subtended angle, that is the angle at **A** between the line joining **A** and **B** and the chord κ,

then $$h = c' \sin S' \sec D_2.$$

But $$D_2 = D_b + r_b + \frac{g_a - i_b}{c' \sin 1''},$$

$$D_1 = D_a + r_a + \frac{g_b - i_a}{c' \sin 1''};$$

therefore if we take $r_a = r_b = r''$, we get

$$S' = \frac{D_2 - D_1}{2} = \tfrac{1}{2}(D_b - D_a) + \frac{\delta}{2\,c' \sin 1''};$$

and neglecting insignificant quantities,

$$h = c' \sin \tfrac{1}{2}(D_b - D_a) \sec D_b + \frac{\delta}{2};$$

or if S is put for $\frac{1}{2}(D_b - D_a)$

$$h = c' \sin S \sec D_b + \frac{\delta}{2}.$$

It will be seen from the formula for h that the sec D_b is required, and it is the logarithm of this which is given in Table XII. The log secant is rejectaneous if the angle is less than 16′ 25″, while it is seldom greater than 2° 7′: the table has accordingly been given within these limits.

To calculate the refraction,

if c'' = the contained arc in seconds,

$$c'' = D_1 + D_2,$$

$$= D_a + D_b + 2\,r'' - \frac{i_a - g_a + i_b - g_b}{c' \sin 1''}.$$

Put $$\gamma = i_a - g_a + i_b - g_b$$

and $$2\,\beta'' = \frac{\gamma}{c' \sin 1''},$$

then $$r'' = \tfrac{1}{2}\{c'' - (D_a + D_b)\} + \beta''.$$

If either of the observed angles at **A** or **B** is an elevation $-E_a$ or $-E_b$ must be substituted for D_a or D_b.

As the difference of height is only required to the nearest foot, it will be sufficient to take δ to the nearest 0·1 foot, while γ need only be kept to the nearest 0·5 foot.

TABLE XIII.—*Computation of Heights.—For obtaining the Quantity β'' in the formula for finding the Terrestrial Refraction.*

The coefficient of refraction between the two stations, at which reciprocal verticals have been observed, is usually deduced at the same time as the difference of height, the former being required in the calculation of heights of surrounding points from which reciprocal observations have not been taken. The table gives β'' where, as in the preceding table,

$$\beta'' = \frac{\gamma \text{ feet. cosec } 1''}{2\,c' \text{ feet}} = \frac{\gamma \text{ feet. cosec } 1''}{2 \times 5280 \text{ (distance in miles)}} = 19''\cdot 53 \frac{\gamma}{\text{distance in miles}}.$$

The table is constructed for values of γ up to 12 feet and for all distances likely to be required; where the limits of the table are exceeded, β'' must be calculated by the above formula.

To obtain β'' enter the table with the value of γ and look under it for the number of miles representing the distance between the stations, and take the corresponding value of β'' given in the margin. β'' has the same sign as γ.

The following form has been adopted for the computation of differences of height and of refraction :—

EXAMPLE 1.—Angles at **A** and **B** both observed; height of **A** above sea level 2790·0, and log distance **A** to **B** at same level 5·13535 in mean lat. 26°.

No. of Deduction.	Astronomical Dates of Observation.		Station.	No. of Observations.	Observed Vertical Angles.	S = ½ (D − D) or ½ (D + E). R = ½ (D + D) or ½ (D − E).
	18	h. m.	(1)	(2)	(3)	(4)
					° ′ ″	° ′ ″
1	Dec. 3	2 55	**A** Bhít . . . . H.S.	4	D = 0 42 2·3	S =
	„ 21	2 59	**B** Láli . . . . „	4	E = 0 22 30·2	R =

Measured Heights in Feet.			Computed Heights in Feet.			Distance in Miles, and Contained Arc or c''	Terrestrial Refraction.		Height of Tower or Platform in feet.
Instrument or i.	Signal or g.	δ γ	**B** − **A**	Above Sea Level. **B**	Above Sea Level. Mean **B**		r''	$\frac{r''}{c''}$	
(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
i_a 5·3	g_b 2·8	δ				25·87			3
i_b 5·3	g_a 2·7	γ							

Then $S = \frac{D + E}{2} = 0° 32' 16\cdot''3$ [enter this in the blank space for S in col. 4;]

$R = \frac{D - E}{2} = 0 \quad 9 \quad 46$ [„ „ „ R „ ;]

$\delta = -0\cdot1$; $\gamma = +5$ [enter these in the blank spaces for δ and γ in col. 7;]

also from Table X, $c'' = 1349''$ [„ this „ space for c'' in col. 11.]

Now enter the following form :—

Logarithms	Corrn. for height of **A** (Table IX) = 0·00006 Angle at **B** (Table XII) sec = 0·00001 S sin = $\bar{3}$·97252 Geodetic distance **A** to **B** in feet = 5·13535 a = 3·10794	β'' (from Table XIII) = 4'' $-R''$ . . . . = − 586 $\frac{c''}{2}$ . . . . = 675 r'' . . . . = 93 Enter in col. 12.
	Angle at **B** being less than that at **A**, a = − 1282·2 $\frac{\delta}{2}$ = − ·1 Enter in col. 8 **B** − **A** = − 1282·3 which added to height of **A** gives the quantity to be entered in col. 9.	Coeff. of refraction = $\frac{r''}{c''}$ = ·068 Enter in col. 13.

When only one angle has been observed the following form is employed :—

Example 2.—Angle at **A** only observed.

A Menai T.S. **B** Mt. Everest	° ′ ″ E = 2 2 17	S =	i_a = + 5	δ = + 5	**A** to **B** miles = 113·76 c'' =	Mean lat. = 27° Height of **A** = 237 feet $\frac{r''}{c''}$ = ·075

From Table X, $c'' = 5933''$ [enter this in the blank space for c''.]

Now $D_b = c'' - D_a - 2r''$. ° ′ ″ c'' = ... 1 38 53 $-D_a$ = ... +2 2 17 3 41 10 $-2r''$ = − 2 × ·075 × 5933″ = − 14 50	Logarithms	Correction for height of **A** = 0·00000 Angle at **B** (Table XII) sec = 0·00078 S sin = 2·67924 Geodetic distance **A** to **B** in feet = 5·77863 a = 4·45865
D_b = ... +3 26 20 $S = \frac{D_b - D_a}{2}$ = 2 44 19 Enter S in the blank space provided for it.		Angle at **B** being greater than that at **A**, a = + 28751 δ = + 5 **B** − **A** = + 28756

Instead of employing the foregoing method of finding S we may use either Table XIV or Table XV.

It will be noticed that we add δ to a instead of $\frac{\delta}{2}$. The reason of this is that as we only observe one angle, and that from a height δ above **A**, we get the difference of height between **B** and **A** too small by this quantity and must therefore add it to the result to obtain the true difference of height.

TABLE XIV.—*Computation of Heights.—To facilitate finding the Subtended Angle when only one angle has been observed and the Distance between Stations* **A** *and* **B** *is given in Feet.*

The table is constructed for coefficients of refraction ranging from ·00 to ·5, for distances from 100 feet to 400,000 feet, and for latitude 20°, the mean between the limits generally adopted in these tables; by means of it the subtended angle can be found at once when the distance is given in feet and the coefficient of refraction is known.

The table gives a quantity, which may be called K, and from it the subtended angle S is found by subtracting depressions or adding elevations.

The quantity K is obtained as follows, using the notation in Table XII:—

$$S = \frac{D_b - D_a}{2},$$

$$D_b = c'' - D_a - 2r'';$$

therefore $$S = \frac{c'' - 2D_a - 2r''}{2}.$$

Now $r'' = k\,c''$, where k is the coefficient of refraction;

therefore $$S = c''\frac{1-2k}{2} - D_a.$$

But $$c'' = c\,\frac{\rho+\nu}{2\rho\nu}\,\text{cosec}\,1'';$$

therefore $$S = \frac{1-2k}{2}\cdot\frac{\rho+\nu}{2\rho\nu}\cdot c\,\text{cosec}\,1'' - D_a$$

$$= K - D$$

Example.—To find K when $c = 10000$ feet and $k = \cdot 08$

$\log \frac{\rho+\nu}{2\rho\nu}\,\text{cosec}\,1'' = 3\cdot9949133$ from Table XI as on page 25.

$\frac{1-2k}{2} = \cdot 42$ . . . . $\log = \bar{1}\cdot6232493$

$c = 10000$ . . . $\log = 4$

Nat. No. $= 41\cdot5$ . . . $\log = 1\cdot6181626$

Therefore $K = 42''$ as in the table.

Example.—To find S when the coefficient of refraction is ·07, the distance is 77,746 feet and the observed depression is 0° 14′ 35″.

It is sufficient to keep the distance to the nearest 100 feet.

			° ′ ″
From the table, for 70,000 feet	. . . . .	K =	0 4 58
„ 7,000 „	. . . . . .	„ =	30
„ 700 „	. . . . . .	„ =	3
therefore „ 77,700 „	. . . . . .	K =	0 5 31
		D =	0 14 35
	Therefore S = K − D	=	0 9 4

If the observed vertical angle be an elevation of 4′ 17″, then

$$S = K + E = 0°\ 9'\ 48''.$$

TABLE XV.—*Computation of Heights.—To facilitate finding the Subtended Angle when only one angle has been observed and the Distance between Stations* **A** *and* **B** *is given in Log. Feet.*

This table is designed to meet both variation of refraction and change of latitude, and at the same time it is only necessary to know the log distance in feet between **A** and **B**. The range for the coefficient of refraction is from ·03 to ·20, while the latitude is given for every 5° from 0° to 40°.

The quantity given in the table is the co-logarithm of $\frac{1-2k}{2} \cdot \frac{\rho+\nu}{2\rho\nu}$ cosec 1″ of the preceding table.

Taking the example on the last page, *viz.*, k = ·08, and latitude 20°, we get

$$\log \frac{1-2k}{2} \cdot \frac{\rho+\nu}{2\rho\nu} \operatorname{cosec} 1'' = \bar{3}\cdot 6182,$$

therefore

$$\text{co-log}\ \frac{1-2k}{2} \cdot \frac{\rho+\nu}{2\rho\nu} \operatorname{cosec} 1'' = 2\cdot 3818,$$

which is the quantity in the table corresponding to the given conditions.

If any refraction between those given in the table is to be used, it will be sufficient to interpolate by simple proportion between the next lower and the next higher.

As before we have

$$S = K - D \text{ or } K + E.$$

To find K :—

Rule.—Subtract the quantity in the table from the log distance in feet and look out the result in the 4-place logarithms. The natural number corresponding is K in seconds of arc.

Example.—Given log c = 4·8907 and D = 0° 14′ 35″, to find S in lat. 20° with a coefficient of refraction = ·07

$$\text{Log } c = 4\cdot 8907$$
$$\text{Tabular No.} = 2\cdot 3716$$
$$\text{Log K} = 2\cdot 5191$$

therefore

$$K = 330'' = 0^\circ\ 5'\ 30''$$
$$D = 0\ \ 14\ \ 35$$
$$\text{Hence } S = K - D = 0\ \ 9\ \ 5$$

TABLE XVI.—*Computation of Heights.—Correction for Curvature and Refraction in determining Heights with the Clinometer.*

This table gives the correction, for curvature of the earth and for refraction, to the difference of height found by multiplying the distance in feet by the tangent of the angle of depression or elevation obtained from the clinometer. It has been calculated with a radius equal to the radius of curvature to the meridian in latitude 20° and with coefficients of refraction 0·10, 0·07 and 0·05. The correction is only required to the nearest foot, and the table is so arranged as to give this by inspection for any distance up to 48,000 feet.

The correction is found thus:—

Let the tangent at **A** meet the normal at **B** in B; then if B' is vertically below **B** at a height equal to that of **A**

$$\text{the correction for curvature} = B'\,B = \frac{(\text{distance})^2}{2\ \text{radius}}.$$

Again, the correction for refraction = distance × k $\frac{\text{distance}}{\text{radius}}$, where k is the coefficient of refraction,

$$= k\,\frac{(\text{distance})^2}{\text{radius}};$$

therefore

$$\text{the total correction} = \frac{(\text{distance})^2}{\text{radius}}\left\{\frac{1-2k}{2}\right\}.$$

Example.—Given k = ·10 and the correction = 0·5, find the corresponding distance;

$$(\text{distance})^2 = \frac{\text{radius}}{\cdot 8}$$

$$\log \text{radius} = 7\cdot 3182362$$

$$\log \cdot 8 = \bar{1}\cdot 9030900$$

$$\log (\text{distance})^2 = 7\cdot 4151462$$

$$\log \text{distance} = 3\cdot 7075731;$$

therefore

$$\text{distance} = 5100 \text{ feet.}$$

The argument with which to enter the table is the distance in feet. Thus suppose the distance was 20,000 feet and the coefficient of refraction 0·10; then as 20,000 lies between 19,752 and 21,028 the correction will lie between 7·5 and 8·5, and will consequently be 8.

Example.—Computation of Clinometric Heights.

(1) Fixed Station **A**	Hill temple.	Pamta Cone Rock.	Pamta H.S.	Pamta N. po. 2.
(2) Deduced Station **B**	Rampur ⊙	Ditto	Tiri ⊙	Ditto
(3) Reading at	**A** − ·115	**A** − ·0775	**B** + ·096	**B** + ·0375
(4) Distance feet	9,950	13,230	10,900	10,100
(5) h = (3) × (4)	− 1,141	− 1,025	− 1,046	− 379
(6) Correction	+ 2	+ 3	− 2	− 2
(7) i − s	− 4	− 4	+ 4	+ 4
(8) Difference of ht.	− 1,146	− 1,026	− 1,044	− 377
(9) Height of **A**	2,181	2,063	1,961	1,295
(10) Height of **B**	1,035	1,037	917	918
(11) Mean Height	1,036		918	

Note.—The correction from table is always − when the angle observed is at **B**, and + when the angle observed is at **A**.

When the angle observed is at **A**, h and i − s are to be entered with their proper signs.

When the angle observed is at **B**, h and i − s are to be entered with their signs changed.

TABLE XVII.—*Computation of Heights.—Natural Tangents to 5 places of Decimals.*

The table gives the tangents of angles for each minute from 0° to 16°, and is intended to aid in the calculation of heights when a clinometer is not available.

TABLE XVIII.—*Computation of Heights.—For determining Differences of Height with the Barometer.*—LOOMIS.

The formula on which this table depends as investigated in works on Hydrostatics (see Besant's *Hydro-Mechanics*, page 123) is as follows :—

Let H = height of barometer in inches at lower station,

H′ = „ „ „ upper „

T = temperature of barometer in degrees Fah. at lower station,

T′ = „ „ „ upper „

t = „ air „ lower „

t′ = „ „ „ upper „

λ = mean latitude.

Let s = height in feet of lower station above sea level,

x = difference between the heights of the two stations,

μ = the modulus of the common system of logarithms,

θ = the difference of expansion between mercury and brass for 1° Fah.,

then

$$x = 60158 \cdot 6 \text{ feet} \left\{ \log \frac{H}{H'} - \mu\,\theta\,(T - T') \right\}$$

$$\times \left\{ 1 + \frac{t + t' - 64}{900} \right\} \times (1 + 0 \cdot 00265 \cos 2\lambda)$$

$$\times \left\{ 1 + \frac{x + 52251}{20888629} + \frac{s}{10444315} \right\},$$

taking the mean radius of the earth = 20888629 feet.

The coefficient of expansion of mercury for 1° Fah. = ·0001;

„ „ brass scale „ = ·0000104;

therefore if we take the difference, *viz.*, ·0000896 for θ, the first line becomes

$$60158 \cdot 6 \log \frac{H}{H'} - 2 \cdot 3409\,(T - T').$$

The formula then stands as given by Loomis.

Part I of the table gives the value in feet of the expression 60158·6 log H for heights of the barometer from 11 to 31 inches, only that each value has been decreased by 27541·5 feet, which does not change the difference.

$$60158 \cdot 6 \log H - 60158 \cdot 6 \log H'.$$

Part II gives the correction − 2·3409 (T − T′) depending on the difference of temperatures of the barometers at the two stations. This correction is to be omitted if aneroid barometers are employed.

Part III gives the correction due to the term 0·00265 cos 2λ.

Part IV „ „ „ $\frac{x + 52251}{20888629}$.

Part V „ „ „ $\frac{s}{10444315}$.

The method of using the table is as follows:—

From Part I take out the two numbers corresponding to the heights of the barometers at the upper and lower stations.

To their difference apply the correction in Part II corresponding to the value of $T - T'$, the difference of reading of the two attached thermometers, unless the barometers are aneroids, when this correction is not required. This gives a first approximate difference of height; denote this by a and apply the correction $\frac{a}{900} \times (t + t' - 64^\circ)$ for the temperature of the air: this gives a second approximation b.

Enter Part III with the two arguments, b and the latitude;

„ IV „ argument b;

„ V „ two arguments, b and the height of the barometer at the lower station.

The sum of the three corrections thus obtained when applied to b give the required difference of height.

Example:—

Dehra (Lower Station) $H = 27 \cdot 563$ inches, $T = 79^\circ \cdot 0$ Fah., $t = 79^\circ \cdot 6$ Fah.,

Mussooree (Upper Station) $H' = 23 \cdot 408$, $T' = 70 \cdot 1$ „ , $t' = 65 \cdot 1$ „ ,

Mean latitude $= 30^\circ$.

Part I gives for H		25396·1	feet
„ H′		21127·2	„
Difference	=	4268·9	„
Part II gives for $T - T' = 8^\circ \cdot 9$		− 20·9	„
1*st* Approximation	a =	4248·0	„
$\frac{a}{900} \times (t + t' - 64^\circ)$ . . .	=	+ 380·9	„
2*nd* Approximation	b =	4628·9	„
Part III gives for b = 4629 feet and lat. 30° . .		+ 6·1	„
„ IV „ b = 4629		+ 12·6	„
„ V „ b = 4629 and H = 27·56 inches		+ 1·0	„
Therefore the height of Mussooree above Dehra	=	4648·6	„

TABLE XIX.—*Computation of Heights.—For determining Differences of Height with the Barometer.*—Baily.

The formula on which this table depends is the same as that given in the last table, but in a modified form.

The constants employed by Baily are in some cases different from those of Loomis: he takes the coefficient of $\cos 2\lambda$ as ·002695 instead of ·00265, and the mean radius of the earth as 20898240 feet.

Assuming s to be 4000 feet, and taking an approximate value of x, the expression $60158\cdot6\left\{1 + \frac{x + 2\mu x}{r} + \frac{2s}{r}\right\}$, from which the formula in the preceding table is derived, becomes equal to 60345·51. So that the formula is, if we leave out the expansion of the thermometer scale,

$$x = 60345\cdot51\left\{1 + \frac{t + t' - 64}{900}\right\} \times (1 + 0\cdot002695 \cos 2\lambda)$$

$$\times \log\left\{\frac{H}{H'}\,\frac{1}{\{1 + \cdot0001\,(T - T')\}}\right\}.$$

The quantity A in Part I is the logarithm of $60345\cdot51\left\{1 + \frac{t + t' - 64}{900}\right\}$,

„ B „ II „ of $1 + \cdot0001\,(T - T')$,

„ C „ III „ of $1 + \cdot002695 \cos 2\lambda$.

The method of using the table is as follows:—

From Part II take out the quantity B corresponding to the difference $T - T'$ of the attached thermometers (if aneroid barometers are employed B is zero), add it to log H′, and subtract the sum from log H. This gives a quantity D.

To the logarithm of D add the quantity A from Part I corresponding to the sum $t + t'$ of the detached thermometers, and the quantity C from Part III corresponding to the latitude. The natural number of the resulting logarithm will be the required difference of height in feet.

EXAMPLE:—

Dehra (Lower Station)	H = 27·563 inches,	T = 79°·0 Fah., t = 79°·6 Fah.,
Mussooree (Upper Station)	H′ = 23·408,	T′ = 70 ·1 „ , t′ = 65 ·1 „

Mean latitude = 30°.

Part II gives for $T - T' = 8°\cdot9$ . . . B	= 0·00039
log H′	= 1·36936
Sum	= 1·36975
log H	= 1·44033
D = difference	= 0·07058
log D	= $\bar{2}\cdot84868$
Part I gives for $t + t' = 144°\cdot7$ . . . A	= 4·81794
„ III „ lat. = 30° C	= 0·00058
Sum	= 3·66720

Therefore the height of Mussooree above Dehra = 4647·3 feet.

TABLE XX.—*Computation of Heights.—Local Corrections for Comparison with the Barometer at Simla.*—BOILEAU.

The observations from which this table has been constructed were made at the Simla Magnetic Observatory, height above sea level about 7100 feet, during the years 1843-44-45, and the table is to be considered as applicable to observations taken on mountains in the neighbouring provinces.

The corrections furnished by this table were obtained as follows:—The means, m_1, m_2, &c., were found for the three years for each hour of the day in each particular month, and also the mean M of all the readings taken during the three years: the differences, $M - m_1$, &c., give the corrections exhibited in the table for the several hours of the corresponding months.

The numbers in the last column were obtained by taking the mean of all the readings registered at the corresponding hours during the first halves of these three years and also during the second halves. The mean of the numbers in this column is 23·185 inches which was the yearly mean reading at the Simla Magnetic Observatory. This quantity can also be arrived at by applying to any of the readings in the last column the mean of the corrections in the same horizontal line.

In using the table the observed reading of the barometer must first be reduced to 32° Fah., and the tabular correction for the month and hour of reading applied; the result will be the mean yearly reading at the place of observation which may be used in conjunction with the mean yearly reading at Simla, *viz.*, 23·185 inches, to find the difference of height.

EXAMPLE.—A reading of the barometer taken at the top of the Dukanee Hill, above Chadwick's Bungalow, in the month of May 1846 at $2^h\ 30^m$ P.M., corrected for capillarity and temperature, was found to be 22·657 inches; what is the reading corrected for mean variation according to Table XX.

Observation of the barometer	=	22·657	inches
Correction from table for May at $2^h\ 29^m$ P.M.	=	+·032	„
Reading corrected for variation from the mean	=	22·689	„

TABLE XXI.—*Computation of Heights.—For determining Heights with the Boiling Point Thermometer.*—BOILEAU.

The heights of the barometer corresponding to different boiling points are derived from the results of Regnault's Experiments (see Deschanel's "Natural Philosophy," eighth edition, pages 374–5) by conversion from French into English units.

The approximate heights in the third column of Part I may be obtained by subtracting the feet of Table XVIII from 27541·5 feet, which is the value in that table corresponding to the reading of the barometer at the sea level, *viz.*, 29·921 inches.

The multipliers in Part II are found, on the supposition that dry air expands 0·00208333 of its volume for 1° Fah., from the formula—multiplier = $1 + (t^\circ - 32^\circ) \times 0{\cdot}00208333$, where t° is the mean temperature of the stratum of air passed through. Now the temperature of the air decreases 1° Fah. for every 331 feet ascended; so that if T is the temperature at a height h, the temperature at the sea level is $T + \frac{h}{331}$, and the mean temperature $= T + \frac{h}{660}$ nearly.

The method of using the table is as follows:—

Enter Part I with the given boiling point as argument and take out the approximate height.

Divide it by 660 and add the result to the air temperature. This gives the mean temperature of the stratum of air passed through.

Enter Part II with the mean temperature as argument, and the corresponding quantity when multiplied by the approximate height will give the required height above the sea level.

EXAMPLE.—The boiling point of water at Dehra is 208°·14 Fah. when the temperature of the air is 78°·5 Fah. To find the height of Dehra above the sea level.

Part I gives for 208°·14 . . . approximate height = 2023 feet;

therefore . . . mean temperature $= 78°\cdot5 + \left[\frac{2023}{660}\right]^\circ = 81°\cdot6.$

Part II gives for 81°·6 . . . multiplier = 1·103;

therefore height of Dehra above sea level = 1·103 × 2023 feet = 2231 feet.

TABLE XXII.—*Atmospherical Refractions.*

This table gives the mean refractions of celestial objects for altitudes ranging from 0° to 89°, when the height of the barometer is 30 inches and the air temperature is 50° Fah.

The table (as stated in the Nautical Almanac for 1826) is computed upon principles explained by Dr. Young, in the "Philosophical Transactions" for 1819, from the formula:—

$$\cdot0002825 = v\,\frac{r}{s} + (2\cdot47 + 0\cdot5\,v^2)\,\frac{r^2}{s^2} + 3600\,v\,\frac{r^3}{s^3} + 3600\,(1\cdot235 + 0\cdot25\,v^2)\,\frac{r^4}{s^4};$$

where r is the refraction expressed in circular measure, v is the sine of the altitude, and s the cosine.

In addition to this, the third, fourth and fifth columns of the table supply the requisite data for computing the refraction for any altitude and for other readings of the barometer and thermometer. The refraction and differences which correspond most nearly to the apparent altitude are to be employed.

If r' is the refraction corresponding to a height h of the barometer and an air temperature t; then

$$r' : r = \frac{h}{1 + \mathrm{E\,t}} : \frac{30}{1 + 50\,\mathrm{E}};$$

therefore

$$r' = r\,\frac{h}{30}\left\{1 + \mathrm{E}\,(50 - \mathrm{t})\right\};$$

where E = coefficient of expansion of air = ·0021 nearly for 1° Fah.

This formula is accurate, for all practical purposes, for altitudes down to within a few degrees of zero.

EXAMPLE.—To find the refraction for an altitude 13° 43′ with the barometer at 29·85 inches and the temperature of the air 45° Fah.

			′ ″
The table gives for altitude 13° 40′, ...		refraction =	3 55·5
,, correction for	3′ of altitude = − 0″·29 × 3	= −	0·87
	− ·15 in. of barometer = − 7 ·89 × 0·15	= −	1·18
	− 5° of temperature = + 0 ·482 × 5	= +	2·41
	Total correction	= +	0·36
	Therefore the required refraction	=	3 55·86

TABLE XXIII.—*Parallax of the Sun.*

This table gives the parallax of the sun for different months of the year at altitudes increasing by 5° from 0° to 90°. The values of the parallax for altitudes other than those given in the table may be found from inspection by simple interpolation.

The quantities given in the first line of the table are the angles subtended by the equatorial radius of the earth at the sun; and as the sun's distance is constantly changing, this quantity is greatest when the sun is nearest, that is in January, and least when the sun is furthest away, that is in July. The ratio of these two quantities is $1 + \frac{1}{60} : 1 - \frac{1}{60}$, since the eccentricity of the earth's orbit $= \frac{1}{60}$ nearly.

The values given in the first line are the "horizontal parallaxes" for the particular months, and for other altitudes the parallaxes have been found by multiplying the quantities in the first line by the cosines of the corresponding altitudes.

TABLE XXIV.—*Computation of Circumpolar Azimuths.—To Facilitate the Calculation of the Corrections—for Instrumental Errors of Collimation, Inclination and Deviation—to the Observed Times of Transit.*

The use of the table will be seen at once from the formulæ for the corrections.

Let *a, b, c* be the corrections in seconds of arc for *deviation, inclination,* and *collimation* respectively.

Then the correction to the observed time of transit in seconds of time

$$= \frac{a \sin \text{Z.D.} + b \cos \text{Z.D.} + c}{15 \sin \text{N.P.D.}}.$$

The table gives the values of the sine and cosine of the star's zenith distance for each degree from 0° to 90°, and the value of the factor $\frac{1}{15 \sin \text{N.P.D.}}$ for N. or S. declinations of stars for each degree from 0° to 45°.

The three quantities in the numerator of the above expression ought to be kept to the first place of decimals, while the resulting correction must be obtained to two places of decimals.

The rules for the signs of the corresponding corrections are as follows:—

with the star above the pole,

Collimation + {when F. L. reads highest with circles reading from left to right and the transit is observed with the face to the east.

Inclination + when west pivot of telescope is highest.

Deviation {+ for north stars / − „ south „} when the reading of the azimuth circle is too high with circles reading from left to right.

TABLE XXV.—*Computation of Circumpolar Azimuths.—To Facilitate the Computation of δA or the Reduction to Elongation.*

Let A = the azimuth of the star at maximum elongation,

P = the corresponding hour angle in arc,

δP = the interval in time from maximum elongation at a given moment,

δA = the corresponding change in azimuth;

then δA is found in seconds of arc (see *Account of the Operations of the Great Trigonometrical Survey of India,* Vol. II, pages 145—7) from the formula:—

$$\delta A = \frac{2 \sin^2 \frac{1}{2} \delta P \operatorname{cosec} 1'' \tan A \cos^2 \text{N.P.D.}}{1 - 2 \sin^2 \text{N.P.D.} \sin^2 \frac{1}{2} \delta P \pm \cot P \sin \delta P}.$$

The sign of the last term of the denominator is + or − according as the star is below or above its position of maximum elongation.

Part I of the table gives the values in natural numbers of $2 \sin^2 \text{N.P.D.} \sin^2 \frac{1}{2} \delta P$ for every minute of time of δP from 0^m to 30^m and for every degree of arc of the star's N.P.D. from 0° to 10°. Enter the table with δP in minutes of time and carry the eye along the line until the quantity corresponding to the N.P.D. of the star is reached. The variation either for N.P.D. or for δP is so slow that the quantity can readily be taken out by inspection. Subtract it from unity and enter the result in the form for computation.

Part II contains values of the term cotP sinδP in natural numbers between the limits P = 82° and P = 90° and for values of δP from 0^m to 30^m. The differences for each minute of time and for each 10 minutes of arc are so nearly constant that the column for 1^m may be taken as giving the former, and the horizontal line corresponding to P = 89° 50′ as giving the latter.

To use Part II of the table, enter with P to the nearest 10′ and carry the eye along the corresponding horizontal line until the column headed with the integral part of δP in minutes of time is reached. Interpolate for minutes and decimals of a minute of P in arc, using the quantity in the last line but one as the common difference. Next add the product between the decimals of δP in minutes and the quantity in the column for 1^m corresponding to the value of P.

EXAMPLE.—To find the value of cotP sinδP, when P = 87° 42′ 16″ or 87° 42′·3 and δP = 15^m·72.

For	P = 87° 40′, the column for 15^m gives	·00266
	Common difference for 10′ = − ·00019	
therefore	difference for 2′·3 . . . = − ·00019 × ·23 = −	4
„	P = 87° 42′·3 gives	·00262
	Common difference for 1^m . = + ·00018	
„	difference for 0^m·72 . . . = + ·00018 × ·72 = +	13
	Therefore the required result =	·00275

Part III contains the logarithmic values of 2 $\sin^2\frac{1}{2}\delta$P cosec 1″ for every second of time of δP from 0^m to 30^m, and is to be used in computing the numerator of the expression for δA, δP for the purpose being kept to two places of decimals of seconds.

Tables XXIV and XXV have been constructed to facilitate the calculation involved in determining the meridian from circumpolar star observations. The method, which is described below, is a rigorous one and is only to be employed in the principal operations of the Survey of India. It is not to be adopted except where great accuracy is required.

Observations are made between some fixed mark or station, which is called the referring mark, and a circumpolar star near its elongation. As the position of the star at each observation has to be referred to its position at elongation the time must be carefully noted, and it is necessary therefore to employ a chronometer of which the error and rate are known. These may be determined in several ways, but the usual method, when the station at which the observations are made appertains to triangulation, is to place the telescope of the theodolite in the plane of the meridian as given by the triangulation, and to observe the transits of suitable stars every night throughout the time occupied by the observations for azimuth.

When commencing work the first thing to be done is to level the instrument with extreme care. As the transit axis level does not show errors of level in the body of the instrument, the readings of a level fixed near the base of the pillars of the instrument parallel to the transit axis are necessary. With this level any residual errors which may exist prior to and at the conclusion of the observations, are to be carefully noted in the four positions of the vertical circle facing N., S., E., and W., both ends of the level being read and entered in the field book.

The instrument should now be set to the adopted meridian and the transit axis tested for inclination with the transit axis level, the two ends of the level being read with its cross-level both east and west, the position of the face of the instrument, E. or W., being also noted, as this position must be maintained when observing the time star. These readings are required for finding the corrections to the times of transit of the time stars due to the dislevelment of the transit axis, but the operation should be repeated at the end of the observations as a test of the stability of the instrument. Level readings on one face are not to be combined with those on the opposite face for the determination of the correction to the time star. The time stars should for convenience be taken from the Nautical Almanac and ought to be near the equator. One time star each night is all that is absolutely necessary, as the rate of the chronometer for 24 hours is what is wanted, but it is preferable to have two in case of accidents. It is not material whether they are observed before or after the azimuth observations, but it is safer to commence with the time star lest clouds interfere with its observation afterwards. In setting for the star it should be remembered that

$$\text{zenith distance} = \text{latitude} \mp \text{declination};$$

the sign being − for north stars and + for south stars.

The time stars being chosen, let us suppose, to precede the azimuth observations, the telescope should be brought round, say, from left to right to intersect the referring mark and the readings of all the microscopes taken and recorded in the field book. It should then be moved on in the same direction till placed in the adopted meridian, when the first time star should be transited and the readings of the microscopes again taken and entered. The method of reducing these observations will be explained hereafter.

To enable the observer to find the circumpolar star to which observations are to be taken it is necessary to compute its horary angle P, its altitude, and its azimuth A, all at elongation, by the formulæ :—

$$\begin{aligned} &1.\ \log\cos P &&= \log\tan \text{N.P.D.} + \log\tan\lambda, \\ &2.\ \log\sin A &&= \log\sin \text{N.P.D.} + \log\sec\lambda, \\ &3.\ \log\sin \text{Alt.} &&= \log\sec \text{N.P.D.} + \log\sin\lambda, \end{aligned}$$

where λ is the latitude of the place. The true altitude thus found must be corrected for refraction by adding the proper quantity given in Table XXII.

The horary angle reduced to time will, when added to the star's right ascension, give the sidereal time of western elongation and when subtracted it will give the time of eastern elongation; from these the chronometer times of elongation may be found. It is convenient to know the different apparent altitudes of the star during the observations, and for this purpose the change in altitude from elongation may be found with sufficient approximation by the formula :—

Increment in altitude for 1 minute of time for n° of polar distance

$$= \frac{2\pi n^\circ}{60 \times 24} = 5'' \times 3{\cdot}14159n = 15''{\cdot}71 \times n.$$

A small table showing the apparent altitude and zenith distance at intervals of say 5 minutes before and after elongation may with advantage be constructed and placed conveniently for reference, as follows :—

Bradley 402—for 1st January 1887, Latitude 30° N., Longitude 75° E. of Gh:

N. P. D. = 5° 29′ 21″: $n = 5{\cdot}49$.

	Chronometer Time	Apparent Altitude	Apparent Zenith Distance
	h m s	° ′ ″	° ′ ″
	7 27 40	29 27 42	60 32 18
	32 40	34 53	25 7
	37 40	42 4	17 56
	42 40	49 15	10 45
	47 40	56 27	3 33
	52 40	30 3 38	59 56 22
At E. Elongation	57 40	10 49	49 11
	8 2 40	18 0	42 0
	7 40	25 11	34 49
	12 40	32 23	27 37
	17 40	39 34	20 26
	22 40	46 45	13 15
	27 40	53 56	6 4

About 20 or 30 minutes before elongation the observer intersects the referring mark, moving the telescope from the side opposite the star, and registers the reading. He then raises the telescope to the required altitude and moves the instrument to within half a minute of the star's azimuthal reading, when he clamps the instrument and employs the tangent screw to bring it into such a position that the star, after the lapse of a few seconds, may transit the wire, and directs the assistant to count the beats of the chronometer aloud, so that when the star appears bisected on the wire the observer may be able to call out the exact second, which is recorded with the hour and minute. The level on the body of the instrument is then read and recorded and also the microscope readings of the horizontal limb. The observer next unclamps and overshoots the star and then with a reverse motion he again observes first the star and then the mark : this gives a pair of observations on one face. A similar pair is then taken on the other face beginning with the referring mark. Four pairs of observations are generally taken, and they should be so timed that two are before and two after elongation.

In circumpolar star observations two different systems may be adopted. First, one star may be observed at both elongations, or secondly, two stars may be selected, of approximately equal polar distance, but differing by about 12 hours in right ascension, and the one observed at its eastern and the other at its western elongation. The advantage of the first method is that any errors which may exist in the tabulated place of the star do not affect the result; but on the other hand the observations must be conducted near sun-rise and sun-set, when both star and referring mark may be difficult to see. The second method has the advantage that the stars can be chosen so as to be observed at night when small stars are easily visible, but the results of the observations are burdened by the errors in the stars' places, so that the first method is the preferable of the two.

When the second method is adopted, care should be taken to select stars of which the north polar distances are nearly equal, and it is advisable that their times of elongation should differ by about 45 minutes so as to allow of the observations to one star being completed before those to the other are begun. When they are simultaneously at elongation both may be observed in the same round of angles with the referring mark, but this should not be attempted by any but a rapid and experienced observer.

If the selected stars are not in the Nautical Almanac, their mean places must be computed for the first day of the year either from a catalogue or from Table LIV, by the formula :—

Mean Right Ascension on 1st January (1887 + y) = Mean Right Ascension on 1st January 1887 + $\left(p + \mu + \frac{s\,y}{200}\right) y$,

where p = annual precession in Right Ascension,

μ = annual proper motion ,,

s = secular variation ,,

y = number of years,

with a similar formula for North Polar Distance.

The following is a specimen of the observations as entered in the field book :—

Observations for Azimuth to Polaris at its Western Elongation, taken at Asu H.S. on the 18*th February* 1880, *with Barrow's* 24-*inch Theodolite No.* 2.

Face of Vertical Circle.	Readings of Level on Body of Instrument ($1^d = 1''\cdot103$) at commencement.	
East	East end 73·5,	West end 76·5,
South	South ,, 73·0,	North ,, 77·5,
West	West ,, 73·0,	East ,, 77·5,
North	North ,, 74·0,	South ,, 76·5.

Face of Vertical Circle.	Cross Level.	Transit Axis Level ($1^d = 0''\cdot875$) at commencement.	
East	East . . .	East end 56·0,	West end 52·5,
	West . . .	West „ 39·0,	East „ 70·0.

Object	Face and Zero	Micrometer Readings						Angle	Chronometer Time	Level on body of Instrument	
		A	B	C	D	E	Mean			East −	West +
		° ′ ″	″	″	″	″	° ′ ″	° ′ ″	h m s		
Referring Mark Lamp	East	100 45 1·0	19·4	33·1	28·2	26·6	100 45 21·66				
γ Geminorum . . .		57 34 45·0	61·7	77·8	71·0	71·0	57 35 5·30	43 10 16·86	6 30 17·5		
Sirius		57 34 35·8	52·5	68·2	63·1	63·8	57 34 56·68	43 10 23·12	6 39 21·5		
Referring Mark Lamp		100 44 58·9	75·6	91·2	87·5	85·8	100 45 19·80				
Referring Mark . .	L 259° 12′	280 44 47·9	60·1	73·2	70·3	71·5	280 45 4·60				
Polaris		236 5 7·9	20·6	35·0	27·1	30·2	236 5 24·16	44 39 40·44	7 0 8·0	77·0	78·0
Polaris		236 5 10·8	25·3	39·8	32·1	34·7	236 5 28·54	44 39 37·16	7 2 10·5	77·5	77·5
Referring Mark . .		280 44 45·8	62·2	76·0	72·2	72·3	280 45 5·70				
Referring Mark . .	R 79° 12′	100 44 53·2	72·3	87·2	83·2	78·6	100 45 14·90				
Polaris		56 5 12·8	29·2	48·0	41·5	38·8	56 5 34·06	44 39 40·84	7 7 53·5	76·5	78·5
Polaris		56 5 15·9	32·8	49·2	44·8	42·3	56 5 37·00	44 39 39·40	7 10 3·0	77·5	78·0
Referring Mark . .		100 44 55·1	70·5	88·2	85·0	83·2	100 45 16·40				
Referring Mark . .	L	280 44 47·2	60·0	72·6	69·1	72·8	280 45 4·34				
Polaris		236 5 3·2	16·5	30·8	23·0	26·2	236 5 19·94	44 39 44·40	7 16 22·0	77·0	78·5
Polaris		236 5 8·7	23·3	36·8	30·0	31·1	236 5 25·98	44 39 42·14	7 18 27·0	78·0	77·0
Referring Mark . .		280 44 47·8	65·4	78·0	76·2	73·2	280 45 8·12				
Referring Mark . .	R	100 44 53·9	72·1	86·8	81·7	79·8	100 45 14·86				
Polaris		56 5 22·1	38·5	56·2	50·3	47·1	56 5 42·84	44 39 32·02	7 24 35·0	77·0	78·0
Polaris		56 5 28·3	49·2	64·0	59·4	58·8	56 5 51·94	44 39 25·16	7 26 35·5	78·0	78·0
Referring Mark . .		100 44 55·6	73·2	87·2	84·8	84·7	100 45 17·10				

Here follow level readings similar to those at the commencement but in the reverse order.

In these observations L denotes that the face of the instrument is to the left and R that it is to the right of the observer, while 259° 12′ and 79° 12′ are the zero-settings of the instrument which remain the same for one night but are changed on successive nights in accordance with the system of zero-settings adopted in observing horizontal angles.

The reduction of the observations now remains. The corrections to the times of transit of the time stars for collimation, inclination and deviation must first be obtained.

The collimation correction is found from the observations of the referring mark taken during the azimuth observations, by comparing the readings on faces right and left in which the instrument has been moved in the same direction; thus a reading of referring mark, before intersection of the circumpolar star, on face left will be compared with a similar reading on face right. Following this method in the example given, we get the numbers $10''\cdot3$, $10''\cdot7$, $10''\cdot5$ and $9''\cdot0$. Half the mean of these is $5''\cdot0$, so that the correction for collimation in seconds of time is $-5 \frac{1}{15 \sin \text{N.P.D.}}$, the sign being determined by the rule given in Table XXIV.

The readings of the transit axis level are W. 91·5, E. 126·0, and the difference divided by the number of readings, or 8·6 divisions, multiplied by the value of one division of the scale, *viz.*, $0''\cdot875$, gives $7''\cdot5$. The correction for inclination is therefore $-7\cdot5 \cos \text{Z. D.} \times \frac{1}{15 \sin \text{N.P.D.}}$ seconds of time, the sign being determined by the rule in Table XXIV.

To obtain the deviation correction apply the angle between the referring mark and the transit star to the azimuth of the referring mark, to deduce the azimuth at which the star was transited. The difference between this and 180° gives the horizontal deviation of the instrument in arc E. or W. of the meridian, and when multiplied by $\frac{\sin \text{Z. D.}}{15 \sin \text{N.P.D.}}$ we have the correction to the transit in seconds of time. The sign of the correction is determined by the rule in Table XXIV. For the example given, the azimuth of the referring mark is 223° 10′ 25″·33; hence the horizontal deviation for γ Geminorum is $8''\cdot97$ E. and for Sirius is $2''\cdot21$ E.

The sum of the three corrections gives the total correction to be applied to the star's transit and for γ Geminorum it is $-1^s\cdot0$ and for Sirius $-0^s\cdot8$.

The chronometer times of transits of the stars as noted were $6^h\ 30^m\ 17^s\cdot5$ and $6^h\ 39^m\ 21^s\cdot5$ so that the corrected times were $6^h\ 30^m\ 16^s\cdot5$ and $6^h\ 39^m\ 20^s\cdot7$. The right ascensions of the stars were $6^h\ 30^m\ 49^s\cdot3$ and $6^h\ 39^m\ 53^s\cdot8$, therefore the error of the chronometer as deduced from the two time stars was $33^s\cdot0$ slow. The observations of the next night furnish the rate of the chronometer.

Now proceeding to the calculation of the azimuth: the right ascension and north polar distance of the circumpolar star or stars have to be deduced rigorously for the times of elongation. These elements are first found for the times of the upper local transit on the first and last nights of observation, and the rest of the process is by interpolation. A list of circumpolar stars for the epoch 1st January 1887 is given in a subsequent table: the star constants if not available from a recent catalogue should be computed as required by the formulæ given in that table as they vary rapidly for stars near the pole.

The horary angle P and azimuth at elongation A of the circumpolar star, are found for the first day from the formulæ previously given. Instead of computing these for each day their changes are found corresponding to the daily change in N.P.D. from the formulæ:—

$$\text{change in hour angle} = -\sec^2 \text{N.P.D.} \tan \lambda \operatorname{cosec} P \times \text{change in N.P.D.},$$

$$\text{,, azimuth} = +\cos \text{N.P.D.} \sec \lambda \sec A \times \text{change in N.P.D.},$$

whence follow the N.P.D., azimuth and sidereal time at elongation on the dates of observation.

The recorded times of observing the star are now corrected for the error of the chronometer and for the rate of the chronometer for the interval elapsed from the time star's transit. The corrected times being subtracted from the sidereal time of elongation give the interval in time between each observation and elongation, and the differences between the azimuth of the star at these times and at elongation are found by the formula in Table XXV, the several terms being found by means of that table. The observed angle between the star and the referring mark is corrected up by this quantity and the corrected angle applied to the azimuth of the star at elongation, the result being the angle between the referring mark and the north point. The mean of these results is taken for each zero on each face.

There is still one further correction to be applied due to the dislevelment of the body of the instrument. To obtain this, take the level readings for each star reading and add the mean of all the east readings on face left to the mean of all the east readings on face right, doing the same for the west readings. A quarter of the difference reduced to seconds of arc and multiplied by the tangent of the star's apparent altitude at the time of elongation will give the correction to the deduced angle between the referring mark and the north point, due to dislevelment. The sign of this correction is found by the following rule:—

If the sum of the east end readings is greater than that of the west, the sign will be + when the referring mark is to the east of north, and – when the referring mark is to the west of north, the reverse holding when the west end readings are the greater.

The correction will have the same sign for all observations of the same group whether on face right or face left and whether the instrument reads from left to right or from right to left. It must be determined separately for each star and should be applied to the zero means of face left and face right. If the referring mark is not in the horizon a further correction to the angle, which is generally insignificant, is necessary, *viz.*, a quarter of the difference of the level readings multiplied by the tangent of the altitude of the mark. The sign of this correction is always opposite to that of the former one.

The dislevelment in divisions of the level scale obtained as above is 0·3 and this multiplied by 1″·103 × tan Alt. gives 0″·17: the sign is — because the west end readings are greatest and the mark E. of north.

Applying the corrections the angle between the referring mark and the north point is obtained for the different zeros; the means are then taken out by eastern and western elongation, and finally the general mean deduced. 180° ± this angle gives the azimuth of the referring mark.

TABLE XXVI.—*Linear Value in Feet of one Second of Arc and its Logarithm, measured along the Meridian.*

The formula on which this table is based may be deduced as follows:—

Let s_1 = the length in feet of the arc between lats λ and $\lambda + \frac{l}{2}$,

s_2 = " " " λ and $\lambda - \frac{l}{2}$;

then

$$s_1 = \frac{l}{2}\sin 1''\frac{ds}{d\lambda} + \frac{1}{1.2}\left(\frac{l}{2}\right)^2\sin^2 1''\frac{d^2s}{d\lambda^2} + \frac{1}{1.2.3}\left(\frac{l}{2}\right)^3\sin^3 1''\frac{d^3s}{d\lambda^3} + \&c.,$$

$$-s_2 = -\frac{l}{2}\sin 1''\frac{ds}{d\lambda} + \frac{1}{1.2}\left(\frac{l}{2}\right)^2\sin^2 1''\frac{d^2s}{d\lambda^2} - \frac{1}{1.2.3}\left(\frac{l}{2}\right)^3\sin^3 1''\frac{d^3s}{d\lambda^3} + \&c.;$$

therefore if s_m = the length in feet of an arc of l'',

$$s_m = s_1 + s_2,$$

$$= l\sin 1''\frac{ds}{d\lambda} + \frac{1}{24}l^3\sin^3 1''\frac{d^3s}{d\lambda^3} + \&c.$$

Now $\frac{ds}{d\lambda} = \rho = \frac{a(1-e^2)}{(1-e^2\sin^2\lambda)^{\frac{3}{2}}}$ where ρ is the radius of curvature to the meridian in lat. λ;

therefore $\frac{d^3s}{d\lambda^3} = 3e^2\rho\cos 2\lambda$, neglecting terms in e^4;

" $s_m = \rho\, l\sin 1'' + \frac{1}{8}\rho\, l^3\sin^3 1''\, e^2\cos 2\lambda + \&c.$

The value of this second term when $\lambda = 0°$ is ·000 000 000 002 l^3 feet; or ·09 feet for an arc of 1°.

So that for calculating the length of an arc of 1″ we may use the formula:—

$$s_m = \rho\, l\sin 1''.$$

The table is computed for every 5′ of latitude from 0° to 40°, and is to be used in conjunction with the two succeeding tables in computing rectangular co-ordinates, as is explained on page 47.

TABLE XXVII.—*Linear Value in Feet of one Second of Arc and its Logarithm, measured along Parallels of Latitude.*

The formula on which the table is based is deduced as follows:—

Let s_p = the length in feet of arc of p'' in a parallel of latitude where radius is r.

then $$s_p = \frac{\pi}{180 \times 3600} \cdot r p''.$$

But $$r = \nu \cos \lambda;$$

therefore $$s_p = \cdot 00000\ 48481\ 36811\ \nu \cos \lambda\, p''.$$

The table is computed for parallels of latitude 5′ apart between the latitudes 0° and 40°, and is to be used in conjunction with the preceding and succeeding table in computing rectangular co-ordinates, as is explained on page 47.

TABLE XXVIII.—*Arc-versines of Spheroidal Arcs of Parallel 1° in length.*

If **O** and **P** are two points on the surface of the earth, and if the parallel through **P** cuts the meridian through **O** in p: and if a great circle through **P** be drawn perpendicular to this meridian cutting it in **N**, then p **N** is called the Arc-versine of the arc **P** p.

We can find this quantity as follows:—Equations (1) and (2) on page 20 give the expressions for the differences of latitude and longitude of two points. If we employ them for finding the position of **P** referred to **N** we shall have, see page 19, since the azimuth of **P** at **N** is 270°,

$$\delta_1 \lambda = -\frac{c}{\rho} \cos A \operatorname{cosec} 1'' = 0,$$

so that $$\Delta\lambda = -\mathrm{R}'\, \delta_1 L^2,$$

$$\text{and } \Delta L = \delta_1 L - \mathrm{Y}'\, \delta_1 L^3.$$

Now if $\delta_1 L$ is taken as 1°, we have

$$\mathrm{Y}'\, \delta_1 L^3 = 0''\cdot 04 \text{ in latitude } 20°.$$

So that if we take $\Delta L = \delta_1 L$ we commit an error of $0''\cdot 04$ or 4 feet in 1°.

Now $$\mathbf{P}p = \Delta L \quad\text{and}\quad \mathbf{PN} = \delta_1 L,$$

therefore **P** p may be employed in place of **P N**;

and $$\Delta\lambda = p\,\mathbf{N} = \text{arc-versine of } \mathbf{P}p.$$

Therefore we have $$\text{Arc-versine of } \mathbf{P}p = -\mathrm{R}'\, \Delta L^2,$$

where R′ is that for the latitude of **N** which is practically the same as for **P**.

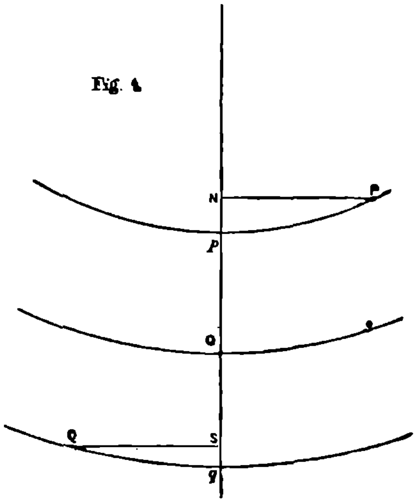
The table gives the arc-versine in seconds and in feet for an arc of 1° at every 5′ of latitude from 0° to 40°. It also gives for the same latitudes the logarithm of the number of seconds in the arc-versine of an arc of 1″, and it is this last logarithm which is to be used in conjunction with the two preceding tables in computing rectangular co-ordinates, as is explained below.

Tables XXVI, XXVII and XXVIII have been prepared to enable surveyors whose operations are based on rectangular co-ordinates to convert the latitudes and longitudes of the Trigonometrical Survey Stations, which fall within range of their operations, into rectangular co-ordinates, and thus obtain data for correcting the errors of their operations by simple proportion.

The operations of the Revenue Survey are based on rectangular co-ordinates computed on the supposition that the earth is a plane, and this assumption introduces errors which are insensible in small areas, and insignificant when compared with the ordinary errors of measurement.

Suppose **O**, **P**, **Q** are three stations of the Trigonometrical Survey whose latitudes and longitudes are known, and we want the co-ordinates of **P** and **Q** with respect to **O** which are respectively perpendicular and parallel to the meridian at **O**.

Fig. 1



Draw the parallels **O** *o*, **P** *p*, **Q** *q*, cutting the meridian through **O** in **O**, *p*, *q*, and draw **P N** and **Q S** perpendicular to the meridian through **O**.

Then the co-ordinates of **P** and **Q** are:—

$$X = PN, \quad X = QS,$$
and
$$Y = ON, \quad Y = OS.$$

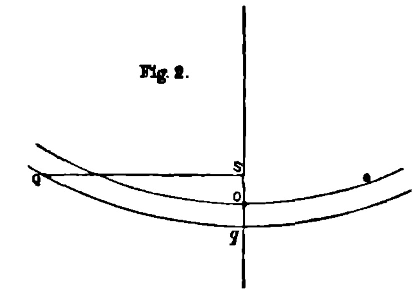
As explained on the preceding page, the X co-ordinates **P N** and **Q S** may be considered equal to the arcs **P** *p* and **Q** *q*.

Also $ON = pN + Op,$

and $OS = Sq - Oq,$

O S being negative because **S** falls south of **O**.

Fig. 2.



Therefore X = the difference of longitude converted into feet by Table XXVII, and

$$Y = \left\{\begin{matrix}\text{the arc-versine}\\ \text{in feet from}\\ \text{Table XXVIII}\end{matrix}\right\} \pm \left\{\begin{matrix}\text{the difference of}\\ \text{latitude convert-}\\ \text{ed into feet by}\\ \text{Table XXVI.}\end{matrix}\right\}$$

The + sign being used when the point is north of **O**,

and the − ,, ,, ,, south of **O**;

in the latter case Y will be + or − according as the arc-versine is greater or less than the difference of latitude.

We have thus the following rules:—

Rule I.—To find the perpendicular co-ordinate X in feet.

Find the difference of longitude between the point and the origin in seconds; take its logarithm and add the logarithm from Table XXVII corresponding to the latitude of the point. This will give the logarithm of X in feet.

X will be + or − according as the longitude of the point is greater or less than that of the origin.

Rule II.—To find the arc-versine in seconds.

To twice the logarithm of the difference of longitude in seconds add the logarithm from Table XXVIII corresponding to the latitude of the point. This will give the logarithm of the arc-versine in seconds.

Rule III.—To find the meridional co-ordinate Y in feet.

Find Y in seconds from the equation,

Y seconds = arc-versine + latitude of point − latitude of origin,

and note its sign. To the logarithm of Y in seconds add the logarithm in Table XXVI corresponding to a latitude = latitude of origin ± ½ Y. This will give the logarithm of Y in feet; the sign of Y in feet will be the same as that of Y in seconds.

Example:—

Let the latitude of the origin be 20° 15′ 30″·62, the longitude 72° 10′ 13″·73

" " " point **Q** " 20 15 26 ·50, " 71 20 10 ·25

To find the rectangular co-ordinates of **Q**.

Difference of longitude = 50′ 3″·48 = 3003″·48 . . log = 3·4776247

From Table XXVII corresponding to latitude of **Q** log = 1·9786412

Therefore X = − 285,934 feet . . . . . log = 5·4562659

Twice logarithm of difference of longitude . . . . = 6·9552

From Table XXVIII log corresponding to latitude of **Q** = $\bar{7}$·8987

Therefore arc-versine = 7″·14 . . . . . log = 0·8539

Y secs. = 7″·14 + 20° 15′ 26″·50 − 20° 15′ 30″·62 = + 3″·02, log = 0·4800069

Latitude of origin + ½ Y″ = 20° 15′ 32″·13. From Table XXVI, log = 2·0038236

Therefore Y = + 305 feet . . . . . log = 2·4838305

Tables XXVI, XXVII and XXVIII may also be employed, with all the accuracy desirable for most practical purposes, for determining the latitude and longitude of a Revenue Survey Station whose rectangular co-ordinates have been corrected for errors of measurement and made consistent with the corresponding co-ordinates of the Trigonometrical Survey Stations in the districts under survey. The latitude and longitude of the origin must of course be known, and the given rectangular co-ordinates must be perpendicular and parallel to the meridian of the origin.

The method of proceeding will be as follows:—

Rule I.—Divide the given value of Y in feet by 100 to obtain an approximate value of Y in seconds (see Table XXVI): find the approximate middle latitude = latitude of origin ± ½ Y and with it enter Table XXVI and take out the corresponding logarithm: subtract this from the logarithm of Y in feet, and the result will be the logarithm of Y in seconds of arc.

Rule II.—Find the logarithm of X in feet to 4 places of decimals; subtract from it the logarithm in Table XXVII corresponding to a latitude = latitude of the origin ± Y in arc; multiply this by 2 and add the logarithm in Table XXVIII corresponding to the same latitude: the result will be the logarithm of the arc-versine in seconds.

Rule III.—To find the latitude of the point.

The required latitude = latitude of origin $\pm$ Y in arc − arc-versine, where Y has the same sign in arc as it has in feet.

Rule IV.—To find the longitude of the point.

From the logarithm of X in feet subtract the logarithm in Table XXVII corresponding to the latitude just found. This will give the logarithm of the difference of longitude in seconds. This difference must be added to the longitude of the origin if X is + and subtracted when X is −.

Example.—The rectangular co-ordinates of a point **P** are

X = + 217,482 feet; Y = + 189,919 feet:

and the latitude of origin = 20° 15′ 30″·62; longitude = 72° 10′ 13″·73.

To find the latitude and longitude of **P**.

	Y in feet = 189,919	log = 5·2785684
therefore	Y in arc = 1,899 seconds approximately, = 31′ 39″,	
„	latitude of origin + ½ Y = 20° 31′ 20″, {corresponding log in Table XXVI}	= 2·0038367
„	Y in arc = + 31′ 22″·49 = 1882″·49	log = 3·2747317

X in feet = 217,482	log = 5·3374
Latitude of origin + Y in arc = 20° 47′, from Table XXVII	log = 1·9772
Difference =	3·3602
	2
	6·7204
From Table XXVIII corresponding to latitude 20° 47′,	log = $\bar{7}$·9079
therefore arc-versine = 4″·25	log = 0·6283

Latitude of **P** = 20° 15′ 30″·62 + 31′ 22″·49 − 4″·25 = 20° 46′ 48″·86.

X in feet = 217,482	log = 5·3374233
Table XXVII corresponding to latitude 20° 46′ 48″·86 . .	log = 1·9771663
X in arc = + 38′ 12″·22 = + 2292″·22 . .	log = 3·3602570

Therefore longitude of **P** = 72° 10′ 13″·73 + 38′ 12″·22 = 72° 48′ 25″·95.

TABLE XXIX.—*Linear Value in Miles of a Degree of Arc measured along the Meridian.*

This table is computed from the same formula as Table XXVI, the unit being changed from feet to miles. The term $\rho\, l \sin 1''$ gives the result correct to 4 places of decimals of a mile.

The argument in this table is the mean latitude of the extremities of the given arc. Thus the meridional distance between the parallels of 7½° and 8½° is 68·7159 miles and may be reckoned as the length of a degree *at* the latitude of 8°. The table is constructed for mean latitudes ranging from 0° to 46°.

EXAMPLE.—Required the meridional distance between the parallels of 8° 5′ and 8° 38′.

The mean latitude . . . . $= \frac{8^\circ 5' + 8^\circ 38'}{2} = 8^\circ{\cdot}358.$

		Miles
The table gives the length of degree at 8°		= 68·7159
Difference for 1°	= + ·0035	
Therefore difference for 0°·358	= + ·0035 × ·358	= + ·0013
Length of a degree at 8°·358		= 68·7172

Therefore distance between the parallels of 8° 5′ and 8° 38′

$$= \frac{33}{60} \times 68{\cdot}7172 \text{ miles} = 37{\cdot}7945 \text{ miles.}$$

TABLE XXX.—*Linear Value in Miles of a Degree of Arc measured along Parallels of Latitude.*

This table is computed by the same formula as Table XXVII, the unit being changed from feet to miles.

The argument in this table is the latitude of the parallel on which the length is required. Thus the distance on the parallel of 28° between two meridians 1° apart is 61·1109 miles. The table is constructed for parallels of latitude 1° apart from latitude 0° to latitude 46°.

EXAMPLE.—Required the distance between the meridians 78° 24′ and 78° 53′ on the parallel of 28° 41′ = 28°·683.

If $F^{(n)}$ = value in miles of 1° on the parallel of 28°·683

F = „ „ „ 28°

then $$F^{(n)} = F + n\,a + \frac{n\,\overline{n-1}\,b}{1.2} + \&c. \quad \text{(see note to Table I.)}$$

where $n = {\cdot}683$, and a and b are the 1st and 2nd differences given by the table.

				Miles
The table gives			F =	61·1109
„	$a = -\,{\cdot}5734$;	therefore .	$n\,a$ =	$-\,{\cdot}3916$
„	$b = -\,{\cdot}0185$	„	$\frac{n\,\overline{n-1}\,b}{1.2}$ =	$+\,{\cdot}0020$
therefore			$F^{(n)}$ =	60·7213

Therefore the distance between meridians 78° 24′ and 78° 53′ on the parallel of 28°·683

$$= \frac{29}{60} \times 60{\cdot}7213 \text{ miles} = 29{\cdot}3486 \text{ miles.}$$

TABLE XXXI.—*Graticules of maps.—Sides and Diagonals of Squares of ⅛th of a Degree of Latitude and Longitude, on the Scale of 1 Inch to ½ a mile.*

TABLE XXXII.—*Graticules of maps.—Sides and Diagonals of Squares of* $\frac{1}{4}$*th of a Degree of Latitude and Longitude, on the Scale of* 1 *Inch to* 1 *mile.*

TABLE XXXIII.—*Graticules of maps.—Sides and Diagonals of Squares of* $\frac{1}{2}$ *of a Degree of Latitude and Longitude, on the Scale of* 1 *Inch to* 4 *miles.*

TABLE XXXIV.—*Graticules of maps.—Sides and Diagonals of Squares of* $\frac{1}{2}$ *of a Degree of Latitude and Longitude, on the Scale of the Atlas of India or* $\frac{1}{255561}$ *of Nature.*

TABLE XXXV.—*Graticules of maps.—Sides and Diagonals of Squares of* 1 *Degree of Latitude and Longitude, on the Scale of* 1 *Inch to* 8 *miles.*

TABLE XXXVI.—*Graticules of maps.—Sides and Diagonals of Squares of* 2 *Degrees of Latitude and Longitude, on the Scale of* 1 *Inch to* 12 *miles.*

TABLE XXXVII.—*Graticules of maps.—Sides and Diagonals of Squares of* 2 *Degrees of Latitude and Longitude, on the Scale of* 1 *Inch to* 16 *miles.*

TABLE XXXVIII.—*Graticules of maps.—Sides and Diagonals of Squares of* 2 *Degrees of Latitude and Longitude, on the Scale of* 1 *Inch to* 24 *miles.*

TABLE XXXIX.—*Graticules of maps.—Sides and Diagonals of Squares of* 2 *Degrees of Latitude and Longitude, on the Scale of* 1 *Inch to* 32 *miles.*

TABLE XL.—*Graticules of maps.—Sides and Diagonals of Squares of* 2 *Degrees of Latitude and Longitude, on the Scale of* 1 *Inch to* 48 *miles.*

TABLE XLI.—*Graticules of maps.—Sides and Diagonals of Squares of* 2 *Degrees of Latitude and Longitude, on the Scale of* 1 *Inch to* 96 *miles.*

Tables XXXI to XXXV are computed for latitudes ranging from 0° to 40°, and Tables XXXVI to XLI for latitudes ranging from 0° to 46°.

The quantities given in the tables are :—m = **Q R** or **P S**, the meridional distance between the parallels there stated, n = **P Q** and p = **S R**, the lengths of the corresponding portions of these parallels, and q = **S Q** or **R P** the diagonal of the square : m is obtained from Table XXIX, and n and p from Table XXX by simple proportion, while q may be determined as follows :—

$$q^2 = m^2 + n^2 - 2\,m\,n \cos \mathbf{P},$$

and

$$q^2 = m^2 + p^2 + 2\,m\,p \cos \mathbf{P},$$

since angle **R** = 180° − angle **P**;

therefore

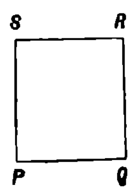
$$q^2 = m^2 + n\,p,$$

and

$$q = \sqrt{m^2 + n\,p}.$$

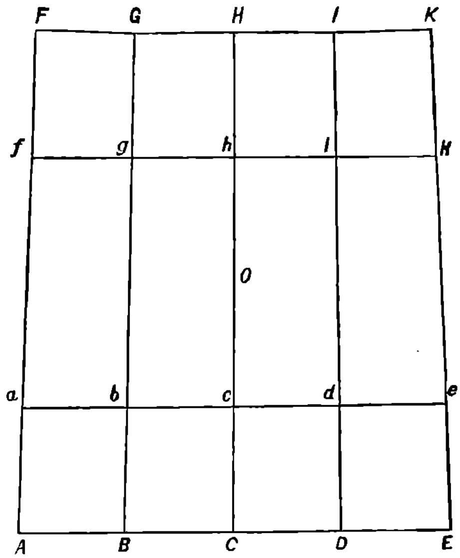
These tables are for use in constructing the graticules of maps on the different scales mentioned. Suppose that a graticule has to be drawn comprising 4° of latitude and 4° of longitude between the latitudes λ° and λ° + 4°, on any particular scale. Select the corresponding table and construct with great accuracy, on a piece of tracing paper, a quadrilateral figure **P Q R S** whose sides **P Q** = n and **S R** = p shall be the length of a degree of parallel in latitudes λ° and λ° + 1° respectively, and whose sides **P S** and **Q R** each = m shall be the meridional distance between those parallels. Construct also a similar quadrilateral for parallels λ° + 3° and λ° + 4°.

Fig. 3.



Draw a line **H C** down the middle of the paper to represent the central meridian and cut off parts **C** *c*, *c* **O**, **O** *h*, and *h* **H** each to represent a degree in the corresponding latitude on the given scale. Place the first quadrilateral with **Q R** on **C** *c* and prick through the point **P** thus giving the point **B**: similarly placing the second quadrilateral on **H** *h* obtain the point **G**. Join **B G** and cut off **B** *b* = **C** *c*, and **G** *g* = **H** *h*. With **B** *b* and **G** *g* as bases for starting proceed as before and determine the points **A** and **F** and the line **A F** which will be one of the outside meridians. A similar process on the other side of **H C** will give the points **D, E, I, K.** Join the points **A, B**; **B, C**; **C, D**; **D, E**, &c., and **F, G**; **G, H**; **H, I**; **I, K**, &c., and we get the parallels of latitude which cut each of the meridians at the same angle different for each parallel. We have now only to divide the lines *fa*, *gb*, &c., into parts equal to *h* **O** and **O** *c* and unite the points of intersection and the graticule is complete. The practical check on the process is that if it has been constructed accurately, the meridians **A F, B G, D I,** and **E K**, will be sensibly equal to the central meridian **C H**, and the diagonals **A H, C F, C K, E H**, will be sensibly equal to each other.

Fig. 4.



ATLAS SHEETS.—With reference to Table XXXIV it may not be out of place to give the following additional information extracted from a memorandum on the subject by Colonel J. T. Walker, written in 1872 and published as an appendix to Markham's "Indian Surveys."

After explaining the difficulty he experienced in obtaining reliable information owing to the circumstance that the publisher of the Atlas of India, Mr. John Walker, who had lately died, "had been in the habit of constructing the projections and compiling the materials of the Atlas Sheets with his own hands," Colonel Walker goes on to say that:—

The projection "is one of the numerous modifications of the conical development; it represents the parallels of latitude by concentric arcs, but the meridians by arcs concave to the central meridian, and not by straight lines as in the true conical development. A cone is assumed to roll over the spheroid tangentially to an adopted central parallel of latitude, the distance from the vertex of the cone to this parallel (= normal × cot latitude) is the radius of projection of the parallel, and may be considered as the fundamental radius of the projection; for the radii of all other parallels are determined by adding to or subtracting from it the distances between those parallels and the central parallel. The angle subtended at the vertex of the cone by a longitudinal arc of 1° in length is called the "angle of the projection" for the parallel of latitude to which the arc appertains; as this angle varies with the latitude, its value is computed for each parallel.

* * * * * * * *

"The elements of the figure of the earth which are employed are not stated, but there can be no doubt that they must have been those determined by Colonel Lambton from his measurements on the Great Indian Arc, and are given in Volume xiii of the "Asiatic Researches". * * * The longitudinal degrees of the projection are all but identical with Colonel Lambton's, and the differences between the radii of projection practically correspond with his meridional degrees in every case, excepting between 33° and 34°, where there is a considerable error, which, however, has been allowed for in the practical construction of the projection, and has not very materially influenced the accuracy of this portion of the Atlas.

* * * * * * * *

"With these elements of projection, the rectangular co-ordinates of the points of intersection of the principal meridians with the principal parallels were computed with reference to an adopted central meridian, and the points of its intersection by the parallels. Putting θ for the "angle of projection" for 1° of longitude on any given parallel, and r for the corresponding radius of projection, then the co-ordinates of the extremity of an arc of n degrees on that parallel, as referred to the central meridian and the point at which it is intersected by the parallel, will be

$$r \text{ sine } n\theta, \quad \text{and} \quad r \text{ versine } n\theta,$$

the former perpendicular and the latter parallel to the given meridian.

* * * * * * * *

"The meridian which has been adopted as the central meridian or axis of the projection is 76° 30′ east of Greenwich. * * What parallel was adopted as the central parallel is nowhere stated, and the data by which it might be ascertained are incomplete, but the values of the radii of projection clearly shew that it must lie between 24° and 25°, and most probably is 24° 30′.

"The sheets of the Atlas are rectangular, their dimensions as taken between the marginal lines on the copper plates being 38 by 24·4 inches, representing a distance of 134,850 fathoms lengthways, on the perpendicular to the central meridian, and a distance equivalent to the length of a meridional arc of 1° 28′ breadthways.

"The sheets are situated unsymmetrically with reference to the central meridian, for it passes over the central sheets at a distance corresponding to 37,100 fathoms from the west, and 97,750 fathoms from the east margin. This is exceedingly inconvenient, entailing separate computations for the projection of the sheets east and west of the central meridian, which would have been avoided if a symmetrical arrangement had been adopted.

"The origin of co-ordinates is at the intersection of the parallel of 5° with the central meridian; but each of the points at successive intervals of 1° 26′ on the central meridian, from latitude 5° upwards, may be said to be origins of co-ordinates, and employed as such in the calculations for the corresponding belts of sheets, right and left.

* * * * * * * *

"There can be little doubt—though it is nowhere stated in words on the Atlas sheets—that the scale of the Atlas must originally have been intended to be that of 1 inch to 4 miles, or the $\frac{1}{253440}$th part of nature: for this, the entire length of the fathom scale, from 0 to 60,000 should be 17·045 English inches, but on comparing it with a standard yard by Troughton and Simms, it was found to be only 16·904 inches; the scale of the Atlas is therefore the $\frac{1}{255561}$th part of nature or somewhat less than 1 inch to 4 miles, as has hitherto been supposed. The value of the meridional degree on Mr. Walker's scale is taken at 60,500 fathoms, and the actual length of this degree on the scale is equal to 17·055 inches of Troughton and Simms' standard yard, or very nearly what the length of the fathom scale should have been. On the other hand, the fathom scale has been prolonged to a point beyond the 60,000 fathom division, at a distance from the zero of that scale which is almost exactly equal to what the length of the meridional degree should have been. Hence it seems probable that the lengths of the scales were laid off with all desirable accuracy in the first instance, but by some mistake the fathom scale length was mistaken for that of the meridional degree and sub-divided accordingly, and *vice versâ*. In consequence of this error the dimensions of the copper plates, which should have been 38·31 by 24·65 inches within the border lines are only 38·00 by 24·45 inches. The error necessitates a reduction in scale of all geographical materials which are drawn on the quarter-inch scale, before they can be correctly inserted on the copper plates, but otherwise it is of little importance".

TABLE XLII.—*Rectangular Co-ordinates in Chains of the Corners of ⅛th Degree Squares, referred to the centre of the Degree as origin.*

This table gives the rectangular co-ordinates in chains of the corners of ⅛th degree squares referred to the centre of the degree as origin for latitudes ranging from 0° to 40°.

It is computed according to the principles laid down in Tables XXVI, XXVII, and XXVIII, and is for the use of Revenue Surveyors and others whose operations are based on rectangular co-ordinates referred to the centre of a square degree as origin, but which are intended for publication in maps based on spherical co-ordinates. The points of which the rectangular co-ordinates are given in the table are the corners of 7′ 30″ squares.

TABLE XLIII.—*Convergency between Meridians 1 Mile apart measured on Parallels of Latitude.*

The formula from which this table has been constructed may be deduced as follows:—

Let **P** and **Q** be two points 1 mile apart on the parallel of latitude $\lambda°$; draw tangents at the points **P** and **Q** to the meridians through **P** and **Q**; these tangents will meet at a point **T** on the polar axis of the earth.

Then the convergency = the angle **P T Q** $= \Delta L \sin \lambda$

$$\text{or} = PQ \operatorname{cosec} 1'' \frac{\tan \lambda}{\nu} = 5280 \operatorname{cosec} 1'' \frac{\tan \lambda}{\nu}$$

where ΔL is the difference of longitude between **P** and **Q** and ν is the normal to the meridian in latitude λ.

Example.—To find the convergency of two points 1 mile apart in latitude 17° 40′,

$$\log 5280 = 3 \cdot 72263$$

$$\log \operatorname{cosec} 1'' = 5 \cdot 31443$$

$$\log \tan \lambda = \bar{1} \cdot 50311$$

$$\log \frac{1}{\nu} = \bar{8} \cdot 67924 \text{ from Table I}$$

$$\text{Nat. No.} = 16 \cdot 57 \quad \ldots\ldots \quad \log = 1 \cdot 21941$$

therefore the convergency = 16″·6 as given in the table.

The table is constructed for every 5′ of latitude from 0° to 40°, and enables Revenue Surveyors and others who employ rectangular co-ordinates, to refer observed azimuths or azimuths obtained through triangulation to their meridian of origin.

Rule.—Enter the table with the latitude of the point at which the convergency is wanted, and multiply the quantity so obtained by the number of miles in the perpendicular co-ordinate of the point: the result will be the convergency required, and will be additive to the observed azimuth if *west* of the origin, subtractive if *east*.

Example.—In latitude 30° 25′ let the length of the co-ordinate perpendicular to the meridian of origin be 15·67 miles,

Then the convergency $= 15 \cdot 67 \times 30'' \cdot 5 = 477'' \cdot 9 = 7' \, 57'' \cdot 9$.

TABLE XLIV.—*Lengths of Circular Arcs.*

This table gives, to 7 places of decimals in terms of radius unity, the lengths of arcs of a circle subtending angles at the centre ranging from 0″·01 to 180°. The tabular numbers are also of course the circular measures of the corresponding angles.

Rule I.—To find the length of the arc which subtends a given angle at the centre of a circle of given radius. Find the tabular number corresponding to the given angle and multiply it by the radius.

Example.—

To find the length of an arc of 57° 17′ 44″·8 with a radius of 100 feet.

Tabular No.	for	57°	is	0·9948377
,,	,,	17′	,,	49451
,,	,,	44″	,,	2133
,,	,,	″·8	,,	39
				1·0000000

Therefore the length of the arc = 100 feet.

Rule II.—To find the degrees, &c., subtended by a given arc at the centre of a circle of given radius. Divide the arc by the radius; from the result subtract the next lower tabular number; from the difference the next lower and so on till no subtrahend remains; and opposite the several numbers subtracted will be the degrees, minutes, &c.

Example.—To find the angle subtended by an arc of 13·6578 feet in a circle whose radius is 100 feet.

	arc ÷ radius	=	·1365780
The table gives for	. . . . 7°	—	·1221730
			·0144050
,, ,,	. . . . 49′	—	·0142535
			·0001515
,, ,,	. . . . 31″	—	1503
			·0000012
,, ,,	. . . . ″·25	—	12
Therefore the required angle = 7° 49′ 31″·25.			0

TABLE XLV.—*For converting Feet into Miles.*

The table gives the equivalent in miles of any number of feet from 1 to 99999, and by simply altering the decimal points it can be used for any larger number.

Example.—To find the number of miles in 35,798 feet.

	The table gives	35,000 feet	=	6·6288	miles
	„ „	790 „	=	0·1496	„
	„ „	8 „	=	0·0015	„
Therefore		35,798 „	=	6·7799	„

TABLE XLVI.—*For converting Miles into Feet.*

The table gives the equivalent in feet of any number of miles from 0·01 to 99·99, and by altering the decimal place it can be used for any number of miles.

Example.—To convert 6·7799 miles into feet.

	The table gives	6 miles	=	31680	feet,
	„ „	·7700 „	=	4065·6	„
	„ „	·0099 „	=	52·3	„
Therefore		6·7799 „	=	35798	„

TABLE XLVII.—*For converting Links into Feet.*

The table gives the value in feet of any number of links between 0 and 99,999 and may be used for any other number by altering the decimal place.

Example.—To find the number of feet in 77210·52 links.

	The table gives	77000 links	=	50820	feet,
	„ „	210 „	=	138·6	„
	„ „	·52 „	=	·34	„
Therefore		77210·52 „	=	50958·94	„

TABLE XLVIII.—*For converting Feet into Links.*

The table gives the value in links of any number of feet between 0 and 99,999 and may be used for any other number by altering the decimal places.

Example.—To find the number of links in 50958·94 feet.

	The table gives	50,000 feet	=	75757·6	links,
	„ „	950 „	=	1439·4	„
	„ „	8 „	=	12·1	„
	„ „	·94 „	=	1·42	„
Therefore		50958·94 „	=	77210·52	„

TABLE XLIX.—*Gauss's Sum and Difference Logarithms.*

This table contains Gauss's Logarithms *adapted from Shortrede's Mathe-*

matical Tables, and Galbraith and Haughton's Manual, and by means of it the logarithms of the sum and difference of two numbers may be immediately derived from the logarithms of the numbers themselves. The table consists of three parts headed respectively A, B and C, the construction of which is as follows :—

$$\left.\begin{aligned} A &= \log m \\ B &= \log\left(1 + \frac{1}{m}\right) \\ C &= \log\,(1 + m) \end{aligned}\right\} \text{for successive values of } m \text{ from } 1{\cdot}001 \text{ to } 1000.$$

Hence it follows that C = A + B.

First, let it be required to find the logarithm of $(a + b)$ when $\log a$ and $\log b$ are given, a being $> b$. Put $m = \frac{a}{b}$; then

$$\log m = \log a - \log b = \text{A in table,}$$

$$\log\,(a + b) = \log a\left(1 + \frac{b}{a}\right) = \log a + \log\left(1 + \frac{1}{m}\right) = \log a + \text{B in table,}$$

$$\text{or } \log\,(a + b) = \log b\left(1 + \frac{a}{b}\right) = \log b + \log\,(1 + m) = \log b + \text{C in table.}$$

Rule.—Subtract the lesser logarithm from the greater; with the difference enter part A and find the corresponding number in part B, which must be added to the greater logarithm; or enter part A and find the corresponding number in part C, which must be added to the lesser logarithm. Either process will give the logarithm of $(a + b)$.

Example.—Find the logarithm of the sum of the numbers whose logarithms are 0·36173 and 0·23045.

$$\log a = 0{\cdot}36173$$
$$\log b = 0{\cdot}23045$$
$$\log a - \log b = 0{\cdot}13128 = \text{A},$$
$$\text{corresponding value in B} = 0{\cdot}24033$$
$$\log a = 0{\cdot}36173$$
$$\log\,(a + b) = 0{\cdot}60206$$
$$\text{or corresponding value in C} = 0{\cdot}37161$$
$$\log b = 0{\cdot}23045$$
$$\log\,(a + b) = 0{\cdot}60206$$

Next, let it be required to find $\log\,(a - b)$ with the same data. There will be two cases, one in which $\frac{a}{b}$ will be > 2 or $\log a - \log b > 0{\cdot}30103$, the other in which $\frac{a}{b}$ will be < 2 or $\log a - \log b < 0{\cdot}30103$, a being $> b$ in both cases.

In the 1st case let $\frac{a}{b} = 1 + m$, then $a - b = \dfrac{a}{1 + \frac{1}{m}}$

$$\log a - \log b = \log(1 + m) = \text{C in table,}$$

$$\log(a - b) = \log a - \log\left(1 + \frac{1}{m}\right) = \log a - \text{B in table.}$$

RULE.—When $\log a - \log b$ is $> 0{\cdot}30103$, with the difference enter part C, and find the corresponding number in part B, which must be subtracted from the greater logarithm to find $\log(a - b)$.

In the 2nd case let $\frac{a}{b} = 1 + \frac{1}{m}$, then $a - b = \frac{a}{1 + m}$

$$\log a - \log b = \log\left(1 + \frac{1}{m}\right) = \text{B in table}$$

$$\log(a - b) = \log a - \log(1 + m) = \log a - \text{C in table.}$$

RULE.—When $\log a - \log b$ is $< 0{\cdot}30103$, with the difference enter part B, and find the corresponding number in part C, which must be subtracted from the greater logarithm to find $\log(a - b)$.

EXAMPLE 1.—Find the logarithm of the difference of the numbers whose logarithms are 3·44134 and 1·21352.

$$\log a = 3{\cdot}44134$$
$$\log b = 1{\cdot}21352$$
$$\log a - \log b = 2{\cdot}22782$$

Next lower number in C = 2·22261 . . . corresponding value in B = 0·00261

Remainder = 521, Tabular difference in C = 994, ,, ,, in B = 6 . . . . subtract $\frac{521 \times 6}{994}$ = 3

B = 0·00258

$\log a$ = 3·44134

$\log(a - b) = \log a - \text{B} = 3{\cdot}43876$

EXAMPLE 2.—Find the logarithm of the difference of the numbers whose logarithms are 0·25042 and 0·08395.

$$\log a = 0{\cdot}25042$$
$$\log b = 0{\cdot}08395$$
$$\log a - \log b = 0{\cdot}16647$$

Next lower number in B = 0·16633 . . . corresponding value in C = 0·49733

Remainder = 14, Tabular difference in B = 32, ,, ,, in C = 68 . . . . subtract $\frac{14 \times 68}{32}$ = 30

C = 0·49703

$\log a$ = 0·25042

$\log(a - b) = \log a - \text{C} = \bar{1}{\cdot}75339$

Gauss's Tables give logarithmically the correlations of the following functions:—

A	B	C
x	$1 + \frac{1}{x}$	$1 + x$
$y - 1$	$\frac{y}{y - 1}$	y
$\frac{z}{1 - z}$	$\frac{1}{z}$	$\frac{1}{1 - z}$
$\tan^2\theta$	$\operatorname{cosec}^2\theta$	$\sec^2\theta$
$\frac{1}{A}$	C	B

Thus if the log of $\tan^2\theta$ is given, enter part A of the table therewith as an argument; the corresponding number in part B will be the log of $\operatorname{cosec}^2\theta$, and in part C the log of $\sec^2\theta$.

Example.—Given log $\tan^2\theta = 0{\cdot}47712$, part A; then from part B log $\operatorname{cosec}^2\theta = 0{\cdot}12494$, and from part C log $\sec^2\theta = 0{\cdot}60206$.

When the index of the given logarithm is negative enter part A with the corresponding negative logarithm, then the logarithm of the function B will be found in part C, and the logarithm of the function C will be found in part B. Conversely when the logarithm of B or C is only to be found in part C or B the corresponding logarithm of the function A will be negative.

Example.—Given log $\tan^2\theta = \bar{2}{\cdot}04324 = -1{\cdot}95676$, part A; then from part C log $\operatorname{cosec}^2\theta = 1{\cdot}96153$, and from part B log $\sec^2\theta = 0{\cdot}00477$.

Again log a being given let it be required to find $\log(1 + a)$.

Rule 1.—When a is greater than 1, *i.e.*, log a positive, enter part A with the given log, the corresponding number in C will be $\log(1 + a)$.

Rule 2.—When a is less than 1, *i.e.*, log a negative, enter part A with the negative log of a, the corresponding number in B will be $\log(1 + a)$.

Examples.

1. Given log a = 2·62562

Next lower number in A = 2·62000 . . . corresponding value in C = 2·62104

Difference = 562 }
Tabular difference in C = 998 } . . . add $\frac{562 \times 998}{1000}$ = 561

$\log(1 + a) = C = 2{\cdot}62665$

2. Given $\log a = \bar{2}\cdot62562$

Then the negative log of $a = 1\cdot37438$

Next lower number in A $= 1\cdot37400$ . . . corresponding value in B $= 0\cdot01798$

Difference $= 38$ }
Tabular difference in B $= 4$ } . . . subtract $\dfrac{38 \times 4}{100} = 2$

$\log(1 + a) = B = 0\cdot01796$

Lastly, $\log a$ being given let it be required to find $\log(a - 1)$ or $\log(1 - a)$.

RULE 1.—If $\log a$ is $> 0\cdot30103$, *i.e.*, $a > 2$, enter part C with it, the corresponding number in A will be $\log(a - 1)$.

RULE 2.—If $\log a$ is $< 0\cdot30103$ but > 0, *i.e.*, $a < 2$ but > 1, enter part B with it, the corresponding number in A will be the negative log of $(a - 1)$.

RULE 3.—If $\log a$ be negative, *i.e.*, $a < 1$, with the negative log of a enter part B or C and take the corresponding number in C or B; this will be the negative log of $(1 - a)$.

EXAMPLES.

1. Given $\log a = 2\cdot62562$

Next lower number in C $= 2\cdot62104$ . . . corresponding value in A $= 2\cdot62000$

Difference $= 458$ }
Tabular difference in C $= 998$ } . . . add $\dfrac{458 \times 1000}{998} = 459$

$\log(a - 1) = A = 2\cdot62459$

2. Given $\log a = 0\cdot03981$

Next higher number in B $= 0\cdot03987$ . . . corresponding value in A $= 1\cdot01700$

Difference $= 6$ }
Tabular difference in B $= 8$ } . . . add $\dfrac{6 \times 100}{8} = 75$

therefore negative log of $(a - 1) = 1\cdot01775$

therefore $\log(a - 1) = A = \bar{2}\cdot98225$

3. Given $\log a = \bar{1}\cdot62562$

Then the negative log of $a = 0\cdot37438$

Next lower number in C $= 0\cdot37433$ . . . corresponding value in B $= 0\cdot23833$

Difference $= 5$ }
Tabular difference in B $= 42$ } . . . subtract $\dfrac{5 \times 42}{58} = 4$
" " in C $= 58$ }

therefore negative log of $(1 - a) = B = 0\cdot23829$

therefore $\log(1 - a) = \bar{1}\cdot76171$

TABLE L.—*Common Logarithms to 4 places of Decimals.*

This table gives the logarithms to 4 places of decimals of all numbers between 100 and 1000, arranged in one opening.

TABLE LI.—*Common Logarithms to 5 places of Decimals.*

This table gives the logarithms to 5 places of decimals of all numbers between 1000 and 10000, and is intended especially to aid the calculations of the Revenue Branch of this Survey.

TABLE LII.—*Logarithmic Sines and Cosines to 5 places of Decimals.*

This table gives the logarithmic sines and cosines of angles differing by 1′ between 0° and 90°, and is intended especially to aid in the traverse calculations of the Revenue Branch of this Survey.

TABLE LIII.—*Azimuth and Apparent Altitude of Polaris computed with North Polar Distance 1° 17′ and Mean Refraction.*

This table, which was originally published in an abbreviated form in the United States Coast Survey Report for 1870, is intended for field use to aid in placing the meridian instrument approximately in the plane of the meridian. The table is constructed for a North Polar Distance of Polaris 1° 17′, but as corrections for every 10″ of N. P. D. are given, it can be used for the correct North Polar Distance as given by the Nautical Almanac. The time being known, all that is necessary is to intersect the star and read the horizontal circle, then the azimuth can be obtained by inspection from the table. The table is constructed to suit latitudes differing by 2° between 0° and 40° and for hour angles from 0^h to 12^h. The table further gives the hour angle at elongation with its correction for an increment of 10″ in N. P. D.

The formulæ by which the altitude and azimuth and the changes in them due to change in N.P.D. (Δ) have been computed are as follows:—

Let t = hour angle at any time except elongation,

λ = latitude,

δ = the declination,

ζ = the zenith distance,

q = the parallactic angle,

A = the azimuth,

then
$$\sin \tfrac{1}{2}\zeta = n \sec N \quad \text{and} \quad \sin A = \operatorname{cosec} \zeta \sin \Delta \sin t;$$

where
$$\tan N = \frac{m}{n} \sin \tfrac{1}{2} t; \quad m = \sqrt{\cos \lambda \cos \delta}; \text{ and } n = \sin \tfrac{1}{2}(\delta - \lambda).$$

$$d\,(\text{alt.}) = -\cos q \, d\Delta \quad \text{and} \quad dA = \frac{\sin q}{\sin \zeta} d\Delta;$$

where
$$\sin q = \frac{\cos \lambda \sin A}{\sin \Delta}.$$

From the above the true zenith distance ζ has been computed and the mean refraction, from Table I of Chauvenet's Astronomy, Vol. II, has been applied to obtain the apparent altitude.

The formulæ *at* elongation, P being the hour angle, are:—

$$\sin (\text{alt.}) = \sin \lambda \sec \Delta; \quad \sin A = \sin \Delta \sec \lambda; \quad \text{and} \cos P = \tan \lambda \tan \Delta;$$

the apparent altitude being found as before.

The changes in the preceding elements for a change in Δ are:—

$$d\,P = -\tan\lambda \operatorname{cosec} P \sec^2\Delta\, d\,\Delta\,;$$

$$d\,(\text{alt.}) = -\,d\,P \sin\Delta\,;$$

$$d\,A = d\,\Delta \sec(\text{alt.}).$$

The table may be used for two purposes. *First,* Given the altitude and hour angle, the latitude may be obtained by a series of interpolations. The results only differ by a few seconds from those arrived at by the method given in the Nautical Almanac, but the computation is rather laborious and cannot be recommended. *Second,* Given the latitude and hour angle, to find the azimuth.

EXAMPLE:—

On Nov. 9th 1886, in latitude 27° 47′ 26″ an observation was taken to Polaris at $21^h\ 4^m\ 54^s$; determine the azimuth.

	h	m	s
On Nov. 9th 1886, the Right Ascension of Polaris =	25	18	25
Sidereal time of observation =	21	4	54
Hour angle =	4	13	31

The North Polar Distance of Polaris = 1° 17′ 37″: correcting the tabular quantities for 37″ of N. P. D., we get:—

		°	′	″		h	m	s			°	′	″
	In latitude	26	0	0	at	4	0	0	Azimuth	=	1	15	12
	,,		,,		,,	4	20	0	,,	=	1	18	38
	,,	28	0	0	,,	4	0	0	,,	=	1	16	36
	,,		,,		,,	4	20	0	,,	=	1	20	4
therefore	,,	26	0	0	,,	4	13	31	,,	=	1	17	31
and	,,	28	0	0			,,		,,	=	1	18	57
whence	,,	27	47	26			,,		,,	=	1	18	48

so that the required azimuth of Polaris = 1 18 48.

It is evident that the arithmetic in this computation would have been much simplified if Polaris had been observed at one of the hour angles mentioned in the table; but as this may not be convenient at all times, an example of the most general type has been chosen.

TABLE LIV.—*Elements of Circumpolar Stars for* 1*st January* 1887.

The table contains a list of 60 circumpolar stars down to the 7th magnitude situated within 9° of the Pole and arranged in order of their right ascensions. The mean right ascensions and declinations are given to 2 places of decimals of a second, except those of the Nautical Almanac stars: the apparent places of the latter can be taken out at once from the almanac. The mean right ascensions and declinations, and the annual precessions in right ascension and declination have been computed by the rigorous formulæ given in 'Chauvenet's Astronomy', while the secular variations have been obtained from the formulæ given in the Greenwich 12-year Catalogue 1836-47. The third differences have been obtained by bringing up the right ascensions and declinations to 1887, using only first and second differences; then subtracting the results from the value obtained by the rigorous formulæ and dividing the result by one-sixth of the cube of the number of years from the Epoch of the Catalogue so that what are denoted 3rd differences really include the remainder of the series. In most cases the 9-year Catalogue was used, but a few stars which are not there given were obtained from the other recent Greenwich Catalogues or from the 2nd Radcliffe Catalogue for 1860. The proper motion was taken from the corresponding Catalogue when given there, and when not it is left blank. The unit in the columns headed $\frac{d^3a}{dt^3}$ and $\frac{d^3\delta}{dt^3}$ is the sixth place of decimals or the quantities are in millionths of a second.

The formulæ for finding the mean place of a star on the 1st January of the year (1887 + y) are:—

$$a' = a + \frac{da}{dt} \cdot y + \frac{d^2a}{dt^2} \cdot \frac{y^2}{200} + \frac{d^3a}{dt^3} \cdot \frac{y^3}{6}$$

$$\delta' = \delta + \frac{d\delta}{dt} \cdot y + \frac{d^2\delta}{dt^2} \cdot \frac{y^2}{200} + \frac{d^3\delta}{dt^3} \cdot \frac{y^3}{6}$$

where a and δ are the mean Right Ascension and Declination on 1st January 1887,

and $\frac{da}{dt}$ and $\frac{d\delta}{dt}$ are the annual precessions in Right Ascension and Declination,

,, $\frac{d^2a}{dt^2}$ and $\frac{d^2\delta}{dt^2}$,, secular variations ,, ,, ,,

The apparent place for Greenwich mean midnight will be found as usual by applying to the mean place on the 1st January of the year of observation the corrections:—

in right ascension . . $Ee + Ff + Gg + Hh + L + l - 300 + \mu \times$ fraction of year,

,, declination . . . . $Ee' + Ff' + Gg' + Hh' + L + l' - 300 + \mu' \times$,, ,, ;

where μ and μ' are the respective proper motions in right ascension and declination; E, F, &c., are Airy's Day-Numbers, and e, e', f, f', &c., are the star constants. If there is a Catalogue whose Epoch is near the year of observation the star constants may be used from it, but if not, as the constants change very considerably for stars near the pole, they ought to be computed from the following formulæ:—

Let ω = mean obliquity of the ecliptic (from Nautical Almanac),

$m = 46''\cdot0871 + 0''\cdot0002849\ y$,

$n = 20''\cdot0532 - 0''\cdot0000863\ y$,

a' = the mean R.A. in time on 1st January of year 1887 + y,

Δ = ,, N.P.D. ,, ,, ,, ;

then $e = +\frac{1}{15} \cos a' \operatorname{cosec} \Delta + 1\cdot2$,

$f = +\frac{1}{15} \sin a' \operatorname{cosec} \Delta + 1\cdot2$,

$$g = +\frac{m}{15} + \frac{n}{15}\sin a' \cot \Delta + 25,$$

$$h = +\frac{1}{15}\cos a' \cot \Delta + 1{\cdot}2,$$

$$l = 210 - 25 \times e - 25 \times f - 1{\cdot}2 \times g - 25 \times h,$$

$$e' = -\tan \omega \sin \Delta + \sin a' \cos \Delta + 1{\cdot}2,$$

$$f' = -\cos a' \cos \Delta + 1{\cdot}2,$$

$$g' = -n \cos a' + 25,$$

$$h' = +\sin a' + 1{\cdot}2,$$

$$l' = 210 - 25 \times e' - 25 \times f' - 1{\cdot}2 \times g' - 25 \times h'.$$

TABLE LV.—*Values of* $\frac{2 \, Sin^2 \frac{1}{2} t}{Sin \, 1''}$ *for the Reduction of Circum-meridian Observations for Latitude.*

This table is intended to be employed in the computation of latitude from circum-meridian observations of the sun or a star. The formula for finding the latitude is as follows:—

If λ = the true latitude,

ζ = the true meridian zenith distance,

ζ_0 = an observed ex-meridian zenith distance corrected for refraction, and in the case of the sun or a planet also for semi-diameter and parallax,

δ = the declination of the sun or star,

$\lambda_0 = \delta \pm \zeta_0$ = an approximate value of λ,

t = the hour angle;

then $\zeta = \zeta_0 \mp Am$ where $A = \frac{\cos \lambda_0 \cos \delta}{\sin \zeta_0}$ and $m = 2\frac{\sin^2 \frac{1}{2} t}{\sin 1''}$,

the negative sign being used when the star is above the pole and the positive one when the star is below it,

and $\lambda = \delta \pm \zeta$.

In the above formula *t should be less than 20 minutes and* ζ *greater than 10°*, and consequently the table is only constructed to give m for all values of the hour angle from 0^s to 20^m. The logarithms of the several quantities m, should they be required, will be found in Table XXV.

In practice a number of observations (say ten) should be taken, and it is better that some should be on one side and some on the other side of the meridian, but it is not necessary to reduce each of these separately: the above formula is sufficiently accurate if ζ_0 represent the mean of the zenith distances corrected as above described and m the mean of the quantities $\frac{2 \sin^2 \frac{1}{2} t}{\sin 1''}$ corresponding to the respective hour angles of observation. In case of the Sun δ is the declination corresponding to the mean of the times of observation.

EXAMPLE.—Circum-meridian Observations for Latitude to λ Sagittarii, (South), at Camp Kilki, August 3, 1885.

Face	Circle Readings A	Circle Readings B	Circle Readings Mean	Chronometer Times	t	m	
	° ′ ″	′ ″	′ ″	h m s	m s		h m s
L	30 27 0	27 30	27 15	18 11 55	8 14	133	R. A. of Star = 18 20 56
R	59 25 50	25 20	25 35	13 51	6 18	78	Chronometer Error = − 47
R	59 25 20	24 50	25 5	15 13	4 56	48	Chronometer Time of transit = 18 20 9
L	30 28 40	29 0	28 50	17 24	2 45	15	
L	30 28 20	29 20	28 50	18 34	1 35	5	
R	59 24 20	24 10	24 15	21 12	1 3	2	
R	59 24 30	23 50	24 10	22 37	2 28	12	
L	30 28 20	28 30	28 25	25 49	5 40	63	° ′ ″
L	30 27 10	27 40	27 25	27 36	7 27	109	ζ_0 = 59 29 48 . . log cosec = 0·06469
R	59 26 40	26 20	26 30	29 4	8 55	156	δ = −25 28 52 . . log cos = $\bar{1}$·95556
							λ_0 = 34 0 56 . . log cos = $\bar{1}$·91849

	° ′ ″
Mean of altitudes =	30 31 31
Refraction =	1 19
	30 30 12
ζ_0 . . . . =	59 29 48

Mean m = 62·1 . . . . log = 1·79309

Am = 54″ . . . log = 1·73183

$\zeta = \zeta_0 - Am$ = 59° 28′ 54″

δ . . . . = − 25 28 52

λ = 34 0 2

TABLE LVI.—*Factors for Bessel's Probable Error Formulæ.*

The formulæ for finding the probable error of a single observation of a group, or of the mean of the group, are given in "Airy's Theory of Errors of Observations, 1875" article 60, as follows :—

$$p.e. \text{ of a single observation } = \frac{0\cdot6745}{\sqrt{n-1}} \cdot \sqrt{\text{sum of squares of apparent errors.}}$$

$$p.e. \text{ of the mean } = \frac{0\cdot6745}{\sqrt{n\,(n-1)}} \cdot \sqrt{\text{sum of squares of apparent errors.}}$$

The table gives the values of the two factors $\frac{0\cdot6745}{\sqrt{n-1}}$ and $\frac{0\cdot6745}{\sqrt{n\,(n-1)}}$ for values of n from 2 to 100 inclusive.

TABLE LVII.—*Quadrilateral Surfaces of 15′ in Latitude and in Longitude on the Terrestrial Ellipsoid.*

This table gives the areas in square miles, to 3 places of decimals, of squares of 15′ side between the latitudes 0° and 40°.

The table is computed from the formula :—

$$\text{Area} = \frac{\rho\nu \cos\lambda}{(5280)^2} \times (\text{circular measure of } 15')^2 = \left(\frac{15}{88}\right)^2 \rho\nu \cos\lambda \sin^2 1''.$$

For purposes of interpolation each area given in the table must be considered as corresponding to its middle latitude and the interpolation carried on, as in the foot-note to Table I, for the middle latitude of the space required.

If the area of a 5′ space is required, the areas in the table must first be divided by 9 and then considered as the 5′ spaces corresponding to the middle latitudes, and the interpolation carried on as before.

More generally, if the area of an n' space is required, multiply the 15′ areas by $\frac{n^2}{225}$ and interpolate as before.

TABLE LVIII.—*Semi-diurnal and Semi-nocturnal Arcs, showing the time of the rising and setting of the Sun, Moon, or Equatorial Stars.*

The table, abridged from that in "Hints to Travellers," gives half the time that a celestial body continues above or below the horizon when the latitude and declination are of the same or of contrary names : it affords the means of computing the rising and setting of the sun, moon and equatorial stars, and the length of the day and night. No allowance is made for refraction which in extreme cases will cause an error of 3^m. For convenience a table of the dates corresponding to sun's declination is added.

To find the time of the sun's rising or setting. Enter the table with arguments latitude and declination. Then the tabular number is the apparent time of the sun's setting or rising according as the arguments are of the same or contrary names, and this subtracted from 12 hours will be the apparent time of rising in the former case or setting in the latter. Twice the time of rising or setting will give the length of the night or day.

Example.—To find the apparent time of sunrise and sunset and the length of the day and night in lat. 32° N., declination 18° N.

			h *m*
For arguments, lat. 32°, declination 18° . . .	tabular number	=	6 47
Therefore the time of sunset = *h* *m* 6 47 . . .	Length of the day	=	13 34
And „ „ sunrise = 5 13 . . .	„ „ night	=	10 26

To find the time of a star's rising and setting. Find the right ascensions of the sun and star from the Nautical Almanac and subtract the former from the latter increased by 24 hours if necessary. The difference is the approximate time of the star's passing the meridian. Enter the table with arguments latitude and declination, the tabular number is half the time the star is above or below the horizon according as the latitude and declination are of the same or different names, and in the latter case it must be subtracted from 12 hours to get half the time of continuance above the horizon ; subtract or add half the time above the horizon from star's meridian passage and the result will be the time of the star's rising or setting.

Example.—At what apparent time does δ Ophiuchi rise and set on May 1st 1887 in lat. 30° N. ?

		h *m*
Star's Right Ascension on 1st May 1887	=	16 8
Sun's „ „ „	=	2 33
Approximate time of star's meridian passage . .	=	13 35

Arguments, lat. 30° N., declination 3° 24′ S.

		h m	
Tabular number = $6^h\ 8^m$, subtract from 12 hours .	=	5 52	
Time of star's rising	=	7 43 P.M.	
„ „ setting	=	19 27 „	or = 7 27 A.M.

TABLE LIX.—*Corrections for reducing Apparent to Mean Solar Time.*

These corrections must be applied to the apparent time with the signs given in the table to reduce to mean time. If greater accuracy is required the Nautical Almanac must be used where the quantities will be found under the heading "Equation of Time," on page 1 of each month.

TABLE LX.—*Showing Links to be subtracted from each Chain, in an ascending or descending line, in order to reduce it to the Horizontal Measure.*

This table gives the number of links to be subtracted from each chain on different ascents or descents from 1° to 30° so as to reduce it to the horizontal.

The horizontal space passed over in ascending 1 chain on a slope of θ degrees is 100 $\cos\theta$ links, so that the numbers given in the tables are the values corresponding to 100 versin θ for different values of θ from 1° to 30°.

Thus if the slope be 12°,

$$\text{Tabular expression} = 100 \text{ versin } 12° = 100 \times \cdot021852 = 2\cdot19.$$

Example.—To find the horizontal measure corresponding to a distance of 2 chains 56 links on an incline of 3° 20′.

$$\text{Tabular number corresponding to } 3°\ 20' = 0\cdot14 + \frac{20}{60} \times \cdot10 = 0\cdot173\,;$$

therefore the number of links to be subtracted $= 2\cdot56 \times \cdot173 = \cdot44$,

and the horizontal distance = 2 chains 55·56 links.

TABLE LXI.—*For the Conversion of Versts and Kilometres into Miles and vice versâ.*

This table gives the values, to 4 places of decimals of miles, of distances from 1 to 10 versts and from 1 to 10 kilometres: and it gives values of distances from 1 to 10 miles in versts and kilometres: it also gives the accurate value in kilometres of 1 mile and the value in feet of 1 verst.

TABLE LXII.—*For the conversion of French into English Measures.*

TABLE LXIII.—*For the conversion of English into French Measures.*

APPENDIX.

APPENDIX.

§ (1). *Alternative Formulæ for Computing Differences of Latitude, Longitude and Azimuth in Secondary Triangulation, and for the Reverse Process.*

Let **A** and **B** be two points on the earth's surface, and let λ, L be the latitude and longitude of **A** and A the azimuth of **B** at **A**, and $\lambda + \Delta\lambda$, $L + \Delta L$ and $\pi + A + \Delta A$ be the corresponding quantities for **B**, and $c =$ the distance **AB**.

Let O be the middle point of **A B**, and let its latitude and longitude be Λ and l respectively, and the azimuth of **A** at O be a and of **B** at O be $\pi + a$, and let $\Delta_B \Lambda$, &c., $\Delta_A \Lambda$, &c., represent the differences of latitude, &c., between O and **B** and **A**.

Then the formulæ on page 15 gives :—

$$\Delta_A \Lambda \sin 1'' = -\frac{c}{2\rho}\cos a - \frac{1}{2}\frac{c^2}{4\rho\nu}\sin^2 a \tan\Lambda - \frac{3}{4}\frac{c^2}{4\rho\nu}\frac{e^2}{1-e^2}\cos^2 a \sin 2\Lambda$$
$$+ \frac{1}{6}\frac{c^3}{8\rho\nu^2}\sin^2 a \cos a\,(1 + 3\tan^2\Lambda);$$

$$\Delta_B \Lambda \sin 1'' = +\frac{c}{2\rho}\cos a - \frac{1}{2}\frac{c^2}{4\rho\nu}\sin^2 a \tan\Lambda - \frac{3}{4}\frac{c^2}{4\rho\nu}\frac{e^2}{1-e^2}\cos^2 a \sin 2\Lambda$$
$$- \frac{1}{6}\frac{c^3}{8\rho\nu^2}\sin^2 a \cos a\,(1 + 3\tan^2\Lambda);$$

therefore $\Delta\lambda \sin 1'' = \dfrac{c}{\rho}\cos a - \dfrac{1}{24}\dfrac{c^3}{\rho\nu^2}\sin^2 a \cos a\,(1 + 3\tan^2\Lambda).$

Similarly $\Delta L \sin 1'' = \dfrac{c}{\nu}\dfrac{\sin a}{\cos\Lambda} + \dfrac{1}{24}\dfrac{c^3}{\nu^3}\left\{\dfrac{1 + 3\tan^2\Lambda}{\cos\Lambda}\,.\,\sin 2a \cos a - 2\sin^3 a\,.\,\dfrac{\tan^2\Lambda}{\cos\Lambda}\right\}$

$$\Delta A \sin 1'' = \frac{c}{\nu}\sin a \tan\Lambda + \frac{1}{4}\frac{c^3}{\nu^3}\left\{\left(\frac{5}{6} + \tan^2\Lambda\right)\frac{\tan\Lambda}{2}\sin 2a\cos a\right.$$
$$\left. - \frac{1}{6}\sin^3 a \tan\Lambda\,(1 + 2\tan^2\Lambda)\right\}.$$

Now $\pi + a + \Delta_B a = A + \Delta A$,

therefore $$\pi + a = A + \frac{\Delta A}{2} - \frac{1}{16}\frac{c^2}{\nu^2}\left(1 + 2\tan^2\Lambda + \frac{e^2\cos^2\Lambda}{1-e^2}\right)\sin 2a \operatorname{cosec} 1''.$$

Now the maximum value of the last term for a distance of 60 miles and $\Lambda = 45°$ is between 8″ and 9″;

therefore $$-\cos a = \cos\left(A + \frac{\Delta A}{2}\right) + \sin\left(A + \frac{\Delta A}{2}\right) \times \cdot 00004,$$

$$= \cos\left(A + \frac{\Delta A}{2}\right) \text{ very nearly;}$$

and $$-\sin a = \sin\left(A + \frac{\Delta A}{2}\right) \text{ very nearly.}$$

Also $$\Lambda = \lambda - \Delta_A \Lambda = \left(\lambda + \frac{\Delta\lambda}{2}\right) + \frac{1}{8}\frac{c^2}{\rho\nu}\sin^2 a \tan\Lambda \operatorname{cosec} 1'',$$

and the maximum value of the second term is about 6″;

therefore $$\sin\Lambda = \sin\left(\lambda + \frac{\Delta\lambda}{2}\right) \text{ and } \cos\Lambda = \cos\left(\lambda + \frac{\Delta\lambda}{2}\right) \text{ nearly.}$$

Consequently leaving out the terms containing third powers of c which are small we get :—

$$\left.\begin{aligned} \Delta\lambda &= -\frac{c}{\rho}\cos\left(A + \frac{\Delta A}{2}\right)\operatorname{cosec} 1'' \\ \Delta L &= -\frac{c}{\nu}\frac{\sin\left(A + \frac{\Delta A}{2}\right)}{\cos\left(\lambda + \frac{\Delta\lambda}{2}\right)}\operatorname{cosec} 1'' \\ \Delta A &= \Delta L \sin\left(\lambda + \frac{\Delta\lambda}{2}\right) \end{aligned}\right\}$$

The terms in c^3 are :—

In $\Delta\lambda$ . . . $-\frac{1}{24}\frac{c^3}{\rho\nu^2}\cdot\sin^2\theta\cos\theta\,(2 + 3\tan^2\phi)\operatorname{cosec} 1''$.

„ ΔL . . . $-\frac{1}{24}\frac{c^3}{\nu^3}\cdot\sin\theta\sec\phi\left\{\sin^2\theta\sec^2\phi - 1\right\}\operatorname{cosec} 1''$,

„ ΔA . . . $-\frac{1}{24}\frac{c^3}{\nu^3}\cdot\sin\theta\tan\phi\left\{2 + \tan^2\phi\sin^2\theta\right\}\operatorname{cosec} 1''$;

where $$\theta = A + \frac{\Delta A}{2} \text{ and } \phi = \lambda + \frac{\Delta\lambda}{2},$$

and the greatest values of these for a distance of 60 miles in latitude 40° are :—

In $\Delta\lambda$ . . . 0″·05 on an azimuth 54° 44′.

„ ΔL . . . 0″·03 „ 90°,

„ ΔA . . . 0″·07 „ 90°.

We have therefore with all requisite amount of accuracy for secondary triangulation and snow peaks, the three formulæ :—

$$\Delta\lambda = -\frac{c}{\rho}\cos\left(A + \frac{\Delta A}{2}\right)\operatorname{cosec} 1'' \quad . . . . \quad (1)$$

$$\Delta L = -\frac{c}{\nu}\frac{\sin\left(A + \frac{\Delta A}{2}\right)}{\cos\left(\lambda + \frac{\Delta\lambda}{2}\right)}\operatorname{cosec} 1'' \quad . . . . \quad (2)$$

$$\frac{\Delta A}{2} = \frac{\Delta L}{2}\sin\left(\lambda + \frac{\Delta\lambda}{2}\right) \quad . . . . \quad (3)$$

In the preceding formulæ

$$\log \frac{\operatorname{cosec} 1''}{\rho} = \text{co-log (Tab. XXVI)}, \text{ and } \log \frac{\operatorname{cosec} 1''}{\nu \cos\left(\lambda + \frac{\Delta\lambda}{2}\right)} = \text{co-log (Tab. XXVII)}$$

The Reverse Process follows at once; for since λ, $\Delta\lambda$, L, ΔL, ρ and ν are given we have:—

$$\tan\left(A + \frac{\Delta A}{2}\right) = \frac{\nu.\cos\left(\lambda + \frac{\Delta\lambda}{2}\right)}{\rho} \cdot \frac{\Delta L}{\Delta\lambda};$$

or $\log\tan\left(A + \frac{\Delta A}{2}\right) = \log\text{ (Tab. XXVII)} - \log\text{ (Tab. XXVI)} + \log\Delta L - \log\Delta\lambda$

This gives $A + \frac{\Delta A}{2}$: c follows from equation (1) and ΔA from equation (3), so that A and c are determined.

The Forward Process, *viz.*, Given c and A to find $\Delta\lambda$, ΔL and ΔA, is effected by approximation as follows:—

Approximate values of $\frac{\Delta\lambda}{2}$ and $\frac{\Delta L}{2}$ are first obtained from the formulæ $\frac{c}{2}\sin A$ and $\frac{c}{2}\cos A$ or from a traverse indicator, to which has been added scales of latitude and longitude, by laying off the distance $\frac{c}{2}$ along the given azimuth. Putting these in equation (3) $\frac{\Delta A}{2}$ is obtained approximately. $\frac{\Delta A}{2}$ is now introduced into equation (1) and a new value of $\Delta\lambda$ obtained, by the aid of which a new value of ΔL is obtained from (2), and then from (3) ΔA is found, which has always the same sign as ΔL. The process may be continued, but as a general rule this will suffice.

EXAMPLE 1.—Given the latitude and longitude of station **A**, and the azimuth and distance of station **B**; to find the latitude and longitude of station **B** and the back azimuth of station **A**.

Given data at Station **A**

$\lambda = 24^\circ\ 8'\ 3''\cdot72$; $L = 78^\circ\ 3'\ 7''\cdot91$; $A = 178^\circ\ 15'\ 55''\cdot09$;
$\log c = 5\cdot0354049$. $c = 108494$ feet.

$\frac{\Delta\lambda}{2} = +\ 542'' = +\ 9'\ 2''$, and $\frac{\Delta L}{2} = -\ 16''$ approximately.

From (3):

$$\log\frac{\Delta L}{2} = 1\cdot2041$$
$$\log\sin\left(\lambda + \frac{\Delta\lambda}{2}\right) = \bar{1}\cdot6141$$
$$\log\frac{\Delta A}{2} = 0\cdot8182 \quad \therefore \frac{\Delta A}{2} = -\ 7''$$

From (1):

$$\log c = 5\cdot0354049$$
$$\text{co-log (Tab. XXVI)} = \bar{3}\cdot9959631$$
$$\log\cos\left(A + \frac{\Delta A}{2}\right) = \bar{1}\cdot9998005$$
$$\log\Delta\lambda = 3\cdot0311685$$
$$\Delta\lambda = +\ 1074''\cdot41$$
$$= 17'\ 54''\cdot41$$

From (2):

$$\log c = 5\cdot0354049$$
$$\text{co-log (Tab. XXVII)} = \bar{2}\cdot0337969$$
$$\log\sin\left(A + \frac{\Delta A}{2}\right) = \bar{2}\cdot4815273$$
$$\log\Delta L = 1\cdot5507291$$
$$\Delta L = -\ 35''\cdot54$$

therefore latitude of **B** $= 24^\circ\ 25'\ 58''\cdot13$, and longitude of **B** $= 78^\circ\ 2'\ 32''\cdot37$.

Again

From (3):

$$\log \Delta L = 1 \cdot 55072$$

$$\log \sin\left(\lambda + \frac{\Delta\lambda}{2}\right) = \bar{1} \cdot 61411$$

$$\log \Delta A = 1 \cdot 16483$$

$$\Delta A = -14'' \cdot 62$$

and the azimuth of **A** at **B** = 358° 15′ 40″·47.

EXAMPLE 2.—Given the latitude and longitude of stations **A** and **B**, to find the distance between them and their mutual azimuths.

Given data

		° ′ ″		° ′ ″
Station **A**,	Lat. =	24 8 3·72	Long. =	78 3 7·91
„ **B**,	„ =	24 25 58·13	„ =	78 2 32·37
	$\lambda + \frac{\Delta\lambda}{2}$ =	24 17 0·93	$\frac{\Delta L}{2}$ =	− 17·77
	$\Delta\lambda$ =	+ 17 54·41	ΔL =	− 35·54

$$\log \frac{\Delta L}{2} = 1 \cdot 24969$$

$$\log \sin\left(\lambda + \frac{\Delta\lambda}{2}\right) = \bar{1} \cdot 61411$$

$$\log \frac{\Delta A}{2} = 0 \cdot 86380 \quad . \quad . \quad . \quad \frac{\Delta A}{2} = -7'' \cdot 31$$

$$\log (\text{Tab. XXVII}) = 1 \cdot 9662079$$

$$\text{co-log} (\text{ „ XXVI}) = 3 \cdot 9959632$$

$$\log \Delta L = 1 \cdot 5507174$$

$$\text{co-log}\, \Delta\lambda = \bar{4} \cdot 9688300$$

$$\log \tan\left(A + \frac{\Delta A}{2}\right) = \bar{2} \cdot 4817185$$

$$\log \Delta\lambda = 3 \cdot 0311700$$

$$\log (\text{Tab. XXVI}) = 2 \cdot 0040368$$

$$\log \sec\left(A + \frac{\Delta A}{2}\right) = 0 \cdot 0001995$$

$$\log c = 5 \cdot 0354063$$

$$A + \frac{\Delta A}{2} = 178^\circ\ 15'\ 48'' \text{ as } \Delta\lambda \text{ is } + \text{ and } \Delta L\ -$$

Therefore azimuth of **B** at **A** = 178° 15′ 55″

and azimuth of **A** at **B** = 358 15 41.

§ (2). *Methods of determining Time, Latitude and Azimuth from Astronomical Observations.*

The following methods for determining *Time, Latitude* and *Azimuth* by astronomical observation are those in most general use among explorers and surveyors engaged in Trans-frontier work, and are here given to obviate the necessity of consulting larger works. The methods for determining *Longitude* are purposely omitted, as the results will in general not be found more accurate than those derived from dead reckoning.

I.—To find the Time.

1st Method. *By a single altitude of a star or of the sun when the latitude is known.*

The altitude should be observed with a sextant, or with a theodolite on both faces, and the time noted by a clock or watch. For greater precision observe several altitudes in quick succession, noting the time of each, and take the mean of the altitudes as corresponding to the mean of the times. Correct the observed altitude for instrumental errors, refraction and also, in case of the sun or a planet, for semi-diameter and parallax.

Then if ζ = the resulting zenith distance,

γ = the co-latitude,

Δ = the north polar distance,

t = the hour angle,

T = clock time corresponding to ζ;

$$\sin \tfrac{1}{2} t = \sqrt{\frac{\sin \frac{1}{2} (\zeta + \Delta - \gamma) \sin \frac{1}{2} (\zeta + \gamma - \Delta)}{\sin \gamma \sin \Delta}},$$

or

$$\tan \tfrac{1}{2} t = \sqrt{\frac{\sin \frac{1}{2} (\zeta + \Delta - \gamma) \sin \frac{1}{2} (\zeta + \gamma - \Delta)}{\sin \frac{1}{2} (\zeta + \Delta + \gamma) \sin \frac{1}{2} (\Delta + \gamma - \zeta)}}.$$

If a = the right ascension of the star or planet for the approximate time of observation, then the sidereal time of observation $= a \pm \frac{t}{15}$, the upper or lower sign being used according as the star is west or east of the meridian; and the error of the clock on sidereal time is $T - \left(a \pm \frac{t}{15}\right)$. If the clock employed gives mean time, the sidereal time at mean noon must be subtracted from the sidereal time of observation and the result converted to mean time; the difference from the clock time is the clock error.

If the sun be observed, then the *apparent time* $= \frac{t}{15}$ if on the west side, or $\left(12 \text{ hrs.} - \frac{t}{15}\right)$ if on the east side of the meridian. To this must be applied the equation of time to obtain the true mean time of observation. The difference from the clock time is now the clock error.

The body observed should not have less than 10° of altitude and should be as near the prime vertical as possible.

Example.—The zenith distance of β Orionis (west of the meridian) observed at Dehra, in lat. 30° 19′ 29″ N. and long. 78° 6′ E., on 9th April 1885, when corrected for refraction was found to be 67° 0′ 2″, and the clock time of observation was $7^h\ 53^m\ 5^s{\cdot}5$.

$\zeta =$	67°	0′	2″		
$\gamma =$	59	40	31	. . . . Log sin	$\bar{1}\cdot 9361002$
$\Delta =$	98	20	25	. . . . „	$\bar{1}\cdot 9953825$
$2s = \zeta + \gamma + \Delta =$	225	0	58	Sum	$\bar{1}\cdot 9314827$
$s = \frac{1}{2}(\zeta + \Delta + \gamma) =$	112	30	29	Ar. compt.	$0\cdot 0685173$
$s - \gamma = \frac{1}{2}(\zeta + \Delta - \gamma) =$	52	49	58	. . . . Log sin	$\bar{1}\cdot 9013906$
$s - \Delta = \frac{1}{2}(\zeta + \gamma - \Delta) =$	14	10	4	. . . . „	$\bar{1}\cdot 3887443$
				Sum = Log $\sin^2 \frac{1}{2} t$	$\bar{1}\cdot 3586522$
				Log sin $\frac{1}{2} t$	$\bar{1}\cdot 6793261$
					° ′ ″
				$\frac{1}{2} t$ in arc	28 32 51·2
				t „	57 5 42·4
					h m s
				* t in time +	3 48 22·8

Star's Right Ascension	5 9 0·7
True Local Sidereal Time of Observation	8 57 23·5
„ „ at Mean Noon	1 10 43·3
Sidereal Interval from Mean Noon	7 46 40·2
Corresponding Mean Interval, *i.e.*, True Mean Time of Observation	7 45 23·7
Clock Time of Observation	7 53 5·5
Clock error +	7 41·8

2nd Method. *By equal altitudes of a star or the sun.*

If T_1, T_2 be the times marked by a clock when a star has the same altitude before and after crossing the meridian, then $T = \frac{1}{2}(T_1 + T_2)$ will be the clock time of its meridian transit, and the error of the clock can at once be found.

If instead of a star the sun be employed, the clock time of *apparent noon* will be equal to

$$T - \left(\frac{\tan \lambda}{\sin t} - \frac{\cot \Delta}{\tan t}\right)\frac{t\,\theta}{15},$$

where $2t$ = the elapsed time between the observations, θ = the small horary *decrease*

---

* If the sun has been observed, the remainder of the calculation will be as follows:—

t in time	=
Equation of time	=
True Mean Time of Observation	=
Clock time	=
Error	=

of polar distance: if the polar distance is increasing θ will be negative. The equation of time having been applied the clock error on mean noon is known.

For equal altitudes of the sun before and after midnight, *i.e.*, on the afternoon of one day and the morning of the next, $\tan \lambda$ changes sign and the clock time of *apparent midnight* is $T + \left(\frac{\tan \lambda}{\sin t} + \frac{\cot \Delta}{\tan t}\right) \frac{t\,\theta}{15}$.

The most favourable condition of observation will be when the object is observed nearly *east* or *west* of the meridian, but the altitude should not be less than 10°.

The advantage of this method is that any error of graduation of the sextant or theodolite will have no effect; and the disadvantage is that some hours must elapse between the two observations, as the star should not be near the meridian.

II.—To find the Time and the Latitude simultaneously.

1st Method. *By simultaneous altitudes of two known stars.*

When there is only one observer he may proceed as follows:—Take the altitude of the first star, S_1, then the altitude of the second star, S_2, and again the altitude of S_1, noting the corresponding times. During the few minutes that this will occupy the changes of altitude may be supposed uniform, and therefore the altitude of S_1 corresponding to the instant of the observed altitude of S_2 can be found.

Let ζ_1 and ζ_2 be the true zenith distances of the two stars,

Δ_1 and Δ_2 „ north polar „ „

d „ difference of right ascension;

and put

$$\tan x = \tan \Delta_1 \cos d,$$

$$\cos y = \frac{\cos \Delta_1 \cos (\Delta_2 - x)}{\cos x},$$

$$\tan \tfrac{1}{2} z = \sqrt{\frac{\sin \frac{1}{2}(\Delta_2 + \Delta_1 - y) \sin \frac{1}{2}(\Delta_2 + y - \Delta_1)}{\sin \frac{1}{2}(\Delta_2 + \Delta_1 + y) \sin \frac{1}{2}(\Delta_1 + y - \Delta_2)}},$$

$$\tan \tfrac{1}{2} w = \sqrt{\frac{\sin \frac{1}{2}(\zeta_2 + \zeta_1 - y) \sin \frac{1}{2}(\zeta_2 + y - \zeta_1)}{\sin \frac{1}{2}(\zeta_2 + \zeta_1 + y) \sin \frac{1}{2}(\zeta_1 + y - \zeta_2)}},$$

$$u = z - w;$$

then

$$\sin \lambda = \frac{\cos \Delta_1 \cos (\zeta_1 - \theta)}{\cos \theta},$$

where

$$\tan \theta = \tan \Delta_1 \cos u;$$

and

$$\sin (\text{hour angle} = t) = \frac{\sin \zeta_1 \sin u}{\cos \lambda}.$$

The values of the quantities y and z may be tabulated for certain pairs of stars and much labour saved.

The most favourable condition of observation will be when the verticals of the two bodies are on the same side of the meridian and equally inclined to the prime vertical, the difference of the azimuths being near 90° if possible.

Example.—The altitudes of α Persei and β Orionis observed at Dehra on the 11th April 1887, were found to be respectively 29° 41′ 51″ and 28° 11′ 50″ both stars being west of the meridian, and the clock time of observation was $8^h\ 29^m\ 33^s{\cdot}5$.

	α Persei	β Orionis
	° ′ ″	° ′ ″
Observed altitude	29 41 51	28 11 50
Refraction	− 1 28	− 1 34
True altitude	29 40 23	28 10 16
„ zenith distance . . = ζ_1 =	60 19 37	ζ_2 = 61 49 44
	h m s	h m s
Right Ascension	3 16 14·3	5 9 5·8
North Polar distance = Δ_1 =	40° 32′ 34″	Δ_2 = 98° 20′ 15″

Difference of Right Ascension . . . . $= d =$ $1^h\ 52^m\ 51^s{\cdot}5$

„ „ . . . . . . in arc = 28° 12′ 53″

Log tan Δ_1	= $\bar{1}$·9321554	Log cos Δ_1	= $\bar{1}$·8807684
„ cos d	= $\bar{1}$·9450656	„ cos $(\Delta_2 - x)$	= $\bar{1}$·6810162
„ tan x	= $\bar{1}$·8772210	„ sec x	= 0·0976895
x	= 37° 0′ 24″	„ cos y	= $\bar{1}$·6594741
$\Delta_2 - x$	= 61 19 51	y	= 62° 50′ 11″

	° ′ ″		° ′ ″
Δ_2 =	98 20 15	ζ_2 =	61 49 44
Δ_1 =	40 32 34	ζ_1 =	60 19 37
y =	62 50 11	y =	62 50 11
Sum = $2s$ =	201 43 0	Sum = $2s$ =	184 59 32

	° ′ ″					
s =	100 51 30	Log cosec 0·0078461	s =	92 29 46	Log cosec	0·0004123
$s - \Delta_2$ =	2 31 15	„ „ 1·3567186	$s - \zeta_2$ =	30 40 2	„ „	0·2923865
$s - \Delta_1$ =	60 18 56	„ sin $\bar{1}$·9389028	$s - \zeta_1$ =	32 10 9	„ sin	$\bar{1}$·7262550
$s - y$ =	38 1 19	„ „ $\bar{1}$·7895548	$s - y$ =	29 39 35	„ „	$\bar{1}$·6944717

Sum = Log $\tan^2 \frac{1}{2} z$ = 1·0930223 Sum = Log $\tan^2 \frac{1}{2} w$ = $\bar{1}$·7135255

„ tan $\frac{1}{2} z$ = 0·5465112 „ tan $\frac{1}{2} w$ = $\bar{1}$·8567628

$\frac{1}{2} z$ = 74° 8′ 22″ $\frac{1}{2} w$ = 35° 43′ 6″

z = 148 16 44 w = 71 26 12

$$u = z - w = 76° 50' 32''$$

Log tan Δ_1	$\bar{1}$·9321554	Log sin ζ_1	$\bar{1}$·9389520
„ cos u	$\bar{1}$·3572359	„ sin u	$\bar{1}$·9884461
„ tan θ	$\bar{1}$·2893913	„ sec λ	0·0638591
θ	11° 1′ 6″	Sum = Log sin t	$\bar{1}$·9912572
$\zeta_1 - \theta$	49 18 31	t in arc	78° 32′ 31″
Log cos $(\zeta_1 - \theta)$	$\bar{1}$·8142372	t in time	h m s 5 14 10·1
Log cos Δ_1	$\bar{1}$·8807684	R. A. of α Persei	3 16 14·3
„ sec θ	0·0080805	S. T. of observation	8 30 24·4
Sum = Log sin λ	$\bar{1}$·7030861	Clock time of observation	8 29 33·5
λ	30° 18′ 56″	Error of clock	− 0 50·9

2nd Method. *By two observations of the altitude of a star and the elapsed time.*

This is the same problem as the last: the elapsed sidereal time reduced to arc will give d.

Here
$$\sin\frac{y}{2} = \sin\Delta\sin\frac{d}{2},$$
$$\cot z = \cos\Delta\tan\frac{d}{2};$$

and the remainder of the solution will be as before.

The same solution will evidently apply to two altitudes of the sun and the elapsed time, provided this elapsed time be reckoned in sidereal hours. The north polar distance of the sun may be considered constant.

III.—To find the Latitude by Observation.

1st Method. *By circum-meridian altitudes of a star or the sun.*

If a number of altitudes be taken when the star or sun is very near the meridian, either all on one side, or better still some on one side of the meridian and some on the other; and if ζ_1, ζ_2, &c., be the zenith distances corrected for refraction—or for refraction, parallax and semi-diameter in case of the sun—and if t_1, t_2, &c., be the hour angles at the times of observation, and m_1, m_2, &c., the values of $\dfrac{2\sin^2\frac{t}{2}}{\sin 1''}$, (see Table LV), then if ζ_0 be the mean of ζ_1, ζ_2, &c., m the mean of m_1, m_2, &c., δ the declination for the mean of the times, and $\lambda_0 = \delta \pm \zeta_0$, the true meridian zenith distance ζ is given by the expression

$$\zeta = \zeta_0 - A.m, \text{ where } A = \frac{\cos\lambda_0\cos\delta}{\sin\zeta_0}$$

and the latitude $= \delta \pm \zeta$.

If the star is below the pole, $\zeta = \zeta_0 + A.m$, reckoning the hour angle from the lower transit. The intervals t_1, &c., should be in sidereal time for stars and in apparent time for the sun, and they should in no case exceed 20 minutes, nor should the zenith distance be less than 10°.

For an example see page 64.

2nd Method. *By altitude of the pole star out of the meridian.*

Adopting the notation employed in the Preface to the Nautical Almanac.

If l = the latitude,

a = the true altitude of the star,

p = the apparent polar distance,

$h = \text{S} - \alpha$; S being the sideral time of observation and α the right ascension of the star;

then $l = \text{a} - p \cos h + \frac{1}{2} \sin 1'' \, (p \sin h)^2 \tan \text{a}$.

The Nautical Almanac, pages 477–9, gives tables to facilitate the computation as follows:—

Table I gives $p \cos h$, or the *first correction.*

" II " $\frac{1}{2} \sin 1'' \, (p \sin h)^2 \tan \text{a}$, or the *second correction* on the assumption that $p = 78' \, 0''$ and $a = 19° \, 15'$.

Table III, which depends on the difference between the true and assumed values of p and a, contains the *third correction* increased by 1′ to render the quantities additive, and this accounts for the 1′ which is subtracted from the "corrected altitude" in the example given in the explanation of the Nautical Almanac.

For an example see the Nautical Almanac.

IV.—To find the Azimuth by Observation.

1st Method. *Given the time and the latitude.* The azimuth can be obtained from Polaris at once by means of Table LIII; the method of proceeding will be found in the explanation of that table.

2nd Method. *Given the latitude and also the time approximately.* Observe the angle between the referring mark and a circumpolar star at elongation.

The time of elongation of the star, its azimuth and the altitude for setting the telescope may all be found from formulæ 1, 2 and 3 on page 40. The azimuth of the mark from north will be the angle between star and mark $\pm$ the azimuth of the star at elongation according as the star is between the mark and the pole or otherwise.

3rd Method. *Given the time and the latitude approximately.* Observe the angles M_1 and M_2 between the referring mark and two circumpolar stars at their respective elongations, selecting stars which are nearly in opposition or nearly in conjunction and will attain their maximum elongations nearly at the same time.

Let their azimuths from the north be A_1 and A_2,

" declinations be δ_1 and δ_2,

then $M_2 \pm M_1 = A_1 \pm A_2$,

and $\tan \frac{1}{2}(A_1 - A_2) = \tan \frac{1}{2}(A_1 + A_1) \tan \frac{1}{2}(\delta_1 + \delta_2) \tan \frac{1}{2}(\delta_2 - \delta_1)$,

or $\tan \frac{1}{2}(A_1 + A_2) = \tan \frac{1}{2}(A_1 - A_2) \cot \frac{1}{2}(\delta_1 + \delta_2) \cot \frac{1}{2}(\delta_2 - \delta_1)$.

The azimuth of the R. M. from north will be found by applying A_1 to M_1 or A_2 to M_2.

EXAMPLE.—Observations for Azimuth were made at Dehra New Observatory on the 4th June 1887, to δ Ursæ Minoris at Eastern Elongation and Cephei 51 (Hev.) at Western Elongation. The observed angles were :—

Between Referring Mark and { δ Ursæ Minoris $= M_1 =$ 3° 56′ 53″; Cephei 51 (Hev.) $= M_2 =$ 3° 11′ 46″ }

Sum $= M_1 + M_2 = A_1 + A_2 =$ 7° 8′ 39″

$\delta_1 =$ 86° 36′ 42″

$\delta_2 =$ 87° 13′ 20″

$\frac{1}{2}(A_1 + A_2) =$	3 34 20	. . . Log tan	$\bar{2}$·7953791
$\frac{1}{2}(\delta_1 + \delta_2) =$	86 55 1	. . . ,,	1·2687218
$\frac{1}{2}(\delta_2 - \delta_1) =$	0 18 19	. . . ,,	$\bar{3}$·7265767
Sum = Log tan $\frac{1}{2}(A_1 - A_2)$		=	$\bar{3}$·7906776
$\frac{1}{2}(A_1 - A_2)$		=	0° 21′ 14″
$\frac{1}{2}(A_1 + A_2)$		=	3 34 20
A_1		=	3 55 34
A_2		=	3 13 6
Azimuth of R. M. from north $= M_1 - A_1$		=	0 1 19
,, ,, $= A_2 - M_2$		=	0 1 20

4th Method. *Given the latitude and time.* Observe the angle between the referring mark and a circumpolar star *near* elongation.

If t be the hour angle at elongation, and dt the interval before or after elongation, and δA the corresponding difference in azimuth,

$$\text{then } \tan \delta A = -2 \sin^2 \frac{dt}{2} \cdot \sec \lambda . \cot \delta . \operatorname{cosec} t \text{ approximately;}$$

$$\text{or } \delta A'' = -2 \frac{\sin^2 \frac{dt}{2}}{\sin 1''} \cdot \sec \lambda . \cot \delta . \operatorname{cosec} t.$$

The log. of the first part is given in Table XXV, Part III.

EXAMPLE.—From observations taken at Kanjamalai, latitude 11° 36′ 56″, longitude 78° 6′, on 27th November 1869, to δ Ursæ Minoris *near* Western Elongation, the angle between the referring mark and star was 138° 20′ 58″, the sidereal time of observation being $23^h\ 53^m\ 52^s{\cdot}5$.

The declination $\delta = 86^\circ\ 36'\ 35''$

First to obtain dt, the time from elongation, employ formula 1 on page 40 which changing symbols may be written,

$$\log \cos t = \log \tan \lambda + \log \cot \delta$$

$$
\begin{aligned}
\text{Log} \tan \lambda &= \bar{1}\cdot3129248 \\
\text{,,} \cot \delta &= \bar{2}\cdot7726199 \\
\text{,,} \cos t &= \bar{2}\cdot0855447 \\
t \text{ in arc} &= 89^\circ\ 18'\ 8'' \\
t \text{ in time} &= 5^h\ 57^m\ 12^s\cdot5
\end{aligned}
$$

	h	m	s
Star's Right Ascension at elongation . .	18	14	4·6
Sidereal time ,, . .	0	11	17·1
,, of observation	23	53	52·5
dt	0	17	24·6

$$
\begin{aligned}
\text{Log } 2 \sin^2 \frac{dt}{2} \operatorname{cosec} 1'' &= 2\cdot77450 \\
\text{,,} \sec \lambda \quad . . . . . &\ 0\cdot00899 \\
\text{,,} \cot \delta \quad . . . . . &\ \bar{2}\cdot77262 \\
\text{,,} \operatorname{cosec} t \quad . . . . &\ 0\cdot00003 \\
\text{Sum} = \text{Log } \delta \text{A} \quad . . . &\ 1\cdot55614 \\
\delta \text{A} \quad . . . &- 36''
\end{aligned}
$$

Angle between R. M. and star . . =	138°	20′	58″
Corrected angle ,, . . =	138	20	22
Azimuth of star at elongation . . =	3	27	41
,, Mark from north . . =	141	48	3

5th Method. *Given the latitude.* Observe the angle between the referring mark and the star and the star's altitude simultaneously, which is done by getting the star on the intersection of the cross wires of the theodolite. The star should not be at a high altitude: it should be near the prime vertical and rather on the side towards the apparent pole than on the other side.

Then if ζ = zenith distance of the star,

Δ = north polar distance ,,

A = the azimuth ,,

γ = co-latitude,

then

$$\tan \frac{A}{2} = \sqrt{\frac{\sin \frac{1}{2}(\Delta + \gamma - \zeta) \sin \frac{1}{2}(\Delta + \zeta - \gamma)}{\sin \frac{1}{2}(\Delta + \gamma + \zeta) \sin \frac{1}{2}(\gamma + \zeta - \Delta)}}.$$

Example.—From observations for Azimuth made on α Canis Majoris East of Meridian at Dehra Dún New Solar Photo-Observatory, on the 26th January 1887, the zenith distance corrected for refraction was found to be 68° 11′ 26″ and the angle between the referring mark and star to be 35° 14′ 9″, the mark being south of the star.

		°	′	″		
Zenith Distance	$= \zeta =$	68	11	26		
Co-latitude	$= \gamma =$	59	40	31		
North Polar Distance	$= \Delta =$	106	33	59		
	Sum $= 2s =$	234	25	56		
	$s =$	117	12	58	Log cosec	0·0509577
$\frac{1}{2}(\zeta + \gamma - \Delta) =$	$s - \Delta =$	10	38	59	,, ,,	0·7332880
$\frac{1}{2}(\Delta + \zeta - \gamma) =$	$s - \gamma =$	57	32	27	,, sin	$\bar{1}$·9262262
$\frac{1}{2}(\Delta + \gamma - \zeta) =$	$s - \zeta =$	49	1	32	,, ,,	$\bar{1}$·8779482

Sum = Log $\tan^2 \frac{A}{2}$ 0·5884201

Log $\tan \frac{A}{2}$ 0·2942101

$\frac{A}{2}$ 63° 4′ 24″

A 126 8 48

Angle, R. M. and star 35 14 9

Azimuth of Mark from north 161 22 57

6th Method. *Given the time and latitude.* Observe the angle between the referring mark and any star. The best result will be got when the star is near the pole.

Then if t = the hour angle of the star,

Δ = north polar distance ,,

A = azimuth of ,,

γ = the co-latitude ;

and if $\tan \phi = \tan \Delta \cos t,$

then $\cot A = \frac{\sin (\gamma - \phi) \cot t}{\sin \phi}.$

An example does not appear necessary.

Note.—In all these cases, as the zenith distances must be corrected for refraction, barometric and thermometric readings should be taken.

§ (3). *Formulæ frequently employed in Calculations.*

Solution of Oblique Angled Spherical Triangles.

Given the three sides, a, b, c.

1. $\cos A = \dfrac{\cos(a+\theta)}{\sin b \sin c \cos\theta}$, where $\tan\theta = \dfrac{\cos b \cos c}{\sin a}$.

2. $\sin \tfrac{1}{2} A = \sqrt{\dfrac{\sin(s-b)\sin(s-c)}{\sin b \sin c}}$; $\cos\tfrac{1}{2} A = \sqrt{\dfrac{\sin s \sin(s-a)}{\sin b \sin c}}$;

$$\tan\tfrac{1}{2} A = \sqrt{\frac{\sin(s-b)\sin(s-c)}{\sin s \sin(s-a)}},\quad \text{where } s = \tfrac{1}{2}(a+b+c).$$

Given two sides and the contained angle, a, b, C.

1. $\cos c = \cos a \cos b + \sin a \sin b \cos C$

$$= \frac{\cos a \cos(b-\theta)}{\cos\theta}, \text{ where } \tan\theta = \tan a \cos C.$$

2. $\tan\dfrac{A+B}{2} = \dfrac{\cos\frac{1}{2}(a-b)}{\cos\frac{1}{2}(a+b)}\cdot\cot\tfrac{1}{2}C$; $\tan\dfrac{A-B}{2} = \dfrac{\sin\frac{1}{2}(a-b)}{\sin\frac{1}{2}(a+b)}\cot\tfrac{1}{2}C$.

Given two sides and an angle opposite one of them, a, b, A.

Let $\tan\theta = \tan b \cos A$,

and $\cos\theta' = \dfrac{\cos\theta \cos a}{\cos b}$,

then $c = \theta \pm \theta'$.

There are two triangles fulfilling the given conditions, except that values of c greater than 180° or negative must be neglected.

The other parts can be found by one of the formulæ, 2, of the first group.

Given the three angles, A, B, C.

1. $\cos a = \dfrac{\sin(A+\theta)}{\sin B \sin C \sin\theta}$, where $\cot\theta = \dfrac{\cos B \cos C}{\sin A}$.

2. $\sin\tfrac{1}{2} a = \sqrt{\dfrac{-\cos S \cos(S-A)}{\sin B \sin C}}$; $\cos\tfrac{1}{2} a = \sqrt{\dfrac{\cos(S-B)\cos(S-C)}{\sin B \sin C}}$;

$$\tan\tfrac{1}{2} a = \sqrt{\frac{-\cos S \cos(S-A)}{\cos(S-B)\cos(S-C)}},\quad \text{where } S = \tfrac{1}{2}(A+B+C).$$

Given two angles and the side adjacent, A, B, *c*.

1. $\cos C = -\cos A \cos B + \sin A \sin B \cos c$.

$$= \frac{\cos A \sin(B-\theta)}{\sin\theta}, \text{ where } \cot\theta = \cos c \tan A.$$

2. $\tan \frac{a+b}{2} = \frac{\cos \frac{1}{2}(A-B)}{\cos \frac{1}{2}(A+B)} . \tan \frac{1}{2} c$; $\tan \frac{a-b}{2} = \frac{\sin \frac{1}{2}(A-B)}{\sin \frac{1}{2}(A+B)} . \tan \frac{1}{2} c.$

Given two angles and a side opposite one of them, A, B, *a*.

Let $$\cot \theta = \tan B \cos a,$$

and $$\sin \theta' = \frac{\sin \theta \cos A}{\cos B},$$

then $$C = \theta + \theta'.$$

There will be two triangles fulfilling the required conditions, except that values of C greater than 180° or negative must be neglected.

The three angles being known, the other parts can be found by one of the formulæ, 2, of the fourth group.

Solution of Right Angled Spherical Triangles.

Arrange the five parts a, 90° − B, 90° − c, 90° − A and b in a circle leaving out the right angle C; consider any one of them as a middle part, then all the formulæ follow from Napier's two rules:—

1. The sine of the middle part = The product of the tangents of the adjacent parts.
2. " " = " cosines " opposite "

Solution of Oblique Angled Plane Triangles.

Given the three sides, a, b, c.

$$\sin \frac{A}{2} = \sqrt{\frac{(s-b)(s-c)}{bc}}; \quad \cos \frac{A}{2} = \sqrt{\frac{s(s-a)}{bc}};$$

$$\tan \frac{A}{2} = \sqrt{\frac{(s-b)(s-c)}{s(s-a)}}, \text{ where } s = \tfrac{1}{2}(a+b+c).$$

Given two sides and the angle contained, a, b, C.

1.

Let $$\tan^2 \phi = \frac{a}{b}$$

and $$\sin \theta = \sin 2\phi \cos \tfrac{1}{2} C,$$

then $$c = b \sec^2 \phi \cos \theta.$$

2.

Let $$\tan x = \frac{a}{b} \sin C$$

then $$\tan A = \frac{\sin C \sin x}{\sin (C - x)}$$

and c can be found from the formula, $c = \frac{a \sin C}{\sin A}$.

Given the angles and a side, A, B, C, a.

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}.$$

Given two sides and an angle opposite one of them, a, b, A.

$$\sin B = \frac{b}{a} \sin A \text{; and } c = \frac{a \sin C}{\sin A}.$$

If $b > a$ there are two triangles fulfilling the required conditions.

Reduction of the reading of a Mercurial Barometer to any temperature.

Let h = observed height of the Barometer,

t = temperature of the Attached Thermometer,

T = temperature to which the observed height is to be reduced,

m = expansion, in volume, of mercury

l = linear expansion of scale,

θ = normal temperature of standard scale (generally = 62° Fah.)

then the reduction to the required temperature will be

$$-h \cdot \frac{m(t-T) - l(t-\theta)}{1 + m(t-T)}.$$

For reduction to the freezing point if the temperature is given in degrees Fah. $T = 32°$.

§ (4). *Certain Numerical Quantities frequently required.*

Base of Napierian Logarithms . . . . = ϵ = 2·718 2818 285.

Modulus of the common Logarithms . . . . = $\log \epsilon$ = 0·434 2944 819.

Ratio of the circumference of a circle to its diameter . = π = 3·141 5926 536.

$\log \pi$ = 0·497 1498 727.

Arc of a circle equal in length to the radius . . . . = 57° 17′ 44″·8.

Sin 1″ = 0·0000048481 . . . . $\log \sin 1''$ = $\bar{6}$·685 5748 668.

$\log \operatorname{cosec} 1''$ = 5·314 4251 332.

Weight of a litre of dry air (bar. = 760 millimetres, ther. = 0° C) = 1·293 grammes.

„ cubic foot of water = 436247·424 grains . . . = 62·32 lbs. avoir.

Length of the seconds pendulum in latitude of Greenwich . . = 39·1393 inches.

Acceleration produced by gravity „ „ = 32·190784 ft. per sec.

Co-efficient of expansion of air in volume per 1° Fahrenheit = 0·0020361.

„ „ mercury in volume „ = 0·0001001.

„ of linear expansion of brass „ = 0·0000104.

„ „ „ iron „ = 0·0000065.

„ „ „ glass „ = 0·0000044.

Velocity of light = 186000 miles per second.

„ sound in air at 32° Fahrenheit = 1090 feet per second.

THE MORSE ALPHABET.

As employed in Army Signalling.

The system adopted in the army and navy is called the *flashing system,* and has for its elements a long and a short flash, representing a dash (——) and a dot (-). Every requisite signal is formed of a combination of these symbols with pauses of proper duration. A dash occupies the space of three dots. The pause between the symbols composing a letter or other sign equals a dot; that between the letters of a word a dash.

All messages are spelt out by means of the Morse alphabet. No abbreviations are used, except such as are common in ordinary writing, or may be specially authorised.

A - ——	B —— - - -
C —— - —— -	D —— - -
E -	F - - —— -
G —— —— -	H - - - -
I - -	J - —— —— ——
K —— - ——	L - —— - -
M —— ——	N —— -
O —— —— ——	P - —— —— -
Q —— —— - ——	R - —— -
S - - -	T ——
U - - ——	V - - - ——
W - —— ——	X —— - - ——
Y —— - —— ——	Z —— —— - -

Miscellaneous Signs.

Station sign - —— —— -	Repeat - - —— —— - -
Right - —— - ——	Cipher —— - —— - —— - —— -
Comma - —— - —— - ——	Full stop - - - - - -

Preparative or Erasure - - - - - - - - - - etc.

Stop —— —— —— —— —— —— —— etc.

General answer —— - —— - —— - etc.

The *station sign* followed by a letter is the distinguishing signal of the station to which that letter has been assigned. This is used at the beginning of every message as a call signal, and at the end to show that the message is finished.

The *repeat sign* is used after receiving a message to show what words require repetition. The numerical order of such words is indicated by the letters a. b. c. . . . . . . k instead of the figures 1. 2. 3. . . . . . . 0. Thus "repeat" bk means repeat the 20th word of the message.

The *cipher sign* is used when the whole or part of a message is to be transmitted in cipher. It should precede and follow the portion in cipher.

The *preparative* is used when communicating with two or more stations in sight to call their attention. It is also used to call the attention of an unknown station. To acknowledge this sign, the receiving station should give, instead of the "general answer", its own distinguishing letter (without the prefix P.), and repeat this till the next signal is begun.

This sign is also the *erasure*, and is used to erase a word that has been wrongly sent. It should in this case be acknowledged by the erasure.

The *stop* denotes the end of a message that has been preceded by no distinguishing signal.

The *general answer* is the acknowledgment of a signal received.

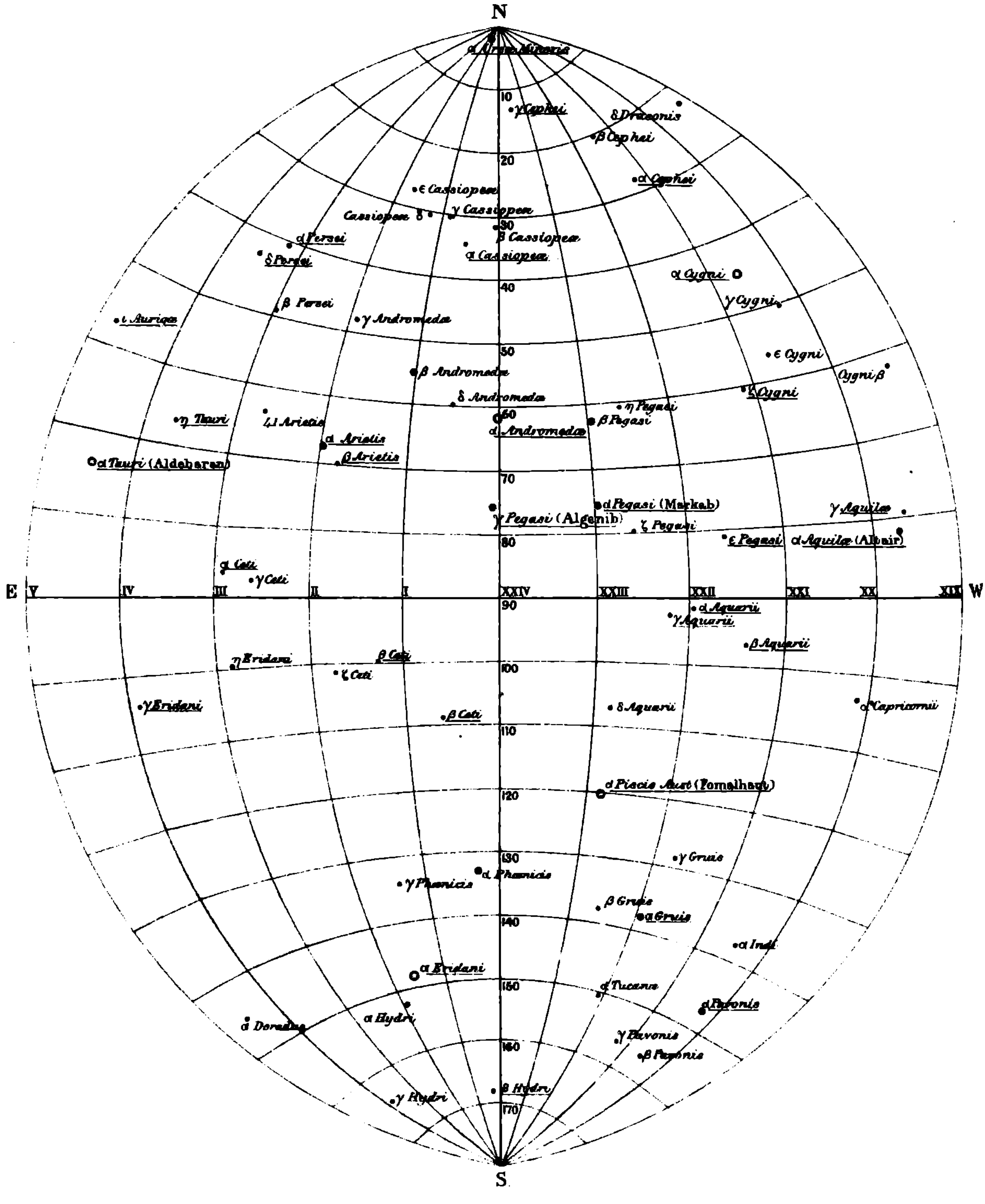
Every word must be repeated till answered before the next word is sent.

PLATE No. I.

STAR CHART

Showing all Stars of the 1st, 2nd, and 3rd Magnitudes.

IN FOUR PLATES.



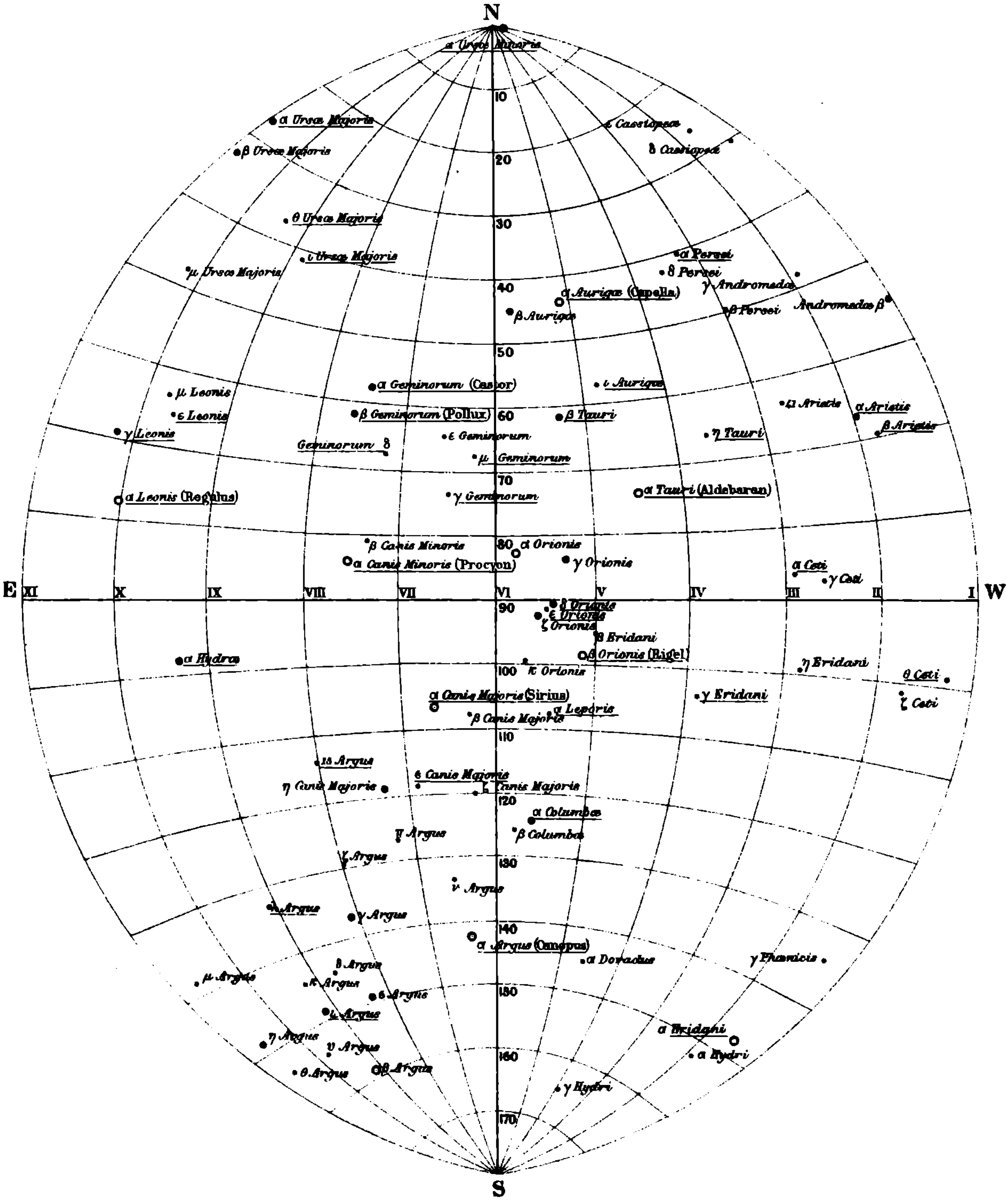
NOTE.—*The Stars whose names are underlined are Nautical Almanac Stars.*

STAR CHART

PLATE No. II.

Showing all Stars of the 1st, 2nd, and 3rd Magnitudes.

IN FOUR PLATES.



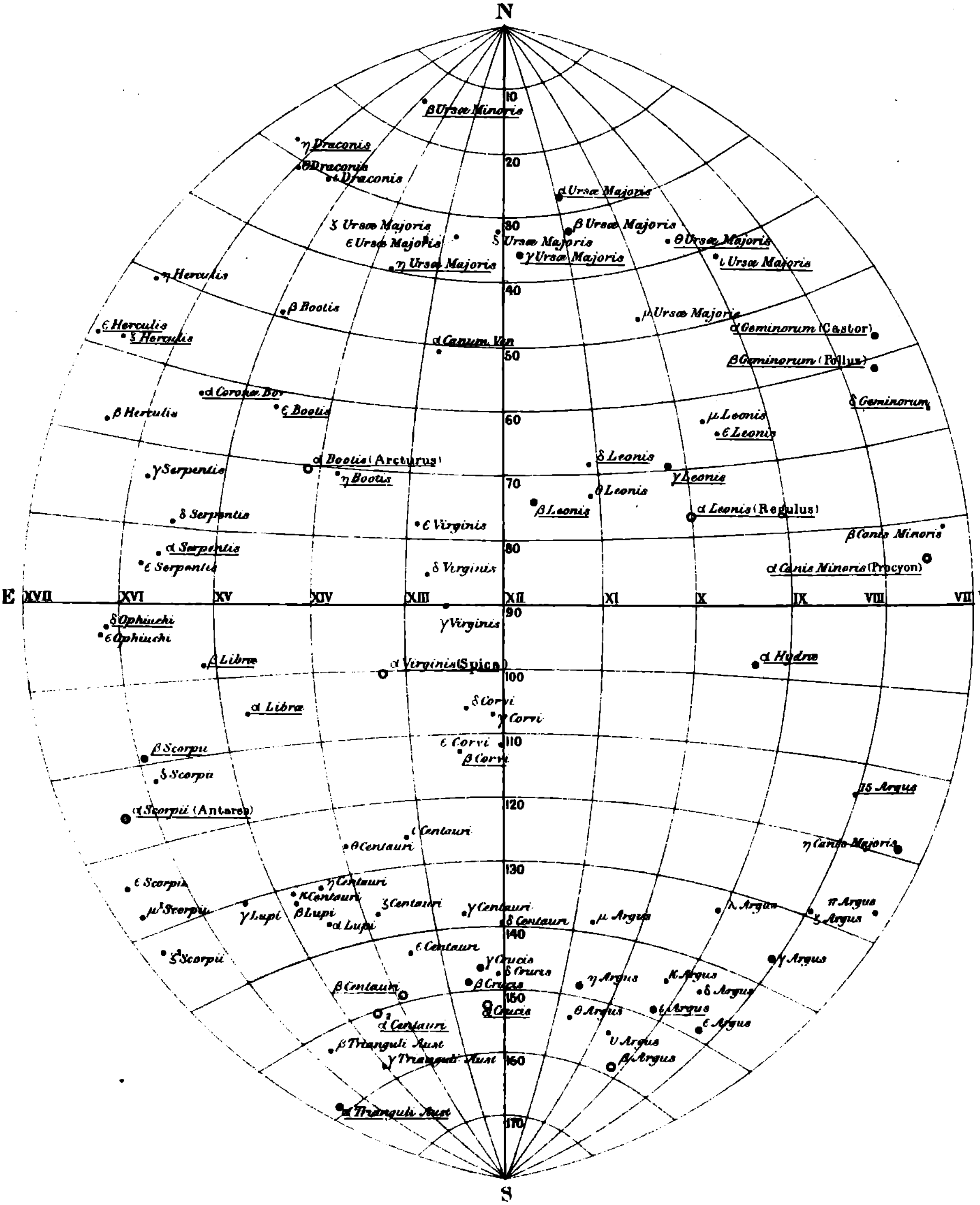
NOTE.—*The Stars whose names are underlined are Nautical Almanac Stars.*

PLATE No. III.

STAR CHART

Showing all Stars of the 1st, 2nd, and 3rd Magnitudes.

IN FOUR PLATES.



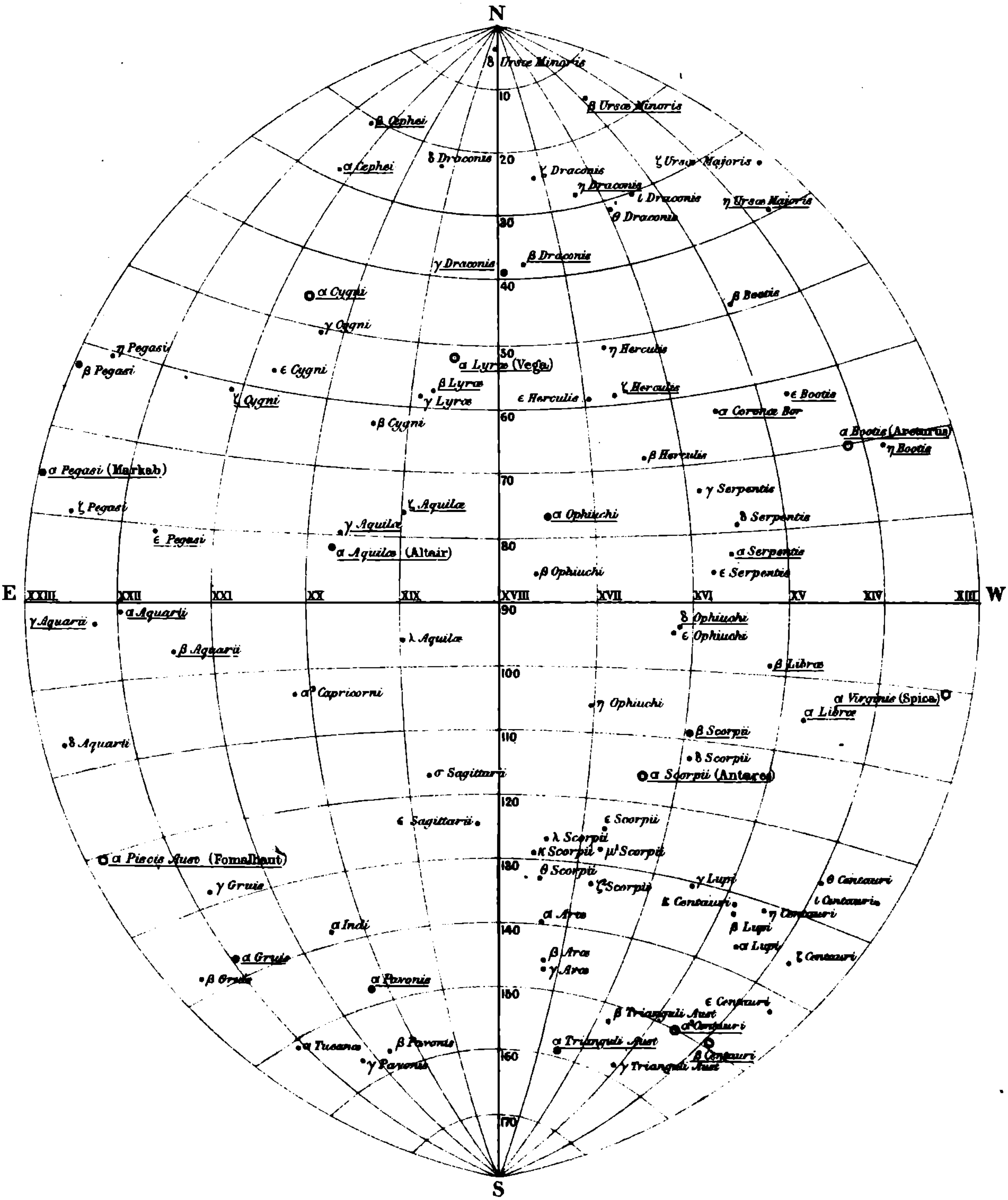
NOTE.—The Stars whose names are underlined are Nautical Almanac Stars.

STAR CHART

PLATE No. IV.

Showing all Stars of the 1st, 2nd, and 3rd Magnitudes.

IN FOUR PLATES.



NOTE.—*The Stars whose names are underlined are Nautical Almanac Stars.*

TABLES.

TABLE I.—Normals terminated by the Minor Axis, and their Logarithms.

Latitude.	Normals in feet.	Diff.	Logarithms of the Normals.	Diff.	Latitude.	Normals in feet.	Diff.	Logarithms of the Normals.	Diff.
° ′	209	+	7·320	+	° ′	209	+	7·320	+
0 0	22931·8		6225,40		10 0	25026·0		6660,07	
10	22932·4	0·6	6225,52	,12	10	25095·7	69·7	6674,53	14,46
20	22934·2	1·8	6225,88	,36	20	25166·5	70·8	6689,22	14,69
30	22937·1	2·9	6226,49	,61	30	25238·3	71·8	6704,13	14,91
40	22941·2	4·1	6227,35	,86	40	25311·3	73·0	6719,27	15,14
50	22946·5	5·3	6228,44	1,09	50	25385·3	74·0	6734,64	15,37
1 0	22953·0	6·5	6229,79	1,35	11 0	25460·5	75·2	6750,24	15,60
10	22960·6	7·6	6231,37	1,58	10	25536·7	76·2	6766,06	15,82
20	22969·4	8·8	6233,20	1,83	20	25614·1	77·4	6782,11	16,05
30	22979·4	10·0	6235,27	2,07	30	25692·5	78·4	6798,39	16,28
40	22990·5	11·1	6237,59	2,32	40	25772·0	79·5	6814,89	16,50
50	23002·9	12·4	6240,15	2,56	50	25852·6	80·6	6831,61	16,72
2 0	23016·4	13·5	6242,95	2,80	12 0	25934·2	81·6	6848,56	16,95
10	23031·1	14·7	6246,00	3,05	10	26017·0	82·8	6865,73	17,17
20	23046·9	15·8	6249,29	3,29	20	26100·8	83·8	6883,12	17,39
30	23063·9	17·0	6252,82	3,53	30	26185·6	84·8	6900,74	17,62
40	23082·1	18·2	6256,60	3,78	40	26271·6	86·0	6918,57	17,83
50	23101·5	19·4	6260,61	4,01	50	26358·6	87·0	6936,63	18,06
3 0	23122·0	20·5	6264,88	4,27	13 0	26446·6	88·0	6954,90	18,27
10	23143·7	21·7	6269,38	4,50	10	26535·8	89·2	6973,40	18,50
20	23166·6	22·9	6274,13	4,75	20	26625·9	90·1	6992,11	18,71
30	23190·6	24·0	6279,12	4,99	30	26717·2	91·3	7011,05	18,94
40	23215·8	25·2	6284,35	5,23	40	26809·5	92·3	7030,20	19,15
50	23242·2	26·4	6289,82	5,47	50	26902·8	93·3	7049,57	19,37
4 0	23269·7	27·5	6295,53	5,71	14 0	26997·1	94·3	7069,15	19,58
10	23298·4	28·7	6301,49	5,96	10	27092·6	95·5	7088,95	19,80
20	23328·3	29·9	6307,69	6,20	20	27189·0	96·4	7108,96	20,01
30	23359·3	31·0	6314,13	6,44	30	27286·5	97·5	7129,19	20,23
40	23391·5	32·2	6320,81	6,68	40	27385·0	98·5	7149,64	20,45
50	23424·8	33·3	6327,73	6,92	50	27484·5	99·5	7170,29	20,65
5 0	23459·3	34·5	6334,89	7,16	15 0	27585·1	100·6	7191,16	20,87
10	23495·0	35·7	6342,29	7,40	10	27686·6	101·5	7212,24	21,08
20	23531·8	36·8	6349,93	7,64	20	27789·2	102·6	7233,53	21,29
30	23569·8	38·0	6357,81	7,88	30	27892·8	103·6	7255,03	21,50
40	23608·9	39·1	6365,93	8,12	40	27997·5	104·7	7276,74	21,71
50	23649·2	40·3	6374,29	8,36	50	28103·1	105·6	7298,65	21,91
6 0	23690·6	41·4	6382,89	8,60	16 0	28209·7	106·6	7320,78	22,13
10	23733·2	42·6	6391,73	8,84	10	28317·3	107·6	7343,11	22,33
20	23776·9	43·7	6400,80	9,07	20	28425·9	108·6	7365,65	22,54
30	23821·8	44·9	6410,12	9,32	30	28535·5	109·6	7388,40	22,75
40	23867·8	46·0	6419,67	9,55	40	28646·1	110·6	7411,35	22,95
50	23914·9	47·1	6429,46	9,79	50	28757·7	111·6	7434,50	23,15
7 0	23963·2	48·3	6439,48	10,02	17 0	28870·3	112·6	7457,86	23,36
10	24012·7	49·5	6449,75	10,27	10	28983·8	113·5	7481,42	23,56
20	24063·3	50·6	6460,24	10,49	20	29098·3	114·5	7505,19	23,77
30	24115·0	51·7	6470,98	10,74	30	29213·8	115·5	7529,15	23,96
40	24167·8	52·8	6481,95	10,97	40	29330·3	116·5	7553,31	24,16
50	24221·8	54·0	6493,16	11,21	50	29447·7	117·4	7577,67	24,36
8 0	24277·0	55·2	6504,60	11,44	18 0	29566·0	118·3	7602,24	24,57
10	24333·2	56·2	6516,27	11,67	10	29685·4	119·4	7627,00	24,76
20	24390·6	57·4	6528,18	11,91	20	29805·6	120·2	7651,95	24,95
30	24449·1	58·5	6540,33	12,15	30	29926·9	121·3	7677,10	25,15
40	24508·7	59·6	6552,70	12,37	40	30049·0	122·1	7702,45	25,35
50	24569·5	60·8	6565,31	12,61	50	30172·1	123·1	7727,99	25,54
9 0	24631·4	61·9	6578,16	12,85	19 0	30296·1	124·0	7753,73	25,74
10	24694·4	63·0	6591,23	13,07	10	30421·1	125·0	7779,66	25,93
20	24758·5	64·1	6604,54	13,31	20	30547·0	125·9	7805,78	26,12
30	24823·7	65·2	6618,08	13,54	30	30673·8	126·8	7832,09	26,31
40	24890·0	66·3	6631,84	13,76	40	30801·5	127·7	7858,59	26,50
50	24957·5	67·5	6645,84	14,00	50	30930·1	128·6	7885,28	26,69
60	25026·0	68·5	6660,07	14,23	60	31059·7	129·6	7912,16	26,88
	209		7·320			209		7·320	

TABLE I.—Normals terminated by the Minor Axis, and their Logarithms.

Latitude.	Normals in feet.	Diff.	Logarithms of the Normals.	Diff.	Latitude.	Normals in feet.	Diff.	Logarithms of the Normals.	Diff.
° ′	209	+	7·320	+	° ′	209	+	7·320	+
20 0	31059·7	130·4	7912,16	27,06	30 0	40313·8	175·7	9831,86	36,44
10	31190·1	131·4	7939,22	27,25	10	40489·5	176·3	9868,30	36,55
20	31321·5	132·2	7966,47	27,44	20	40665·8	176·8	9904,85	36,67
30	31453·7	133·1	7993,91	27,62	30	40842·6	177·4	9941,52	36,80
40	31586·8	134·0	8021,53	27,81	40	41020·0	178·0	9978,32	36,91
50	31720·8	134·9	8049,34	27,99	50	41198·0	178·5	0015,23	37,03
21 0	31855·7	135·8	8077,33	28,17	31 0	41376·5	179·1	0052,26	37,14
10	31991·5	136·6	8105,50	28,35	10	41555·6	179·7	0089,40	37,26
20	32128·1	137·6	8133,85	28,53	20	41735·3	180·2	0126,66	37,37
30	32265·7	138·3	8162,38	28,71	30	41915·5	180·7	0164,03	37,48
40	32404·0	139·3	8191,09	28,89	40	42096·2	181·3	0201,51	37,59
50	32543·3	140·1	8219,98	29,06	50	42277·5	181·8	0239,10	37,70
22 0	32683·4	140·9	8249,04	29,24	32 0	42459·3	182·3	0276,80	37,81
10	32824·3	141·8	8278,28	29,42	10	42641·6	182·9	0314,61	37,92
20	32966·1	142·6	8307,70	29,59	20	42824·5	183·3	0352,53	38,02
30	33108·7	143·5	8337,29	29,76	30	43007·8	183·9	0390,55	38,12
40	33252·2	144·3	8367,05	29,94	40	43191·7	184·3	0428,67	38,23
50	33396·5	145·1	8396,99	30,10	50	43376·0	184·9	0466,90	38,33
23 0	33541·6	145·9	8427,09	30,28	33 0	43560·9	185·3	0505,23	38,43
10	33687·5	146·8	8457,37	30,44	10	43746·2	185·8	0543,66	38,53
20	33834·3	147·5	8487,81	30,62	20	43932·0	186·2	0582,19	38,62
30	33981·8	148·4	8518,43	30,78	30	44118·2	186·8	0620,81	38,72
40	34130·2	149·2	8549,21	30,94	40	44305·0	187·2	0659,53	38,82
50	34279·4	149·9	8580,15	31,11	50	44492·2	187·6	0698,35	38,91
24 0	34429·3	150·8	8611,26	31,28	34 0	44679·8	188·1	0737,26	39,00
10	34580·1	151·5	8642,54	31,44	10	44867·9	188·6	0776,26	39,09
20	34731·6	152·3	8673,98	31,60	20	45056·5	188·9	0815,35	39,19
30	34883·9	153·1	8705,58	31,76	30	45245·4	189·4	0854,54	39,27
40	35037·0	153·9	8737,34	31,92	40	45434·8	189·8	0893,81	39,35
50	35190·9	154·6	8769,26	32,07	50	45624·6	190·3	0933,16	39,45
25 0	35345·5	155·4	8801,33	32,24	35 0	45814·9	190·6	0972,61	39,53
10	35500·9	156·2	8833,57	32,39	10	46005·5	191·1	1012,14	39,61
20	35657·1	156·9	8865,96	32,55	20	46196·6	191·4	1051,75	39,69
30	35814·0	157·6	8898,51	32,70	30	46388·0	191·8	1091,44	39,77
40	35971·6	158·4	8931,21	32,86	40	46579·8	192·2	1131,21	39,85
50	36130·0	159·1	8964,07	33,00	50	46772·0	192·6	1171,06	39,93
26 0	36289·1	159·9	8997,07	33,16	36 0	46964·6	193·0	1210,99	40,01
10	36449·0	160·5	9030,23	33,31	10	47157·6	193·3	1251,00	40,08
20	36609·5	161·3	9063,54	33,45	20	47350·9	193·7	1291,08	40,15
30	36770·8	162·0	9096,99	33,61	30	47544·6	194·0	1331,23	40,23
40	36932·8	162·7	9130,60	33,75	40	47738·6	194·4	1371,46	40,30
50	37095·5	163·4	9164,35	33,89	50	47933·0	194·7	1411,76	40,37
27 0	37258·9	164·1	9198,24	34,04	37 0	48127·7	195·0	1452,13	40,43
10	37423·0	164·8	9232,28	34,18	10	48322·7	195·4	1492,56	40,50
20	37587·8	165·5	9266,46	34,33	20	48518·1	195·7	1533,06	40,57
30	37753·3	166·2	9300,79	34,46	30	48713·8	196·0	1573,63	40,63
40	37919·5	166·8	9335,25	34,60	40	48909·8	196·3	1614,26	40,70
50	38086·3	167·5	9369,85	34,75	50	49106·1	196·6	1654,96	40,75
28 0	38253·8	168·2	9404,60	34,88	38 0	49302·7	196·8	1695,71	40,82
10	38422·0	168·8	9439,48	35,01	10	49499·5	197·2	1736,53	40,87
20	38590·8	169·4	9474,49	35,15	20	49696·7	197·5	1777,40	40,93
30	38760·2	170·2	9509,64	35,29	30	49894·2	197·7	1818,33	40,99
40	38930·4	170·7	9544,93	35,41	40	50091·9	198·0	1859,32	41,04
50	39101·1	171·4	9580,34	35,55	50	50289·9	198·2	1900,36	41,09
29 0	39272·5	172·0	9615,89	35,68	39 0	50488·1	198·5	1941,45	41,15
10	39444·5	172·7	9651,57	35,80	10	50686·6	198·7	1982,60	41,19
20	39617·2	173·2	9687,37	35,94	20	50885·3	199·0	2023,79	41,25
30	39790·4	173·9	9723,31	36,06	30	51084·3	199·2	2065,04	41,29
40	39964·3	174·5	9759,37	36,18	40	51283·5	199·4	2106,33	41,34
50	40138·8	175·0	9795,55	36,31	50	51482·9	199·7	2147,67	41,38
60	40313·8		9831,86		60	51682·6		2189,05	
	209		7·320			209		7·321	

TABLE II.—Radii of Curvature to the Meridian, and their Logarithms.

Latitude.	Radii of Curvature in feet.	Diff.	Logthms. of the Radii of Curvature.	Diff.	Latitude.	Radii of Curvature in feet.	Diff.	Logthms. of the Radii of Curvature.	Diff.
° ′	207	+	7·317	+	° ′	207	+	7·317	+
0 0	84048·6	1·8	7301,49	,37	10 0	90290·2	207·7	8605,52	43,37
10	84050·4	5·2	7301,86	1,10	10	90497·9	210·9	8648,89	44,06
20	84055·6	8·8	7302,96	1,82	20	90708·8	214·2	8692,95	44,75
30	84064·4	12·2	7304,78	2,57	30	90923·0	217·5	8737,70	45,43
40	84076·6	15·8	7307,35	3,29	40	91140·5	220·7	8783,13	46,11
50	84092·4		7310,64		50	91361·2		8829,24	
1 0	84111·6	19·2	7314,66	4,02	11 0	91585·2	224·0	8876,03	46,79
10	84134·4	22·8	7319,42	4,76	10	91812·5	227·3	8923,50	47,47
20	84160·7	26·3	7324,91	5,49	20	92043·0	230·5	8971,65	48,15
30	84190·4	29·7	7331,12	6,21	30	92276·8	233·8	9020,47	48,82
40	84223·7	33·3	7338,07	6,95	40	92513·7	236·9	9069,97	49,50
50	84260·4	36·7	7345,75	7,68	50	92753·9	240·2	9120,14	50,17
2 0	84300·7	40·3	7354,16	8,41	12 0	92997·4	243·5	9170,98	50,84
10	84344·4	43·7	7363,30	9,14	10	93244·0	246·6	9222,49	51,51
20	84391·6	47·2	7373,17	9,87	20	93493·8	249·8	9274,67	52,18
30	84442·4	50·8	7383,77	10,60	30	93746·8	253·0	9327,51	52,84
40	84496·6	54·2	7395,10	11,33	40	94003·0	256·2	9381,02	53,51
50	84554·3	57·7	7407,15	12,05	50	94262·4	259·4	9435,19	54,17
3 0	84615·5	61·2	7419,94	12,79	13 0	94524·9	262·5	9490,02	54,83
10	84680·1	64·6	7433,45	13,51	10	94790·6	265·7	9545,51	55,49
20	84748·3	68·2	7447,69	14,24	20	95059·4	268·8	9601,65	56,14
30	84819·9	71·6	7462,65	14,96	30	95331·4	272·0	9658,45	56,80
40	84895·0	75·1	7478,35	15,70	40	95606·5	275·1	9715,90	57,45
50	84973·6	78·6	7494,77	16,42	50	95884·7	278·2	9774,01	58,11
4 0	85055·6	82·0	7511,91	17,14	14 0	96166·0	281·3	9832,76	58,75
10	85141·1	85·5	7529,78	17,87	10	96450·4	284·4	9892,16	59,40
20	85230·1	89·0	7548,37	18,59	20	96738·0	287·6	9952,20	60,04
30	85322·6	92·5	7567,69	19,32	30	97028·6	290·6	0012,89	60,69
40	85418·5	95·9	7587,73	20,04	40	97322·3	293·7	0074,21	61,32
50	85517·8	99·3	7608,49	20,76	50	97619·0	296·7	0136,18	61,97
5 0	85620·7	102·9	7629,97	21,48	15 0	97918·8	299·8	0198,78	62,60
10	85726·9	106·2	7652,18	22,21	10	98221·6	302·8	0262,02	63,24
20	85836·6	109·7	7675,10	22,92	20	98527·5	305·9	0325,89	63,87
30	85949·8	113·2	7698,74	23,64	30	98836·4	308·9	0390,39	64,50
40	86066·4	116·6	7723,10	24,36	40	99148·3	311·9	0455,52	65,13
50	86186·4	120·0	7748,18	25,08	50	99463·2	314·9	0521,27	65,75
6 0	86309·9	123·5	7773,98	25,80	16 0	99781·1	317·9	0587,65	66,38
10	86436·8	126·9	7800,49	26,51	10	00102·0	320·9	0654,65	67,00
20	86567·1	130·3	7827,72	27,23	20	00425·9	323·9	0722,27	67,62
30	86700·8	133·7	7855,66	27,94	30	00752·7	326·8	0790,51	68,24
40	86838·0	137·2	7884,31	28,65	40	01082·5	329·8	0859,36	68,85
50	86978·5	140·5	7913,68	29,37	50	01415·2	332·7	0928,82	69,46
7 0	87122·5	144·0	7943,76	30,08	17 0	01750·8	335·6	0998,89	70,07
10	87269·9	147·4	7974,54	30,78	10	02089·4	338·6	1069,58	70,69
20	87420·6	150·7	8006,04	31,50	20	02430·8	341·4	1140,86	71,28
30	87574·8	154·2	8038,25	32,21	30	02775·2	344·4	1212,75	71,89
40	87732·3	157·5	8071,16	32,91	40	03122·4	347·2	1285,24	72,49
50	87893·2	160·9	8104,78	33,62	50	03472·5	350·1	1358,33	73,09
8 0	88057·5	164·3	8139,10	34,32	18 0	03825·5	353·0	1432,02	73,69
10	88225·2	167·7	8174,13	35,03	10	04181·3	355·8	1506,29	74,27
20	88396·2	171·0	8209,86	35,73	20	04539·9	358·6	1581,16	74,87
30	88570·6	174·4	8246,29	36,43	30	04901·4	361·5	1656,62	75,46
40	88748·4	177·8	8283,42	37,13	40	05265·7	364·3	1732,66	76,04
50	88929·4	181·0	8321,25	37,83	50	05632·8	367·1	1809,29	76,63
9 0	89113·9	184·5	8359,78	38,53	19 0	06002·6	369·8	1886,49	77,20
10	89301·6	187·7	8399,00	39,22	10	06375·3	372·7	1964,28	77,79
20	89492·7	191·1	8438,92	39,92	20	06750·7	375·4	2042,64	78,36
30	89687·1	194·4	8479,53	40,61	30	07128·9	378·2	2121,57	78,93
40	89884·9	197·8	8520,84	41,31	40	07509·8	380·9	2201,07	79,50
50	90085·9	201·0	8562,84	42,00	50	07893·4	383·6	2281,14	80,07
60	90290·2	204·3	8605,52	42,68	60	08279·7	386·3	2361,78	80,64
	207		7·317			208		7·318	

TABLE II.—Radii of Curvature to the Meridian, and their Logarithms.

Latitude.	Radii of Curvature in feet.	Diff.	Logthms. of the Radii of Curvature.	Diff.	Latitude.	Radii of Curvature in feet.	Diff.	Logthms. of the Radii of Curvature.	Diff.
° ′	208	+	7·318	+	° ′	208	+	7·318	+
20 0	08279·7		2361,78		30 0	35891·6		8120,90	
10	08668·8	389·1	2442,97	81,19	10	36416·0	524·4	8230,19	109,29
20	09060·5	391·7	2524,73	81,76	20	36942·1	526·1	8339,86	109,67
30	09454·9	394·4	2607,04	82,31	30	37470·0	527·9	8449,88	110,02
40	09852·0	397·1	2689,91	82,87	40	37999·6	529·6	8560,26	110,38
50	10251·7	399·7	2773,32	83,41	50	38531·0	531·4	8671,00	110,74
21 0	10654·0	402·3	2857,29	83,97	31 0	39064·0	533·0	8782,08	111,08
10	11059·0	405·0	2941,80	84,51	10	39598·7	534·7	8893,51	111,43
20	11466·6	407·6	3026,85	85,05	20	40135·0	536·3	9005,28	111,77
30	11876·7	410·1	3112,45	85,60	30	40673·0	538·0	9117,39	112,11
40	12289·5	412·8	3198,58	86,13	40	41212·6	539·6	9229,84	112,45
50	12704·8	415·3	3285,24	86,66	50	41753·8	541·2	9342,61	112,77
22 0	13122·6	417·8	3372,43	87,19	32 0	42296·6	542·8	9455,72	113,11
10	13543·1	420·5	3460,16	87,73	10	42841·0	544·4	9569,14	113,42
20	13966·0	422·9	3548,40	88,24	20	43386·9	545·9	9682,89	113,75
30	14391·4	425·4	3637,17	88,77	30	43934·3	547·4	9796,95	114,06
40	14819·4	428·0	3726,46	89,29	40	44483·2	548·9	9911,33	114,38
50	15249·8	430·4	3816,27	89,81	50	45033·7	550·5	0026,01	114,68
23 0	15682·7	432·9	3906,59	90,32	33 0	45585·6	551·9	0141,00	114,99
10	16118·0	435·3	3997,41	90,82	10	46139·0	553·4	0256,28	115,28
20	16555·8	437·8	4088,75	91,34	20	46693·8	554·8	0371,86	115,58
30	16996·0	440·2	4180,59	91,84	30	47250·0	556·2	0487,74	115,88
40	17438·6	442·6	4272,93	92,34	40	47807·6	557·6	0603,90	116,16
50	17883·6	445·0	4365,77	92,84	50	48366·6	559·0	0720,35	116,45
24 0	18331·0	447·4	4459,10	93,33	34 0	48927·0	560·4	0837,08	116,73
10	18780·8	449·8	4552,93	93,83	10	49488·7	561·7	0954,09	117,01
20	19232·9	452·1	4647,24	94,31	20	50051·7	563·0	1071,37	117,28
30	19687·4	454·5	4742,04	94,80	30	50616·1	564·4	1188,91	117,54
40	20144·1	456·7	4837,32	95,28	40	51181·7	565·6	1306,73	117,82
50	20603·2	459·1	4933,08	95,76	50	51748·6	566·9	1424,80	118,07
25 0	21064·6	461·4	5029,31	96,23	35 0	52316·7	568·1	1543,13	118,33
10	21528·2	463·6	5126,02	96,71	10	52886·1	569·4	1661,72	118,59
20	21994·1	465·9	5223,19	97,17	20	53456·7	570·6	1780,55	118,83
30	22462·3	468·2	5320,84	97,65	30	54028·5	571·8	1899,63	119,08
40	22932·6	470·3	5418,94	98,10	40	54601·5	573·0	2018,95	119,32
50	23405·2	472·6	5517,50	98,56	50	55175·6	574·1	2138,50	119,55
26 0	23880·0	474·8	5616,52	99,02	36 0	55750·8	575·2	2258,29	119,79
10	24357·0	477·0	5716,00	99,48	10	56327·2	576·4	2378,31	120,02
20	24836·1	479·1	5815,92	99,92	20	56904·6	577·4	2498,55	120,24
30	25317·4	481·3	5916,28	100,36	30	57483·1	578·5	2619,01	120,46
40	25800·8	483·4	6017,09	100,81	40	58062·7	579·6	2739,69	120,68
50	26286·3	485·5	6118,34	101,25	50	58643·3	580·6	2860,58	120,89
27 0	26773·9	487·6	6220,03	101,69	37 0	59225·0	581·7	2981,68	121,10
10	27263·7	489·8	6322,15	102,12	10	59807·6	582·6	3102,99	121,31
20	27755·4	491·7	6424,69	102,54	20	60391·2	583·6	3224,49	121,50
30	28249·3	493·9	6527,66	102,97	30	60975·8	584·6	3346,20	121,71
40	28745·1	495·8	6631,06	103,40	40	61561·3	585·5	3468,09	121,89
50	29243·0	497·9	6734,87	103,81	50	62147·8	586·5	3590,17	122,08
28 0	29742·9	499·9	6839,10	104,23	38 0	62735·1	587·3	3712,44	122,27
10	30244·8	501·9	6943,73	104,63	10	63323·3	588·2	3834,88	122,44
20	30748·6	503·8	7048,78	105,05	20	63912·4	589·1	3957,51	122,63
30	31254·4	505·8	7154,23	105,45	30	64502·3	589·9	4080,30	122,79
40	31762·2	507·8	7260,08	105,85	40	65093·1	590·8	4203,26	122,96
50	32271·8	509·6	7366,33	106,25	50	65684·6	591·5	4326,38	123,12
29 0	32783·3	511·5	7472,97	106,64	39 0	66276·9	592·3	4449,66	123,28
10	33296·8	513·5	7580,01	107,04	10	66870·0	593·1	4573,10	123,44
20	33812·1	515·3	7687,43	107,42	20	67463·8	593·8	4696,69	123,59
30	34329·2	517·1	7795,23	107,80	30	68058·4	594·6	4820,43	123,74
40	34848·2	519·0	7903,41	108,18	40	68653·6	595·2	4944,30	123,87
50	35369·0	520·8	8011,97	108,56	50	69249·5	595·9	5068,32	124,02
60	35891·6	522·6	8120,90	108,93	60	69846·1	596·6	5192,47	124,15
	208		7·318			208		7·319	

TABLE III.—Logarithms of the Factor $\frac{(\rho + \nu)^2 \operatorname{cosec} 1''}{8 \rho^2 \nu^2}$ for computing the Spherical Excess of a Triangle.

Latitude.	Logarithms.	Latitude.	Logarithms.	Latitude.	Logarithms.	Latitude.	Logarithms.
°		°		°		°	
0	$\overline{10}$·37505	11	$\overline{10}$·37484	22	$\overline{10}$·37424	33	$\overline{10}$·37333
1	505	12	480	23	417	34	324
2	504	13	476	24	409	35	315
3	503	14	471	25	402	36	305
4	502	15	466	26	394	37	295
5	500	16	461	27	386	38	286
6	498	17	455	28	377	39	276
7	496	18	450	29	369	40	266
8	494	19	444	30	360		
9	491	20	437	31	351		
10	487	21	431	32	342		

TABLE IV.—For determining the Spherical Excess in Secondary Operations.

Area of Triangle in Square Miles.	Mean Latitude of Triangle.								
	0°	5°	10°	15°	20°	25°	30°	35°	40°
	"	"	"	"	"	"	"	"	"
5	0·07	0·07	0·07	0·07	0·07	0·07	0·07	0·07	0·07
10	·13	·13	·13	·13	·13	·13	·13	·13	·13
15	·20	·20	·20	·20	·20	·20	·20	·20	·20
20	·26	·26	·26	·26	·26	·26	·26	·26	·26
30	·40	·40	·40	·40	·40	·40	·40	·39	·39
40	·53	·53	·53	·53	·53	·53	·53	·53	·53
50	·66	·66	·66	·66	·66	·66	·66	·66	·66
60	·79	·79	·79	·79	·79	·79	·79	·79	·79
70	·93	·93	·93	·93	·92	·92	·92	·92	·92
80	1·06	1·06	1·06	1·06	1·06	1·06	1·05	1·05	1·05
90	1·19	1·19	1·19	1·19	1·19	1·19	1·19	1·18	1·18
100	1·32	1·32	1·32	1·32	1·32	1·32	1·32	1·32	1·32
200	2·64	2·64	2·64	2·64	2·64	2·64	2·64	2·63	2·63
300	3·97	3·97	3·97	3·96	3·96	3·96	3·95	3·95	3·95
400	5·29	5·29	5·29	5·28	5·28	5·28	5·27	5·27	5·26
500	6·61	6·61	6·61	6·61	6·60	6·60	6·59	6·58	6·58
600	7·93	7·93	7·93	7·93	7·92	7·92	7·91	7·90	7·89
700	9·26	9·26	9·25	9·25	9·24	9·23	9·23	9·22	9·21
800	10·58	10·58	10·57	10·57	10·56	10·55	10·54	10·53	10·52
900	11·90	11·90	11·90	11·89	11·88	11·87	11·86	11·85	11·84
1000	13·22	13·22	13·22	13·21	13·20	13·19	13·18	13·17	13·15

TABLE V.—Reciprocals of Numbers to facilitate the Computation of Weights of Observed Angles.

Numbers.	Reciprocals.	Numbers.	Reciprocals.	Numbers.	Reciprocals.	Numbers.	Reciprocals.	Numbers.	Reciprocals.
200·000		4·878		2·469		1·653		1·242	
	0·01		0·21		0·41		0·61		0·81
66·667		4·651		2·410		1·626		1·227	
	·02		·22		·42		·62		·82
40·000		4·444		2·353		1·600		1·212	
	·03		·23		·43		·63		·83
28·571		4·255		2·299		1·575		1·198	
	·04		·24		·44		·64		·84
22·222		4·082		2·247		1·550		1·183	
	·05		·25		·45		·65		·85
18·182		3·922		2·198		1·527		1·170	
	·06		·26		·46		·66		·86
15·385		3·774		2·151		1·504		1·156	
	·07		·27		·47		·67		·87
13·333		3·636		2·105		1·481		1·143	
	·08		·28		·48		·68		·88
11·765		3·509		2·062		1·460		1·130	
	·09		·29		·49		·69		·89
10·526		3·390		2·020		1·439		1·117	
	·10		·30		·50		·70		·90
9·524		3·279		1·980		1·418		1·105	
	·11		·31		·51		·71		·91
8·696		3·175		1·942		1·399		1·093	
	·12		·32		·52		·72		·92
8·000		3·077		1·905		1·379		1·081	
	·13		·33		·53		·73		·93
7·407		2·985		1·869		1·361		1·070	
	·14		·34		·54		·74		·94
6·897		2·899		1·835		1·342		1·058	
	·15		·35		·55		·75		·95
6·452		2·817		1·802		1·325		1·047	
	·16		·36		·56		·76		·96
6·061		2·740		1·770		1·307		1·036	
	·17		·37		·57		·77		·97
5·714		2·667		1·739		1·290		1·026	
	·18		·38		·58		·78		·98
5·405		2·597		1·709		1·274		1·015	
	·19		·39		·59		·79		·99
5·128		2·532		1·681		1·258		1·005	
	·20		·40		·60		·80		1·00
4·878		2·469		1·653		1·242		0·995	

TABLE VI.—Logarithms for facilitating the Computation of

Latitude.	P	Diff.	Q	Diff.	R	Diff.	S	Diff.	T	Diff.
° ′		−		+		−		+		−
0 0	$\bar{3}$·9966950		$\bar{1}$·9971076		$\bar{8}$·38124		0·29814		Infinite	
10	6949	1	1076	0	24	0	814	0	2·23814	Infinite
20	6948	1	1077	1	24	0	815	1	1·93712	30102
30	6947	1	1078	1	24	0	816	1	76105	17607
40	6944	3	1080	2	24	0	817	1	63614	12491
50	6941	3	1082	2	24	0	818	1	53927	9687
1 0	$\bar{3}$·9966937	4	$\bar{1}$·9971085	3	$\bar{8}$·38124	0	0·29820	2	1·46014	7913
10	6932	5	1088	3	24	0	823	3	39325	6689
20	6926	6	1092	4	24	0	826	3	33532	5793
30	6920	6	1096	4	24	0	829	3	28423	5109
40	6913	7	1101	5	24	0	832	3	23856	4567
50	6905	8	1106	5	24	0	836	4	19725	4131
2 0	$\bar{3}$·9966897	8	$\bar{1}$·9971111	5	$\bar{8}$·38124	0	0·29841	5	1·15956	3769
10	6888	9	1117	6	23	1	845	4	12490	3466
20	6878	10	1124	7	23	0	850	5	09283	3207
30	6868	10	1131	7	23	0	856	6	06299	2984
40	6856	12	1139	8	23	0	862	6	03509	2790
50	6844	12	1147	8	23	0	868	6	00890	2619
3 0	$\bar{3}$·9966831	13	$\bar{1}$·9971155	8	$\bar{8}$·38123	0	0·29874	6	0·98423	2467
10	6818	13	1164	9	23	0	881	7	96090	2333
20	6804	14	1174	10	23	0	888	7	93879	2211
30	6789	15	1184	10	22	1	896	8	91777	2102
40	6773	16	1194	10	22	0	904	8	89775	2002
50	6757	16	1205	11	22	0	912	8	87863	1912
4 0	$\bar{3}$·9966739	18	$\bar{1}$·9971216	11	$\bar{8}$·38122	0	0·29921	9	0·86034	1829
10	6722	17	1228	12	22	0	930	9	84282	1752
20	6703	19	1241	13	22	0	940	10	82600	1682
30	6684	19	1254	13	21	1	950	10	80983	1617
40	6664	20	1267	13	21	0	960	10	79427	1556
50	6643	21	1281	14	21	0	971	11	77927	1500
5 0	$\bar{3}$·9966621	22	$\bar{1}$·9971295	14	$\bar{8}$·38121	0	0·29982	11	0·76479	1448
10	6599	22	1310	15	20	1	993	11	75080	1399
20	6576	23	1325	15	20	0	0·30005	12	73728	1352
30	6553	23	1341	16	20	0	017	12	72418	1310
40	6528	25	1357	16	20	0	029	12	71150	1268
50	6503	25	1374	17	20	0	042	13	69919	1231
6 0	$\bar{3}$·9966477	26	$\bar{1}$·9971391	17	$\bar{8}$·38119	1	0·30055	13	0·68725	1194
10	6451	26	1409	18	19	0	069	14	67566	1159
20	6424	27	1427	18	19	0	083	14	66439	1127
30	6396	28	1446	19	18	1	098	15	65342	1097
40	6367	29	1465	19	18	0	112	14	64276	1066
50	6338	29	1484	19	18	0	127	15	63237	1039
7 0	$\bar{3}$·9966308	30	$\bar{1}$·9971504	20	$\bar{8}$·38118	0	0·30143	16	0·62224	1013
10	6277	31	1525	21	17	1	159	16	61238	986
20	6245	32	1546	21	17	0	175	16	60275	963
30	6213	32	1567	21	17	0	192	17	59336	939
40	6180	33	1589	22	16	1	209	17	58419	917
50	6147	33	1612	23	16	0	226	17	57523	896
8 0	$\bar{3}$·9966112	35	$\bar{1}$·9971635	23	$\bar{8}$·38116	0	0·30244	18	0·56648	875
10	6077	35	1658	23	15	1	262	18	55792	856
20	6041	36	1682	24	15	0	281	19	54955	837
30	6005	36	1706	24	15	0	300	19	54136	819
40	5968	37	1731	25	14	1	319	19	53335	801
50	5930	38	1756	25	14	0	339	20	52551	784
9 0	$\bar{3}$·9965892	38	$\bar{1}$·9971782	26	$\bar{8}$·38113	1	0·30359	20	0·51783	768
10	5852	40	1808	26	13	0	379	20	51030	753
20	5812	40	1834	26	13	0	400	21	50293	737
30	5772	40	1861	27	12	1	421	21	49570	723
40	5730	42	1889	28	12	0	443	22	48861	709
50	5688	42	1917	28	11	1	465	22	48166	695
60	5646	42	1945	28	11	0	487	22	47484	682

Terrestrial Latitudes, Longitudes, and Reverse Azimuths.

Latitude.		V	Diff.	U	Diff.	W	Diff.	X	Diff.	Y	Diff.	Z	Diff.
°	′		+		−		+		−		+		−
0	0	Inf. neg.	Infinite	Infinite	Infinite	Inf. neg.	Infinite	Infinite	Infinite	Inf. neg.	Infinite	Infinite	Infinite
	10	$\bar{5}$·766	301	$\bar{4}$·735	301	$\bar{3}$·862	301	1·840	301	$\bar{5}$·226	602	2·235	301
	20	$\bar{4}$·067	176	434	176	$\bar{2}$·163	176	539	176	— 828	352	1·934	176
	30	243	125	258	125	339	125	363	125	$\bar{4}$·180	250	758	125
	40	368	97	133	97	464	97	238	97	430	193	633	97
	50	465		036		561		141		623		536	
1	0	$\bar{4}$·544	79	$\bar{5}$·957	79	$\bar{2}$·640	79	1·062	79	$\bar{4}$·782	159	1·457	79
	10	610	66	890	67	706	66	0·995	67	— 916	134	390	67
	20	668	58	833	57	764	58	937	58	$\bar{3}$·031	115	332	58
	30	719	51	782	51	815	51	886	51	134	103	281	51
	40	765	46	736	46	861	46	841	45	225	91	236	45
	50	806	41	695	41	902	41	800	41	308	83	194	42
2	0	$\bar{4}$·844	38	$\bar{5}$·658	37	$\bar{2}$·940	38	0·762	38	$\bar{3}$·383	75	1·157	37
	10	878	34	623	35	— 974	34	727	35	452	69	122	35
	20	910	32	592	31	$\bar{1}$·006	32	695	32	517	65	090	32
	30	940	30	562	30	036	30	665	30	576	59	060	30
	40	967	27	535	27	064	28	638	27	632	56	032	28
	50	993	26	509	26	090	26	611	27	685	53	006	26
3	0	$\bar{3}$·018	25	$\bar{5}$·484	25	$\bar{1}$·115	25	0·587	24	$\bar{3}$·734	49	0·981	25
	10	041	23	462	22	138	23	563	24	781	47	958	23
	20	063	22	440	22	160	22	541	22	825	44	936	22
	30	084	21	419	21	181	21	520	21	867	42	915	21
	40	104	20	400	19	201	20	500	20	907	40	895	20
	50	122	18	381	19	220	19	481	19	946	39	876	19
4	0	$\bar{3}$·140	18	$\bar{5}$·363	18	$\bar{1}$·238	18	0·463	18	$\bar{3}$·982	36	0·858	18
	10	158	18	346	17	255	17	446	17	$\bar{2}$·017	35	840	18
	20	174	16	330	16	272	17	429	17	051	34	823	17
	30	190	16	314	16	288	16	413	16	084	33	807	16
	40	205	15	300	14	303	15	397	16	115	31	792	15
	50	220	15	285	15	318	15	382	15	145	30	777	15
5	0	$\bar{3}$·234	14	$\bar{5}$·271	14	$\bar{1}$·332	14	0·368	14	$\bar{2}$·174	29	0·762	15
	10	248	14	258	13	346	14	354	14	202	28	748	14
	20	261	13	245	13	360	14	340	14	229	27	734	14
	30	274	13	233	12	372	12	327	13	255	26	721	13
	40	286	12	221	12	385	13	315	12	281	26	709	12
	50	298	12	209	12	397	12	303	12	306	25	696	13
6	0	$\bar{3}$·309	11	$\bar{5}$·198	11	$\bar{1}$·409	12	0·291	12	$\bar{2}$·330	24	0·684	12
	10	321	12	187	11	420	11	279	12	353	23	673	11
	20	332	11	177	10	431	11	268	11	376	23	662	11
	30	342	10	167	10	442	11	257	11	398	22	651	11
	40	352	10	157	10	452	10	247	10	419	21	640	11
	50	362	10	147	10	463	11	236	11	440	21	630	10
7	0	$\bar{3}$·372	10	$\bar{5}$·138	9	$\bar{1}$·472	9	0·226	10	$\bar{2}$·461	21	0·619	11
	10	381	9	129	9	482	10	216	10	480	19	610	9
	20	390	9	121	8	491	9	207	9	500	20	600	10
	30	399	9	112	9	501	10	198	9	519	19	591	9
	40	408	9	104	8	509	8	188	10	537	18	581	10
	50	416	8	096	8	518	9	180	8	555	18	573	8
8	0	$\bar{3}$·425	9	$\bar{5}$·088	8	$\bar{1}$·527	9	0·171	9	$\bar{2}$·573	18	0·564	9
	10	433	8	081	7	535	8	162	9	590	17	555	9
	20	440	7	074	7	543	8	154	8	607	17	547	8
	30	448	8	066	8	551	8	146	8	624	17	539	8
	40	456	8	060	6	559	8	138	8	640	16	531	8
	50	463	7	053	7	566	7	130	8	656	16	523	8
9	0	$\bar{3}$·470	7	$\bar{5}$·046	7	$\bar{1}$·574	8	0·123	7	$\bar{2}$·672	16	0·515	8
	10	477	7	040	6	581	7	115	8	687	15	508	7
	20	484	7	034	6	588	7	108	7	702	15	500	8
	30	490	6	028	6	595	7	101	7	716	14	493	7
	40	497	7	022	6	602	7	094	7	731	15	486	7
	50	503	6	016	6	608	6	087	7	745	14	479	7
	60	509	6	011	5	615	7	080	7	759	14	472	7

TABLE VI.—Logarithms for facilitating the Computation of

Latitude.		P	Diff.	Q	Diff.	R	Diff.	S	Diff.	T	Diff.
°	′		−		+		−		+		−
10	0	$\bar{3}$·9965646		$\bar{1}$·9971945		$\bar{8}$·38111		0·30487		0·47484	
	10	5602	44	1974	29	11	0	510	23	46815	669
	20	5558	44	2004	30	10	1	533	23	46159	656
	30	5514	44	2034	30	10	0	557	24	45514	645
	40	5468	46	2064	30	09	1	581	24	44881	633
	50	5422	46	2095	31	09	0	605	24	44260	621
11	0	$\bar{3}$·9965375	47	$\bar{1}$·9972126	31	$\bar{8}$·38108	1	0·30630	25	0·43649	611
	10	5328	47	2157	31	08	0	655	25	43050	599
	20	5280	48	2190	33	07	1	680	25	42460	590
	30	5231	49	2222	32	07	0	706	26	41881	579
	40	5181	50	2255	33	06	1	732	26	41311	570
	50	5131	50	2289	34	06	0	759	27	40751	560
12	0	$\bar{3}$·9965080	51	$\bar{1}$·9972322	33	$\bar{8}$·38105	1	0·30786	27	0·40201	550
	10	5029	51	2357	35	05	0	813	27	39659	542
	20	4977	52	2392	35	04	1	841	28	39127	532
	30	4924	53	2427	35	04	0	869	28	38603	524
	40	4870	54	2462	35	03	1	898	29	38087	516
	50	4816	54	2499	37	03	0	927	29	37580	507
13	0	$\bar{3}$·9964761	55	$\bar{1}$·9972535	36	$\bar{8}$·38102	1	0·30956	29	0·37080	500
	10	4706	55	2572	37	02	0	986	30	36589	491
	20	4650	56	2610	38	01	1	0·31016	30	36105	484
	30	4593	57	2647	37	00	1	046	30	35628	477
	40	4535	58	2686	39	00	0	077	31	35159	469
	50	4477	58	2724	38	$\bar{8}$·38099	1	109	32	34697	462
14	0	$\bar{3}$·9964419	58	$\bar{1}$·9972764	40	$\bar{8}$·38099	0	0·31140	31	0·34242	455
	10	4359	60	2803	39	98	1	172	32	33794	448
	20	4299	60	2843	40	97	1	205	33	33352	442
	30	4238	61	2884	41	97	0	238	33	32917	435
	40	4177	61	2925	41	96	1	271	33	32488	429
	50	4115	62	2966	41	96	0	305	34	32066	422
15	0	$\bar{3}$·9964053	62	$\bar{1}$·9973008	42	$\bar{8}$·38095	1	0·31339	34	0·31649	417
	10	3989	64	3050	42	94	1	373	34	31239	410
	20	3925	64	3092	42	94	0	408	35	30835	404
	30	3861	64	3135	43	93	1	443	35	30436	399
	40	3796	65	3179	44	92	1	479	36	30043	393
	50	3730	66	3223	44	92	0	515	36	29655	388
16	0	$\bar{3}$·9963664	66	$\bar{1}$·9973267	44	$\bar{8}$·38091	1	0·31552	37	0·29273	382
	10	3597	67	3312	45	90	1	588	36	28896	377
	20	3529	68	3357	45	90	0	626	38	28525	371
	30	3461	68	3402	45	89	1	663	37	28158	367
	40	3392	69	3448	46	88	1	701	38	27797	361
	50	3323	69	3494	46	88	0	740	39	27440	357
17	0	$\bar{3}$·9963252	71	$\bar{1}$·9973541	47	$\bar{8}$·38087	1	0·31779	39	0·27089	351
	10	3182	70	3588	47	86	1	818	39	26742	347
	20	3110	72	3636	48	86	0	858	40	26400	342
	30	3039	71	3684	48	85	1	898	40	26062	338
	40	2966	73	3732	48	84	1	938	40	25729	333
	50	2893	73	3781	49	83	1	979	41	25400	329
18	0	$\bar{3}$·9962819	74	$\bar{1}$·9973830	49	$\bar{8}$·38083	0	0·32021	42	0·25076	324
	10	2745	74	3879	49	82	1	062	41	24756	320
	20	2670	75	3929	50	81	1	105	43	24440	316
	30	2595	75	3980	51	80	1	147	42	24128	312
	40	2519	76	4030	50	80	0	190	43	23821	307
	50	2442	77	4081	51	79	1	234	44	23517	304
19	0	$\bar{3}$·9962365	77	$\bar{1}$·9974133	52	$\bar{8}$·38078	1	0·32277	43	0·23217	300
	10	2287	78	4185	52	77	1	322	45	22922	295
	20	2209	78	4237	52	77	0	366	44	22630	292
	30	2130	79	4289	52	76	1	411	45	22341	289
	40	2050	80	4342	53	75	1	457	46	22057	284
	50	1970	80	4396	54	74	1	503	46	21776	281
	60	1890	80	4450	54	73	1	549	46	21498	278

Terrestrial Latitudes, Longitudes, and Reverse Azimuths.

Latitude.		V	Diff.	U	Diff.	W	Diff.	X	Diff.	Y	Diff.	Z	Diff.
°	′		+		−		+		−		+		−
10	0	$\bar{3}$·509	6	$\bar{5}$·011	6	$\bar{1}$·615	6	0·080	6	$\bar{2}$·759	13	0·472	6
	10	515	6	005	5	621	6	074	7	772	14	466	7
	20	521	6	000	5	627	7	067	6	786	13	459	6
	30	527	5	$\bar{6}$·995	5	634	6	061	6	799	13	453	7
	40	532	6	990	5	640	5	055	6	812	12	446	6
	50	538		985		645		049		824		440	
11	0	$\bar{3}$·543	5	$\bar{6}$·981	4	$\bar{1}$·651	6	0·043	6	$\bar{2}$·837	13	0·434	6
	10	548	5	976	5	657	6	037	6	849	12	428	6
	20	554	6	972	4	662	5	031	6	861	12	422	6
	30	559	5	967	5	668	6	025	6	873	12	416	6
	40	563	4	963	4	673	5	020	5	885	12	411	5
	50	568	5	959	4	678	5	014	6	896	11	405	6
12	0	$\bar{3}$·573	5	$\bar{6}$·955	4	$\bar{1}$·684	6	0·009	5	$\bar{2}$·908	12	0·399	6
	10	578	5	951	4	689	5	003	6	919	11	394	5
	20	582	4	947	4	694	5	$\bar{1}$·998	5	930	11	389	5
	30	586	4	944	3	698	4	993	5	940	10	384	5
	40	591	5	940	4	703	5	988	5	951	11	378	6
	50	595	4	937	3	708	5	983	5	962	11	373	5
13	0	$\bar{3}$·599	4	$\bar{6}$·933	4	$\bar{1}$·713	5	$\bar{1}$·978	5	$\bar{2}$·972	10	0·368	5
	10	603	4	930	3	717	4	973	5	982	10	363	5
	20	607	4	927	3	722	5	968	5	992	10	359	4
	30	611	4	924	3	726	4	964	4	$\bar{1}$·002	10	354	5
	40	615	4	921	3	730	4	959	5	012	10	349	5
	50	618	3	918	3	734	4	954	5	021	9	345	4
14	0	$\bar{3}$·622	4	$\bar{6}$·915	3	$\bar{1}$·739	5	$\bar{1}$·950	4	$\bar{1}$·031	10	0·340	5
	10	626	4	913	2	743	4	946	4	040	9	336	4
	20	629	3	910	3	747	4	941	5	049	9	331	5
	30	632	3	907	3	751	4	937	4	058	9	327	4
	40	636	4	905	2	755	4	933	4	067	9	323	4
	50	639	3	903	2	758	3	929	4	076	9	318	5
15	0	$\bar{3}$·642	3	$\bar{6}$·900	3	$\bar{1}$·762	4	$\bar{1}$·925	4	$\bar{1}$·085	9	0·314	4
	10	645	3	898	2	766	4	920	5	093	8	310	4
	20	648	3	896	2	769	3	916	4	102	9	306	4
	30	651	3	894	2	773	4	913	3	110	8	302	4
	40	654	3	892	2	777	4	909	4	119	9	298	4
	50	657	3	890	2	780	3	905	4	127	8	294	4
16	0	$\bar{3}$·659	2	$\bar{6}$·888	2	$\bar{1}$·783	3	$\bar{1}$·901	4	$\bar{1}$·135	8	0·290	4
	10	662	3	886	2	787	4	897	4	143	8	287	3
	20	665	3	885	1	790	3	894	3	151	8	283	4
	30	667	2	883	2	793	3	890	4	158	7	279	4
	40	670	3	882	1	796	3	887	3	166	8	276	3
	50	672	2	880	2	800	4	883	4	174	8	272	4
17	0	$\bar{3}$·675	3	$\bar{6}$·879	1	$\bar{1}$·803	3	$\bar{1}$·880	3	$\bar{1}$·181	7	0·269	3
	10	677	2	877	2	806	3	876	4	189	8	265	4
	20	679	2	876	1	809	3	873	3	196	7	262	3
	30	681	2	875	1	812	3	869	4	203	7	258	4
	40	683	2	874	1	815	3	866	3	210	7	255	3
	50	685	2	873	1	817	2	863	3	217	7	252	3
18	0	$\bar{3}$·687	2	$\bar{6}$·872	1	$\bar{1}$·820	3	$\bar{1}$·860	3	$\bar{1}$·224	7	0·249	3
	10	689	2	871	1	823	3	856	4	231	7	245	4
	20	691	2	870	1	826	3	853	3	238	7	242	3
	30	693	2	869	1	828	2	850	3	245	7	239	3
	40	695	2	868	1	831	3	847	3	251	6	236	3
	50	697	2	867	1	834	3	844	3	258	7	233	3
19	0	$\bar{3}$·698	1	$\bar{6}$·867	0	$\bar{1}$·836	2	$\bar{1}$·841	3	$\bar{1}$·265	7	0·230	3
	10	700	2	866	1	839	3	838	3	271	6	227	3
	20	702	2	866	0	841	2	835	3	277	6	224	3
	30	703	1	865	1	844	3	832	3	284	7	221	3
	40	705	2	865	0	846	2	829	3	290	6	219	2
	50	706	1	864	1	848	2	827	2	296	6	216	3
	60	708	2	864	0	851	3	824	3	302	6	213	3

TABLE VI.—Logarithms for facilitating the Computation of

Latitude.		P	Diff.	Q	Diff.	R	Diff.	S	Diff.	T	Diff.
°	′		−		+		−		+		−
20	0	$\bar{3}$·9961890	82	$\bar{1}$·9974450	54	$\bar{8}$·38073	0	0·32549	47	0·21498	273
	10	1808	81	4504	54	73	1	596	47	21225	271
	20	1727	83	4558	55	72	1	643	47	20954	267
	30	1644	83	4613	55	71	1	690	48	20687	263
	40	1561	83	4668	56	70	1	738	49	20424	261
	50	1478		4724		69		787		20163	
21	0	$\bar{3}$·9961394	84	$\bar{1}$·9974780	56	$\bar{8}$·38068	1	0·32836	49	0·19906	257
	10	1310	84	4836	56	68	0	885	49	19653	253
	20	1224	86	4893	57	67	1	935	50	19402	251
	30	1139	85	4950	57	66	1	985	50	19154	248
	40	1053	86	5007	57	65	1	0·33035	50	18910	244
	50	0966	87	5065	58	64	1	086	51	18669	241
22	0	$\bar{3}$·9960879	87	$\bar{1}$·9975123	58	$\bar{8}$·38063	1	0·33138	52	0·18430	239
	10	0791	88	5182	59	62	1	189	51	18195	235
	20	0703	88	5241	59	62	0	242	53	17962	233
	30	0614	89	5300	59	61	1	294	52	17732	230
	40	0525	89	5359	59	60	1	348	54	17506	226
	50	0435	90	5419	60	59	1	401	53	17281	225
23	0	$\bar{3}$·9960345	90	$\bar{1}$·9975479	60	$\bar{8}$·38058	1	0·33455	54	0·17060	221
	10	0254	91	5540	61	57	1	510	55	16841	219
	20	0163	91	5601	61	56	1	565	55	16625	216
	30	0071	92	5662	61	55	1	620	55	16412	213
	40	$\bar{3}$·9959978	93	5724	62	54	1	676	56	16201	211
	50	9886	92	5786	62	53	1	732	56	15993	208
24	0	$\bar{3}$·9959792	94	$\bar{1}$·9975848	62	$\bar{8}$·38052	1	0·33788	56	0·15788	205
	10	9698	94	5910	62	51	1	846	58	15584	204
	20	9604	94	5973	63	51	0	903	57	15384	200
	30	9509	95	6036	63	50	1	961	58	15185	199
	40	9414	95	6100	64	49	1	0·34020	59	14990	195
	50	9318	96	6164	64	48	1	078	58	14796	194
25	0	$\bar{3}$·9959222	96	$\bar{1}$·9976228	64	$\bar{8}$·38047	1	0·34138	60	0·14605	191
	10	9125	97	6292	64	46	1	197	59	14416	189
	20	9028	97	6357	65	45	1	258	61	14229	187
	30	8930	98	6422	65	44	1	318	60	14045	184
	40	8832	98	6488	66	43	1	380	62	13863	182
	50	8734	98	6553	65	42	1	441	61	13683	180
26	0	$\bar{3}$·9958635	99	$\bar{1}$·9976619	66	$\bar{8}$·38041	1	0·34503	62	0·13505	178
	10	8535	100	6686	67	40	1	566	63	13330	175
	20	8435	100	6752	66	39	1	629	63	13156	174
	30	8335	100	6819	67	38	1	692	63	12984	172
	40	8234	101	6886	67	37	1	756	64	12815	169
	50	8133	101	6954	68	36	1	820	64	12648	167
27	0	$\bar{3}$·9958031	102	$\bar{1}$·9977022	68	$\bar{8}$·38035	1	0·34885	65	0·12482	166
	10	7929	102	7090	68	34	1	950	65	12319	163
	20	7827	102	7158	68	33	1	0·35016	66	12157	162
	30	7724	103	7227	69	32	1	082	66	11998	159
	40	7620	104	7296	69	31	1	149	67	11840	158
	50	7516	104	7365	69	30	1	216	67	11685	155
28	0	$\bar{3}$·9957412	104	$\bar{1}$·9977435	70	$\bar{8}$·38029	1	0·35284	68	0·11531	154
	10	7308	104	7504	69	28	1	352	68	11379	152
	20	7203	105	7574	70	27	1	421	69	11228	151
	30	7097	106	7645	71	25	2	490	69	11080	148
	40	6991	106	7715	70	24	1	559	69	10933	147
	50	6885	106	7786	71	23	1	629	70	10788	145
29	0	$\bar{3}$·9956778	107	$\bar{1}$·9977857	71	$\bar{8}$·38022	1	0·35700	71	0·10645	143
	10	6671	107	7928	71	21	1	771	71	10504	141
	20	6564	107	8000	72	20	1	842	71	10364	140
	30	6456	108	8072	72	19	1	914	72	10226	138
	40	6348	108	8144	72	18	1	986	72	10089	137
	50	6239	109	8216	72	17	1	0·36059	73	09955	134
	60	6130	109	8289	73	16	1	133	74	09821	134

Terrestrial Latitudes, Longitudes, and Reverse Azimuths.

Latitude.		V	Diff.	U	Diff.	W	Diff.	X	Diff.	Y	Diff.	Z	Diff.
°	′						+		−		+		−
20	0	$\bar{3}$·708	+ 1	$\bar{6}$·864	− 0	$\bar{1}$·851	2	$\bar{1}$·824	3	$\bar{1}$·302	6	0·213	3
	10	709	1	864	1	853	2	821	3	308	6	210	2
	20	710	1	863	0	855	3	818	2	314	6	208	3
	30	711	2	863	0	858	2	816	3	320	6	205	3
	40	713	1	863	0	860	2	813	3	326	6	202	2
	50	714		863		862		810		332		200	
21	0	$\bar{3}$·715	1	$\bar{6}$·863	0	$\bar{1}$·864	2	$\bar{1}$·808	2	$\bar{1}$·338	6	0·197	3
	10	716	1	863	0	866	2	805	3	343	5	195	2
	20	717	1	863	0	868	2	802	3	349	6	192	3
	30	718	1	863	0	870	2	800	2	355	6	190	2
	40	719	1	863	0	872	2	797	3	360	5	187	3
	50	720	1	863	0	874	2	795	2	366	6	185	2
22	0	$\bar{3}$·721	1	$\bar{6}$·864	+ 1	$\bar{1}$·876	2	$\bar{1}$·793	2	$\bar{1}$·371	5	0·182	3
	10	722	1	864	0	878	2	790	3	376	5	180	2
	20	722	0	864	0	880	2	788	2	382	6	178	2
	30	723	1	865	1	882	2	785	3	387	5	175	3
	40	724	1	865	0	884	2	783	2	392	5	173	2
	50	724	0	866	1	885	1	781	2	397	5	171	2
23	0	$\bar{3}$·725	1	$\bar{6}$·866	0	$\bar{1}$·887	2	$\bar{1}$·778	3	$\bar{1}$·403	6	0·169	2
	10	726	1	867	1	889	2	776	2	408	5	167	2
	20	726	0	868	1	891	2	774	2	413	5	164	3
	30	727	1	868	0	892	1	771	3	418	5	162	2
	40	727	0	869	1	894	2	769	2	423	5	160	2
	50	727	0	870	1	896	2	767	2	428	5	158	2
24	0	$\bar{3}$·728	1	$\bar{6}$·870	0	$\bar{1}$·897	1	$\bar{1}$·765	2	$\bar{1}$·432	4	0·156	2
	10	728	0	871	1	899	2	763	2	437	5	154	2
	20	728	0	872	1	900	1	761	2	442	5	152	2
	30	729	1	873	1	902	2	758	3	447	5	150	2
	40	729	0	874	1	903	1	756	2	451	4	148	2
	50	729	0	875	1	905	2	754	2	456	5	146	2
25	0	$\bar{3}$·729	0	$\bar{6}$·876	1	$\bar{1}$·906	1	$\bar{1}$·752	2	$\bar{1}$·461	5	0·144	2
	10	729	0	877	1	908	2	750	2	465	4	143	1
	20	729	0	878	1	909	1	748	2	470	5	141	2
	30	729	0	880	2	911	2	746	2	474	4	139	2
	40	729	0	881	1	912	1	744	2	479	5	137	2
	50	729	0	882	1	914	2	742	2	483	4	135	2
26	0	$\bar{3}$·729	0	$\bar{6}$·883	1	$\bar{1}$·915	1	$\bar{1}$·740	2	$\bar{1}$·487	4	0·133	2
	10	729	0	885	2	916	1	738	2	492	5	132	1
	20	729	0	886	1	918	2	736	2	496	4	130	2
	30	729	0	888	2	919	1	734	2	500	4	128	2
	40	729	0	889	1	920	1	732	2	505	5	127	1
	50	728	− 1	890	1	921	1	730	2	509	4	125	2
27	0	$\bar{3}$·728	0	$\bar{6}$·892	2	$\bar{1}$·923	2	$\bar{1}$·729	1	$\bar{1}$·513	4	0·123	2
	10	728	0	894	2	924	1	727	2	517	4	122	1
	20	727	1	895	1	925	1	725	2	521	4	120	2
	30	727	0	897	2	926	1	723	2	525	4	119	1
	40	727	0	898	1	927	1	721	2	529	4	117	2
	50	726	1	900	2	929	2	719	2	533	4	115	2
28	0	$\bar{3}$·726	0	$\bar{6}$·902	2	$\bar{1}$·930	1	$\bar{1}$·717	2	$\bar{1}$·537	4	0·114	1
	10	725	1	904	2	931	1	716	1	541	4	112	2
	20	725	0	906	2	932	1	714	2	545	4	111	1
	30	724	1	907	1	933	1	712	2	549	4	109	2
	40	724	0	909	2	934	1	710	2	553	4	108	1
	50	723	1	911	2	935	1	709	1	557	4	107	1
29	0	$\bar{3}$·722	1	$\bar{6}$·913	2	$\bar{1}$·936	1	$\bar{1}$·707	2	$\bar{1}$·561	4	0·105	2
	10	722	0	915	2	937	1	705	2	565	4	104	1
	20	721	1	917	2	938	1	703	2	568	3	102	2
	30	720	1	919	2	939	1	702	1	572	4	101	1
	40	719	1	921	2	940	1	700	2	576	4	100	1
	50	718	1	924	3	941	1	698	2	580	4	098	2
	60	718	0	926	2	942	1	697	1	583	3	097	1

TABLE VI.—Logarithms for facilitating the Computation of

Latitude.		P	Diff.	Q	Diff.	R	Diff.	S	Diff.	T	Diff.
°	′		−		+		−		+		−
30	0	$\bar{3}$·9956130	109	$\bar{1}$·9978289	73	$\bar{8}$·38016	1	0·36133	74	0·09821	131
	10	6021	110	8362	73	15	1	207	74	09690	130
	20	5911	110	8435	73	14	1	281	75	09560	129
	30	5801	110	8508	74	13	2	356	75	09431	127
	40	5691	111	8582	74	11	1	431	76	09304	125
	50	5580		8656		10		507		09179	
31	0	$\bar{3}$·9955469	111	$\bar{1}$·9978730	74	$\bar{8}$·38009	1	0·36584	77	0·09055	124
	10	5358	111	8804	74	08	1	661	77	08932	123
	20	5246	112	8879	75	07	1	738	77	08811	121
	30	5134	112	8953	74	06	1	816	78	08692	119
	40	5021	113	9028	75	05	1	894	78	08574	118
	50	4909	112	9104	76	04	1	973	79	08457	117
32	0	$\bar{3}$·9954796	113	$\bar{1}$·9979179	75	$\bar{8}$·38002	2	0·37053	80	0·08342	115
	10	4682	114	9255	76	01	1	133	80	08228	114
	20	4568	114	9330	75	00	1	213	80	08115	113
	30	4454	114	9406	76	$\bar{8}$·37999	1	294	81	08004	111
	40	4340	114	9483	77	98	1	376	82	07894	110
	50	4225	115	9559	76	97	1	458	82	07786	108
33	0	$\bar{3}$·9954110	115	$\bar{1}$·9979636	77	$\bar{8}$·37996	1	0·37540	82	0·07678	108
	10	3995	115	9713	77	94	2	623	83	07572	106
	20	3879	116	9790	77	93	1	707	84	07468	104
	30	3764	115	9867	77	92	1	791	84	07364	104
	40	3647	117	9944	77	91	1	876	85	07262	102
	50	3531	116	$\bar{1}$·9980022	78	90	1	961	85	07161	101
34	0	$\bar{3}$·9953414	117	$\bar{1}$·9980100	78	$\bar{8}$·37989	1	0·38047	86	0·07062	99
	10	3297	117	0178	78	87	2	133	86	06963	99
	20	3180	117	0256	78	86	1	220	87	06866	97
	30	3062	118	0334	78	85	1	307	87	06770	96
	40	2945	117	0413	79	84	1	395	88	06675	95
	50	2827	118	0492	79	83	1	483	88	06581	94
35	0	$\bar{3}$·9952708	119	$\bar{1}$·9980571	79	$\bar{8}$·37982	1	0·38572	89	0·06488	93
	10	2590	118	0650	79	80	2	662	90	06397	91
	20	2471	119	0729	79	79	1	752	90	06306	91
	30	2352	119	0808	79	78	1	842	90	06217	89
	40	2232	120	0888	80	77	1	934	92	06129	88
	50	2113	119	0967	79	76	1	0·39025	91	06042	87
36	0	$\bar{3}$·9951993	120	$\bar{1}$·9981047	80	$\bar{8}$·37974	2	0·39118	93	0·05956	86
	10	1873	120	1127	80	73	1	211	93	05871	85
	20	1753	120	1207	80	72	1	304	93	05787	84
	30	1632	121	1288	81	71	1	398	94	05704	83
	40	1512	120	1368	80	70	1	493	95	05622	82
	50	1391	121	1449	81	68	2	588	95	05541	81
37	0	$\bar{3}$·9951270	121	$\bar{1}$·9981530	81	$\bar{8}$·37967	1	0·39683	95	0·05461	80
	10	1148	122	1610	80	66	1	780	97	05382	79
	20	1027	121	1691	81	65	1	877	97	05304	78
	30	0905	122	1773	82	64	1	974	97	05227	77
	40	0783	122	1854	81	62	2	0·40072	98	05151	76
	50	0661	122	1935	81	61	1	171	99	05076	75
38	0	$\bar{3}$·9950539	122	$\bar{1}$·9982017	82	$\bar{8}$·37960	1	0·40270	99	0·05002	74
	10	0416	123	2098	81	59	1	370	100	04928	74
	20	0294	122	2180	82	57	2	470	100	04856	72
	30	0171	123	2262	82	56	1	571	101	04785	71
	40	0048	123	2344	82	55	1	673	102	04714	71
	50	$\bar{3}$·9949925	123	2426	82	54	1	775	102	04644	70
39	0	$\bar{3}$·9949802	123	$\bar{1}$·9982508	82	$\bar{8}$·37953	1	0·40878	103	0·04576	68
	10	9678	124	2591	83	51	2	981	103	04508	68
	20	9555	123	2673	82	50	1	0·41085	104	04441	67
	30	9431	124	2755	82	49	1	190	105	04374	67
	40	9307	124	2838	83	48	1	295	105	04309	65
	50	9183	124	2921	83	46	2	401	106	04244	65
	60	9059	124	3003	82	45	1	508	107	04181	63

Terrestrial Latitudes, Longitudes, and Reverse Azimuths.

Latitude °	′	V	Diff.	U	Diff.	W	Diff.	X	Diff.	Y	Diff.	Z	Diff.
			−		+		+		−		+		−
30	0	$\bar{3}$·718		$\bar{6}$·926		$\bar{1}$·942		$\bar{1}$·697		$\bar{1}$·583		0·097	
	10	717	1	928	2	943	1	695	2	587	4	096	1
	20	716	1	930	2	944	1	693	2	590	3	094	2
	30	715	1	932	2	945	1	692	1	594	4	093	1
	40	714	1	935	3	946	1	690	2	598	4	092	1
	50	713	1	937	2	947	1	688	2	601	3	091	1
31	0	$\bar{3}$·712	1	$\bar{6}$·939	2	$\bar{1}$·947	0	$\bar{1}$·687	1	$\bar{1}$·605	4	0·089	2
	10	711	1	942	3	948	1	685	2	608	3	088	1
	20	710	1	944	2	949	1	684	1	612	4	087	1
	30	708	2	947	3	950	1	682	2	615	3	086	1
	40	707	1	949	2	951	1	680	2	619	4	085	1
	50	706	1	952	3	952	1	679	1	622	3	083	2
32	0	$\bar{3}$·705	1	$\bar{6}$·954	2	$\bar{1}$·952	0	$\bar{1}$·677	2	$\bar{1}$·625	3	0·082	1
	10	704	1	957	3	953	1	676	1	629	4	081	1
	20	702	2	960	3	954	1	674	2	632	3	080	1
	30	701	1	962	2	955	1	672	2	635	3	079	1
	40	700	1	965	3	955	0	671	1	639	4	078	1
	50	698	2	968	3	956	1	669	2	642	3	077	1
33	0	$\bar{3}$·697	1	$\bar{6}$·971	3	$\bar{1}$·957	1	$\bar{1}$·668	1	$\bar{1}$·645	3	0·076	1
	10	696	1	973	2	958	1	666	2	649	4	075	1
	20	694	2	976	3	958	0	665	1	652	3	074	1
	30	693	1	979	3	959	1	663	2	655	3	073	1
	40	691	2	982	3	960	1	662	1	658	3	072	1
	50	690	1	985	3	960	0	660	2	661	3	071	1
34	0	$\bar{3}$·688	2	$\bar{6}$·988	3	$\bar{1}$·961	1	$\bar{1}$·659	1	$\bar{1}$·665	4	0·070	1
	10	687	1	991	3	962	1	657	2	668	3	069	1
	20	685	2	994	3	962	0	656	1	671	3	068	1
	30	683	2	997	3	963	1	654	2	674	3	067	1
	40	682	1	$\bar{5}$·000	3	963	0	653	1	677	3	066	1
	50	680	2	003	3	964	1	651	2	680	3	065	1
35	0	$\bar{3}$·678	2	$\bar{5}$·006	3	$\bar{1}$·965	1	$\bar{1}$·650	1	$\bar{1}$·683	3	0·064	1
	10	676	2	010	4	965	0	648	2	686	3	063	1
	20	675	1	013	3	966	1	647	1	689	3	062	1
	30	673	2	016	3	966	0	645	2	692	3	061	1
	40	671	2	019	3	967	1	644	1	695	3	060	1
	50	669	2	023	4	967	0	642	2	698	3	059	1
36	0	$\bar{3}$·667	2	$\bar{5}$·026	3	$\bar{1}$·968	1	$\bar{1}$·641	1	$\bar{1}$·701	3	0·059	0
	10	665	2	029	3	969	1	639	2	704	3	058	1
	20	663	2	033	4	969	0	638	1	707	3	057	1
	30	661	2	036	3	970	1	636	2	710	3	056	1
	40	659	2	040	4	970	0	635	1	713	3	055	1
	50	657	2	043	3	971	1	633	2	716	3	055	0
37	0	$\bar{3}$·655	2	$\bar{5}$·047	4	$\bar{1}$·971	0	$\bar{1}$·632	1	$\bar{1}$·719	3	0·054	1
	10	653	2	050	3	972	1	631	1	722	3	053	1
	20	651	2	054	4	972	0	629	2	725	3	052	1
	30	649	2	057	3	973	1	628	1	728	3	051	1
	40	647	2	061	4	973	0	626	2	731	3	051	0
	50	645	2	065	4	974	1	625	1	734	3	050	1
38	0	$\bar{3}$·642	3	$\bar{5}$·068	3	$\bar{1}$·974	0	$\bar{1}$·623	2	$\bar{1}$·736	2	0·049	1
	10	640	2	072	4	975	1	622	1	739	3	049	0
	20	638	2	076	4	975	0	620	2	742	3	048	1
	30	636	2	080	4	975	0	619	1	745	3	047	1
	40	633	3	084	4	976	1	618	1	748	3	046	1
	50	631	2	088	4	976	0	616	2	751	3	046	0
39	0	$\bar{3}$·628	3	$\bar{5}$·091	3	$\bar{1}$·977	1	$\bar{1}$·615	1	$\bar{1}$·753	2	0·045	1
	10	626	2	095	4	977	0	613	2	756	3	044	1
	20	624	2	099	4	977	0	612	1	759	3	044	0
	30	621	3	103	4	978	1	610	2	761	2	043	1
	40	619	2	107	4	978	0	609	1	764	3	042	1
	50	616	3	111	4	979	1	608	1	767	3	042	0
	60	614	2	115	4	979	0	606	2	770	3	041	1

TABLE VII.—Directions for applying the Signs to the Terms of the Latitude, Longitude and Azimuth Formulæ.

Terms of the Formulæ.	Magnitude of the given Azimuth A.			
	0° to 90°	90° to 180°	180° to 270°	270° to 360°
$\delta_1 \lambda$	−	+	+	−
$\delta_1 L$	−	−	+	+
$\delta_1 A$	−	−	+	+
$\delta_2 \lambda$	−	−	−	−
$\delta_2 L$	+	−	+	−
$\delta_2 A$	+	−	+	−
$\delta_3 \lambda$	−	−	−	−
$\delta_3 L$	−	−	+	+
$\delta_3 A$	−	−	+	+
$\delta_4 \lambda$	+	−	−	+
$\delta_4 L$	+	+	−	−
$\delta_4 A$	+	+	−	−

TABLE VIII.—For calculating Azimuths and Distances of Points of which the Latitudes and Longitudes are known.

Lat.	R′	Diff.	S′	Diff.	T′	Diff.
° ′		+		+		+
0 0	Inf. neg.	Inf.	Inf. neg.	Inf.	$\bar{6}$·38454	1
10	$\bar{9}$·85116	30102	$\bar{8}$·14641	30103	38455	2
20	$\bar{8}$·15218	17608	44744	17610	38457	3
30	32826	12492	62354	12495	38460	3
40	45318	9689	74849	9692	38463	5
50	55007	7916	84541	7919	38468	6
1 0	$\bar{8}$·62923	6691	$\bar{8}$·92460	6697	$\bar{6}$·38474	7
10	69614	5796	– 99157	5801	38481	9
20	75410	5111	$\bar{7}$·04958	5117	38490	9
30	80521	4571	10075	4578	38499	10
40	85092	4134	14653	4142	38509	12
50	89226	3773	18795	3782	38521	12
2 0	$\bar{8}$·92999	3470	$\bar{7}$·22577	3479	$\bar{6}$·38533	14
10	96469	3212	26056	3222	38547	14
20	– 99681	2989	29278	3000	38561	17
30	$\bar{7}$·02670	2795	32278	2807	38578	16
40	05465	2625	35085	2637	38594	18
50	08090	2473	37722	2487	38612	19
3 0	$\bar{7}$·10563	2339	$\bar{7}$·40209	2352	$\bar{6}$·38631	21
10	12902	2218	42561	2233	38652	21
20	15120	2109	44794	2124	38673	22
30	17229	2010	46918	2026	38695	23
40	19239	1919	48944	1936	38718	25
50	21158	1837	50880	1854	38743	26
4 0	$\bar{7}$·22995	1761	$\bar{7}$·52734	1779	$\bar{6}$·38769	26
10	24756	1690	54513	1710	38795	28
20	26446	1626	56223	1645	38823	29
30	28072	1566	57868	1587	38852	30
40	29638	1510	59455	1531	38882	30
50	31148	1458	60986	1480	38912	32
5 0	$\bar{7}$·32606	1408	$\bar{7}$·62466	1431	$\bar{6}$·38944	33
10	34014	1364	63897	1387	38977	35
20	35378	1320	65284	1345	39012	35
30	36698	1280	66629	1304	39047	36
40	37978	1242	67933	1268	39083	37
50	39220	1205	69201	1232	39120	39
6 0	$\bar{7}$·40425	1172	$\bar{7}$·70433	1200	$\bar{6}$·39159	39
10	41597	1140	71633	1167	39198	41
20	42737	1109	72800	1138	39239	41
30	43846	1080	73938	1109	39280	43
40	44926	1052	75047	1083	39323	44
50	45978	1026	76130	1057	39367	44
7 0	47004		77187		39411	
7 0	$\bar{7}$·47004	1001	$\bar{7}$·77187	1033	$\bar{6}$·39411	46
10	48005	977	78220	1009	39457	47
20	48982	953	79229	987	39504	48
30	49935	932	80216	966	39552	49
40	50867	911	81182	946	39601	50
50	51778	891	82128	926	39651	51
8 0	$\bar{7}$·52669	871	$\bar{7}$·83054	908	$\bar{6}$·39702	52
10	53540	853	83962	890	39754	53
20	54393	835	84852	872	39807	54
30	55228	818	85724	857	39861	55
40	56046	801	86581	840	39916	56
50	56847	785	87421	826	39972	57
9 0	$\bar{7}$·57632	770	$\bar{7}$·88247	810	$\bar{6}$·40029	58
10	58402	755	89057	797	40087	59
20	59157	740	89854	783	40146	61
30	59897	727	90637	770	40207	61
40	60624	713	91407	757	40268	62
50	61337	700	92164	745	40330	63
10 0	$\bar{7}$·62037	688	$\bar{7}$·92909	733	$\bar{6}$·40393	64
10	62725	675	93642	722	40457	66
20	63400	664	94364	711	40523	66
30	64064	652	95075	700	40589	67
40	64716	641	95775	689	40656	68
50	65357	631	96464	680	40724	69
11 0	$\bar{7}$·65988	620	$\bar{7}$·97144	670	$\bar{6}$·40793	71
10	66608	609	97814	661	40864	71
20	67217	600	98475	651	40935	72
30	67817	590	99126	643	41007	73
40	68407	581	– 99769	634	41080	74
50	68988	572	$\bar{6}$·00403	625	41154	75
12 0	$\bar{7}$·69560	562	$\bar{6}$·01028	618	$\bar{6}$·41229	76
10	70122	554	01646	609	41305	77
20	70676	546	02255	602	41382	78
30	71222	537	02857	595	41460	79
40	71759	530	03452	587	41539	80
50	72289	521	04039	580	41619	81
13 0	$\bar{7}$·72810	514	$\bar{6}$·04619	574	$\bar{6}$·41700	81
10	73324	507	05193	566	41781	83
20	73831	499	05759	560	41864	84
30	74330	492	06319	554	41948	84
40	74822	485	06873	548	42032	86
50	75307	478	07421	541	42118	86
14 0	75785		07962		42204	

Lat.	U′	Diff.	Y′	Diff.	V′	Diff.	X′	Diff.	W′	Diff.	Z′	Diff.
°		+		+		+		+		+		+
0	$\bar{12}$·888	1	Inf. neg.	Infinite	Inf. neg.	Infinite	$\bar{12}$·593	0	Inf. neg.	Infinite	Inf. neg.	Infinite
1	889	1	$\bar{15}$·378	602	$\bar{10}$·926	300	593	1	$\bar{13}$·528	302	$\bar{14}$·835	301
2	890	2	— 980	352	$\bar{9}$·226	176	594	2	— 830	177	$\bar{13}$·136	177
3	892	3	$\bar{14}$·332	249	402	124	596	1	$\bar{12}$·007	125	313	126
4	895	3	581	194	526	96	597	3	132	98	439	98
5	$\bar{12}$·898	4	$\bar{14}$·775	157	$\bar{9}$·622	79	$\bar{12}$·600	2	$\bar{12}$·230	81	$\bar{13}$·537	80
6	902	6	— 932	134	701	65	602	4	311	69	617	68
7	908	5	$\bar{13}$·066	115	766	57	606	4	380	60	685	60
8	913	7	181	102	823	50	610	4	440	54	745	53
9	920	7	283	90	873	44	614	4	494	48	798	48
10	$\bar{12}$·927	8	$\bar{13}$·373	82	$\bar{9}$·917	39	$\bar{12}$·618	6	$\bar{12}$·542	44	$\bar{13}$·846	43
11	935	9	455	75	956	36	624	5	586	41	889	40
12	944	9	530	68	— 992	33	629	6	627	38	929	37
13	953	10	598	63	$\bar{8}$·025	29	635	6	665	36	— 966	35
14	963		661		054		641		701		$\bar{12}$·001	

TABLE VIII.—For calculating Azimuths and Distances of Points of which the Latitudes and Longitudes are known.

Lat.	R′	Diff.	S′	Diff.	T′	Diff.	Lat.	R′	Diff.	S′	Diff.	T′	Diff.
° ′		+		+		+	° ′		+		+		+
14 0	$\bar{7}$·75785	471	$\bar{6}$·07962	536	$\bar{6}$·42204	88	21 0	$\bar{7}$·91155	278	$\bar{6}$·26723	377	$\bar{6}$·46629	124
10	76256	465	08498	530	42292	88	10	91433	275	27100	375	46753	123
20	76721	459	09028	524	42380	89	20	91708	272	27475	372	46876	125
30	77180	452	09552	519	42469	90	30	91980	269	27847	370	47001	126
40	77632	446	10071	514	42559	91	40	92249	266	28217	367	47127	126
50	78078	440	10585	508	42650	92	50	92515	262	28584	366	47253	127
15 0	$\bar{7}$·78518	435	$\bar{6}$·11093	503	$\bar{6}$·42742	93	22 0	$\bar{7}$·92777	260	$\bar{6}$·28950	363	$\bar{6}$·47380	128
10	78953	428	11596	498	42835	94	10	93037	256	29313	361	47508	128
20	79381	423	12094	494	42929	95	20	93293	254	29674	359	47636	129
30	79804	417	12588	488	43024	95	30	93547	251	30033	357	47765	130
40	80221	412	13076	484	43119	97	40	93798	247	30390	355	47895	131
50	80633	407	13560	480	43216	97	50	94045	245	30745	352	48026	132
16 0	$\bar{7}$·81040	401	$\bar{6}$·14040	475	$\bar{6}$·43313	98	23 0	$\bar{7}$·94290	242	$\bar{6}$·31097	351	$\bar{6}$·48158	132
10	81441	396	14515	471	43411	99	10	94532	239	31448	349	48290	133
20	81837	391	14986	466	43510	100	20	94771	237	31797	347	48423	133
30	82228	386	15452	462	43610	101	30	95008	233	32144	345	48556	134
40	82614	382	15914	459	43711	102	40	95241	231	32489	344	48690	136
50	82996	376	16373	454	43813	103	50	95472	228	32833	341	48826	136
17 0	$\bar{7}$·83372	372	$\bar{6}$·16827	450	$\bar{6}$·43916	103	24 0	$\bar{7}$·95700	226	$\bar{6}$·33174	340	$\bar{6}$·48962	136
10	83744	367	17277	447	44019	104	10	95926	223	33514	338	49098	138
20	84111	363	17724	443	44123	106	20	96149	220	33852	336	49236	138
30	84474	358	18167	439	44229	106	30	96369	218	34188	335	49374	138
40	84832	354	18606	435	44335	107	40	96587	215	34523	333	49512	140
50	85186	349	19041	432	44442	107	50	96802	213	34856	331	49652	140
18 0	$\bar{7}$·85535	345	$\bar{6}$·19473	429	$\bar{6}$·44549	109	25 0	$\bar{7}$·97015	210	$\bar{6}$·35187	330	$\bar{6}$·49792	141
10	85880	341	19902	425	44658	109	10	97225	207	35517	328	49933	141
20	86221	337	20327	422	44767	111	20	97432	206	35845	326	50074	142
30	86558	333	20749	419	44878	111	30	97638	202	36171	325	50216	143
40	86891	329	21168	416	44989	112	40	97840	201	36496	324	50359	144
50	87220	324	21584	412	45101	112	50	98041	198	36820	322	50503	144
19 0	$\bar{7}$·87544	321	$\bar{6}$·21996	409	$\bar{6}$·45213	114	26 0	$\bar{7}$·98239	195	$\bar{6}$·37142	320	$\bar{6}$·50647	145
10	87865	317	22405	407	45327	114	10	98434	193	37462	320	50792	146
20	88182	314	22812	403	45441	116	20	98627	191	37782	317	50938	146
30	88496	309	23215	401	45557	116	30	98818	189	38099	317	51084	147
40	88805	306	23616	398	45673	116	40	99007	186	38416	315	51231	147
50	89111	303	24014	395	45789	118	50	99193	184	38731	313	51378	149
20 0	$\bar{7}$·89414	299	$\bar{6}$·24409	392	$\bar{6}$·45907	118	27 0	$\bar{7}$·99377	182	$\bar{6}$·39044	313	$\bar{6}$·51527	149
10	89713	295	24801	389	46025	120	10	99559	179	39357	311	51676	149
20	90008	292	25190	387	46145	120	20	99738	178	39668	309	51825	150
30	90300	288	25577	385	46265	120	30	$\bar{7}$·99916	175	39977	309	51975	151
40	90588	285	25962	382	46385	122	40	$\bar{6}$·00091	173	40286	307	52126	152
50	90873	282	26344	379	46507	122	50	00264	171	40593	306	52278	152
21 0	91155		26723		46629		28 0	00435		40899		52430	

Lat.	U′	Diff.	Y′	Diff.	V′	Diff.	X′	Diff.	W′	Diff.	Z′	Diff.
°		+		+		+		+		+		+
14	$\bar{12}$·963	10	$\bar{13}$·661	59	$\bar{8}$·054	28	$\bar{12}$·641	7	$\bar{12}$·701	34	$\bar{12}$·001	33
15	973	11	720	55	082	25	648	6	735	33	034	31
16	984	12	775	51	107	23	654	8	768	31	065	30
17	$\bar{12}$·996	12	826	48	130	22	662	7	799	30	095	28
18	$\bar{11}$·008	13	874	45	152	20	669	7	829	28	123	26
19	$\bar{11}$·021	13	$\bar{13}$·919	43	$\bar{8}$·172	19	$\bar{12}$·676	8	$\bar{12}$·857	28	$\bar{12}$·149	26
20	034	14	$\bar{13}$·962	41	191	18	684	8	885	27	175	25
21	048	14	$\bar{12}$·003	38	209	16	692	8	912	26	200	24
22	062	15	041	37	225	15	700	9	938	26	224	23
23	077	15	078	35	240	14	709	8	964	25	247	22
24	$\bar{11}$·092	15	$\bar{12}$·113	33	$\bar{8}$·254	13	$\bar{12}$·717	9	$\bar{12}$·989	25	$\bar{12}$·269	21
25	107	16	146	32	267	13	726	8	$\bar{11}$·014	24	290	21
26	123	17	178	30	280	11	734	9	038	24	311	20
27	140	16	208	29	291	11	743	9	062	24	331	20
28	156		237		302		752		086		351	

TABLE VIII.—For calculating Azimuths and Distances of Points of which the Latitudes and Longitudes are known.

Lat. ° ′	R′	Diff. +	S′	Diff. +	T′	Diff. +	Lat. ° ′	R′	Diff. +	S′	Diff. +	T′	Diff. +
28 0	$\bar{6}$·00435	168	$\bar{6}$·40899	305	$\bar{6}$·52430	153	34 0	$\bar{6}$·05267	101	$\bar{6}$·51257	273	$\bar{6}$·58319	174
10	00603	167	41204	304	52583	153	10	05368	98	51530	273	58493	176
20	00770	164	41508	302	52736	154	20	05466	97	51803	271	58669	175
30	00934	163	41810	302	52890	155	30	05563	96	52074	271	58844	176
40	01097	160	42112	300	53045	156	40	05659	93	52345	271	59020	177
50	01257		42412		53201		50	05752		52616		59197	
29 0	$\bar{6}$·01415	158	$\bar{6}$·42711	299	$\bar{6}$·53356	155	35 0	$\bar{6}$·05844	92	$\bar{6}$·52886	270	$\bar{6}$·59374	177
10	01571	156	43009	298	53513	157	10	05935	91	53155	269	59552	178
20	01725	154	43306	297	53670	157	20	06023	88	53424	269	59730	178
30	01877	152	43602	296	53828	158	30	06110	87	53692	268	59909	179
40	02027	150	43897	295	53987	159	40	06196	86	53960	268	60089	180
50	02176	149	44191	295	54146	159	50	06280	84	54227	267	60269	180
30 0	$\bar{6}$·02322	146	$\bar{6}$·44484	293	$\bar{6}$·54306	160	36 0	$\bar{6}$·06362	82	$\bar{6}$·54494	267	$\bar{6}$·60450	181
10	02466	144	44776	292	54466	160	10	06442	80	54760	266	60631	181
20	02608	142	45067	291	54627	161	20	06521	79	55026	266	60813	182
30	02748	140	45357	290	54789	162	30	06598	77	55291	265	60995	182
40	02887	139	45647	290	54950	161	40	06674	76	55556	265	61178	183
50	03023	136	45935	288	55114	164	50	06748	74	55820	264	61361	183
31 0	$\bar{6}$·03158	135	$\bar{6}$·46222	287	$\bar{6}$·55277	163	37 0	$\bar{6}$·06820	72	$\bar{6}$·56084	264	$\bar{6}$·61545	184
10	03290	132	46509	287	55441	164	10	06891	71	56348	264	61729	184
20	03421	131	46794	285	55606	165	20	06960	69	56611	263	61915	186
30	03550	129	47079	285	55771	165	30	07028	68	56873	262	62100	185
40	03677	127	47363	284	55937	166	40	07094	66	57135	262	62286	186
50	03802	125	47646	283	56103	166	50	07159	65	57397	262	62473	187
32 0	$\bar{6}$·03926	124	$\bar{6}$·47928	282	$\bar{6}$·56270	167	38 0	$\bar{6}$·07222	63	$\bar{6}$·57659	262	$\bar{6}$·62660	187
10	04047	121	48210	282	56437	167	10	07283	61	57920	261	62848	188
20	04167	120	48490	280	56606	169	20	07343	60	58180	260	63036	188
30	04285	118	48770	280	56774	168	30	07401	58	58441	261	63225	189
40	04401	116	49049	279	56944	170	40	07458	57	58701	260	63415	190
50	04516	115	49328	279	57113	169	50	07513	55	58960	259	63604	189
33 0	$\bar{6}$·04628	112	$\bar{6}$·49606	278	$\bar{6}$·57284	171	39 0	$\bar{6}$·07567	54	$\bar{6}$·59220	260	$\bar{6}$·63795	191
10	04739	111	49883	277	57455	171	10	07619	52	59479	259	63986	191
20	04848	109	50159	276	57627	172	20	07670	51	59737	258	64178	192
30	04955	107	50434	275	57799	172	30	07719	49	59996	259	64370	192
40	05061	106	50709	275	57971	172	40	07766	47	60254	258	64562	192
50	05165	104	50984	275	58145	174	50	07812	46	60511	257	64756	194
34 0	05267	102	51257	273	58319	174	40 0	07857	45	60769	258	64950	194

Lat. °	U′	Diff. +	Y′	Diff. +	V′	Diff. +	X′	Diff. +	W′	Diff. +	Z′	Diff. +
28	$\overline{11}$·156	17	$\overline{12}$·237	28	$\bar{8}$·302	10	$\overline{12}$·752	8	$\overline{11}$·086	23	$\overline{12}$·351	19
29	173	18	265	27	312	9	760	9	109	24	370	19
30	191	17	292	26	321	8	769	9	133	23	389	18
31	208		318		329		778		156		407	
32	$\overline{11}$·227	19	$\overline{12}$·342	24	$\bar{8}$·337	8	$\overline{12}$·787	9	$\overline{11}$·179	23	$\overline{12}$·425	18
33	245	18	366	24	344	7	795	8	202	23	442	17
34	264	19	389	23	351	7	804	9	225	23	459	17
35	283	19	411	22	357	6	813	9	248	23	475	16
36	$\overline{11}$·302	19	$\overline{12}$·432	21	$\bar{8}$·362	5	$\overline{12}$·821	8	$\overline{11}$·270	22	$\overline{12}$·491	16
37	322	20	453	21	367	5	830	9	294	24	507	16
38	342	20	473	20	371	4	838	8	316	22	522	15
39	363	21	492	19	374	3	846	8	340	24	537	15
40	384	21	510	18	377	3	855	9	363	23	551	14

TABLE IX.—Computation of Heights.—Reduction of Log. Distance in Feet between two Stations A and B to reduce to the Level of Station A.

Correction to the 7th place of decimals.

Latitude.	Height in Feet of Station A.									
	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
°										
0	208·3	416·5	624·8	833·0	1041·3	1249·6	1457·8	1666·1	1874·4	2082·6
1	3	5	8	0	3	6	8	1	4	6
2	3	5	8	0	3	6	8	1	3	6
3	3	5	8	0	3	5	8	1	3	6
4	3	5	8	0	3	5	8	0	3	6
5	208·3	416·5	624·8	833·0	1041·3	1249·5	1457·8	1666·0	1874·3	2082·5
6	2	5	7	0	2	5	7	0	2	5
7	2	5	7	0	2	5	7	1665·9	2	4
8	2	5	7	832·9	2	4	6	9	1	3
9	2	5	7	9	1	4	6	8	1	3
10	208·2	416·4	624·7	832·9	1041·1	1249·3	1457·5	1665·8	1874·0	2082·2
11	2	4	6	9	1	3	5	7	1873·9	1
12	2	4	6	8	0	2	4	6	8	0
13	2	4	6	8	0	1	3	5	7	2081·9
14	2	4	5	7	1040·9	1	3	4	6	8
15	208·2	416·3	624·5	832·7	1040·9	1249·0	1457·2	1665·4	1873·5	2081·7
16	2	3	5	6	8	1248·9	1	3	4	6
17	1	3	4	6	7	9	0	1	3	4
18	1	3	4	5	6	8	1456·9	0	2	3
19	1	2	3	5	6	7	8	1664·9	0	1
20	208·1	416·2	624·3	832·4	1040·5	1248·6	1456·7	1664·8	1872·9	2081·0
21	1	2	3	3	4	5	6	7	8	2080·8
22	1	1	2	3	4	4	5	6	6	7
23	1	1	2	2	3	3	4	4	5	5
24	0	1	1	1	2	2	2	3	3	3
25	208·0	416·0	624·0	832·1	1040·1	1248·1	1456·1	1664·1	1872·1	2080·1
26	0	0	0	0	0	0	0	0	0	0
27	0	415·9	623·9	831·9	1039·9	1247·8	1455·8	1663·8	1871·8	2079·7
28	0	9	9	8	8	7	7	6	6	6
29	207·9	9	8	7	7	6	6	5	4	4
30	207·9	415·8	623·8	831·7	1039·6	1247·5	1455·4	1663·3	1871·3	2079·2
31	9	8	7	6	5	4	3	1	0	2078·9
32	9	7	6	5	4	2	1	0	1870·9	7
33	9	7	6	4	3	1	0	1662·8	7	5
34	8	7	5	3	2	0	1454·8	6	5	3
35	207·8	415·6	623·4	831·2	1039·0	1246·8	1454·6	1662·5	1870·3	2078·1
36	8	6	3	1	1038·9	7	5	3	0	2077·8
37	8	5	3	0	8	6	3	1	1869·8	6
38	7	5	2	830·9	7	4	2	1661·9	6	4
39	7	4	1	9	6	3	0	7	4	1
40	7	4	1	8	5	1	1453·8	5	2	2076·9

Correction to the 5th place of decimals

for any latitude between 0° and 40°.

	2	4	6	8	10	12	15	17	19	21

TABLE X.—Computation of Heights.—For converting Geodetic Distance in Miles into Seconds of Contained Arc.

Latitude.	Geodetic Distance in Miles.								
	10	20	30	40	50	60	70	80	90
°	″	″	″	″	″	″	″	″	″
0	522·3	1044·5	1566·8	2089·0	2611·3	3133·5	3655·8	4178·1	4700·3
1	3	5	8	0	3	5	8	1	3
2	3	5	8	0	3	5	8	0	3
3	2	5	7	0	2	5	7	0	2
4	2	5	7	0	2	4	7	4177·9	2
5	522·2	1044·5	1566·7	2088·9	2611·2	3133·4	3655·6	4177·9	4700·1
6	2	4	7	9	1	3	5	8	0
7	2	4	6	8	0	2	4	7	4699·9
8	2	4	6	8	0	1	3	5	7
9	2	3	5	7	2610·9	0	2	4	6
10	522·2	1044·3	1566·5	2088·6	2610·8	3132·9	3655·1	4177·2	4699·4
11	1	3	4	5	7	8	3654·9	1	2
12	1	2	3	4	5	6	8	4176·9	0
13	1	2	2	3	4	5	6	7	4698·7
14	1	1	2	2	3	3	4	4	5
15	522·0	1044·1	1566·1	2088·1	2610·1	3132·2	3654·2	4176·2	4698·2
16	0	0	0	0	0	·0	0	0	4697·9
17	0	1043·9	1565·9	2087·8	2609·8	3131·8	3653·7	4175·7	7
18	521·9	9	8	7	6	6	5	4	3
19	9	8	7	6	4	3	2	1	0
20	521·9	1043·7	1565·6	2087·4	2609·3	3131·1	3653·0	4174·8	4696·7
21	8	6	4	2	1	3130·9	3652·7	5	3
22	8	5	3	1	2608·9	6	4	2	4695·9
23	7	5	2	2086·9	6	4	1	4173·8	6
24	7	4	1	7	4	1	3651·8	5	2
25	521·6	1043·3	1564·9	2086·6	2608·2	3129·8	3651·5	4173·1	4694·7
26	6	2	8	4	0	5	1	4172·7	3
27	5	1	6	2	2607·7	3	3650·8	3	4693·9
28	5	0	5	0	5	0	4	4171·9	4
29	4	1042·9	3	2085·8	2	3128·7	1	5	0
30	521·4	1042·8	1564·2	2085·6	2607·0	3128·3	3649·7	4171·1	4692·5
31	3	7	0	3	2606·7	0	4	4170·7	0
32	3	6	1563·8	1	4	3127·7	0	3	4691·5
33	2	5	7	2084·9	1	4	3648·6	4169·8	1
34	2	3	5	7	2605·9	0	2	4	4690·6
35	521·1	1042·2	1563·3	2084·5	2605·6	3126·7	3647·8	4168·9	4690·0
36	1	1	2	2	3	4	4	5	4689·5
37	·0	0	0	0	0	0	0	0	0
38	520·9	1041·9	1562·8	2083·8	2604·7	3125·7	3646·6	4167·5	4688·5
39	9	8	6	5	4	3	2	1	4687·9
40	8	6	5	3	1	3124·9	3645·8	4166·6	4

Miles.	·00	·01	·02	·03	·04	·05	·06	·07	·08	·09
	″	″	″	″	″	″	″	″	″	″
·0		·5	1·0	1·6	2·1	2·6	3·1	3·7	4·2	4·7
·1	5·2	5·7	6·3	6·8	7·3	7·8	8·3	8·9	9·4	9·9
·2	10·4	11·0	11·5	12·0	12·5	13·0	13·6	14·1	14·6	15·1
·3	15·6	16·2	16·7	17·2	17·7	18·3	18·8	19·3	19·8	20·3
·4	20·9	21·4	21·9	22·4	23·0	23·5	24·0	24·5	25·0	25·6
·5	26·1	26·6	27·1	27·6	28·2	28·7	29·2	29·7	30·3	30·8
·6	31·3	31·8	32·3	32·9	33·4	33·9	34·4	35·0	35·5	36·0
·7	36·5	37·0	37·6	38·1	38·6	39·1	39·6	40·2	40·7	41·2
·8	41·7	42·3	42·8	43·3	43·8	44·3	44·9	45·4	45·9	46·4
·9	46·9	47·5	48·0	48·5	49·0	49·6	50·1	50·6	51·1	51·6

TABLE XI.—Computation of Heights.—For converting Geodetic Distance in Feet into Seconds of Contained Arc.

Latitude.	Geodetic Distance in Feet.								
	1000	2000	3000	4000	5000	6000	7000	8000	9000
°	"	"	"	"	"	"	"	"	"
0	−0·109	−0·218	−0·326	−0·435	−0·544	−0·65	−0·76	−0·87	−0·98
1	109	218	326	435	544	65	76	87	98
2	109	218	326	435	544	65	76	87	98
3	109	218	327	436	545	65	76	87	98
4	109	218	327	436	545	65	76	87	98
5	109	219	328	437	546	66	76	87	98
6	109	219	328	438	547	66	77	88	99
7	110	219	329	439	549	66	77	88	99
8	110	220	330	440	550	66	77	88	99
9	110	221	331	441	552	66	77	88	99
10	111	221	332	443	554	66	78	89	1·00
11	111	222	333	445	556	67	78	89	1·00
12	112	223	335	446	558	67	78	89	1·00
13	112	224	336	448	560	67	78	90	1·01
14	113	225	338	450	563	68	79	90	1·01
15	113	226	339	453	566	68	79	91	1·02
16	114	228	341	455	569	68	80	91	1·02
17	114	229	343	457	572	69	80	91	1·03
18	115	230	345	460	575	69	81	92	1·04
19	116	231	347	463	579	69	81	93	1·04
20	116	233	349	466	582	70	82	93	1·05
21	117	234	352	469	586	70	82	94	1·05
22	118	236	354	472	590	71	83	94	1·06
23	119	238	356	475	594	71	83	95	1·07
24	120	239	359	479	598	72	84	96	1·08
25	121	241	362	482	603	72	84	96	1·08
26	121	243	364	486	607	73	85	97	1·09
27	122	245	367	489	612	73	86	98	1·10
28	123	246	370	493	616	74	86	99	1·11
29	124	248	373	497	621	75	87	99	1·12
30	125	250	376	501	626	75	88	1·00	1·13
31	126	252	379	505	631	76	88	1·01	1·14
32	127	254	382	509	636	76	89	1·02	1·14
33	128	257	385	513	641	77	90	1·03	1·15
34	129	259	388	517	647	78	91	1·03	1·16
35	130	261	391	522	652	78	91	1·04	1·17
36	131	263	394	526	657	79	92	1·05	1·18
37	133	265	398	530	663	80	93	1·06	1·19
38	134	267	401	535	668	80	94	1·07	1·20
39	135	270	404	539	674	81	94	1·08	1·21
40	136	272	408	544	680	82	95	1·09	1·22

TABLE XII.—Computation of Heights.—Log. Secant of Observed Angle at Station B.

Angle.	Log. Secant.	Angle.	Log. Secant.	Angle.	Log. Secant.
° ′ ″		° ′ ″		° ′ ″	
0 16 25	0·00000,5	1 15 35	0·00010,5	1 45 37	0·00020,5
0 28 32	1,5	1 19 6	11,5	1 48 10	21,5
0 36 51	2,5	1 22 28	12,5	1 50 39	22,5
0 43 37	3,5	1 25 42	13,5	1 53 5	23,5
0 49 28	4,5	1 28 49	14,5	1 55 28	24,5
0 54 42	5,5	1 31 50	15,5	1 57 47	25,5
0 59 28	6,5	1 34 45	16,5	2 0 5	26,5
1 3 52	7,5	1 37 35	17,5	2 2 19	27,5
1 8 0	8,5	1 40 20	18,5	2 4 32	28,5
1 11 54	9,5	1 43 0	19,5	2 6 42	29,5

TABLE XIII.—Computation of Heights.—For obtaining the Quantity β'' in the formula for finding the Terrestrial Refraction.

β''	Values of γ in feet																								β''
	0·5	1	1·5	2	2·5	3	3·5	4	4·5	5	5·5	6	6·5	7	7·5	8	8·5	9	9·5	10	10·5	11	11·5	12	
"	Distance between Stations A and B in Miles																								"
29·5																								7·9	29·5
28·5																								8·2	28·5
27·5																						7·8	8·2	8·5	27·5
26·5																						8·1	8·5	8·8	26·5
25·5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	8·4	8·8	9·2	25·5
24·5																				8·0	8·4	8·8	9·2	9·6	24·5
23·5																				8·3	8·7	9·1	9·6	10·0	23·5
22·5																		7·8	8·2	8·7	9·1	9·5	10·0	10·4	22·5
21·5																	7·7	8·2	8·6	9·1	9·5	10·0	10·4	10·9	21·5
20·5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	7·6	8·1	8·6	9·1	9·5	10·0	10·5	11·0	11·4	20·5
19·5																8·0	8·5	9·0	9·5	10·0	10·5	11·0	11·5	12·0	19·5
18·5															7·9	8·4	9·0	9·5	10·0	10·6	11·1	11·6	12·1	12·7	18·5
17·5														7·8	8·4	8·9	9·5	10·0	10·6	11·2	11·7	12·3	12·8	13·4	17·5
16·5													7·7	8·3	8·9	9·5	10·1	10·7	11·2	11·8	12·4	13·0	13·6	14·2	16·5
15·5	...	...	...	...	...	...	...	...	...	...	...	7·6	8·2	8·8	9·5	10·1	10·7	11·3	12·0	12·6	13·2	13·9	14·5	15·1	15·5
14·5												8·1	8·8	9·4	10·1	10·8	11·5	12·1	12·8	13·5	14·1	14·8	15·5	16·2	14·5
13·5											8·0	8·7	9·4	10·1	10·9	11·6	12·3	13·0	13·7	14·5	15·2	15·9	16·6	17·4	13·5
12·5										7·8	8·6	9·4	10·2	10·9	11·7	12·5	13·3	14·1	14·8	15·6	16·4	17·2	18·0	18·8	12·5
11·5									7·6	8·5	9·3	10·2	11·0	11·9	12·7	13·6	14·4	15·3	16·1	17·0	17·8	18·7	19·5	20·4	11·5
10·5	...	...	...	...	...	...	...	7·4	8·4	9·3	10·2	11·2	12·1	13·0	14·0	14·9	15·8	16·7	17·7	18·6	19·5	20·5	21·4	22·3	10·5
9·5							7·2	8·2	9·3	10·3	11·3	12·3	13·4	14·4	15·4	16·4	17·5	18·5	19·5	20·6	21·6	22·6	23·6	24·7	9·5
8·5							8·0	9·2	10·3	11·5	12·6	13·8	14·9	16·1	17·2	18·4	19·5	20·7	21·8	23·0	24·1	25·3	26·4	27·6	8·5
7·5						7·8	9·1	10·4	11·7	13·0	14·3	15·6	16·9	18·2	19·5	20·8	22·1	23·4	24·7	26·0	27·3	28·6	30·0	31·3	7·5
6·5					7·5	9·0	10·5	12·0	13·5	15·0	16·5	18·0	19·5	21·0	22·5	24·0	25·5	27·0	28·5	30·1	31·6	33·1	34·6	36·1	6·5
5·5	...	...	...	7·1	8·9	10·7	12·4	14·2	16·0	17·8	19·5	21·3	23·1	24·9	26·6	28·4	30·2	32·0	33·7	35·5	37·3	39·1	40·8	42·6	5·5
4·5			6·5	8·7	10·9	13·0	15·2	17·4	19·5	21·7	23·9	26·0	28·2	30·4	32·6	34·7	36·9	39·1	41·2	43·4	45·6	47·7	49·9	52·1	4·5
3·5			8·4	11·2	14·0	16·7	19·5	22·3	25·1	27·9	30·7	33·5	36·3	39·1	41·9	44·6	47·4	50·2	53·0	55·8	58·6	61·4	64·2	67·0	3·5
2·5		7·8	11·7	15·6	19·5	23·4	27·3	31·3	35·2	39·1	43·0	46·9	50·8	54·7	58·6	62·5	66·4	70·3	74·2	78·1	82·0	85·9	89·9	93·8	2·5
1·5	6·5	13·0	19·5	26·0	32·6	39·1	45·6	52·1	58·6	65·1	71·6	78·1	84·6	91·2	97·7	104·2	...	...	...	...	...	...	...	...	1·5
0·5	19·5	39·1	58·6	78·1	97·7	117·2	136·7	156·3	175·8	195·3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0·5

This table makes provision for values of γ up to 12 feet and of the distance to 66·4 miles: when these limits are exceeded β'' should be computed by the following formula:— $\beta'' = 19·53 \frac{\gamma}{\text{Dist. in miles}}$.

TABLE XIV.—Computation of Heights.—To facilitate finding the Subtended Angle when only one angle has been observed and the Distance between Stations A and B is given in Feet.

Contained Arc in Feet	Adopted Refraction expressed in Decimals of Contained Arc.														
	0·5	0·4	0·3	0·2	0·1	0·09	0·08	0·07	0·06	0·05	0·04	0·03	0·02	0·01	0·00
	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″
100	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
200	0 0	0 0	0 0	0 1	0 1	0 1	0 1	0 1	0 1	0 1	0 1	0 1	0 1	0 1	0 1
300	0 0	0 0	0 1	0 1	0 1	0 1	0 1	0 1	0 1	0 1	0 1	0 1	0 1	0 1	0 1
400	0 0	0 0	0 1	0 1	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2
500	0 0	0 0	0 1	0 1	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2
600	0 0	0 1	0 1	0 2	0 2	0 2	0 2	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3
700	0 0	0 1	0 1	0 2	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3
800	0 0	0 1	0 2	0 2	0 3	0 3	0 3	0 3	0 3	0 4	0 4	0 4	0 4	0 4	0 4
900	0 0	0 1	0 2	0 3	0 4	0 4	0 4	0 4	0 4	0 4	0 4	0 4	0 4	0 4	0 4
1 000	0 0	0 1	0 2	0 3	0 4	0 4	0 4	0 4	0 4	0 4	0 5	0 5	0 5	0 5	0 5
2 000	0 0	0 2	0 4	0 6	0 8	0 8	0 8	0 9	0 9	0 9	0 9	0 9	0 9	0 10	0 10
3 000	0 0	0 3	0 6	0 9	0 11	0 12	0 12	0 13	0 13	0 13	0 14	0 14	0 14	0 15	0 15
4 000	0 0	0 4	0 8	0 12	0 16	0 16	0 17	0 17	0 17	0 18	0 18	0 19	0 19	0 19	0 20
5 000	0 0	0 5	0 10	0 15	0 20	0 20	0 21	0 21	0 22	0 22	0 23	0 23	0 24	0 24	0 25
6 000	0 0	0 6	0 12	0 18	0 24	0 24	0 25	0 26	0 26	0 27	0 27	0 28	0 28	0 29	0 30
7 000	0 0	0 7	0 14	0 21	0 28	0 28	0 29	0 30	0 30	0 31	0 32	0 33	0 33	0 34	0 35
8 000	0 0	0 8	0 16	0 24	0 32	0 32	0 33	0 34	0 35	0 36	0 36	0 37	0 38	0 39	0 40
9 000	0 0	0 9	0 18	0 27	0 36	0 36	0 37	0 38	0 39	0 40	0 41	0 42	0 43	0 44	0 44
10 000	0 0	0 10	0 20	0 30	0 40	0 41	0 42	0 43	0 43	0 44	0 45	0 46	0 47	0 48	0 49
20 000	0 0	0 20	0 40	0 59	1 19	1 21	1 23	1 25	1 27	1 29	1 31	1 33	1 35	1 37	1 39
30 000	0 0	0 30	0 59	1 29	1 59	2 2	2 5	2 8	2 10	2 13	2 16	2 19	2 22	2 25	2 28
40 000	0 0	0 40	1 19	1 59	2 38	2 42	2 46	2 50	2 54	2 58	3 2	3 6	3 10	3 14	3 18
50 000	0 0	0 49	1 39	2 28	3 18	3 23	3 28	3 33	3 37	3 42	3 47	3 52	3 57	4 2	4 7
60 000	0 0	0 59	1 59	2 58	3 57	4 3	4 9	4 15	4 21	4 27	4 33	4 39	4 45	4 51	4 57
70 000	0 0	1 9	2 18	3 28	4 37	4 44	4 51	4 58	5 4	5 11	5 18	5 25	5 32	5 39	5 46
80 000	0 0	1 19	2 38	3 57	5 16	5 24	5 32	5 40	5 48	5 56	6 4	6 12	6 20	6 27	6 35
90 000	0 0	1 29	2 58	4 27	5 56	6 5	6 14	6 23	6 31	6 40	6 49	6 58	7 7	7 16	7 25
100 000	0 0	1 39	3 18	4 56	6 35	6 45	6 55	7 5	7 15	7 25	7 35	7 45	7 54	8 4	8 14
200 000	0 0	3 18	6 35	9 53	13 11	13 30	13 50	14 10	14 30	14 50	15 9	15 29	15 49	16 9	16 28
300 000	0 0	4 57	9 53	14 50	19 46	20 16	20 45	21 15	21 45	22 14	22 44	23 14	23 43	24 13	24 43
400 000	0 0	6 35	13 11	19 46	26 21	27 1	27 41	28 20	29 0	29 39	30 19	30 58	31 38	32 17	32 57

TABLE XV.—Computation of Heights.—To facilitate finding the Subtended Angle when only one angle has been observed and the Distance between Stations A and B is given in Log. Feet.

Latitude.	Adopted Refraction expressed in Decimals of Contained Arc.								
	0·20	0·10	0·09	0·08	0·07	0·06	0·05	0·04	0·03
°									
0	2·5276	2·4027	2·3920	2·3815	2·3713	2·3613	2·3515	2·3420	2·3327
5	5277	4027	3920	3815	3713	3613	3516	3420	3327
10	5277	4028	3921	3816	3714	3614	3516	3421	3327
15	5278	4029	3922	3817	3715	3615	3517	3422	3328
20	5280	4030	3923	3818	3716	3616	3519	3423	3330
25	5281	4032	3925	3820	3718	3618	3521	3425	3332
30	5284	4034	3927	3822	3720	3620	3523	3427	3334
35	5286	4036	3929	3825	3722	3623	3525	3429	3336
40	5288	4039	3932	3827	3725	3625	3527	3432	3338

TABLE XVI.—Computation of Heights.—Correction for Curvature and Refraction in determining Heights with the Clinometer.

Adopted Refraction expressed in Decimals of Contained Arc.					
0·10		0·07		0·05	
Distance in feet.	Correction in feet.	Distance in feet.	Correction in feet.	Distance in feet.	Correction in feet.
5 100	0·5	4 900	0·5	4 808	0·5
8 834	1·5	8 487	1·5	8 328	1·5
11 404	2·5	10 957	2·5	10 752	2·5
13 493	3·5	12 964	3·5	12 722	3·5
15 300	4·5	14 700	4·5	14 425	4·5
16 915	5·5	16 251	5·5	15 948	5·5
18 388	6·5	17 667	6·5	17 337	6·5
19 752	7·5	18 977	7·5	18 623	7·5
21 028	8·5	20 203	8·5	19 825	8·5
22 231	9·5	21 358	9·5	20 959	9·5
23 371	10·5	22 454	10·5	22 035	10·5
24 459	11·5	23 490	11·5	23 060	11·5
25 500	12·5	24 500	12·5	24 042	12·5
26 501	13·5	25 461	13·5	24 985	13·5
27 465	14·5	26 387	14·5	25 894	14·5
28 396	15·5	27 282	15·5	26 772	15·5
29 297	16·5	28 148	16·5	27 622	16·5
30 172	17·5	28 989	17·5	28 447	17·5
31 022	18·5	29 805	18·5	29 248	18·5
31 850	19·5	30 600	19·5	30 028	19·5
32 656	20·5	31 375	20·5	30 789	20·5
33 443	21·5	32 131	21·5	31 531	21·5
34 212	22·5	32 870	22·5	32 255	22·5
34 964	23·5	33 592	23·5	32 964	23·5
35 700	24·5	34 300	24·5	33 659	24·5
36 422	25·5	34 993	25·5	34 339	25·5
37 129	26·5	35 672	26·5	35 005	26·5
37 823	27·5	36 339	27·5	35 660	27·5
38 504	28·5	36 994	28·5	36 302	28·5
39 174	29·5	37 637	29·5	36 934	29·5
39 833	30·5	38 270	30·5	37 554	30·5
40 480	31·5	38 892	31·5	38 165	31·5
41 118	32·5	39 505	32·5	38 766	32·5
41 746	33·5	40 108	33·5	39 358	33·5
42 364	34·5	40 702	34·5	39 941	34·5
42 974	35·5	41 288	35·5	40 516	35·5
43 575	36·5	41 865	36·5	41 083	36·5
44 168	37·5	42 435	37·5	41 642	37·5
44 753	38·5	42 997	38·5	42 193	38·5
45 330	39·5	43 552	39·5	42 738	39·5
45 900	40·5	44 100	40·5	43 275	40·5
46 464	41·5	44 641	41·5	43 806	41·5
47 020	42·5	45 175	42·5	44 331	42·5
47 570	43·5	45 704	43·5	44 849	43·5
48 114	44·5	46 226	44·5	45 362	44·5
48 651	45·5	46 743	45·5	45 869	45·5
49 183	46·5	47 253	46·5	46 370	46·5
49 709	47·5	47 759	47·5	46 866	47·5
50 230	48·5	48 259	48·5	47 357	48·5
50 745	49·5	48 754	49·5	47 843	49·5
51 256	50·5	49 244	50·5	48 323	50·5

TABLE XVII.—Computation of Heights.—Natural Tangents to 5 places of Decimals.

′	0°	1°	2°	3°	4°	5°	6°	7°	′
0	0·00000	0·01746	0·03492	0·05241	0·06993	0·08749	0·10510	0·12278	0
1	029	775	521	270	·07022	778	540	308	1
2	058	804	550	299	051	807	569	338	2
3	087	833	579	328	080	837	599	367	3
4	116	862	609	357	110	866	628	397	4
5	145	891	638	387	139	895	658	426	5
6	175	920	667	416	168	925	687	456	6
7	204	949	696	445	197	954	716	485	7
8	233	978	725	474	227	983	746	515	8
9	262	·02007	754	503	256	·09013	775	544	9
10	291	037	783	533	285	042	805	574	10
11	0·00320	0·02066	0·03812	0·05562	0·07314	0·09071	0·10834	0·12603	11
12	349	095	842	591	344	101	863	633	12
13	378	124	871	620	373	130	893	662	13
14	407	153	900	649	402	159	922	692	14
15	436	182	929	678	431	189	952	722	15
16	465	211	958	708	461	218	981	751	16
17	495	240	987	737	490	247	·11011	781	17
18	524	269	·04016	766	519	277	040	810	18
19	553	298	046	795	548	306	070	840	19
20	582	328	075	824	578	335	099	869	20
21	0·00611	0·02357	0·04104	0·05854	0·07607	0·09365	0·11128	0·12899	21
22	640	386	133	883	636	394	158	929	22
23	669	415	162	912	665	423	187	958	23
24	698	444	191	941	695	453	217	988	24
25	727	473	220	970	724	482	246	·13017	25
26	756	502	250	999	753	511	276	047	26
27	785	531	279	·06029	782	541	305	076	27
28	815	560	308	058	812	570	335	106	28
29	844	589	337	087	841	600	364	136	29
30	873	619	366	116	870	629	394	165	30
31	0·00902	0·02648	0·04395	0·06145	0·07899	0·09658	0·11423	0·13195	31
32	931	677	424	175	929	688	453	224	32
33	960	706	454	204	958	717	482	254	33
34	989	735	483	233	987	746	511	284	34
35	·01018	764	512	262	·08017	776	541	313	35
36	047	793	541	291	046	805	570	343	36
37	076	822	570	321	075	834	600	372	37
38	105	851	599	350	104	864	629	402	38
39	135	881	628	379	134	893	659	432	39
40	164	910	658	408	163	923	688	461	40
41	0·01193	0·02939	0·04687	0·06438	0·08192	0·09952	0·11718	0·13491	41
42	222	968	716	467	222	981	747	521	42
43	251	997	745	496	251	·10011	777	550	43
44	280	·03026	774	525	280	040	806	580	44
45	309	055	803	554	309	069	836	609	45
46	338	084	833	584	339	099	865	639	46
47	367	114	862	613	368	128	895	669	47
48	396	143	891	642	397	158	924	698	48
49	425	172	920	671	427	187	954	728	49
50	455	201	949	700	456	216	983	758	50
51	0·01484	0·03230	0·04978	0·06730	0·08485	0·10246	0·12013	0·13787	51
52	513	259	·05007	759	514	275	042	817	52
53	542	288	037	788	544	305	072	847	53
54	571	317	066	817	573	334	101	876	54
55	600	346	095	847	602	363	131	906	55
56	629	376	124	876	632	393	160	935	56
57	658	405	153	905	661	422	190	965	57
58	687	434	182	934	690	452	219	995	58
59	716	463	212	963	720	481	249	·14024	59
60	746	492	241	993	749	510	278	054	60

TABLE XVII.—Computation of Heights.—Natural Tangents to 5 places of Decimals.

′	8°	9°	10°	11°	12°	13°	14°	15°	′
0	0·14054	0·15838	0·17633	0·19438	0·21256	0·23087	0·24933	0·26795	0
1	084	868	663	468	286	117	964	826	1
2	113	898	693	498	316	148	995	857	2
3	143	928	723	529	347	179	·25026	888	3
4	173	958	753	559	377	209	056	920	4
5	202	988	783	589	408	240	087	951	5
6	232	·16017	813	619	438	271	118	982	6
7	262	047	843	649	469	301	149	·27013	7
8	291	077	873	680	499	332	180	044	8
9	321	107	903	710	529	363	211	076	9
10	351	137	933	740	560	393	242	107	10
11	0·14381	0·16167	0·17963	0·19770	0·21590	0·23424	0·25273	0·27138	11
12	410	196	993	801	621	455	304	169	12
13	440	226	·18023	831	651	485	335	201	13
14	470	256	053	861	682	516	366	232	14
15	499	286	083	891	712	547	397	263	15
16	529	316	113	921	743	578	428	294	16
17	559	346	143	952	773	608	459	326	17
18	588	376	173	982	804	639	490	357	18
19	618	406	203	·20012	834	670	521	388	19
20	648	435	233	042	864	700	552	419	20
21	0·14678	0·16465	0·18263	0·20073	0·21895	0·23731	0·25583	0·27451	21
22	707	495	293	103	925	762	614	482	22
23	737	525	323	133	956	793	645	513	23
24	767	555	353	164	986	823	676	545	24
25	796	585	384	194	·22017	854	707	576	25
26	826	615	414	224	047	885	738	607	26
27	856	645	444	254	078	916	769	639	27
28	886	674	474	285	108	946	800	670	28
29	915	704	504	315	139	977	831	701	29
30	945	734	534	345	169	·24008	862	732	30
31	0·14975	0·16764	0·18564	0·20376	0·22200	0·24039	0·25893	0·27764	31
32	·15005	794	594	406	231	069	924	795	32
33	034	824	624	436	261	100	955	826	33
34	064	854	654	466	292	131	986	858	34
35	094	884	684	497	322	162	·26017	889	35
36	124	914	714	527	353	193	048	921	36
37	153	944	745	557	383	223	079	952	37
38	183	974	775	588	414	254	110	983	38
39	213	·17004	805	618	444	285	141	·28015	39
40	243	033	835	648	475	316	172	046	40
41	0·15272	0·17063	0·18865	0·20679	0·22505	0·24347	0·26203	0·28077	41
42	302	093	895	709	536	377	235	109	42
43	332	123	925	739	567	408	266	140	43
44	362	153	955	770	597	439	297	172	44
45	391	183	986	800	628	470	328	203	45
46	421	213	·19016	830	658	501	359	234	46
47	451	243	046	861	689	532	390	266	47
48	481	273	076	891	719	562	421	297	48
49	511	303	106	921	750	593	452	329	49
50	540	333	136	952	781	624	483	360	50
51	0·15570	0·17363	0·19166	0·20982	0·22811	0·24655	0·26515	0·28391	51
52	600	393	197	·21013	842	686	546	423	52
53	630	423	227	043	872	717	577	454	53
54	660	453	257	073	903	748	608	486	54
55	689	483	287	104	934	778	639	517	55
56	719	513	317	134	964	809	670	549	56
57	749	543	347	164	995	840	701	580	57
58	779	573	378	195	·23026	871	733	612	58
59	809	603	408	225	056	902	764	643	59
60	838	633	438	256	087	933	795	675	60

TABLE XVIII.—Computation of Heights.—For determining Differences of Height with the Barometer.—Loomis.

Part I.

Argument:—The observed Height of the Barometer at either Station.

Baro. in Inches	Feet	Diff.	Baro. in Inches	Feet	Diff.	Baro. in Inches	Feet	Diff.	Baro. in Inches	Feet	Diff.
11·0	1396·9	236·4	16·0	11186·3	162·8	21·0	18291·0	124·1	26·0	23871·0	100·3
11·1	1633·3	234·3	16·1	11349·1	161·8	21·1	18415·1	123·6	26·1	23971·3	99·9
11·2	1867·6	232·3	16·2	11510·9	160·8	21·2	18538·7	122·9	26·2	24071·2	99·5
11·3	2099·9	230·2	16·3	11671·7	159·8	21·3	18661·6	122·4	26·3	24170·7	99·1
11·4	2330·1	228·2	16·4	11831·5	158·8	21·4	18784·0	121·8	26·4	24269·8	98·8
11·5	2558·3	226·2	16·5	11990·3	157·9	21·5	18905·8	121·2	26·5	24368·6	98·4
11·6	2784·5	224·2	16·6	12148·2	156·9	21·6	19027·0	120·7	26·6	24467·0	98·1
11·7	3008·7	222·4	16·7	12305·1	155·9	21·7	19147·7	120·1	26·7	24565·1	97·6
11·8	3231·1	220·5	16·8	12461·0	155·1	21·8	19267·8	119·6	26·8	24662·7	97·3
11·9	3451·6	218·6	16·9	12616·1	154·1	21·9	19387·4	119·0	26·9	24760·0	97·0
12·0	3670·2	216·8	17·0	12770·2	153·3	22·0	19506·4	118·5	27·0	24857·0	96·6
12·1	3887·0	215·0	17·1	12923·5	152·3	22·1	19624·9	118·0	27·1	24953·6	96·2
12·2	4102·0	213·3	17·2	13075·8	151·5	22·2	19742·9	117·4	27·2	25049·8	95·9
12·3	4315·3	211·6	17·3	13227·3	150·6	22·3	19860·3	116·9	27·3	25145·7	95·5
12·4	4526·9	209·8	17·4	13377·9	149·7	22·4	19977·2	116·4	27·4	25241·2	95·2
12·5	4736·7	208·2	17·5	13527·6	148·9	22·5	20093·6	115·8	27·5	25336·4	94·8
12·6	4944·9	206·5	17·6	13676·5	148·0	22·6	20209·4	115·4	27·6	25431·2	94·5
12·7	5151·4	205·0	17·7	13824·5	147·2	22·7	20324·8	114·8	27·7	25525·7	94·2
12·8	5356·4	203·3	17·8	13971·7	146·3	22·8	20439·6	114·4	27·8	25619·9	93·8
12·9	5559·7	201·7	17·9	14118·0	145·6	22·9	20554·0	113·8	27·9	25713·7	93·4
13·0	5761·4	200·2	18·0	14263·6	144·7	23·0	20667·8	113·3	28·0	25807·1	93·2
13·1	5961·6	198·7	18·1	14408·3	144·0	23·1	20781·1	112·9	28·1	25900·3	92·8
13·2	6160·3	197·2	18·2	14552·3	143·1	23·2	20894·0	112·4	28·2	25993·1	92·5
13·3	6357·5	195·7	18·3	14695·4	142·4	23·3	21006·4	111·9	28·3	26085·6	92·1
13·4	6553·2	194·3	18·4	14837·8	141·6	23·4	21118·3	111·4	28·4	26177·7	91·9
13·5	6747·5	192·8	18·5	14979·4	140·9	23·5	21229·7	110·9	28·5	26269·6	91·5
13·6	6940·3	191·4	18·6	15120·3	140·0	23·6	21340·6	110·5	28·6	26361·1	91·2
13·7	7131·7	190·0	18·7	15260·3	139·4	23·7	21451·1	110·0	28·7	26452·3	90·9
13·8	7321·7	188·6	18·8	15399·7	138·6	23·8	21561·1	109·5	28·8	26543·2	90·5
13·9	7510·3	187·3	18·9	15538·3	137·9	23·9	21670·6	109·1	28·9	26633·7	90·3
14·0	7697·6	186·0	19·0	15676·2	137·1	24·0	21779·7	108·7	29·0	26724·0	89·9
14·1	7883·6	184·6	19·1	15813·3	136·5	24·1	21888·4	108·2	29·1	26813·9	89·6
14·2	8068·2	183·3	19·2	15949·8	135·7	24·2	21996·6	107·7	29·2	26903·5	89·3
14·3	8251·5	182·1	19·3	16085·5	135·0	24·3	22104·3	107·3	29·3	26992·8	89·1
14·4	8433·6	180·8	19·4	16220·5	134·3	24·4	22211·6	106·8	29·4	27081·9	88·7
14·5	8614·4	179·6	19·5	16354·8	133·7	24·5	22318·4	106·4	29·5	27170·6	88·4
14·6	8794·0	178·3	19·6	16488·5	132·9	24·6	22424·8	106·0	29·6	27259·0	88·1
14·7	8972·3	177·2	19·7	16621·4	132·3	24·7	22530·8	105·6	29·7	27347·1	87·8
14·8	9149·5	176·0	19·8	16753·7	131·6	24·8	22636·4	105·1	29·8	27434·9	87·6
14·9	9325·5	174·8	19·9	16885·3	131·0	24·9	22741·5	104·8	29·9	27522·5	87·2
15·0	9500·3	173·5	20·0	17016·3	130·3	25·0	22846·3	104·3	30·0	27609·7	86·9
15·1	9673·8	172·4	20·1	17146·6	129·7	25·1	22950·6	103·8	30·1	27696·6	86·7
15·2	9846·2	171·3	20·2	17276·3	129·0	25·2	23054·4	103·5	30·2	27783·3	86·4
15·3	10017·5	170·2	20·3	17405·3	128·4	25·3	23157·9	103·1	30·3	27869·7	86·0
15·4	10187·7	169·1	20·4	17533·7	127·7	25·4	23261·0	102·6	30·4	27955·7	85·8
15·5	10356·8	168·0	20·5	17661·4	127·2	25·5	23363·6	102·3	30·5	28041·5	85·6
15·6	10524·8	167·0	20·6	17788·6	126·5	25·6	23465·9	101·8	30·6	28127·1	85·2
15·7	10691·8	165·9	20·7	17915·1	125·9	25·7	23567·7	101·5	30·7	28212·3	85·0
15·8	10857·7	164·8	20·8	18041·0	125·3	25·8	23669·2	101·1	30·8	28297·3	84·7
15·9	11022·5	163·8	20·9	18166·3	124·7	25·9	23770·3	100·7	30·9	28382·0	84·4
16·0	11186·3		21·0	18291·0		26·0	23871·0		31·0	28466·4	

TABLE XVIII.—Computation of Heights.—(*Continued*).

PART II.

Correction due to T−T′, or the Difference of the Temperatures, in degrees Fahrenheit, of the Barometers at the two Stations.

Negative when the Temperature at the Upper Station is the lower, and vice versâ.

T−T′	Correction	T−T′	Correction	T−T′	Correction	T−T′	Correction	T−T′	Correction	T−T′	Correction
°	Feet	°	Feet	°	Feet	°	Feet	°	Feet	°	Feet
1	2·3	14	32·8	27	63·2	40	93·6	53	124·1	66	154·5
2	4·7	15	35·1	28	65·5	41	96·0	54	126·4	67	156·8
3	7·0	16	37·5	29	67·9	42	98·3	55	128·7	68	159·2
4	9·4	17	39·8	30	70·2	43	100·7	56	131·1	69	161·5
5	11·7	18	42·1	31	72·6	44	103·0	57	133·4	70	163·9
6	14·0	19	44·5	32	74·9	45	105·3	58	135·8	71	166·2
7	16·4	20	46·8	33	77·3	46	107·7	59	138·1	72	168·6
8	18·7	21	49·2	34	79·6	47	110·0	60	140·4	73	170·9
9	21·1	22	51·5	35	81·9	48	112·4	61	142·8	74	173·3
10	23·4	23	53·8	36	84·3	49	114·7	62	145·1	75	175·6
11	25·8	24	56·2	37	86·6	50	117·0	63	147·5	76	177·9
12	28·1	25	58·5	38	89·0	51	119·4	64	149·8	77	180·3
13	30·4	26	60·9	39	91·3	52	121·7	65	152·2	78	182·6

PART III.

Correction due to the Change of Gravity from the Latitude of 45° to the Latitude of the Place of Observation.

Positive from Latitude 0° to 45°; Negative from Latitude 45° to 90°.

PART IV.

Correction for Decrease of Gravity on a Vertical.

Always Positive.

PART V.

Correction due to the Height of the Lower Station.

Always Positive.

Approximate Altitude.	Part III. Latitude. 0° 90°	10° 80°	20° 70°	30° 60°	40° 50°	45°	Part IV.	Part V. Height of Barometer at Lower Station. 16 in.	18 in.	20 in.	22 in.	24 in.	26 in.	28 in.	Approximate Altitude.
Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet
1 000	2·6	2·5	2·0	1·3	0·5	0	2·5	1·6	1·3	1·0	0·8	0·6	0·4	0·2	1 000
2 000	5·3	5·0	4·1	2·6	0·9	0	5·2	3·1	2·5	2·0	1·5	1·1	0·7	0·3	2 000
3 000	7·9	7·5	6·1	4·0	1·4	0	7·9	4·7	3·8	3·0	2·3	1·7	1·1	0·5	3 000
4 000	10·6	10·0	8·1	5·3	1·8	0	10·8	6·3	5·1	4·0	3·1	2·2	1·4	0·7	4 000
5 000	13·2	12·4	10·1	6·6	2·3	0	13·7	7·8	6·4	5·0	3·8	2·8	1·8	0·8	5 000
6 000	15·9	14·9	12·2	7·9	2·8	0	16·7	9·4	7·6	6·0	4·6	3·3	2·1	1·0	6 000
7 000	18·5	17·4	14·2	9·3	3·2	0	19·9	11·0	8·9	7·1	5·4	3·9	2·5	1·2	7 000
8 000	21·2	19·9	16·2	10·6	3·7	0	23·1	12·5	10·2	8·1	6·2	4·4	2·8	1·3	8 000
9 000	23·8	22·4	18·3	11·9	4·1	0	26·4	14·1	11·4	9·1	6·9	5·0	3·2	1·5	9 000
10 000	26·5	24·9	20·3	13·2	4·6	0	29·8	15·7	12·7	10·1	7·7	5·5	3·5	1·7	10 000
11 000	29·1	27·4	22·3	14·6	5·1	0	33·3	17·2	14·0	11·1	8·5	6·1	3·9	1·8	11 000
12 000	31·8	29·9	24·4	15·9	5·5	0	36·9	18·8	15·3	12·1	9·2	6·6	4·2	2·0	12 000
13 000	34·4	32·4	26·4	17·2	6·0	0	40·6	20·4	16·5	13·1	10·0	7·2	4·6	2·2	13 000
14 000	37·1	34·9	28·4	18·5	6·4	0	44·4	21·9	17·8	14·1	10·8	7·7	4·9	2·3	14 000
15 000	39·7	37·3	30·4	19·9	6·9	0	48·3	23·5	19·1	15·1	11·5	8·3	5·3	2·5	15 000
16 000	42·4	39·8	32·5	21·2	7·4	0	52·3	25·1	20·3	16·1	12·3	8·8	5·6	2·7	16 000
17 000	45·0	42·3	34·5	22·5	7·8	0	56·4	26·6	21·6	17·1	13·1	9·4	6·0	2·8	17 000
18 000	47·7	44·8	36·5	23·8	8·3	0	60·5	28·2	22·9	18·1	13·8	9·9	6·3	3·0	18 000
19 000	50·3	47·3	38·6	25·2	8·7	0	64·8	29·8	24·1	19·2	14·6	10·5	6·7	3·2	19 000
20 000	53·0	49·8	40·6	26 5	9·2	0	69·2	31·3	25·4	20·2	15·4	11·0	7·0	3·3	20 000
21 000	55·6	52·3	42·6	27·8	9·7	0	73·6	32·9	26·7	21·2	16·1	11·6	7·4	3·5	21 000
22 000	58·3	54·8	44·7	29·1	10·1	0	78·2	34·5	28·0	22·2	16·9	12·1	7·7	3·7	22 000
23 000	60·9	57·3	46·7	30·5	10·6	0	82·9	36·0	29·2	23·2	17·7	12·7	8·1	3·8	23 000
24 000	63·6	59·8	48·7	31·8	11·0	0	87·6	37·6	30·5	24·2	18·5	13·2	8·4	4·0	24 000
25 000	66·2	62·2	50·7	33·1	11·5	0	92·5	39·1	31·8	25·2	19·2	13·8	8·8	4·1	25 000

TABLE XIX.—Computation of Heights.—For determining Differences of Height with the Barometer.—Baily.

Part I.—Thermometers in the Open Air in degrees Fahrenheit.

t+t′	A	t+t′	A	t+t′	A	t+t′	A	t+t′	A
°		°		°		°		°	
1	4·74913	37	4·76742	73	4·78497	109	4·80183	145	4·81807
2	74965	38	76791	74	78544	110	80229	146	81851
3	75016	39	76841	75	78592	111	80275	147	81896
4	75068	40	76891	76	78640	112	80321	148	81940
5	75120	41	76940	77	78687	113	80367	149	81984
6	4·75171	42	4·76990	78	4·78735	114	4·80413	150	4·82028
7	75223	43	77039	79	78782	115	80458	151	82072
8	75274	44	77089	80	78830	116	80504	152	82116
9	75326	45	77138	81	78877	117	80550	153	82160
10	75377	46	77187	82	78925	118	80595	154	82204
11	4·75429	47	4·77236	83	4·78972	119	4·80641	155	4·82248
12	75480	48	77285	84	79019	120	80686	156	82291
13	75531	49	77335	85	79066	121	80731	157	82335
14	75582	50	77384	86	79113	122	80777	158	82379
15	75633	51	77433	87	79160	123	80822	159	82423
16	4·75684	52	4·77482	88	4·79207	124	4·80867	160	4·82466
17	75735	53	77530	89	79254	125	80913	161	82510
18	75786	54	77579	90	79301	126	80958	162	82553
19	75837	55	77628	91	79348	127	81003	163	82597
20	75888	56	77677	92	79395	128	81048	164	82640
21	4·75938	57	4·77725	93	4·79442	129	4·81093	165	4·82684
22	75989	58	77774	94	79489	130	81138	166	82727
23	76040	59	77823	95	79535	131	81183	167	82770
24	76090	60	77871	96	79582	132	81228	168	82814
25	76141	61	77919	97	79628	133	81273	169	82857
26	4·76191	62	4·77968	98	4·79675	134	4·81317	170	4·82900
27	76241	63	78016	99	79721	135	81362	171	82943
28	76292	64	78065	100	79768	136	81407	172	82986
29	76342	65	78113	101	79814	137	81452	173	83029
30	76392	66	78161	102	79861	138	81496	174	83072
31	4·76442	67	4·78209	103	4·79907	139	4·81541	175	4·83115
32	76492	68	78257	104	79953	140	81585	176	83158
33	76542	69	78305	105	79999	141	81630	177	83201
34	76592	70	78353	106	80045	142	81674	178	83244
35	76642	71	78401	107	80091	143	81719	179	83287
36	76692	72	78449	108	80137	144	81763	180	83330

Part II.—Attached Thermometers.

T−T′	B	T−T′	B	T−T′	B
°		°		°	
0	0·00000	20	0·00087	40	0·00174
1	00004	21	00091	41	00178
2	00009	22	00096	42	00182
3	00013	23	00100	43	00187
4	00017	24	00104	44	00191
5	0·00022	25	0·00109	45	0·00195
6	00026	26	00113	46	00200
7	00030	27	00117	47	00204
8	00035	28	00122	48	00208
9	00039	29	00126	49	00212
10	0·00043	30	0·00130	50	0·00217
11	00048	31	00135	51	00221
12	00052	32	00139	52	00225
13	00056	33	00143	53	00230
14	00061	34	00148	54	00234
15	0·00065	35	0·00152	55	0·00238
16	00069	36	00156	56	00243
17	00074	37	00161	57	00247
18	00078	38	00165	58	00251
19	00083	39	00169	59	00256

Part III.—Lat. of the Place.

Latitude	C
°	
0	0·00117
5	00115
10	00110
15	00101
20	00090
25	0·00075
30	00058
35	00040
40	00020
45	00000
50	$\bar{1}$·99980
55	99960
60	99942
65	99925
70	99910
75	$\bar{1}$·99900
80	99890
85	99885
90	99883

TABLE XX.—Computation of Heights.—Local Corrections for Comparison with the Barometer at Simla.—BOILEAU.

Corrections to Readings of the Barometer at 32° Fahrenheit, taken at the Hours indicated in the first column.

Mean Time.	January.	February.	March.	April.	May.	June.	Mean Reading at Simla.
h. m.	Inches	Inches	Inches	Inches	Inches	Inches	Inches
Midn. 0 29	−0·046	−0·022	−0·021	−0·028	+0·042	+0·121	23·177
1 29	043	016	012	017	052	129	170
2 29	038	005	000	006	059	137	161
3 29	028	+ 004	+ 010	000	063	139	154
4 29	022	007	014	+ 001	058	137	152
5 29	025	006	007	− 005	051	130	158
6 29	−0·029	−0·004	0·000	−0·017	+0·038	+0·120	23·167
7 29	043	016	− 015	031	025	109	180
8 29	063	033	031	047	014	099	195
9 29	079	048	044	058	006	092	207
10 29	083	056	050	063	002	089	212
11 29	077	053	050	060	003	090	209
Noon 0 29	−0·058	−0·040	−0·040	−0·053	+0·009	+0·096	23·198
1 29	045	025	026	042	019	104	188
2 29	037	013	014	027	032	115	176
3 29	033	006	006	016	045	125	167
4 29	032	004	003	013	053	136	162
5 29	034	006	006	011	056	137	162
6 29	−0·041	−0·011	−0·011	−0·017	+0·052	+0·133	23·168
7 29	047	020	021	028	044	128	166
8 29	052	027	030	038	036	120	184
9 29	059	031	035	042	031	113	189
10 29	057	031	035	041	032	111	189
11 29	054	028	030	037	038	113	185

Mean Time.	July.	August.	September.	October.	November.	December.	Mean Reading at Simla.
h. m.	Inches	Inches	Inches	Inches	Inches	Inches	Inches
Midn. 0 29	+0·117	+0·087	+0·003	−0·081	−0·101	−0·057	23·190
1 29	125	097	009	074	094	052	·183
2 29	133	104	016	066	085	047	·176
3 29	139	109	020	060	080	040	·170
4 29	139	108	018	061	077	033	·169
5 29	133	103	011	067	083	037	·175
6 29	+0·125	+0·096	+0·001	−0·076	−0·093	−0·048	23·184
7 29	114	085	− 012	091	109	062	·198
8 29	106	076	025	107	125	082	·211
9 29	101	068	034	117	136	098	·221
10 29	097	064	037	119	138	102	·224
11 29	100	067	033	112	127	091	·218
Noon 0 29	+0·106	+0·074	−0·025	−0·099	−0·112	−0·077	23·207
1 29	115	085	012	085	099	063	·195
2 29	127	097	+ 003	076	092	053	·184
3 29	138	108	011	071	087	049	·177
4 29	147	114	014	072	085	047	·173
5 29	151	115	014	074	088	048	·173
6 29	+0·144	+0·109	+0·010	−0·082	−0·096	−0·058	23·181
7 29	134	098	001	089	103	064	·189
8 29	125	087	− 008	096	108	072	·197
9 29	115	079	011	098	111	075	·202
10 29	110	076	010	096	110	074	·202
11 29	110	078	007	090	104	068	·199

TABLE XXI.—Computation of Heights.—For determining Heights with the Boiling Point Thermometer.—Boileau.

Part I.—Approximate Height in Feet corresponding to the Observed Boiling Point in Degrees Fahrenheit.

Boiling Point	Barometer	Approx. Height	Boiling Point	Barometer	Approx. Height	Boiling Point	Barometer	Approx. Height	Boiling Point	Barometer	Approx. Height
°	Inches	Feet	°	Inches	Feet	°	Inches	Feet	°	Inches	Feet
212·0	29·921		206·0	26·521	3151	200·0	23·461	6354	194·0	20·690	9638
9	862	52	9	468	3204	9	413	6408	9	647	9693
8	802	104	8	415	3257	8	365	6462	8	603	9749
7	743	156	7	361	3310	7	317	6516	7	560	9804
6	684	208	6	308	3363	6	269	6570	6	516	9859
5	625	260	5	255	3415	5	221	6624	5	473	9914
4	565	312	4	202	3468	4	172	6678	4	429	9970
3	506	365	3	149	3521	3	124	6732	3	386	10025
2	447	417	2	095	3574	2	076	6786	2	342	10081
1	387	470	1	042	3627	1	028	6840	1	299	10137
211·0	29·329	522	205·0	25·989	3680	199·0	22·980	6895	193·0	20·255	10193
9	270	575	9	937	3733	9	933	6949	9	212	10249
8	212	627	8	884	3786	8	885	7003	8	170	10304
7	153	679	7	832	3839	7	838	7058	7	127	10360
6	095	732	6	780	3892	6	791	7112	6	084	10415
5	037	784	5	728	3945	5	744	7166	5	042	10470
4	28·979	836	4	675	3998	4	696	7220	4	19·999	10526
3	921	888	3	623	4051	3	649	7275	3	956	10582
2	862	941	2	571	4104	2	602	7329	2	913	10638
1	804	994	1	518	4157	1	554	7384	1	871	10694
210·0	28·746	1046	204·0	25·466	4210	198·0	22·507	7439	192·0	19·828	10750
9	689	1099	9	415	4263	9	461	7493	9	786	10806
8	632	1151	8	363	4316	8	414	7548	8	744	10861
7	574	1204	7	312	4369	7	368	7602	7	702	10917
6	517	1256	6	260	4423	6	321	7656	6	660	10972
5	460	1308	5	209	4476	5	275	7710	5	619	11028
4	403	1361	4	158	4529	4	228	7765	4	577	11084
3	346	1413	3	106	4582	3	182	7820	3	535	11139
2	288	1466	2	055	4635	2	135	7874	2	493	11195
1	231	1518	1	003	4688	1	089	7929	1	451	11251
209·0	28·174	1571	203·0	24·952	4741	197·0	22·042	7984	191·0	19·409	11307
9	118	1623	9	902	4795	9	21·996	8039	9	368	11363
8	062	1676	8	851	4848	8	950	8093	8	327	11419
7	006	1728	7	801	4902	7	905	8148	7	286	11475
6	27·950	1780	6	750	4956	6	859	8203	6	245	11531
5	894	1833	5	700	5009	5	813	8258	5	204	11587
4	837	1886	4	649	5063	4	767	8313	4	162	11643
3	781	1939	3	599	5116	3	721	8368	3	121	11699
2	725	1992	2	548	5170	2	676	8423	2	080	11755
1	669	2044	1	498	5224	1	630	8478	1	039	11811
208·0	27·613	2097	202·0	24·447	5278	196·0	21·584	8533	190·0	18·998	11867
9	558	2149	9	397	5332	9	539	8588	9	958	11923
8	503	2201	8	348	5385	8	494	8643	8	917	11979
7	448	2254	7	298	5438	7	449	8698	7	877	12035
6	393	2306	6	248	5492	6	404	8753	6	837	12091
5	338	2359	5	199	5545	5	359	8808	5	797	12147
4	282	2412	4	149	5599	4	313	8863	4	756	12203
3	227	2465	3	099	5653	3	268	8918	3	716	12258
2	172	2518	2	049	5707	2	223	8973	2	676	12314
1	117	2571	1	000	5761	1	178	9029	1	635	12370
207·0	27·062	2624	201·0	23·950	5815	195·0	21·133	9084	189·0	18·595	12426
9	008	2676	9	901	5869	9	089	9140	9	555	12482
8	26·954	2728	8	852	5923	8	044	9195	8	516	12538
7	900	2781	7	803	5976	7	000	9250	7	476	12594
6	846	2833	6	754	6030	6	20·956	9305	6	437	12650
5	792	2886	5	706	6084	5	912	9360	5	397	12706
4	737	2939	4	657	6138	4	867	9416	4	357	12762
3	683	2992	3	608	6192	3	823	9471	3	318	12818
2	629	3045	2	559	6246	2	778	9527	2	278	12874
1	575	3098	1	510	6300	1	734	9582	1	239	12931
206·0	521	3151	200·0	461	6354	194·0	690	9638	188·0	199	12988

TABLE XXI.—Computation of Heights.—For determining Heights with the Boiling Point Thermometer.—(*Continued*).

Part I.—(*Continued*).						Part II.—Multipliers for Mean Temperature (Fahrenheit) of the Stratum of Air passed through.					
Boiling Point	Barometer	Approx. Height	Boiling Point	Barometer	Approx. Height	Mean Temp.	Multiplier	Mean Temp.	Multiplier	Mean Temp.	Multiplier
°	Inches	Feet	°	Inches	Feet	°		°		°	
188·0	18·199	12988	182·0	15·964	16412	0·0	0·933	30	0·996	60	1·058
9	160	13045	9	929	16470	0·5	934	30·5	997	60·5	059
8	121	13102	8	894	16528	1	935	31	998	61	060
7	082	13158	7	860	16585	1·5	936	31·5	999	61·5	061
6	043	13215	6	825	16642	2	938	32	1·000	62	062
5	004	13272	5	790	16700	2·5	939	32·5	001	62·5	063
4	17·965	13328	4	755	16757	3	940	33	002	63	065
3	926	13385	3	720	16815	3·5	941	33·5	003	63·5	066
2	887	13442	2	686	16873	4	942	34	004	64	067
1	848	13499	1	651	16931	4·5	943	34·5	005	64·5	068
187·0	17·809	13556	181·0	15·616	16989	5	0·944	35	1·006	65	1·069
9	771	13612	9	582	17047	5·5	945	35·5	007	65·5	070
8	732	13669	8	548	17104	6	946	36	008	66	071
7	694	13726	7	514	17162	6·5	947	36·5	009	66·5	072
6	656	13783	6	480	17219	7	948	37	010	67	073
5	618	13839	5	446	17277	7·5	949	37·5	011	67·5	074
4	579	13896	4	411	17335	8	950	38	013	68	075
3	541	13953	3	377	17393	8·5	951	38·5	014	68·5	076
2	503	14010	2	343	17451	9	952	39	015	69	077
1	464	14067	1	309	17509	9·5	953	39·5	016	69·5	078
186·0	17·426	14124	180·0	15·275	17567	10	0·954	40	1·017	70	1·079
9	388	14181	9	242	17624	10·5	955	40·5	018	70·5	080
8	351	14237	8	208	17682	11	956	41	019	71	081
7	313	14294	7	175	17739	11·5	957	41·5	020	71·5	082
6	276	14351	6	141	17797	12	958	42	021	72	083
5	238	14408	5	108	17855	12·5	959	42·5	022	72·5	084
4	200	14465	4	074	17913	13	960	43	023	73	085
3	163	14522	3	041	17971	13·5	961	43·5	024	73·5	086
2	125	14579	2	007	18029	14	963	44	025	74	087
1	088	14637	1	14·974	18087	14·5	964	44·5	026	74·5	089
185·0	17·050	14694	179·0	14·940	18145	15	0·965	45	1·027	75	1·090
9	013	14751	9	907	18203	15·5	966	45·5	028	75·5	091
8	16·976	14808	8	874	18261	16	967	46	029	76	092
7	939	14865	7	841	18319	16·5	968	46·5	030	76·5	093
6	902	14923	6	808	18377	17	969	47	031	77	094
5	865	14980	5	776	18435	17·5	970	47·5	032	77·5	095
4	829	15037	4	743	18493	18	971	48	033	78	096
3	792	15094	3	710	18551	18·5	972	48·5	034	78·5	097
2	755	15151	2	677	18609	19	973	49	035	79	098
1	718	15209	1	644	18667	19·5	974	49·5	036	79·5	099
184·0	16·681	15266	178·0	14·611	18725	20	0·975	50	1·038	80	1·100
9	645	15323	9	579	18784	20·5	976	50·5	039	80·5	101
8	609	15381	8	546	18842	21	977	51	040	81	102
7	572	15438	7	514	18901	21·5	978	51·5	041	81·5	103
6	536	15495	6	482	18960	22	979	52	042	82	104
5	500	15553	5	450	19019	22·5	980	52·5	043	82·5	105
4	464	15610	4	417	19077	23	981	53	044	83	106
3	428	15667	3	385	19136	23·5	982	53·5	045	83·5	107
2	391	15725	2	353	19194	24	983	54	046	84	108
1	355	15782	1	320	19253	24·5	984	54·5	047	84·5	109
183·0	16·319	15839	177·0	14·288	19311	25	0·985	55	1·048	85	1·110
9	284	15896	9	256	19370	25·5	986	55·5	049	85·5	111
8	248	15953	8	224	19428	26	988	56	050	86	113
7	213	16010	7	193	19487	26·5	989	56·5	051	86·5	114
6	177	16067	6	161	19545	27	990	57	052	87	115
5	142	16124	5	129	19604	27·5	991	57·5	053	87·5	116
4	106	16182	4	097	19662	28	992	58	054	88	117
3	071	16239	3	065	19721	28·5	993	58·5	055	88·5	118
2	035	16297	2	034	19779	29	994	59	056	89	119
1	000	16355	1	002	19838	29·5	995	59·5	057	89·5	120
182·0	15·964	16412	176·0	13·970	19897	30	0·996	60	1·058	90	1·121

TABLE XXII.—Astronomical Refractions.

Mean Refraction of Celestial Objects for Barometer 30 inches and Temperature 50° Fahrenheit.

Apparent Altitude.	Refraction.	Diff. for 1′ Alt.	Diff. for + 1 in. Baro.	Diff. for − 1° Temp.	Apparent Altitude.	Refraction.	Diff. for 1′ Alt.	Diff. for + 1 in. Baro.	Diff. for − 1° Temp.
° ′	′ ″	″	″	″	° ′	′ ″	″	″	″
0 0	33 51	11·7	74	8·1	7 0	7 27	1·0	15·0	0·98
5	32 53	11·3	71	7·6	10	7 17	0·9	14·6	95
10	31 58	10·9	69	7·3	20	7 8	9	14·3	93
15	31 5	10·5	67	7·0	30	6 59	8	14·1	91
20	30 13	10·1	65	6·7	40	6 51	8	13·8	89
25	29 24	9·7	63	6·4	50	6 43	8	13·5	87
30	28 37	9·4	61	6·1	8 0	6 35	0·7	13·3	0·85
35	27 51	9·0	59	5·9	10	6 28	7	13·1	83
40	27 6	8·7	58	5·6	20	6 21	7	12·8	82
45	26 24	8·4	56	5·4	30	6 14	7	12·6	80
50	25 43	8·0	55	5·1	40	6 7	7	12·3	79
55	25 3	7·7	53	4·9	50	6 0	6	12·1	77
1 0	24 25	7·4	52	4·7	9 0	5 54	0·6	11·9	0·76
5	23 48	7·1	50	4·6	10	5 47	6	11·7	74
10	23 13	6·9	49	4·5	20	5 41	6	11·5	73
15	22 40	6·6	48	4·4	30	5 36	6	11·3	71
20	22 8	6·3	46	4·2	40	5 30	5	11·1	71
25	21 37	6·1	45	4·0	50	5 25	5	11·0	70
30	21 7	5·9	44	3·9	10 0	5 20	0·5	10·8	0·69
35	20 38	5·7	43	3·8	10	5 15	5	10·6	67
40	20 10	5·5	42	3·6	20	5 10	5	10·4	65
45	19 43	5·3	40	3·5	30	5 5	5	10·2	64
50	19 17	5·1	39	3·4	40	5 0	5	10·1	63
55	18 52	4·9	39	3·3	50	4 56	4	9·9	62
2 0	18 29	4·8	38	3·2	11 0	4 51	0·4	9·8	0·60
5	18 5	4·6	37	3·1	10	4 47	4	9·6	59
10	17 43	4·4	36	3·0	20	4 43	4	9·5	58
15	17 21	4·3	36	2·9	30	4 39	4	9·4	57
20	17 0	4·1	35	2·8	40	4 35	4	9·2	56
25	16 40	4·0	34	2·8	50	4 31	4	9·1	55
30	16 21	3·9	33	2·7	12 0	4 28·1	0·38	9·00	0·556
35	16 2	3·7	33	2·7	10	4 24·4	37	8·86	548
40	15 43	3·6	32	2·6	20	4 20·8	36	8·74	541
45	15 25	3·5	32	2·5	30	4 17·3	35	8·63	533
50	15 8	3·4	31	2·4	40	4 13·9	33	8·51	524
55	14 51	3·3	30	2·3	50	4 10·7	32	8·41	517
3 0	14 35	3·2	30	2·3	13 0	4 7·5	0·31	8·30	0·509
5	14 19	3·1	29	2·2	10	4 4·4	31	8·20	503
10	14 4	3·0	29	2·2	20	4 1·4	30	8·10	496
15	13 50	2·9	28	2·1	30	3 58·4	30	8·00	490
20	13 35	2·8	28	2·1	40	3 55·5	29	7·89	482
25	13 21	2·7	27	2·0	50	3 52·6	29	7·79	476
30	13 7	2·7	27	2·0	14 0	3 49·9	0·28	7·70	0·469
35	12 53	2·6	26	2·0	10	3 47·1	28	7·61	464
40	12 41	2·5	26	1·9	20	3 44·4	27	7·52	458
45	12 28	2·4	25	1·9	30	3 41·8	26	7·43	453
50	12 16	2·4	25	1·9	40	3 39·2	26	7·34	448
55	12 3	2·3	25	1·8	50	3 36·7	25	7·26	444
4 0	11 52	2·2	24·1	1·70	15 0	3 34·3	0·24	7·18	0·439
10	11 30	2·1	23·4	1·64	30	3 27·3	22	6·95	424
20	11 10	2·0	22·7	1·58	16 0	3 20·6	21	6·73	411
30	10 50	1·9	22·0	1·53	30	3 14·4	20	6·51	399
40	10 32	1·8	21·3	1·48	17 0	3 8·5	19	6·31	386
50	10 15	1·7	20·7	1·43	30	3 2·9	18	6·12	374
5 0	9 58	1·6	20·1	1·38	18 0	2 57·6	0·17	5·98	0·362
10	9 42	1·5	19·6	1·34	19 0	2 47·7	16	5·61	340
20	9 27	1·5	19·1	1·30	20 0	2 38·7	15	5·31	322
30	9 11	1·4	18·6	1·26	21 0	2 30·5	13	5·04	305
40	8 58	1·3	18·1	1·22	22 0	2 23·2	12	4·79	290
50	8 45	1·3	17·6	1·19	23 0	2 16·5	11	4·57	276
6 0	8 32	1·2	17·2	1·15	24 0	2 10·1	0·10	4·35	0·264
10	8 20	1·2	16·8	1·11	25 0	2 4·2	09	4·16	252
20	8 9	1·1	16·4	1·09	26 0	1 58·8	09	3·97	241
30	7 58	1·1	16·0	1·06	27 0	1 53·8	08	3·81	230
40	7 47	1·0	15·7	1·03	28 0	1 49·1	08	3·65	219
50	7 37	1·0	15·3	1·00	29 0	1 44·7	07	3·50	209

TABLE XXII.—Astronomical Refractions—(*Continued*).

Mean Refraction of Celestial Objects for Barometer 30 inches and Temperature 50° Fahrenheit.

Apparent Altitude.	Refraction.	Diff. for 1′ Alt.	Diff. for +1 in. Baro.	Diff. for −1° Temp.	Apparent Altitude.	Refraction.	Diff. for 1′ Alt.	Diff. for +1 in. Baro.	Diff. for −1° Temp.
°	′ ″	″	″	″	°	″	″	″	″
30	1 40·5	0·07	3·36	0·201	60	33·6	0·023	1·12	0·067
31	1 36·6	06	3·23	193	61	32·3	022	1·08	065
32	1 33·0	06	3·11	186	62	31·0	022	1·04	062
33	1 29·5	06	2·99	179	63	29·7	021	0·99	060
34	1 26·1	05	2·88	173	64	28·4	021	95	057
35	1 23·0	05	2·78	167	65	27·2	020	91	055
36	1 20·0	0·05	2·68	0·161	66	25·9	0·020	0·87	0·052
37	1 17·1	05	2·58	155	67	24·7	020	83	050
38	1 14·4	05	2·49	149	68	23·5	020	79	047
39	1 11·8	04	2·40	144	69	22·4	020	75	045
40	1 9·3	04	2·32	139	70	21·2	020	71	043
41	1 6·9	04	2·24	134	71	19·9	020	67	040
42	1 4·6	0·038	2·16	0·130	72	18·8	0·019	0·63	0·038
43	1 2·4	036	2·09	125	73	17·7	018	59	036
44	1 0·3	034	2·02	120	74	16·6	018	56	033
45	0 58·1	034	1·94	117	75	15·5	018	52	031
46	56·1	033	1·88	112	76	14·4	018	48	029
47	54·2	032	1·81	108	77	13·4	017	45	027
48	0 52·3	0·031	1·75	0·104	78	12·3	0·017	0·41	0·025
49	50·5	030	1·69	101	79	11·2	017	38	023
50	48·8	029	1·63	097	80	10·2	017	34	021
51	47·1	028	1·58	094	81	9·2	017	31	018
52	45·4	027	1·52	090	82	8·2	017	27	016
53	43·8	026	1·47	088	83	7·1	017	24	014
54	0 42·2	0·026	1·41	0·085	84	6·1	0·017	0·20	0·012
55	40·8	025	1·36	082	85	5·1	017	17	010
56	39·3	025	1·31	079	86	4·1	017	14	008
57	37·8	025	1·26	076	87	3·1	017	10	006
58	36·4	024	1·22	073	88	2·0	017	07	004
59	35·0	024	1·17	070	89	1·0	017	03	002

TABLE XXIII.—Parallax of the Sun.

Altitude.	January.	February and December.	March and November.	April and October.	May and September.	June and August.	July.	Altitude.
°	″	″	″	″	″	″	″	°
0	9·0	9·0	8·9	8·8	8·8	8·7	8·7	0
5	9·0	8·9	8·9	8·8	8·7	8·7	8·7	5
10	8·9	8·8	8·8	8·7	8·6	8·6	8·6	10
15	8·7	8·7	8·6	8·5	8·5	8·4	8·4	15
20	8·5	8·4	8·4	8·3	8·3	8·2	8·2	20
25	8·2	8·1	8·1	8·0	8·0	7·9	7·9	25
30	7·8	7·8	7·7	7·7	7·6	7·6	7·5	30
35	7·4	7·3	7·3	7·2	7·2	7·1	7·1	35
40	6·9	6·9	6·8	6·8	6·7	6·7	6·7	40
45	6·4	6·3	6·3	6·2	6·2	6·2	6·2	45
50	5·8	5·8	5·7	5·7	5·6	5·6	5·6	50
55	5·2	5·1	5·1	5·1	5·0	5·0	5·0	55
60	4·5	4·5	4·5	4·4	4·4	4·4	4·4	60
65	3·8	3·8	3·8	3·7	3·7	3·7	3·7	65
70	3·1	3·1	3·0	3·0	3·0	3·0	3·0	70
75	2·3	2·3	2·3	2·3	2·3	2·3	2·3	75
80	1·6	1·6	1·6	1·5	1·5	1·5	1·5	80
85	0·8	0·8	0·8	0·8	0·8	0·8	0·8	85
90	0·0	0·0	0·0	0·0	0·0	0·0	0·0	90

TABLE XXIV.—Computation of Circumpolar Azimuths.—To Facilitate the Calculation of the Corrections—for Instrumental Errors of *Collimation, Inclination* and *Deviation*—to the Observed Times of Transit.

Zenith Distance.	Cos. / Sin.	Zenith Distance.	Zenith Distance.	Cos. / Sin.	Zenith Distance.	Declination N. or S.	$\frac{1}{15 \sin. N.P.D.}$
°		°	°		°	°	
0	1·000	90	45	0·707	45	0	0·067
1	1·000	89	46	695	44	1	067
2	0·999	88	47	682	43	2	067
3	999	87	48	669	42	3	067
4	998	86	49	656	41	4	067
5	996	85	50	643	40	5	067
6	0·995	84	51	0·629	39	6	0·067
7	993	83	52	616	38	7	067
8	990	82	53	602	37	8	067
9	988	81	54	588	36	9	067
10	985	80	55	574	35	10	068
11	0·982	79	56	0·559	34	11	0·068
12	978	78	57	545	33	12	068
13	974	77	58	530	32	13	068
14	970	76	59	515	31	14	069
15	966	75	60	500	30	15	069
16	0·961	74	61	0·485	29	16	0·069
17	956	73	62	469	28	17	070
18	951	72	63	454	27	18	070
19	946	71	64	438	26	19	071
20	940	70	65	423	25	20	071
21	0·934	69	66	0·407	24	21	0·071
22	927	68	67	391	23	22	072
23	921	67	68	375	22	23	072
24	914	66	69	358	21	24	073
25	906	65	70	342	20	25	074
26	0·899	64	71	0·326	19	26	0·074
27	891	63	72	309	18	27	075
28	883	62	73	292	17	28	076
29	875	61	74	276	16	29	076
30	866	60	75	259	15	30	077
31	0·857	59	76	0·242	14	31	0·078
32	848	58	77	225	13	32	079
33	839	57	78	208	12	33	079
34	829	56	79	191	11	34	080
35	819	55	80	174	10	35	081
36	0·809	54	81	0·156	9	36	0·082
37	799	53	82	139	8	37	083
38	788	52	83	122	7	38	085
39	777	51	84	105	6	39	086
40	766	50	85	087	5	40	087
41	0·755	49	86	0·070	4	41	0·088
42	743	48	87	052	3	42	090
43	731	47	88	035	2	43	091
44	719	46	89	017	1	44	093
45	707	45	90	000	0	45	094

TABLE XXV.—Computation of Circumpolar Azimuths.—To Facilitate the Computation of δA or the Reduction to Elongation.

PART I.

2 Sin² N. P. D. Sin² ½ δP.—Natural Numbers.

δP	N. P. D.										
	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°
m.											
0	·00000	·00000	·00000	·00000	·00000	·00000	·00000	·00000	·00000	·00000	·00000
1	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	1	1
6	0	0	0	0	0	0	0	1	1	1	1
7	0	0	0	0	0	0	1	1	1	1	1
8	0	0	0	0	0	0	1	1	1	1	2
9	0	0	0	0	0	1	1	1	1	2	2
10	0	0	0	0	0	1	1	1	2	2	3
11	0	0	0	0	1	1	1	2	2	3	3
12	0	0	0	0	1	1	1	2	3	3	4
13	0	0	0	0	1	1	2	2	3	4	5
14	0	0	0	1	1	1	2	3	4	5	6
15	0	0	0	1	1	2	2	3	4	5	6
16	0	0	0	1	1	2	3	4	5	6	7
17	0	0	0	1	1	2	3	4	5	7	8
18	0	0	0	1	2	2	3	5	6	8	9
19	0	0	0	1	2	3	4	5	7	8	10
20	0	0	0	1	2	3	4	6	7	9	11
21	0	0	1	1	2	3	5	6	8	10	13
22	0	0	1	1	2	3	5	7	9	11	14
23	0	0	1	1	2	4	5	7	10	12	15
24	0	0	1	2	3	4	6	8	11	13	17
25	0	0	1	2	3	5	6	9	12	15	18
26	0	0	1	2	3	5	7	10	12	16	19
27	0	0	1	2	3	5	8	10	13	17	21
28	0	0	1	2	4	6	8	11	14	18	22
29	0	0	1	2	4	6	9	12	15	20	24
30	·00000	·00000	·00001	·00002	·00004	·00006	·00009	·00013	·00017	·00021	·00026

TABLE XXV.—Computation of Circumpolar Azimuths.—(*Continued*).

Part II.

Cot P sin δP.—Natural Numbers.

P		δP										
°	′	0^m	1^m	2^m	3^m	4^m	5^m	6^m	7^m	8^m	9^m	10^m
82	0		0·00061	0·00123	0·00184	0·00245	0·00307	0·00368	0·00429	0·00490	0·00552	0·00613
	10		60	120	180	240	300	360	420	480	540	600
	20		59	117	176	235	294	352	411	470	528	587
	30		57	115	172	230	287	345	402	459	517	574
	40		56	112	168	225	281	337	393	449	505	561
	50		55	110	165	219	274	329	384	439	494	548
83	0		0·00054	0·00107	0·00161	0·00214	0·00268	0·00321	0·00375	0·00429	0·00482	0·00536
	10		52	105	157	209	261	314	366	418	470	523
	20		51	102	153	204	255	306	357	408	459	510
	30		50	099	149	199	249	298	348	398	447	497
	40		48	097	145	194	242	291	339	387	436	484
	50		47	094	141	189	236	283	330	377	424	471
84	0		0·00046	0·00092	0·00138	0·00183	0·00229	0·00275	0·00321	0·00367	0·00413	0·00458
	10		45	089	134	178	223	267	312	357	401	446
	20		43	087	130	173	216	260	303	346	390	433
	30		42	084	126	168	210	252	294	336	378	420
	40		41	081	122	163	204	244	285	326	367	407
	50		39	079	118	158	197	237	276	316	355	394
85	0		0·00038	0·00076	0·00115	0·00153	0·00191	0·00229	0·00267	0·00305	0·00343	0·00382
	10		37	074	111	148	184	221	258	295	332	369
	20		36	071	107	142	178	214	249	285	320	356
	30		34	069	103	137	172	206	240	275	309	343
	40		33	066	099	132	165	198	231	264	297	331
	50		32	064	095	127	159	191	222	254	286	318
86	0	0·00000	0·00031	0·00061	0·00092	0·00122	0·00153	0·00183	0·00214	0·00244	0·00275	0·00305
	10		29	058	088	117	146	175	205	234	263	292
	20		28	056	084	112	140	168	196	224	252	280
	30		27	053	080	107	133	160	187	213	240	267
	40		25	051	076	102	127	152	178	203	229	254
	50		24	048	072	097	121	145	169	193	217	241
87	0		0·00023	0·00046	0·00069	0·00091	0·00114	0·00137	0·00160	0·00183	0·00206	0·00229
	10		22	043	065	086	108	130	151	173	194	216
	20		20	041	061	081	102	122	142	163	183	203
	30		19	038	057	076	095	114	133	152	171	190
	40		18	036	053	071	089	107	124	142	160	178
	50		16	033	050	066	083	099	116	132	149	165
88	0		0·00015	0·00030	0·00046	0·00061	0·00076	0·00091	0·00107	0·00122	0·00137	0·00152
	10		14	028	042	056	070	084	098	112	126	140
	20		13	025	038	051	063	076	089	102	114	127
	30		11	023	034	046	057	069	080	091	103	114
	40		10	020	030	041	051	061	071	081	091	102
	50		09	018	027	036	044	053	062	071	080	089
89	0		0·00008	0·00015	0·00023	0·00030	0·00038	0·00046	0·00053	0·00061	0·00069	0·00076
	10		06	013	019	025	032	038	044	051	057	063
	20		05	010	015	020	025	030	036	041	046	051
	30		04	008	011	015	019	023	027	030	034	038
	40		03	005	008	010	013	015	018	020	023	025
	50		01	003	004	005	006	008	009	010	011	013
90	0		0·00000	0·00000	0·00000	0·00000	0·00000	0·00000	0·00000	0·00000	0·00000	0·00000

TABLE XXV.—Computation of Circumpolar Azimuths.—(*Continued*).

Part II.

Cot P sin δP.—Natural Numbers.

P	δP									
	11^{m}	12^{m}	13^{m}	14^{m}	15^{m}	16^{m}	17^{m}	18^{m}	19^{m}	20^{m}
° ′										
82 0	0·00674	0·00736	0·00797	0·00858	0·00919	0·00980	0·01042	0·01103	0·01164	0·01225
10	660	720	780	840	900	960	1020	1079	1139	1199
20	646	705	763	822	880	939	0998	1056	1115	1173
30	632	689	746	804	861	9'8	0976	1033	1090	1147
40	617	674	730	786	842	898	0954	1010	1066	1122
50	603	658	713	768	822	877	0932	0987	1041	1096
83 0	0·00589	0·00643	0·00696	0·00750	0·00803	0·00857	0·00910	0·00963	0·01017	0·01070
10	575	627	679	732	784	836	0888	0940	0992	1044
20	561	612	663	714	764	815	0866	0917	0968	1019
30	547	596	646	696	745	795	0844	0894	0943	0993
40	533	581	629	678	726	774	0823	0871	0919	0967
50	518	565	613	660	707	754	0801	0848	0895	0942
84 0	0·00504	0·00550	0·00596	0·00642	0·00687	0·00733	0·00779	0·00825	0·00870	0·00916
10	490	535	579	624	668	713	0757	0802	0846	0890
20	476	519	563	606	649	692	0735	0779	0822	0865
30	462	504	546	588	630	672	0714	0755	0797	0839
40	448	489	529	570	611	651	0692	0732	0773	0814
50	434	473	513	552	591	631	0670	0709	0749	0788
85 0	0·00420	0·00458	0·00496	0·00534	0·00572	0·00610	0·00648	0·00686	0·00724	0·00763
10	406	443	479	516	553	590	0627	0663	0700	0737
20	392	427	463	498	534	569	0605	0640	0676	0711
30	378	412	446	480	515	549	0583	0617	0652	0686
40	364	397	430	463	496	529	0562	0595	0627	0660
50	350	381	413	445	476	508	0540	0572	0603	0635
86 0	0·00335	0·00366	0·00396	0·00427	0·00457	0·00488	0·00518	0·00549	0·00579	0·00609
10	321	351	380	409	438	467	0497	0526	0555	0584
20	307	335	363	391	419	447	0475	0503	0531	0559
30	293	320	347	373	400	427	0453	0480	0506	0533
40	279	305	330	356	381	406	0432	0457	0482	0508
50	265	290	314	338	362	386	0410	0434	0458	0482
87 0	0·00251	0·00274	0·00297	0·00320	0·00343	0·00366	0·00388	0·00411	0·00434	0·00457
10	237	259	281	302	324	345	0367	0388	0410	0431
20	223	244	264	284	305	325	0345	0365	0386	0406
30	209	229	248	267	286	305	0324	0343	0362	0381
40	195	213	231	249	266	284	0302	0320	0337	0355
50	182	198	214	231	247	264	0280	0297	0313	0330
88 0	0·00168	0·00183	0·00198	0·00213	0·00228	0·00244	0·00259	0·00274	0·00289	0·00304
10	154	168	181	195	209	223	0237	0251	0265	0279
20	140	152	165	178	190	203	0216	0228	0241	0254
30	126	137	148	160	171	183	0194	0205	0217	0228
40	112	122	132	142	152	162	0172	0183	0193	0203
50	098	107	115	124	133	142	0151	0160	0169	0177
89 0	0·00084	0·00091	0·00099	0·00107	0·00114	0·00122	0·00129	0·00137	0·00145	0·00152
10	070	076	082	089	095	101	0108	0114	0120	0127
20	056	061	066	071	076	081	0086	0091	0096	0101
30	042	046	049	053	057	061	0065	0068	0072	0076
40	028	030	033	036	038	041	0043	0046	0048	0051
50	014	015	016	018	019	020	0022	0023	0024	0025
90 0	0·00000	0·00000	0·00000	0·00000	0·00000	0·00000	0·00000	0·00000	0·00000	0·00000

TABLE XXV.—Computation of Circumpolar Azimuths.—(*Continued*).

PART II.

Cot P sin δP.—Natural Numbers.

P	δP 21m	22m	23m	24m	25m	26m	27m	28m	29m	30m
° ′										
82 0	0·01286	0·01347	0·01408	0·01469	0·01530	0·01591	0·01652	0·01713	0·01774	0·01834
10	1259	1319	1378	1438	1498	1557	1617	1677	1736	1796
20	1232	1290	1349	1407	1465	1524	1582	1641	1699	1757
30	1205	1262	1319	1376	1433	1490	1547	1604	1661	1718
40	1178	1233	1289	1345	1401	1457	1513	1568	1624	1680
50	1151	1205	1260	1314	1369	1423	1478	1532	1587	1641
83 0	0·01123	0·01177	0·01230	0·01283	0·01337	0·01390	0·01443	0·01496	0·01550	0·01603
10	1096	1149	1201	1253	1305	1357	1408	1460	1512	1564
20	1070	1120	1171	1222	1272	1323	1374	1424	1475	1526
30	1043	1092	1141	1191	1240	1290	1339	1389	1438	1487
40	1016	1064	1112	1160	1208	1256	1305	1353	1401	1449
50	0989	1036	1082	1129	1176	1223	1270	1317	1364	1410
84 0	0·00962	0·01007	0·01053	0·01099	0·01144	0·01190	0·01235	0·01281	0·01326	0·01372
10	0935	0979	1024	1068	1112	1157	1201	1245	1289	1334
20	0908	0951	0994	1037	1080	1123	1166	1209	1252	1295
30	0881	0923	0965	1006	1048	1090	1132	1173	1215	1257
40	0854	0895	0935	0976	1016	1057	1097	1138	1178	1219
50	0827	0867	0906	0945	0984	1024	1063	1102	1141	1180
85 0	0·00801	0·00839	0·00877	0·00915	0·00952	0·00990	0·01028	0·01066	0·01104	0·01142
10	0774	0810	0847	0884	0921	0957	0994	1031	1067	1104
20	0747	0782	0818	0853	0889	0924	0959	0995	1030	1065
30	0720	0754	0789	0823	0857	0891	0925	0959	0993	1027
40	0693	0726	0759	0792	0825	0858	0891	0923	0956	0989
50	0667	0698	0730	0761	0793	0825	0856	0888	0919	0951
86 0	0·00640	0·00670	0·00701	0·00731	0·00761	0·00792	0·00822	0·00852	0·00882	0·00913
10	0613	0642	0671	0700	0729	0759	0788	0817	0846	0875
20	0586	0614	0642	0670	0698	0725	0753	0781	0809	0836
30	0560	0586	0613	0639	0666	0692	0719	0745	0772	0798
40	0533	0558	0584	0609	0634	0659	0685	0710	0735	0760
50	0506	0530	0554	0578	0602	0626	0650	0674	0698	0722
87 0	0·00480	0·00502	0·00525	0·00548	0·00571	0·00593	0·00616	0·00639	0·00661	0·00684
10	0453	0474	0496	0517	0539	0560	0582	0603	0625	0646
20	0426	0446	0467	0487	0507	0527	0547	0568	0588	0608
30	0400	0418	0437	0456	0475	0494	0513	0532	0551	0570
40	0373	0391	0408	0426	0444	0461	0479	0497	0514	0532
50	0346	0363	0379	0395	0412	0428	0445	0461	0477	0494
88 0	0·00320	0·00335	0·00350	0·00365	0·00380	0·00395	0·00410	0·00426	0·00441	0·00456
10	0293	0307	0321	0335	0348	0362	0376	0390	0404	0418
20	0266	0279	0292	0304	0317	0329	0342	0355	0367	0380
30	0240	0251	0262	0274	0285	0296	0308	0319	0330	0342
40	0213	0223	0233	0243	0253	0263	0274	0284	0294	0304
50	0186	0195	0204	0213	0222	0231	0239	0248	0257	0266
89 0	0·00160	0·00167	0·00175	0·00182	0·00190	0·00198	0·00205	0·00213	0·00220	0·00228
10	0133	0139	0146	0152	0158	0165	0171	0177	0184	0190
20	0106	0112	0117	0122	0127	0132	0137	0142	0147	0152
30	0080	0084	0087	0091	0095	0099	0103	0106	0110	0114
40	0053	0056	0058	0061	0063	0066	0068	0071	0073	0076
50	0027	0028	0029	0030	0032	0033	0034	0035	0037	0038
90 0	0·00000	0·00000	0·00000	0·00000	0·00000	0·00000	0·00000	0·00000	0·00000	0·00000

TABLE XXV.—Computation of Circumpolar Azimuths.—(*Continued*).

Part III.

Log 2 Sin² ½ δP Cosec 1″ for each Second of Time of δP.

	δP										
s	0m	1m	2m	3m	4m	5m	6m	7m	8m	9m	s
0	– Infinite	0·29303	0·89509	1·24727	1·49714	1·69095	1·84931	1·98319	2·09917	2·20146	0
1	$\bar{4}$·73673	30739	0·90230	5208	1·50075	9384	5172	8526	2·10097	0307	1
2	$\bar{3}$·33879	32151	0944	5686	0435	9672	5412	8732	0278	0467	2
3	69097	33541	1653	6162	0793	9960	5652	8937	0458	0627	3
4	94085	34909	2357	6636	1150	1·70246	5890	9142	0637	0787	4
5	$\bar{2}$·13467	36255	3054	7106	1505	0531	6129	9347	0817	0946	5
6	29303	37581	3747	7575	1859	0815	6366	9551	0995	1106	6
7	42692	38888	4433	8040	2211	1099	6603	9755	1174	1264	7
8	54291	40174	5114	8504	2562	1381	6840	9958	1352	1423	8
9	64521	41442	5790	8964	2911	1663	7075	2·00161	1530	1581	9
10	$\bar{2}$·73673	0·42692	0·96461	1·29423	1·53260	1·71943	1·87310	2·00363	2·11707	2·21739	10
11	81951	43924	7127	9879	3606	2223	7545	0565	1884	1897	11
12	89509	45139	7787	1·30332	3952	2502	7779	0766	2061	2055	12
13	96461	46337	8443	0783	4296	2780	8012	0967	2237	2212	13
14	$\bar{1}$·02898	47519	9093	1232	4638	3057	8244	1167	2413	2369	14
15	08891	48685	9739	1679	4980	3333	8476	1367	2589	2525	15
16	14497	49835	1·00380	2123	5319	3608	8708	1566	2764	2682	16
17	19763	50971	1016	2565	5658	3883	8938	1765	2939	2838	17
18	24727	52092	1648	3005	5995	4156	9168	1964	3114	2994	18
19	29423	53198	2275	3443	6331	4429	9398	2162	3288	3149	19
20	$\bar{1}$·33879	0·54291	1·02898	1·33878	1·56666	1·74701	1·89627	2·02360	2·13462	2·23304	20
21	38117	55370	3516	4311	7000	4972	9855	2557	3635	3459	21
22	42157	56435	4130	4742	7332	5242	1·90083	2753	3809	3614	22
23	46018	57488	4740	5171	7663	5511	0310	2950	3981	3768	23
24	49715	58528	5345	5598	7992	5780	0536	3146	4154	3922	24
25	53261	59556	5946	6023	8321	6047	0762	3341	4326	4076	25
26	56667	60572	6543	6445	8648	6314	0987	3536	4498	4230	26
27	59945	61576	7136	6866	8974	6580	1212	3730	4669	4383	27
28	63104	62569	7725	7285	9298	6845	1436	3924	4841	4536	28
29	66152	63551	8310	7701	9622	7110	1660	4118	5011	4689	29
30	$\bar{1}$·69097	0·64521	1·08891	1·38116	1·59944	1·77373	1·91883	2·04311	2·15182	2·24841	30
31	71945	65481	9468	8528	1·60265	7636	2105	4504	5352	4994	31
32	74703	66430	1·10041	8939	0585	7898	2327	4697	5522	5146	32
33	77376	67369	0611	9348	0904	8159	2548	4888	5691	5297	33
34	79968	68298	1176	9755	1221	8420	2769	5080	5860	5449	34
35	82486	69217	1739	1·40160	1538	8680	2989	5271	6029	5600	35
36	84933	70127	2297	0563	1853	8938	3209	5462	6198	5751	36
37	87313	71027	2852	0964	2167	9197	3428	5652	6366	5902	37
38	89629	71918	3404	1363	2480	9454	3646	5842	6534	6052	38
39	91886	72800	3952	1761	2792	9710	3864	6031	6701	6202	39
40	$\bar{1}$·94085	0·73673	1·14496	1·42156	1·63103	1·79966	1·94082	2·06220	2·16868	2·26352	40
41	96229	4537	5037	2550	3412	1·80221	4299	6409	7035	6502	41
42	98323	5393	5575	2942	3721	0476	4515	6597	7202	6651	42
43	0·00366	6240	6110	3333	4028	0729	4731	6785	7368	6800	43
44	02363	7079	6641	3721	4335	0982	4946	6972	7534	6949	44
45	04315	7910	7169	4108	4640	1234	5161	7159	7699	7097	45
46	06224	8734	7694	4493	4944	1486	5375	7346	7865	7246	46
47	08092	9549	8215	4877	5248	1736	5588	7532	8030	7394	47
48	09921	0·80357	8734	5259	5550	1986	5802	7718	8194	7542	48
49	11712	1158	9250	5639	5851	2235	6014	7903	8359	7689	49
50	0·13467	0·81951	1·19762	1·46017	1·66151	1·82484	1·96226	2·08088	2·18523	2·27836	50
51	15187	2737	1·20271	6394	6450	2732	6438	8273	8686	7984	51
52	16873	3516	0778	6769	6748	2979	6649	8457	8850	8130	52
53	18528	4288	1281	7143	7045	3225	6859	8641	9013	8277	53
54	20151	5053	1782	7515	7341	3471	7070	8824	9176	8423	54
55	21745	5812	2280	7885	7635	3716	7279	9007	9338	8569	55
56	23310	6564	2775	8254	7929	3960	7488	9190	9500	8715	56
57	24848	7310	3267	8621	8222	4204	7697	9372	9662	8861	57
58	26358	8049	3756	8987	8514	4447	7905	9554	9824	9006	58
59	27843	8782	4243	9351	8805	4689	8112	9735	9985	9151	59
60	29303	9509	4727	9714	9095	4931	8319	9917	2·20146	9296	60

TABLE XXV.—Computation of Circumpolar Azimuths.—(*Continued*).

Part III.

Log 2 $\sin^2 \frac{1}{2}\,\delta P$ Cosec 1″ for each Second of Time of δP.

	δP										
s	10m	11m	12m	13m	14m	15m	16m	17m	18m	19m	s
0	2·29296	2·37573	2·45129	2·52080	2·58515	2·64506	2·70109	2·75373	2·80335	2·85029	0
1	9441	7705	5250	2191	8618	4602	0200	5458	0416	5105	1
2	9585	7836	5370	2302	8722	4698	0290	5543	0496	5181	2
3	9729	7967	5490	2413	8825	4795	0380	5628	0576	5257	3
4	9873	8098	5610	2524	8928	4891	0470	5713	0656	5333	4
5	2·30017	8229	5730	2635	9030	4987	0560	5797	0736	5409	5
6	0160	8359	5850	2745	9133	5083	0650	5882	0816	5485	6
7	0303	8489	5970	2856	9236	5178	0740	5967	0896	5560	7
8	0446	8619	6089	2966	9338	5274	0830	6051	0976	5636	8
9	0589	8749	6208	3076	9440	5370	0920	6136	1056	5711	9
10	2·30732	2·38879	2·46327	2·53186	2·59543	2·65465	2·71009	2·76220	2·81135	2·85787	10
11	0874	9009	6446	3296	9645	5561	1099	6304	1215	5862	11
12	1016	9138	6565	3406	9747	5656	1188	6388	1294	5938	12
13	1158	9267	6683	3515	9849	5751	1277	6472	1374	6013	13
14	1299	9396	6802	3625	9950	5846	1366	6556	1453	6088	14
15	1441	9525	6920	3734	2·60052	5941	1455	6640	1533	6164	15
16	1582	9653	7038	3843	0153	6036	1544	6724	1612	6239	16
17	1722	9782	7156	3952	0255	6131	1633	6808	1691	6314	17
18	1863	9910	7274	4061	0356	6225	1722	6892	1770	6389	18
19	2004	2·40038	7391	4170	0457	6320	1811	6975	1849	6464	19
20	2·32144	2·40166	2·47509	2·54278	2·60558	2·66414	2·71900	2·77059	2·81928	2·86539	20
21	2284	0293	7626	4387	0659	6508	1988	7142	2007	6613	21
22	2423	0421	7743	4495	0760	6603	2077	7225	2086	6688	22
23	2563	0548	7860	4604	0861	6697	2165	7309	2165	6763	23
24	2702	0675	7977	4712	0961	6791	2253	7392	2243	6837	24
25	2841	0802	8093	4820	1062	6885	2341	7475	2322	6912	25
26	2980	0929	8210	4927	1162	6979	2430	7558	2400	6986	26
27	3119	1055	8326	5035	1262	7072	2518	7641	2479	7061	27
28	3257	1181	8442	5143	1362	7166	2605	7724	2557	7135	28
29	3395	1307	8558	5250	1462	7259	2693	7807	2636	7209	29
30	2·33533	2·41433	2·48674	2·55357	2·61562	2·67353	2·72781	2·77889	2·82714	2·87284	30
31	3671	1559	8790	5464	1662	7446	2869	7972	2792	7358	31
32	3809	1685	8905	5571	1761	7539	2956	8055	2870	7432	32
33	3946	1810	9021	5678	1861	7632	3044	8137	2948	7506	33
34	4083	1935	9136	5785	1960	7725	3131	8220	3026	7580	34
35	4220	2060	9251	5892	2060	7818	3218	8302	3104	7654	35
36	4356	2185	9366	5998	2159	7911	3306	8384	3182	7728	36
37	4493	2310	9481	6104	2258	8004	3393	8466	3259	7802	37
38	4629	2434	9596	6211	2357	8096	3480	8548	3337	7875	38
39	4765	2559	9710	6317	2456	8189	3567	8630	3415	7949	39
40	2·34901	2·42683	2·49824	2·56423	2·62554	2·68281	2·73654	2·78712	2·83492	2·88022	40
41	5036	2807	9939	6528	2653	8374	3740	8794	3570	8096	41
42	5172	2931	2·50053	6634	2752	8466	3827	8876	3647	8169	42
43	5307	3054	0167	6740	2850	8558	3914	8958	3725	8243	43
44	5442	3178	0280	6845	2948	8650	4000	9039	3802	8316	44
45	5577	3301	0394	6951	3046	8742	4087	9121	3879	8390	45
46	5711	3424	0507	7056	3144	8834	4173	9202	3956	8463	46
47	5846	3547	0621	7161	3242	8926	4259	9284	4033	8536	47
48	5980	3670	0734	7266	3340	9017	4345	9365	4110	8609	48
49	6114	3792	0847	7370	3438	9109	4431	9446	4187	8682	49
50	2·36247	2·43915	2·50960	2·57475	2·63536	2·69200	2·74517	2·79528	2·84264	2·88755	50
51	6381	4037	1072	7580	3633	9292	4603	9609	4341	8828	51
52	6514	4159	1185	7684	3730	9383	4689	9690	4417	8901	52
53	6647	4281	1297	7788	3828	9474	4775	9771	4494	8974	53
54	6780	4403	1409	7893	3925	9565	4861	9852	4571	9046	54
55	6913	4524	1522	7997	4022	9656	4946	9932	4647	9119	55
56	7045	4646	1634	8101	4119	9747	5032	2·80013	4724	9192	56
57	7178	4767	1745	8204	4216	9838	5117	0094	4800	9264	57
58	7310	4888	1857	8308	4313	9928	5202	0174	4876	9337	58
59	7442	5009	1969	8412	4409	2·70019	5288	0255	4953	9409	59
60	7573	5129	2080	8515	4506	0109	5373	0335	5029	9481	60

TABLE XXV.—Computation of Circumpolar Azimuths.—(*Continued*).

Part III.

Log 2 Sin² ½ δP Cosec 1″ for each Second of Time of δP.

s.	δP 20ᵐ	21ᵐ	22ᵐ	23ᵐ	24ᵐ	25ᵐ	26ᵐ	27ᵐ	28ᵐ	29ᵐ	s.
0	2·89481	2·93716	2·97754	3·01612	3·05306	3·08848	3·12251	3·15526	3·18681	3·21725	0
1	9554	3785	7820	1675	5366	8906	2307	5579	8732	1774	1
2	9626	3854	7886	1738	5426	8964	2362	5633	8784	1824	2
3	9698	3923	7951	1801	5486	9021	2418	5686	8835	1874	3
4	9770	3992	8017	1863	5546	9079	2473	5739	8887	1924	4
5	9842	4060	8082	1926	5606	9137	2529	5793	8938	1974	5
6	9914	4129	8148	1989	5666	9194	2584	5846	8990	2023	6
7	9986	4197	8213	2051	5726	9252	2640	5900	9041	2073	7
8	2·90058	4266	8279	2114	5786	9309	2695	5953	9093	2123	8
9	0130	4334	8344	2176	5846	9367	2750	6006	9144	2172	9
10	2·90202	2·94403	2·98409	3·02239	3·05906	3·09424	3·12805	3·16059	3·19195	3·22222	10
11	0273	4471	8474	2301	5966	9482	2861	6113	9247	2271	11
12	0345	4539	8540	2363	6026	9539	2916	6166	9298	2321	12
13	0417	4607	8605	2426	6085	9597	2971	6219	9349	2370	13
14	0488	4676	8670	2488	6145	9654	3026	6272	9400	2420	14
15	0560	4744	8735	2550	6205	9711	3081	6325	9452	2469	15
16	0631	4812	8800	2613	6264	9769	3136	6378	9503	2519	16
17	0703	4880	8865	2675	6324	9826	3191	6431	9554	2568	17
18	0774	4948	8930	2737	6384	9883	3246	6484	9605	2617	18
19	0845	5016	8995	2799	6443	9940	3301	6537	9656	2667	19
20	2·90916	2·95083	2·99059	3·02861	3·06503	3·09997	3·13356	3·16590	3·19707	3·22716	20
21	0987	5151	9124	2923	6562	3·10054	3411	6643	9758	2765	21
22	1058	5219	9189	2985	6621	0111	3466	6696	9809	2814	22
23	1129	5287	9253	3047	6681	0168	3521	6749	9860	2864	23
24	1200	5354	9318	3108	6740	0225	3576	6801	9911	2913	24
25	1271	5422	9383	3170	6799	0282	3631	6854	9962	2962	25
26	1342	5489	9447	3232	6858	0339	3685	6907	3·20013	3011	26
27	1413	5557	9512	3294	6918	0396	3740	6960	0064	3060	27
28	1484	5624	9576	3355	6977	0453	3795	7012	0114	3109	28
29	1554	5692	9640	3417	7036	0509	3849	7065	0165	3158	29
30	2·91625	2·95759	2·99705	3·03479	3·07095	3·10566	3·13904	3·17117	3·20216	3·23207	30
31	1695	5826	9769	3540	7154	0623	3958	7170	0267	3256	31
32	1766	5893	9833	3602	7213	0680	4013	7223	0317	3305	32
33	1836	5960	9897	3663	7272	0736	4067	7275	0368	3354	33
34	1907	6028	9961	3724	7331	0793	4122	7327	0419	3403	34
35	1977	6095	3·00025	3786	7389	0849	4176	7380	0469	3452	35
36	2047	6162	0089	3847	7448	0906	4231	7432	0520	3501	36
37	2117	6229	0153	3908	7507	0962	4285	7485	0570	3550	37
38	2188	6295	0217	3969	7566	1019	4339	7537	0621	3599	38
39	2258	6362	0281	4031	7625	1075	4393	7589	0671	3647	39
40	2·92328	2·96429	3·00345	3·04092	3·07683	3·11131	3·14448	3·17642	3·20722	3·23696	40
41	2398	6496	0409	4153	7742	1188	4502	7694	0772	3745	41
42	2468	6562	0473	4214	7800	1244	4556	7746	0823	3793	42
43	2537	6629	0536	4275	7859	1300	4610	7798	0873	3842	43
44	2607	6696	0600	4336	7917	1357	4664	7850	0923	3891	44
45	2677	6762	0664	4397	7976	1413	4718	7903	0974	3939	45
46	2747	6829	0727	4458	8034	1469	4772	7955	1024	3988	46
47	2816	6895	0791	4519	8093	1525	4826	8007	1074	4037	47
48	2886	6962	0854	4579	8151	1581	4880	8059	1124	4085	48
49	2955	7028	0918	4640	8209	1637	4934	8111	1175	4134	49
50	2·93025	2·97094	3·00981	3·04701	3·08267	3·11693	3·14988	3·18163	3·21225	3·24182	50
51	3094	7160	1044	4761	8326	1749	5042	8215	1275	4230	51
52	3164	7227	1108	4822	8384	1805	5096	8266	1325	4279	52
53	3233	7293	1171	4883	8442	1861	5150	8318	1375	4327	53
54	3302	7359	1234	4943	8500	1917	5204	8370	1425	4376	54
55	3371	7425	1297	5004	8558	1973	5257	8422	1475	4424	55
56	3440	7491	1360	5064	8616	2028	5311	8474	1525	4472	56
57	3510	7557	1423	5125	8674	2084	5365	8526	1575	4521	57
58	3579	7623	1486	5185	8732	2140	5418	8577	1625	4569	58
59	3648	7688	1549	5245	8790	2195	5472	8629	1675	4617	59
60	3716	7754	1612	5306	8848	2251	5526	8681	1725	4665	60

TABLE XXVI.—Linear Value in Feet of one Second of Arc and its Logarithm, measured along the Meridian.

Latitude.	Length in feet.	Logarithm.	Diff.	Latitude.	Length in feet.	Logarithm.	Diff.
° ′			+	° ′			+
0 0	100·7639	2·0033050		5 0	100·7715	2·0033379	
5	7639	3050	0	5	7718	3390	11
10	7639	3051	1	10	7720	3401	11
15	7639	3051	0	15	7723	3412	11
20	7639	3051	0	20	7726	3424	12
25	7640	3052	1	25	7729	3435	11
30	7640	3054	2	30	7731	3448	13
35	7640	3054	0	35	7734	3459	11
40	7640	3056	2	40	7737	3472	13
45	7641	3057	1	45	7740	3484	12
50	7641	3059	2	50	7743	3497	13
55	7642	3061	2	55	7746	3510	13
1 0	100·7642	2·0033063	2	6 0	100·7749	2·0033522	12
5	7643	3065	2	5	7752	3536	14
10	7643	3068	3	10	7755	3549	13
15	7644	3070	2	15	7758	3563	14
20	7645	3073	3	20	7761	3576	13
25	7645	3076	3	25	7764	3590	14
30	7646	3080	4	30	7768	3604	14
35	7647	3083	3	35	7771	3618	14
40	7648	3087	4	40	7774	3633	15
45	7648	3090	3	45	7778	3647	14
50	7649	3094	4	50	7781	3663	16
55	7650	3098	4	55	7785	3677	14
2 0	100·7651	2·0033103	5	7 0	100·7788	2·0033692	15
5	7652	3107	4	5	7792	3708	16
10	7653	3112	5	10	7795	3723	15
15	7655	3116	4	15	7799	3739	16
20	7656	3122	6	20	7803	3755	16
25	7657	3127	5	25	7806	3770	15
30	7658	3132	5	30	7810	3787	17
35	7660	3138	6	35	7814	3803	16
40	7661	3143	5	40	7818	3820	17
45	7662	3149	6	45	7822	3836	16
50	7664	3156	7	50	7826	3853	17
55	7665	3162	6	55	7830	3871	18
3 0	100·7667	2·0033169	7	8 0	100·7833	2·0033887	16
5	7668	3175	6	5	7838	3905	18
10	7670	3182	7	10	7842	3923	18
15	7671	3189	7	15	7846	3940	17
20	7673	3196	7	20	7850	3959	19
25	7675	3204	8	25	7854	3977	18
30	7676	3211	7	30	7858	3995	18
35	7678	3219	8	35	7863	4013	18
40	7680	3227	8	40	7867	4032	19
45	7682	3235	8	45	7871	4051	19
50	7684	3244	9	50	7876	4070	19
55	7686	3251	7	55	7880	4089	19
4 0	100·7688	2·0033260	9	9 0	100·7885	2·0034108	19
5	7690	3269	9	5	7889	4128	20
10	7692	3278	9	10	7894	4147	19
15	7694	3288	10	15	7898	4168	21
20	7696	3297	9	20	7903	4188	20
25	7699	3306	9	25	7908	4208	20
30	7701	3316	10	30	7913	4228	20
35	7703	3326	10	35	7917	4249	21
40	7706	3336	10	40	7922	4269	20
45	7708	3347	11	45	7927	4290	21
50	7710	3357	10	50	7932	4311	21
55	7713	3368	11	55	7937	4333	22
60	7715	3379	11	60	7942	4354	21

TABLE XXVI.—Linear Value in Feet of one Second of Arc and its Logarithm, measured along the Meridian.

Latitude.		Length in feet.	Logarithm.	Diff.	Latitude.		Length in feet.	Logarithm.	Diff.
°	′			+	°	′			+
10	0	100·7942	2·0034354		15	0	100·8312	2·0035948	
	5	7947	4376	22		5	8319	5979	31
	10	7952	4398	22		10	8326	6011	32
	15	7957	4419	21		15	8334	6042	31
	20	7962	4442	23		20	8341	6074	32
	25	7967	4464	22		25	8349	6107	33
	30	7972	4486	22		30	8356	6139	32
	35	7978	4509	23		35	8364	6172	33
	40	7983	4532	23		40	8371	6204	32
	45	7988	4554	22		45	8379	6237	33
	50	7994	4578	24		50	8386	6270	33
	55	7999	4601	23		55	8394	6303	33
11	0	100·8005	2·0034625	24	16	0	100·8402	2·0036336	33
	5	8010	4648	23		5	8410	6370	34
	10	8016	4672	24		10	8417	6403	33
	15	8021	4696	24		15	8425	6437	34
	20	8027	4720	24		20	8433	6471	34
	25	8032	4745	25		25	8441	6504	33
	30	8038	4769	24		30	8449	6539	35
	35	8044	4794	25		35	8457	6573	34
	40	8050	4819	25		40	8465	6608	35
	45	8055	4844	25		45	8473	6642	34
	50	8061	4869	25		50	8481	6678	36
	55	8067	4894	25		55	8489	6713	35
12	0	100·8073	2·0034919	25	17	0	100·8497	2·0036747	34
	5	8079	4945	26		5	8506	6783	36
	10	8085	4971	26		10	8514	6818	35
	15	8091	4997	26		15	8522	6854	36
	20	8097	5023	26		20	8530	6889	35
	25	8103	5049	26		25	8539	6925	36
	30	8109	5076	27		30	8547	6961	36
	35	8115	5102	26		35	8555	6997	36
	40	8122	5130	28		40	8564	7034	37
	45	8128	5156	26		45	8572	7070	36
	50	8134	5184	28		50	8581	7107	37
	55	8141	5211	27		55	8589	7144	37
13	0	100·8147	2·0035239	28	18	0	100·8598	2·0037181	37
	5	8153	5266	27		5	8607	7218	37
	10	8160	5294	28		10	8615	7255	37
	15	8166	5322	28		15	8624	7292	37
	20	8173	5350	28		20	8633	7330	38
	25	8179	5378	28		25	8641	7367	37
	30	8186	5407	29		30	8650	7405	38
	35	8193	5436	29		35	8659	7443	38
	40	8199	5464	28		40	8668	7481	38
	45	8206	5493	29		45	8677	7519	38
	50	8213	5522	29		50	8686	7558	39
	55	8220	5552	30		55	8694	7596	38
14	0	100·8227	2·0035582	30	19	0	100·8703	2·0037635	39
	5	8233	5611	29		5	8713	7674	39
	10	8240	5641	30		10	8722	7713	39
	15	8247	5671	30		15	8731	7752	39
	20	8254	5701	30		20	8740	7791	39
	25	8261	5731	30		25	8749	7830	39
	30	8268	5762	31		30	8758	7870	40
	35	8275	5792	30		35	8767	7910	40
	40	8283	5823	31		40	8777	7950	40
	45	8290	5854	31		45	8786	7990	40
	50	8297	5885	31		50	8795	8030	40
	55	8304	5916	31		55	8805	8070	40
	60	8312	5948	32		60	8814	8110	40

TABLE XXVI.—Linear Value in Feet of one Second of Arc and its Logarithm, measured along the Meridian.

Latitude.	Length in feet.	Logarithm.	Diff.	Latitude.	Length in feet.	Logarithm.	Diff.
° ′			+	° ′			+
20 0	100·8814	2·0038110		25 0	100·9434	2·0040778	
5	8823	8151	41	5	9445	0826	48
10	8833	8192	41	10	9456	0875	49
15	8842	8232	40	15	9467	0923	48
20	8852	8273	41	20	9479	0972	49
25	8861	8314	41	25	9490	1021	49
30	8871	8356	42	30	9501	1069	48
35	8880	8397	41	35	9513	1119	50
40	8890	8438	41	40	9524	1167	48
45	8900	8480	42	45	9536	1216	49
50	8909	8522	42	50	9547	1266	50
55	8919	8564	42	55	9559	1315	49
21 0	100·8929	2·0038606	42	26 0	100·9570	2·0041365	50
5	8939	8648	42	5	9582	1415	50
10	8949	8690	42	10	9593	1464	49
15	8958	8733	43	15	9605	1514	50
20	8968	8776	43	20	9617	1564	50
25	8978	8818	42	25	9628	1615	51
30	8988	8861	43	30	9640	1665	50
35	8998	8904	43	35	9652	1715	50
40	9008	8947	43	40	9663	1766	51
45	9018	8990	43	45	9675	1816	50
50	9028	9034	44	50	9687	1867	51
55	9038	9077	43	55	9699	1918	51
22 0	100·9049	2·0039121	44	27 0	100·9710	2·0041968	50
5	9059	9165	44	5	9722	2019	51
10	9069	9209	44	10	9734	2071	52
15	9079	9253	44	15	9746	2122	51
20	9090	9297	44	20	9758	2173	51
25	9100	9341	44	25	9770	2225	52
30	9110	9386	45	30	9782	2276	51
35	9121	9430	44	35	9794	2327	51
40	9131	9475	45	40	9806	2380	53
45	9141	9520	45	45	9818	2431	51
50	9152	9565	45	50	9830	2484	53
55	9162	9610	45	55	9842	2535	51
23 0	100·9173	2·0039655	45	28 0	100·9854	2·0042588	53
5	9183	9701	46	5	9867	2640	52
10	9194	9746	45	10	9879	2692	52
15	9204	9791	45	15	9891	2745	53
20	9215	9837	46	20	9903	2797	52
25	9226	9883	46	25	9915	2850	53
30	9236	9929	46	30	9928	2903	53
35	9247	9975	46	35	9940	2956	53
40	9258	2·0040021	46	40	9952	3009	53
45	9269	0068	47	45	9965	3062	53
50	9279	0114	46	50	9977	3115	53
55	9290	0161	47	55	9989	3168	53
24 0	100·9301	2·0040207	46	29 0	101·0002	2·0043221	53
5	9312	0254	47	5	0014	3275	54
10	9323	0302	48	10	0027	3329	54
15	9334	0349	47	15	0039	3382	53
20	9345	0396	47	20	0052	3436	54
25	9356	0443	47	25	0064	3490	54
30	9367	0490	47	30	0077	3544	54
35	9378	0538	48	35	0089	3598	54
40	9389	0586	48	40	0102	3652	54
45	9400	0634	48	45	0115	3706	54
50	9411	0682	48	50	0127	3760	54
55	9422	0729	47	55	0140	3815	55
60	9434	0778	49	60	0153	3869	54

TABLE XXVI.—Linear Value in Feet of one Second of Arc and its Logarithm, measured along the Meridian.

Latitude.	Length in feet.	Logarithm.	Diff.	Latitude.	Length in feet.	Logarithm.	Diff.
° ′				° ′			
30 0	101·0153	2·0043869	+	35 0	101·0949	2·0047292	+
5	0165	3924	55	5	0963	7351	59
10	0178	3979	55	10	0977	7411	60
15	0191	4034	55	15	0990	7469	58
20	0203	4088	54	20	1004	7529	60
25	0216	4144	56	25	1018	7588	59
30	0229	4198	54	30	1032	7648	60
35	0242	4254	56	35	1046	7708	60
40	0255	4309	55	40	1060	7767	59
45	0268	4364	55	45	1074	7827	60
50	0280	4419	55	50	1087	7887	60
55	0293	4475	56	55	1101	7947	60
31 0	101·0306	2·0044531	56	36 0	101·1115	2·0048007	60
5	0319	4586	55	5	1129	8067	60
10	0332	4642	56	10	1143	8127	60
15	0345	4698	56	15	1157	8187	60
20	0358	4754	56	20	1171	8247	60
25	0371	4810	56	25	1185	8307	60
30	0384	4866	56	30	1199	8368	61
35	0397	4922	56	35	1213	8428	60
40	0410	4978	56	40	1227	8489	61
45	0424	5035	57	45	1242	8549	60
50	0437	5091	56	50	1256	8609	60
55	0450	5148	57	55	1270	8670	61
32 0	101·0463	2·0045204	56	37 0	101·1284	2·0048730	60
5	0476	5261	57	5	1298	8791	61
10	0489	5318	57	10	1312	8851	60
15	0503	5375	57	15	1326	8912	61
20	0516	5431	56	20	1340	8972	60
25	0529	5488	57	25	1354	9033	61
30	0542	5545	57	30	1369	9094	61
35	0556	5603	58	35	1383	9155	61
40	0569	5660	57	40	1397	9216	61
45	0582	5717	57	45	1411	9277	61
50	0596	5774	57	50	1425	9338	61
55	0609	5832	58	55	1440	9399	61
33 0	101·0623	2·0045890	58	38 0	101·1454	2·0049461	62
5	0636	5947	57	5	1468	9522	61
10	0649	6005	58	10	1482	9583	61
15	0663	6062	57	15	1497	9644	61
20	0676	6120	58	20	1511	9706	62
25	0690	6178	58	25	1525	9768	62
30	0703	6236	58	30	1540	9828	60
35	0717	6294	58	35	1554	9890	62
40	0730	6352	58	40	1568	9952	62
45	0744	6411	59	45	1583	2·0050013	61
50	0757	6469	58	50	1597	0074	61
55	0771	6527	58	55	1611	0136	62
34 0	101·0784	2·0046585	58	39 0	101·1626	2·0050198	62
5	0798	6644	59	5	1640	0260	62
10	0812	6703	59	10	1654	0321	61
15	0825	6761	58	15	1669	0383	62
20	0839	6820	59	20	1683	0444	61
25	0853	6878	58	25	1698	0507	63
30	0866	6938	60	30	1712	0568	61
35	0880	6996	58	35	1726	0631	63
40	0894	7055	59	40	1741	0692	61
45	0908	7115	60	45	1755	0755	63
50	0921	7173	58	50	1770	0817	62
55	0935	7232	59	55	1784	0879	62
60	0949	7292	60	60	1799	0941	62

TABLE XXVII.—Linear Value in Feet of one Second of Arc and its Logarithm, measured along Parallels of Latitude.

Latitude.	Length in feet.	Diff.	Logarithm.	Diff.	Latitude.	Length in feet.	Diff.	Logarithm.	Diff.
° ′					° ′				
0 0	101·4372	–	2·0061974	–	5 0	101·0538	–	2·0045526	–
5	4371	1	61970	4	5	0409	129	44972	554
10	4368	3	61956	14	10	0278	131	44409	563
15	4363	5	61933	23	15	0145	133	43837	572
20	4355	8	61901	32	20	0010	135	43256	581
25	4346	9	61860	41	25	100·9873	137	42666	590
30	4334	12	61810	50	30	9733	140	42066	600
35	4320	14	61751	59	35	9592	141	41457	609
40	4304	16	61682	69	40	9448	144	40839	618
45	4286	18	61605	77	45	9302	146	40212	627
50	4266	20	61518	87	50	9154	148	39576	636
55	4243	23	61422	96	55	9004	150	38930	646
1 0	101·4219	24	2·0061317	105	6 0	100·8852	152	2·0038275	655
5	4192	27	61203	114	5	8698	154	37611	664
10	4163	29	61080	123	10	8541	157	36938	673
15	4133	30	60947	133	15	8383	158	36255	683
20	4100	33	60806	141	20	8222	161	35563	692
25	4064	36	60655	151	25	8060	162	34862	701
30	4027	37	60496	159	30	7895	165	34152	710
35	3988	39	60327	169	35	7728	167	33432	720
40	3946	42	60149	178	40	7559	169	32703	729
45	3902	44	59962	187	45	7387	172	31965	738
50	3857	45	59765	197	50	7214	173	31218	747
55	3809	48	59560	205	55	7039	175	30461	757
2 0	101·3759	50	2·0059345	215	7 0	100·6861	178	2·0029695	766
5	3706	53	59122	223	5	6681	180	28920	775
10	3652	54	58889	233	10	6500	181	28136	784
15	3596	56	58647	242	15	6316	184	27342	794
20	3539	57	58396	251	20	6130	186	26539	803
25	3476	63	58136	260	25	5941	189	25727	812
30	3413	63	57866	270	30	5751	190	24905	822
35	3348	65	57588	278	35	5559	192	24075	830
40	3281	67	57300	288	40	5364	195	23234	841
45	3212	69	57003	297	45	5168	196	22385	849
50	3141	71	56697	306	50	4969	199	21526	859
55	3067	74	56382	315	55	4768	201	20658	868
3 0	101·2991	76	2·0056058	324	8 0	100·4565	203	2·0019781	877
5	2914	77	55724	334	5	4360	205	18894	887
10	2834	80	55382	342	10	4153	207	17998	896
15	2752	82	55030	352	15	3944	209	17093	905
20	2668	84	54669	361	20	3732	212	16179	914
25	2581	87	54299	370	25	3519	213	15255	924
30	2493	88	53920	379	30	3303	216	14322	933
35	2402	91	53531	389	35	3085	218	13379	943
40	2310	92	53134	397	40	2866	219	12427	952
45	2215	95	52727	407	45	2644	222	11466	961
50	2118	97	52311	416	50	2420	224	10495	971
55	2019	99	51886	425	55	2193	227	09515	980
4 0	101·1918	101	2·0051452	434	9 0	100·1965	228	2·0008526	989
5	1814	104	51009	443	5	1735	230	07527	999
10	1709	105	50556	453	10	1502	233	06519	1008
15	1601	108	50095	461	15	1268	234	05502	1017
20	1492	109	49624	471	20	1031	237	04475	1027
25	1380	112	49144	480	25	0792	239	03439	1036
30	1266	114	48654	490	30	0551	241	02394	1045
35	1150	116	48156	498	35	0308	243	01339	1055
40	1032	118	47648	508	40	0063	245	00274	1065
45	0912	120	47132	516	45	99·9816	247	1·9999201	1073
50	0789	123	46605	527	50	9567	249	98118	1083
55	0665	124	46070	535	55	9315	252	97025	1093
60	0538	127	45526	544	60	9062	253	95923	1102

TABLE XXVII.—Linear Value in Feet of one Second of Arc and its Logarithm, measured along Parallels of Latitude.

Latitude.		Length in feet.	Diff.	Logarithm.	Diff.	Latitude.		Length in feet.	Diff.	Logarithm.	Diff.
°	′		–		–	°	′		–		–
10	0	99·9062	256	1·9995923	1111	15	0	98·0026	380	1·9912378	1687
	5	8806	258	94812	1121		5	97·9646	383	10691	1697
	10	8548	259	93691	1130		10	9263	385	08994	1707
	15	8289	262	92561	1139		15	8878	386	07287	1716
	20	8027	264	91422	1149		20	8492	389	05571	1726
	25	7763	266	90273	1159		25	8103	391	03845	1736
	30	7497	269	89114	1168		30	7712	393	02109	1746
	35	7228	270	87946	1177		35	7319	395	00363	1756
	40	6958	272	86769	1187		40	6924	397	1·9898607	1765
	45	6686	275	85582	1196		45	6527	399	96842	1776
	50	6411	276	84386	1206		50	6128	402	95066	1785
	55	6135		83180			55	5726		93281	
11	0	99·5856	279	1·9981965	1215	16	0	97·5323	403	1·9891486	1795
	5	5575	281	80740	1225		5	4918	405	89681	1805
	10	5292	283	79506	1234		10	4511	407	87866	1815
	15	5007	285	78262	1244		15	4101	410	86041	1825
	20	4720	287	77009	1253		20	3690	411	84206	1835
	25	4431	289	75746	1263		25	3276	414	82361	1845
	30	4140	291	74474	1272		30	2861	415	80507	1854
	35	3846	294	73192	1282		35	2443	418	78642	1865
	40	3551	295	71901	1291		40	2023	420	76768	1874
	45	3253	298	70601	1300		45	1602	421	74883	1885
	50	2954	299	69290	1311		50	1178	424	72989	1894
	55	2652	302	67971	1319		55	0752	426	71084	1905
12	0	99·2348	304	1·9966641	1330	17	0	97·0324	428	1·9869170	1914
	5	2042	306	65302	1339		5	96·9895	429	67245	1925
	10	1734	308	63954	1348		10	9463	432	65311	1934
	15	1424	310	62596	1358		15	9029	434	63366	1945
	20	1112	312	61228	1368		20	8593	436	61412	1954
	25	0798	314	59851	1377		25	8155	438	59447	1965
	30	0482	316	58465	1386		30	7715	440	57473	1974
	35	0163	319	57068	1397		35	7272	443	55488	1985
	40	98·9843	320	55662	1406		40	6828	444	53494	1994
	45	9520	323	54247	1415		45	6382	446	51489	2005
	50	9196	324	52822	1425		50	5934	448	49474	2015
	55	8869	327	51387	1435		55	5484	450	47449	2025
13	0	98·8540	329	1·9949943	1444	18	0	96·5031	453	1·9845414	2035
	5	8209	331	48489	1454		5	4577	454	43369	2045
	10	7876	333	47025	1464		10	4121	456	41314	2055
	15	7541	335	45552	1473		15	3662	459	39249	2065
	20	7204	337	44069	1483		20	3202	460	37173	2076
	25	6865	339	42577	1492		25	2739	463	35087	2086
	30	6524	341	41075	1502		30	2275	464	32992	2095
	35	6180	344	39563	1512		35	1808	467	30886	2106
	40	5835	345	38042	1521		40	1340	468	28770	2116
	45	5487	348	36511	1531		45	0869	471	26643	2127
	50	5138	349	34970	1541		50	0397	472	24507	2136
	55	4786	352	33419	1551		55	95·9922	475	22360	2147
14	0	98·4432	354	1·9931859	1560	19	0	95·9445	477	1·9820203	2157
	5	4077	355	30289	1570		5	8967	478	18036	2167
	10	3719	358	28709	1580		10	8486	481	15858	2178
	15	3359	360	27120	1589		15	8003	483	13671	2187
	20	2997	362	25521	1599		20	7519	484	11473	2198
	25	2633	364	23912	1609		25	7032	487	09265	2208
	30	2267	366	22294	1618		30	6543	489	07046	2219
	35	1898	369	20666	1628		35	6053	490	04818	2228
	40	1528	370	19027	1639		40	5560	493	02578	2240
	45	1156	372	17380	1647		45	5065	495	00329	2249
	50	0781	375	15722	1658		50	4568	497	1·9798069	2260
	55	0405	376	14055	1667		55	4069	499	95799	2270
	60	0026	379	12378	1677		60	3569	500	93519	2280

TABLE XXVII.—Linear Value in Feet of one Second of Arc and its Logarithm, measured along Parallels of Latitude.

Latitude.	Length in feet.	Diff.	Logarithm.	Diff.	Latitude.	Length in feet.	Diff.	Logarithm.	Diff.
20° 0′	95·3569	–	1·9793519	–	25° 0′	91·9879	–	1·9637307	–
5	3066	503	91228	2291	5	9258	621	34372	2935
10	2561	505	88927	2301	10	8634	624	31426	2946
15	2054	507	86616	2311	15	8009	625	28469	2957
20	1545	509	84294	2322	20	7382	627	25500	2969
25	1034	511	81962	2332	25	6752	630	22521	2979
30	0521	513	79619	2343	30	6121	631	19530	2991
35	0006	515	77266	2353	35	5488	633	16528	3002
40	94·9490	516	74902	2364	40	4853	635	13514	3014
45	8971	519	72528	2374	45	4216	637	10489	3025
50	8450	521	70144	2384	50	3577	639	07453	3036
55	7927	523	67749	2395	55	2937	640	04406	3047
21° 0′	94·7402	525	1·9765343	2406	26° 0′	91·2294	643	1·9601348	3058
5	6875	527	62927	2416	5	1649	645	1·9598278	3070
10	6346	529	60501	2426	10	1003	646	95196	3082
15	5815	531	58064	2437	15	0354	649	92104	3092
20	5283	532	55617	2447	20	90·9704	650	89000	3104
25	4748	535	53159	2458	25	9051	653	85884	3116
30	4211	537	50690	2469	30	8397	654	82757	3127
35	3672	539	48211	2479	35	7741	656	79619	3138
40	3131	541	45721	2490	40	7083	658	76470	3149
45	2588	543	43221	2500	45	6423	660	73308	3162
50	2044	544	40710	2511	50	5761	662	70136	3172
55	1497	547	38188	2522	55	5097	664	66951	3185
22° 0′	94·0948	549	1·9735656	2532	27° 0′	90·4431	666	1·9563756	3195
5	0397	551	33114	2542	5	3764	667	60549	3207
10	93·9845	552	30560	2554	10	3094	670	57330	3219
15	9290	555	27996	2564	15	2423	671	54099	3231
20	8733	557	25421	2575	20	1749	674	50857	3242
25	8174	559	22836	2585	25	1074	675	47604	3253
30	7614	560	20239	2597	30	0397	677	44339	3265
35	7051	563	17632	2607	35	89·9718	679	41062	3277
40	6486	565	15015	2617	40	9037	681	37773	3289
45	5920	566	12386	2629	45	8354	683	34473	3300
50	5351	569	09747	2639	50	7669	685	31161	3312
55	4781	570	07097	2650	55	6982	687	27838	3323
23° 0′	93·4208	573	1·9704437	2660	28° 0′	89·6294	688	1·9524503	3335
5	3634	574	01765	2672	5	5603	691	21155	3348
10	3057	577	1·9699083	2682	10	4911	692	17797	3358
15	2479	578	96390	2693	15	4216	695	14426	3371
20	1898	581	93686	2704	20	3520	696	11044	3382
25	1316	582	90971	2715	25	2822	698	07649	3395
30	0732	584	88245	2726	30	2122	700	04243	3406
35	0145	587	85508	2737	35	1420	702	00825	3418
40	92·9557	588	82761	2747	40	0717	703	1·9497396	3429
45	8967	590	80002	2759	45	0011	706	93954	3442
50	8375	592	77233	2769	50	88·9304	707	90500	3454
55	7781	594	74453	2780	55	8594	710	87035	3465
24° 0′	92·7184	597	1·9671662	2791	29° 0′	88·7883	711	1·9483557	3478
5	6586	598	68859	2803	5	7170	713	80068	3489
10	5986	600	66046	2813	10	6455	715	76566	3502
15	5384	602	63222	2824	15	5738	717	73053	3513
20	4781	603	60387	2835	20	5019	719	69527	3526
25	4175	606	57541	2846	25	4299	720	65989	3538
30	3567	608	54683	2858	30	3576	723	62440	3549
35	2957	610	51815	2868	35	2852	724	58878	3562
40	2345	612	48936	2879	40	2126	726	55304	3574
45	1733	613	46045	2891	45	1397	729	51718	3586
50	1116	616	43144	2901	50	0668	729	48120	3598
55	0499	617	40231	2913	55	87·9936	732	44509	3611
60	91·9879	620	37307	2924	60	9202	734	40887	3622

TABLE XXVII.—Linear Value in Feet of one Second of Arc and its Logarithm, measured along Parallels of Latitude.

Latitude. ° ′	Lenght in feet.	Diff.	Logarithm.	Diff.	Latitude. ° ′	Length in feet.	Diff.	Logarithm.	Diff.
30 0	87·9202	–	1·9440887	–	35 0	83·1834	–	1·9200366	–
5	8467	735	37252	3635	5	0990	844	1·9195956	4410
10	7729	738	33605	3647	10	0144	846	91533	4423
15	6990	739	29946	3659	15	82·9296	848	87095	4438
20	6249	741	26274	3672	20	8446	850	82644	4451
25	5506	743	22590	3684	25	7595	851	78179	4465
30	4761	745	18894	3696	30	6742	853	73700	4479
35	4014	747	15186	3708	35	5887	855	69208	4492
40	3266	748	11465	3721	40	5031	856	64701	4507
45	2515	751	07731	3734	45	4172	859	60181	4520
50	1763	752	03986	3745	50	3312	860	55647	4534
55	1009	754	00227	3759	55	2451	861	51098	4549
31 0	87·0253	756	1·9396457	3770	36 0	82·1587	864	1·9146536	4562
5	86·9496	757	92674	3783	5	0722	865	41960	4576
10	8736	760	88878	3796	10	81·9855	867	37370	4590
15	7975	761	85070	3808	15	8986	869	32765	4605
20	7211	764	81250	3820	20	8116	870	28147	4618
25	6446	765	77416	3834	25	7243	873	23514	4633
30	5679	767	73571	3845	30	6369	874	18867	4647
35	4911	768	69712	3859	35	5494	875	14206	4661
40	4140	771	65841	3871	40	4616	878	09531	4675
45	3368	772	61957	3884	45	3737	879	04841	4690
50	2593	775	58061	3896	50	2856	881	00138	4703
55	1817	776	54152	3909	55	1974	882	1·9095419	4719
32 0	86·1039	778	1·9350230	3922	37 0	81·1089	885	1·9090687	4732
5	0260	779	46296	3934	5	0203	886	85940	4747
10	85·9478	782	42348	3948	10	80·9316	887	81179	4761
15	8695	783	38388	3960	15	8426	890	76403	4776
20	7910	785	34416	3972	20	7535	891	71613	4790
25	7123	787	30430	3986	25	6642	893	66808	4805
30	6334	789	26431	3999	30	5747	895	61989	4819
35	5543	791	22420	4011	35	4851	896	57155	4834
40	4751	792	18395	4025	40	3953	898	52307	4848
45	3957	794	14358	4037	45	3053	900	47443	4864
50	3161	796	10308	4050	50	2152	901	42566	4877
55	2363	798	06244	4064	55	1249	903	37673	4893
33 0	85·1563	800	1·9302168	4076	38 0	80·0344	905	1·9032766	4907
5	0762	801	1·9298079	4089	5	79·9437	907	27844	4922
10	84·9958	804	93976	4103	10	8529	908	22907	4937
15	9153	805	89861	4115	15	7619	910	17955	4952
20	8346	807	85732	4129	20	6707	912	12989	4966
25	7538	808	81590	4142	25	5794	913	08007	4982
30	6727	811	77435	4155	30	4879	915	03011	4996
35	5915	812	73267	4168	35	3962	917	1·8997999	5012
40	5101	814	69086	4181	40	3044	918	92973	5026
45	4285	816	64891	4195	45	2124	920	87931	5042
50	3468	817	60684	4207	50	1202	922	82875	5056
55	2648	820	56462	4222	55	0279	923	77803	5072
34 0	84·1827	821	1·9252228	4234	39 0	78·9354	925	1·8972716	5087
5	1004	823	47980	4248	5	8427	927	67614	5102
10	0179	825	43719	4261	10	7498	929	62497	5117
15	83·9353	826	39445	4274	15	6568	930	57364	5133
20	8524	829	35157	4288	20	5636	932	52216	5148
25	7694	830	30855	4302	25	4703	933	47053	5163
30	6862	832	26540	4315	30	3768	935	41874	5179
35	6029	833	22212	4328	35	2831	937	36680	5194
40	5193	836	17870	4342	40	1892	939	31471	5209
45	4356	837	13515	4355	45	0952	940	26246	5225
50	3517	839	09145	4370	50	0011	941	21005	5241
55	2676	841	04763	4382	55	77·9067	944	15749	5256
60	1834	842	00366	4397	60	8122	945	10478	5271

TABLE XXVIII.—Arc-versines of Spheroidal Arcs of Parallel 1° in length.

Parallel of Latitude.		Arc-versine in seconds.	Arc-versine in feet.	Arc-ver. in sec. $\overline{(3600)^2}$. Logarithm.	Parallel of Latitude.		Arc-versine in seconds.	Arc-versine in feet.	Arc-ver. in sec. $\overline{(3600)^2}$. Logarithm.
°	′				°	′			
0	0	0·00	0·0	−Infinite	5	0	2·75	276·7	$\bar{7}$·3261
	5	05	4·6	$\bar{9}$·5501		5	79	281·3	3332
	10	09	9·3	8512		10	84	285·8	3401
	15	14	13·9	$\bar{8}$·0273		15	88	290·4	3470
	20	18	18·5	1522		20	93	294·9	3538
	25	23	23·2	2491		25	97	299·5	3604
	30	28	27·8	3283		30	3·02	304·0	3670
	35	32	32·4	3952		35	06	308·6	3734
	40	37	37·1	4532		40	11	313·1	3798
	45	41	41·7	5043		45	15	317·7	3860
	50	46	46·3	5501		50	20	322·2	3922
	55	51	51·0	5915		55	24	326·8	3983
1	0	0·55	55·6	$\bar{8}$·6292	6	0	3·29	331·3	$\bar{7}$·4043
	5	60	60·2	6640		5	33	335·8	4102
	10	64	64·9	6961		10	38	340·4	4160
	15	69	69·5	7261		15	42	344·9	4217
	20	74	74·1	7541		20	47	349·4	4274
	25	78	78·8	7804		25	51	353·9	4329
	30	83	83·4	8052		30	56	358·4	4385
	35	87	88·0	8287		35	60	363·0	4439
	40	92	92·6	8509		40	65	367·5	4493
	45	97	97·3	8721		45	69	372·0	4545
	50	1·01	101·9	8923		50	74	376·5	4598
	55	06	106·5	9115		55	78	381·0	4649
2	0	1·10	111·1	$\bar{8}$·9300	7	0	3·83	385·5	$\bar{7}$·4700
	5	15	115·8	9477		5	87	390·0	4751
	10	19	120·4	9647		10	91	394·5	4800
	15	24	125·0	9810		15	96	399·0	4850
	20	29	129·6	9968		20	4·00	403·5	4898
	25	33	134·3	$\bar{7}$·0120		25	05	407·9	4946
	30	38	138·9	0267		30	09	412·4	4994
	35	42	143·5	0409		35	14	416·9	5040
	40	47	148·1	0546		40	18	421·4	5087
	45	52	152·7	0680		45	23	425·8	5132
	50	56	157·3	0809		50	27	430·3	5178
	55	61	161·9	0934		55	31	434·8	5223
3	0	1·65	166·6	$\bar{7}$·1056	8	0	4·36	439·2	$\bar{7}$·5267
	5	70	171·2	1175		5	40	443·7	5311
	10	74	175·8	1290		10	45	448·1	5354
	15	79	180·4	1403		15	49	452·6	5397
	20	84	185·0	1512		20	53	457·0	5439
	25	88	189·6	1619		25	58	461·4	5481
	30	93	194·2	1723		30	62	465·9	5523
	35	97	198·8	1825		35	67	470·3	5564
	40	2·02	203·4	1924		40	71	474·7	5605
	45	06	208·0	2021		45	75	479·2	5645
	50	11	212·6	2116		50	80	483·6	5685
	55	16	217·2	2209		55	84	488·0	5724
4	0	2·20	221·8	$\bar{7}$·2299	9	0	4·89	492·4	$\bar{7}$·5763
	5	25	226·3	2388		5	93	496·8	5802
	10	29	230·9	2476		10	97	501·2	5840
	15	34	235·5	2561		15	5·02	505·6	5878
	20	38	240·1	2645		20	06	510·0	5916
	25	43	244·7	2727		25	10	514·4	5953
	30	47	249·3	2807		30	15	518·8	5990
	35	52	253·8	2886		35	19	523·2	6026
	40	56	258·4	2964		40	23	527·6	6062
	45	61	263·0	3040		45	28	531·9	6098
	50	66	267·6	3115		50	32	536·3	6134
	55	70	272·1	3188		55	36	540·7	6169
	60	75	276·7	3261		60	41	545·0	6204

TABLE XXVIII.—Arc-versines of Spheroidal Arcs of Parallel 1° in length.

Parallel of Latitude.	Arc-versine in seconds	Arc-versine in feet.	Arc-ver. in sec. / $(3600)^2$. Logarithm.	Parallel of Latitude.	Arc-versine in seconds	Arc-versine in feet.	Arc-ver. in sec. / $(3600)^2$. Logarithm.
° ′				° ′			
10 0	5·41	545·0	$\bar{7}$·6204	15 0	7·90	796·8	$\bar{7}$·7852
5	45	549·4	6238	5	94	800·9	7874
10	49	553·7	6272	10	98	804·9	7895
15	54	558·1	6306	15	8·02	808·9	7917
20	58	562·4	6340	20	06	812·9	7938
25	62	566·7	6373	25	10	816·8	7959
30	67	571·1	6406	30	14	820·8	7980
35	71	575·4	6439	35	18	824·8	8001
40	75	579·7	6472	40	22	828·8	8022
45	79	584·0	6504	45	26	832·7	8043
50	84	588·3	6536	50	30	836·7	8063
55	88	592·7	6567	55	34	840·6	8084
11 0	5·92	597·0	$\bar{7}$·6599	16 0	8·38	844·6	$\bar{7}$·8104
5	96	601·2	6630	5	41	848·5	8124
10	6·01	605·5	6661	10	45	852·4	8144
15	05	609·8	6691	15	49	856·3	8164
20	09	614·1	6722	20	53	860·2	8184
25	13	618·4	6752	25	57	864·1	8203
30	18	622·7	6782	30	61	868·0	8223
35	22	626·9	6811	35	65	871·9	8242
40	26	631·2	6841	40	68	875·8	8261
45	30	635·4	6870	45	72	879·7	8280
50	35	639·7	6899	50	76	883·5	8299
55	39	643·9	6927	55	80	887·4	8318
12 0	6·43	648·2	$\bar{7}$·6956	17 0	8·84	891·2	$\bar{7}$·8337
5	47	652·4	6984	5	88	895·1	8356
10	51	656·6	7012	10	91	898·9	8374
15	56	660·9	7040	15	95	902·7	8393
20	60	665·1	7068	20	99	906·6	8411
25	64	669·3	7095	25	9·03	910·4	8429
30	68	673·5	7122	30	06	914·2	8447
35	72	677·7	7149	35	10	918·0	8465
40	76	681·9	7176	40	14	921·8	8483
45	81	686·1	7202	45	18	925·5	8501
50	85	690·2	7229	50	21	929·3	8518
55	89	694·4	7255	55	25	933·1	8536
13 0	6·93	698·6	$\bar{7}$·7281	18 0	9·29	936·8	$\bar{7}$·8553
5	97	702·8	7307	5	33	940·6	8571
10	7·01	706·9	7332	10	36	944·3	8588
15	05	711·1	7358	15	40	948·1	8605
20	09	715·2	7383	20	44	951·8	8622
25	14	719·4	7408	25	47	955·5	8639
30	18	723·5	7433	30	51	959·2	8656
35	22	727·6	7458	35	55	962·9	8672
40	26	731·7	7482	40	58	966·6	8689
45	30	735·9	7506	45	62	970·3	8705
50	34	740·0	7531	50	66	974·0	8722
55	38	744·1	7555	55	69	977·6	8738
14 0	7·42	748·2	$\bar{7}$·7578	19 0	9·73	981·3	$\bar{7}$·8754
5	46	752·3	7602	5	76	984·9	8770
10	50	756·4	7626	10	80	988·6	8786
15	54	760·4	7649	15	84	992·2	8802
20	58	764·5	7672	20	87	995·9	8818
25	62	768·6	7695	25	91	999·5	8834
30	66	772·6	7718	30	94	1003·1	8849
35	70	776·7	7741	35	98	1006·7	8865
40	74	780·7	7763	40	10·01	1010·3	8880
45	78	784·8	7786	45	05	1013·9	8896
50	82	788·8	7808	50	09	1017·4	8911
55	86	792·8	7830	55	12	1021·0	8926
60	90	796·8	7852	60	16	1024·6	8941

TABLE XXVIII.—Arc-versines of Spheroidal Arcs of Parallel 1° in length.

Parallel of Latitude.	Arc-versine in seconds.	Arc-versine in feet.	Arc-ver. in sec. $\overline{(3600)^2}$. Logarithm.	Parallel of Latitude.	Arc-versine in seconds.	Arc-versine in feet.	Arc-ver. in sec. $(3600)^2$. Logarithm.
° ′				° ′			
20 0	10·16	1024·6	$\bar{7}$·8941	25 0	12·10	1221·3	$\bar{7}$·9701
5	19	1028·1	8956	5	13	1224·3	9712
10	23	1031·7	8971	10	16	1227·2	9722
15	26	1035·2	8986	15	19	1230·2	9733
20	30	1038·7	9001	20	22	1233·1	9743
25	33	1042·2	9015	25	24	1236·1	9753
30	37	1045·7	9030	30	27	1239·0	9764
35	40	1049·2	9044	35	30	1241·9	9774
40	43	1052·7	9059	40	33	1244·8	9784
45	47	1056·2	9073	45	36	1247·7	9794
50	50	1059·7	9087	50	39	1250·6	9804
55	54	1063·1	9101	55	42	1253·5	9814
21 0	10·57	1066·6	$\bar{7}$·9115	26 0	12·44	1256·4	$\bar{7}$·9824
5	61	1070·0	9129	5	47	1259·2	9834
10	64	1073·5	9143	10	50	1262·1	9843
15	67	1076·9	9157	15	53	1264·9	9853
20	71	1080·3	9171	20	56	1267·7	9863
25	74	1083·7	9184	25	58	1270·5	9872
30	77	1087·1	9198	30	61	1273·3	9882
35	81	1090·5	9211	35	64	1276·1	9891
40	84	1093·9	9225	40	67	1278·9	9901
45	87	1097·3	9238	45	69	1281·7	9910
50	91	1100·6	9251	50	72	1284·4	9919
55	94	1104·0	9265	55	75	1287·2	9928
22 0	10·97	1107·3	$\bar{7}$·9278	27 0	12·78	1289·9	$\bar{7}$·9937
5	11·01	1110·7	9291	5	80	1292·6	9947
10	04	1114·0	9304	10	83	1295·3	9956
15	07	1117·3	9316	15	86	1298·1	9965
20	11	1120·6	9329	20	88	1300·7	9974
25	14	1123·9	9342	25	91	1303·4	9983
30	17	1127·2	9355	30	93	1306·1	9991
35	20	1130·5	9367	35	96	1308·8	$\bar{6}$·0000
40	23	1133·7	9380	40	99	1311·4	0009
45	27	1137·0	9392	45	13·01	1314·0	0018
50	30	1140·3	9404	50	04	1316·7	0026
55	33	1143·5	9417	55	06	1319·3	0035
23 0	11·36	1146·7	$\bar{7}$·9429	28 0	13·09	1321·9	$\bar{6}$·0043
5	39	1149·9	9441	5	12	1324·5	0052
10	43	1153·1	9453	10	14	1327·1	0060
15	46	1156·3	9465	15	17	1329·6	0069
20	49	1159·5	9477	20	19	1332·2	0077
25	52	1162·7	9489	25	22	1334·7	0085
30	55	1165·9	9501	30	24	1337·3	0093
35	58	1169·1	9512	35	27	1339·8	0101
40	61	1172·2	9524	40	29	1342·3	0109
45	65	1175·4	9536	45	32	1344·8	0118
50	68	1178·5	9547	50	34	1347·3	0126
55	71	1181·6	9559	55	36	1349·8	0133
24 0	11·74	1184·7	$\bar{7}$·9570	29 0	13·39	1352·3	$\bar{6}$·0141
5	77	1187·8	9581	5	41	1354·7	0149
10	80	1190·9	9592	10	44	1357·2	0157
15	83	1194·0	9604	15	46	1359·6	0165
20	86	1197·1	9615	20	48	1362·0	0172
25	89	1200·1	9626	25	51	1364·4	0180
30	92	1203·2	9637	30	53	1366·8	0188
35	95	1206·2	9648	35	56	1369·2	0195
40	98	1209·3	9659	40	58	1371·6	0203
45	12·01	1212·3	9669	45	60	1374·0	0210
50	04	1215·3	9680	50	63	1376·3	0217
55	07	1218·3	9691	55	65	1378·7	0225
60	10	1221·3	9701	60	67	1381·0	0232

TABLE XXVIII.—Arc-versines of Spheroidal Arcs of Parallel 1° in length.

Parallel of Latitude.	Arc-versine in seconds.	Arc-versine in feet.	Arc-ver. in sec. $\frac{}{(3600)^2}$. Logarithm.	Parallel of Latitude.	Arc-versine in seconds.	Arc-versine in feet.	Arc-ver. in sec. $\frac{}{(3600)^2}$. Logarithm.
° ′				° ′			
30 0	13·67	1381·0	$\bar{6}$·0232	35 0	14·83	1498·9	$\bar{6}$·0584
5	69	1383·3	0239	5	84	1500·5	0589
10	72	1385·6	0246	10	86	1502·0	0593
15	74	1387·9	0254	15	87	1503·6	0598
20	76	1390·2	0261	20	89	1505·1	0602
25	78	1392·5	0268	25	90	1506·7	0607
30	81	1394·7	0275	30	92	1508·2	0611
35	83	1397·0	0282	35	93	1509·7	0615
40	85	1399·2	0289	40	95	1511·2	0619
45	87	1401·4	0295	45	96	1512·7	0624
50	89	1403·7	0302	50	98	1514·2	0628
55	92	1405·9	0309	55	99	1515·6	0632
31 0	13·94	1408·1	$\bar{6}$·0316	36 0	15·00	1517·1	$\bar{6}$·0636
5	96	1410·2	0322	5	02	1518·7	0641
10	98	1412·4	0329	10	03	1520·1	0645
15	14·00	1414·5	0335	15	05	1521·5	0649
20	02	1416·7	0342	20	06	1522·9	0652
25	04	1418·8	0348	25	07	1524·3	0656
30	06	1420·9	0355	30	09	1525·7	0660
35	08	1423·0	0361	35	10	1527·0	0664
40	10	1425·1	0368	40	11	1528·4	0668
45	13	1427·2	0374	45	13	1529·7	0672
50	15	1429·3	0380	50	14	1531·0	0675
55	17	1431·4	0386	55	15	1532·3	0679
32 0	14·19	1433·4	$\bar{6}$·0392	37 0	15·17	1533·6	$\bar{6}$·0682
5	21	1435·4	0399	5	18	1534·9	0686
10	23	1437·5	0405	10	19	1536·2	0690
15	25	1439·5	0411	15	20	1537·4	0693
20	26	1441·5	0417	20	21	1538·7	0696
25	28	1443·4	0422	25	23	1539·9	0700
30	30	1445·4	0428	30	24	1541·1	0703
35	32	1447·4	0434	35	25	1542·3	0707
40	34	1449·3	0440	40	26	1543·5	0710
45	36	1451·3	0446	45	27	1544·7	0713
50	38	1453·2	0451	50	28	1545·8	0716
55	40	1455·1	0457	55	29	1547·0	0719
33 0	14·42	1457·0	$\bar{6}$·0463	38 0	15·31	1548·1	$\bar{6}$·0723
5	44	1458·9	0468	5	32	1549·2	0726
10	45	1460·8	0474	10	33	1550·4	0729
15	47	1462·6	0479	15	34	1551·5	0732
20	49	1464·5	0485	20	35	1552·5	0735
25	51	1466·3	0490	25	36	1553·6	0738
30	53	1468·1	0495	30	37	1554·7	0740
35	54	1470·0	0501	35	38	1555·7	0743
40	56	1471·7	0506	40	39	1556·7	0746
45	58	1473·5	0511	45	40	1557·8	0749
50	60	1475·3	0516	50	41	1558·8	0752
55	61	1477·1	0521	55	42	1559·8	0754
34 0	14·63	1478·8	$\bar{6}$·0527	39 0	15·43	1560·7	$\bar{6}$·0757
5	65	1480·6	0532	5	44	1561·7	0760
10	66	1482·3	0537	10	45	1562·7	0762
15	68	1484·0	0542	15	46	1563·6	0765
20	70	1485·7	0546	20	46	1564·5	0767
25	71	1487·4	0551	25	47	1565·4	0770
30	73	1489·1	0556	30	48	1566·3	0772
35	75	1490·7	0561	35	49	1567·2	0775
40	76	1492·4	0566	40	50	1568·1	0777
45	78	1494·0	0570	45	51	1568·9	0779
50	79	1495·6	0575	50	52	1569·8	0782
55	81	1497·3	0580	55	52	1570·6	0784
60	83	1498·9	0584	60	53	1571·4	0786

TABLE XXIX.—Linear Value in Miles of a Degree of Arc measured along the Meridian.

Mean Latitude.	Meridional Degrees in Miles.	Difference.	Mean Latitude.	Meridional Degrees in Miles.	Difference.
°		+	°		+
0	68·7027		23	68·8072	
1	68·7029	2	24	68·8160	88
2	68·7035	6	25	68·8250	90
3	68·7045	10	26	68·8343	93
4	68·7060	15	27	68·8439	96
5	68·7078	18	28	68·8537	98
6	68·7101	23	29	68·8638	101
7	68·7128	27	30	68·8740	102
8	68·7159	31	31	68·8845	105
9	68·7194	35	32	68·8952	107
10	68·7233	39	33	68·9061	109
11	68·7276	43	34	68·9171	110
12	68·7322	46	35	68·9283	112
13	68·7373	51	36	68·9397	114
14	68·7427	54	37	68·9511	114
15	68·7485	58	38	68·9628	117
16	68·7547	62	39	68·9745	117
17	68·7612	65	40	68·9862	117
18	68·7680	68	41	68·9982	120
19	68·7752	72	42	69·0101	119
20	68·7828	76	43	69·0220	119
21	68·7906	78	44	69·0341	121
22	68·7988	82	45	69·0461	120
23	68·8072	84	46	69·0581	120

TABLE XXX.—Linear Value in Miles of a Degree of Arc measured along Parallels of Latitude.

Latitude.	Longitudinal Degrees in Miles.	Difference.	Latitude.	Longitudinal Degrees in Miles.	Difference.
°		−	°		−
0	69·1618		23	63·6960	
1	69·1513	105	24	63·2171	4789
2	69·1199	314	25	62·7190	4981
3	69·0676	523	26	62·2019	5171
4	68·9944	732	27	61·6658	5361
5	68·9003	941	28	61·1109	5549
6	68·7854	1149	29	60·5375	5734
7	68·6496	1358	30	59·9456	5919
8	68·4931	1565	31	59·3355	6101
9	68·3158	1773	32	58·7072	6283
10	68·1179	1979	33	58·0611	6461
11	67·8993	2186	34	57·3973	6638
12	67·6601	2392	35	56·7160	6813
13	67·4005	2596	36	56·0173	6987
14	67·1204	2801	37	55·3015	7158
15	66·8200	3004	38	54·5689	7326
16	66·4993	3207	39	53·8196	7493
17	66·1585	3408	40	53·0538	7658
18	65·7976	3609	41	52·2718	7820
19	65·4168	3808	42	51·4737	7981
20	65·0160	4008	43	50·6600	8137
21	64·5956	4204	44	49·8307	8293
22	64·1556	4400	45	48·9861	8446
23	63·6960	4596	46	48·1265	8596

TABLE XXXI.—Graticules of maps.—Sides and Diagonals of Squares of $\frac{1}{8}$th of a Degree of Latitude and Longitude, on the Scale of 1 Inch to $\frac{1}{2}$ a mile.

Latitude.								Length in Inches.			
								m on Meridian.	*n* on Lower Parallel.	*p* on Upper Parallel.	*q* on Diagonal.
	°	′	″		°	′	″				
From	0	0	0	to	0	7	30	17·176	17·290	17·290	24·371
	0	7	30	„	0	15	0	176	290	290	371
	0	15	0	„	0	22	30	176	290	290	371
	0	22	30	„	0	30	0	176	290	290	371
	0	30	0	„	0	37	30	176	290	289	371
	0	37	30	„	0	45	0	176	289	289	370
	0	45	0	„	0	52	30	176	289	288	370
	0	52	30	„	1	0	0	176	288	288	370
	1	0	0	„	1	7	30	17·176	17·288	17·287	24·369
	1	7	30	„	1	15	0	176	287	286	369
	1	15	0	„	1	22	30	176	286	285	368
	1	22	30	„	1	30	0	176	285	285	368
	1	30	0	„	1	37	30	176	285	284	367
	1	37	30	„	1	45	0	176	284	282	366
	1	45	0	„	1	52	30	176	282	281	365
	1	52	30	„	2	0	0	176	281	280	365
	2	0	0	„	2	7	30	17·176	17·280	17·279	24·364
	2	7	30	„	2	15	0	176	279	277	363
	2	15	0	„	2	22	30	176	277	276	362
	2	22	30	„	2	30	0	176	276	274	361
	2	30	0	„	2	37	30	176	274	272	359
	2	37	30	„	2	45	0	176	272	271	358
	2	45	0	„	2	52	30	176	271	269	357
	2	52	30	„	3	0	0	176	269	267	356
	3	0	0	„	3	7	30	17·176	17·267	17·265	24·354
	3	7	30	„	3	15	0	176	265	263	353
	3	15	0	„	3	22	30	176	263	261	351
	3	22	30	„	3	30	0	176	261	258	350
	3	30	0	„	3	37	30	176	258	256	348
	3	37	30	„	3	45	0	176	256	254	347
	3	45	0	„	3	52	30	176	254	251	345
	3	52	30	„	4	0	0	176	251	249	343
	4	0	0	„	4	7	30	17·177	17·249	17·246	24·341
	4	7	30	„	4	15	0	177	246	243	339
	4	15	0	„	4	22	30	177	243	240	338
	4	22	30	„	4	30	0	177	240	237	336
	4	30	0	„	4	37	30	177	237	235	334
	4	37	30	„	4	45	0	177	235	231	331
	4	45	0	„	4	52	30	177	231	228	329
	4	52	30	„	5	0	0	177	228	225	327
	5	0	0	„	5	7	30	17·177	17·225	17·222	24·325
	5	7	30	„	5	15	0	177	222	218	322
	5	15	0	„	5	22	30	177	218	215	320
	5	22	30	„	5	30	0	177	215	211	318
	5	30	0	„	5	37	30	177	211	208	315
	5	37	30	„	5	45	0	177	208	204	313
	5	45	0	„	5	52	30	177	204	200	310
	5	52	30	„	6	0	0	177	200	196	307
	6	0	0	„	6	7	30	17·178	17·196	17·192	24·305
	6	7	30	„	6	15	0	178	192	188	302
	6	15	0	„	6	22	30	178	188	184	299
	6	22	30	„	6	30	0	178	184	180	296
	6	30	0	„	6	37	30	178	180	176	293
	6	37	30	„	6	45	0	178	176	171	290
	6	45	0	„	6	52	30	178	171	167	287
	6	52	30	„	7	0	0	178	167	162	284
	7	0	0	„	7	7	30	17·178	17·162	17·158	24·281
	7	7	30	„	7	15	0	178	158	153	278
	7	15	0	„	7	22	30	178	153	148	274
	7	22	30	„	7	30	0	179	148	143	271
	7	30	0	„	7	37	30	179	143	139	268
	7	37	30	„	7	45	0	179	139	134	264
	7	45	0	„	7	52	30	179	134	128	261
	7	52	30	„	8	0	0	179	128	123	257

TABLE XXXI.—Graticules of maps.—Sides and Diagonals of Squares of ⅛th of a Degree of Latitude and Longitude, on the Scale of 1 Inch to ½ a mile.

Latitude.								Length in Inches.			
								m on Meridian.	*n* on Lower Parallel.	*p* on Upper Parallel.	*q* on Diagonal.
	°	′	″		°	′	″				
From	8	0	0	to	8	7	30	17·179	17·123	17·118	24·254
	8	7	30	,,	8	15	0	179	118	113	250
	8	15	0	,,	8	22	30	179	113	107	246
	8	22	30	,,	8	30	0	179	107	102	242
	8	30	0	,,	8	37	30	179	102	096	239
	8	37	30	,,	8	45	0	180	096	091	235
	8	45	0	,,	8	52	30	180	091	085	231
	8	52	30	,,	9	0	0	180	085	079	227
	9	0	0	,,	9	7	30	17·180	17·079	17·073	24·223
	9	7	30	,,	9	15	0	180	073	067	219
	9	15	0	,,	9	22	30	180	067	061	214
	9	22	30	,,	9	30	0	180	061	055	210
	9	30	0	,,	9	37	30	180	055	049	206
	9	37	30	,,	9	45	0	181	049	042	202
	9	45	0	,,	9	52	30	181	042	036	197
	9	52	30	,,	10	0	0	181	036	029	193
	10	0	0	,,	10	7	30	17·181	17·029	17·023	24·188
	10	7	30	,,	10	15	0	181	023	016	184
	10	15	0	,,	10	22	30	181	016	010	179
	10	22	30	,,	10	30	0	181	010	003	175
	10	30	0	,,	10	37	30	181	003	16·996	170
	10	37	30	,,	10	45	0	182	16·996	989	165
	10	45	0	,,	10	52	30	182	989	982	160
	10	52	30	,,	11	0	0	182	982	975	155
	11	0	0	,,	11	7	30	17·182	16·975	16·968	24·150
	11	7	30	,,	11	15	0	182	968	960	145
	11	15	0	,,	11	22	30	182	960	953	140
	11	22	30	,,	11	30	0	182	953	946	135
	11	30	0	,,	11	37	30	183	946	938	130
	11	37	30	,,	11	45	0	183	938	930	125
	11	45	0	,,	11	52	30	183	930	923	120
	11	52	30	,,	12	0	0	183	923	915	114
	12	0	0	,,	12	7	30	17·183	16·915	16·907	24·109
	12	7	30	,,	12	15	0	183	907	899	104
	12	15	0	,,	12	22	30	183	899	891	098
	12	22	30	,,	12	30	0	184	891	883	093
	12	30	0	,,	12	37	30	184	883	875	087
	12	37	30	,,	12	45	0	184	875	867	081
	12	45	0	,,	12	52	30	184	867	859	076
	12	52	30	,,	13	0	0	184	859	850	070
	13	0	0	,,	13	7	30	17·184	16·850	16·842	24·064
	13	7	30	,,	13	15	0	185	842	833	058
	13	15	0	,,	13	22	30	185	833	824	052
	13	22	30	,,	13	30	0	185	824	816	047
	13	30	0	,,	13	37	30	185	816	807	041
	13	37	30	,,	13	45	0	185	807	798	035
	13	45	0	,,	13	52	30	185	798	789	028
	13	52	30	,,	14	0	0	186	789	780	022
	14	0	0	,,	14	7	30	17·186	16·780	16·771	24·016
	14	7	30	,,	14	15	0	186	771	762	010
	14	15	0	,,	14	22	30	186	762	753	003
	14	22	30	,,	14	30	0	186	753	743	23·997
	14	30	0	,,	14	37	30	186	743	734	991
	14	37	30	,,	14	45	0	187	734	724	984
	14	45	0	,,	14	52	30	187	724	715	978
	14	52	30	,,	15	0	0	187	715	705	971
	15	0	0	,,	15	7	30	17·187	16·705	16·695	23·964
	15	7	30	,,	15	15	0	187	695	685	958
	15	15	0	,,	15	22	30	188	685	676	951
	15	22	30	,,	15	30	0	188	676	666	944
	15	30	0	,,	15	37	30	188	666	655	937
	15	37	30	,,	15	45	0	188	655	645	931
	15	45	0	,,	15	52	30	188	645	635	924
	15	52	30	,,	16	0	0	189	635	625	917

TABLE XXXI.—Graticules of maps.—Sides and Diagonals of Squares of $\frac{1}{8}$th of a Degree of Latitude and Longitude, on the Scale of 1 Inch to $\frac{1}{2}$ a mile.

Latitude.								Length in Inches.			
								m on Meridian.	*n* on Lower Parallel.	*p* on Upper Parallel.	*q* on Diagonal.
	°	′	″		°	′	″				
From	16	0	0	to	16	7	30	17·189	16·625	16·614	23·910
	16	7	30	„	16	15	0	189	614	604	902
	16	15	0	„	16	22	30	189	604	593	895
	16	22	30	„	16	30	0	189	593	583	888
	16	30	0	„	16	37	30	190	583	572	881
	16	37	30	„	16	45	0	190	572	561	874
	16	45	0	„	16	52	30	190	561	551	866
	16	52	30	„	17	0	0	190	551	540	859
	17	0	0	„	17	7	30	17·190	16·540	16·529	23·851
	17	7	30	„	17	15	0	191	529	518	844
	17	15	0	„	17	22	30	191	518	506	836
	17	22	30	„	17	30	0	191	506	495	829
	17	30	0	„	17	37	30	191	495	484	821
	17	37	30	„	17	45	0	191	484	472	813
	17	45	0	„	17	52	30	192	472	461	806
	17	52	30	„	18	0	0	192	461	449	798
	18	0	0	„	18	7	30	17·192	16·449	16·438	23·790
	18	7	30	„	18	15	0	192	438	426	782
	18	15	0	„	18	22	30	193	426	414	774
	18	22	30	„	18	30	0	193	414	402	766
	18	30	0	„	18	37	30	193	402	390	758
	18	37	30	„	18	45	0	193	390	378	750
	18	45	0	„	18	52	30	193	378	366	742
	18	52	30	„	19	0	0	194	366	354	734
	19	0	0	„	19	7	30	17·194	16·354	16·342	23·725
	19	7	30	„	19	15	0	194	342	330	717
	19	15	0	„	19	22	30	194	330	317	709
	19	22	30	„	19	30	0	195	317	305	700
	19	30	0	„	19	37	30	195	305	292	692
	19	37	30	„	19	45	0	195	292	280	683
	19	45	0	„	19	52	30	195	280	267	675
	19	52	30	„	20	0	0	196	267	254	666
	20	0	0	„	20	7	30	17·196	16·254	16·241	23·658
	20	7	30	„	20	15	0	196	241	228	649
	20	15	0	„	20	22	30	196	228	215	640
	20	22	30	„	20	30	0	197	215	202	631
	20	30	0	„	20	37	30	197	202	189	623
	20	37	30	„	20	45	0	197	189	176	614
	20	45	0	„	20	52	30	197	176	162	605
	20	52	30	„	21	0	0	198	162	149	596
	21	0	0	„	21	7	30	17·198	16·149	16·135	23·587
	21	7	30	„	21	15	0	198	135	122	578
	21	15	0	„	21	22	30	198	122	108	569
	21	22	30	„	21	30	0	199	108	095	559
	21	30	0	„	21	37	30	199	095	081	550
	21	37	30	„	21	45	0	199	081	067	541
	21	45	0	„	21	52	30	199	067	053	532
	21	52	30	„	22	0	0	200	053	039	522
	22	0	0	„	22	7	30	17·200	16·039	16·025	23·513
	22	7	30	„	22	15	0	200	025	011	503
	22	15	0	„	22	22	30	200	011	15·996	494
	22	22	30	„	22	30	0	201	15·996	982	484
	22	30	0	„	22	37	30	201	982	968	475
	22	37	30	„	22	45	0	201	968	953	465
	22	45	0	„	22	52	30	201	953	939	455
	22	52	30	„	23	0	0	202	939	924	446
	23	0	0	„	23	7	30	17·202	15·924	15·909	23·436
	23	7	30	„	23	15	0	202	909	895	426
	23	15	0	„	23	22	30	202	895	880	416
	23	22	30	„	23	30	0	203	880	865	406
	23	30	0	„	23	37	30	203	865	850	397
	23	37	30	„	23	45	0	203	850	835	387
	23	45	0	„	23	52	30	204	835	820	376
	23	52	30	„	24	0	0	204	820	804	366

TABLE XXXI.—Graticules of maps.—Sides and Diagonals of Squares of ⅛th of a Degree of Latitude and Longitude, on the Scale of 1 Inch to ½ a mile.

Latitude.								Length in Inches.			
								m on Meridian.	*n* on Lower Parallel.	*p* on Upper Parallel.	*q* on Diagonal.
	°	′	″		°	′	″				
From	24	0	0	to	24	7	30	17·204	15·804	15·789	23·356
	24	7	30	„	24	15	0	204	789	774	346
	24	15	0	„	24	22	30	205	774	758	336
	24	22	30	„	24	30	0	205	758	743	326
	24	30	0	„	24	37	30	205	743	727	315
	24	37	30	„	24	45	0	206	727	711	305
	24	45	0	„	24	52	30	206	711	696	295
	24	52	30	„	25	0	0	206	696	680	284
	25	0	0	„	25	7	30	17·206	15·680	15·664	23·274
	25	7	30	„	25	15	0	207	664	648	263
	25	15	0	„	25	22	30	207	648	632	253
	25	22	30	„	25	30	0	207	632	616	242
	25	30	0	„	25	37	30	208	616	600	231
	25	37	30	„	25	45	0	208	600	583	221
	25	45	0	„	25	52	30	208	583	567	210
	25	52	30	„	26	0	0	208	567	550	199
	26	0	0	„	26	7	30	17·209	15·550	15·534	23·188
	26	7	30	„	26	15	0	209	534	517	178
	26	15	0	„	26	22	30	209	517	501	167
	26	22	30	„	26	30	0	210	501	484	156
	26	30	0	„	26	37	30	210	484	467	145
	26	37	30	„	26	45	0	210	467	450	134
	26	45	0	„	26	52	30	211	450	433	123
	26	52	30	„	27	0	0	211	433	416	112
	27	0	0	„	27	7	30	17·211	15·416	15·399	23·100
	27	7	30	„	27	15	0	211	399	382	089
	27	15	0	„	27	22	30	212	382	365	078
	27	22	30	„	27	30	0	212	365	348	067
	27	30	0	„	27	37	30	212	348	330	055
	27	37	30	„	27	45	0	213	330	313	044
	27	45	0	„	27	52	30	213	313	295	033
	27	52	30	„	28	0	0	213	295	278	021
	28	0	0	„	28	7	30	17·214	15·278	15·260	23·010
	28	7	30	„	28	15	0	214	260	242	22·998
	28	15	0	„	28	22	30	214	242	225	987
	28	22	30	„	28	30	0	215	225	207	975
	28	30	0	„	28	37	30	215	207	189	963
	28	37	30	„	28	45	0	215	189	171	952
	28	45	0	„	28	52	30	215	171	153	940
	28	52	30	„	29	0	0	216	153	134	928
	29	0	0	„	29	7	30	27·216	15·134	15·116	22·917
	29	7	30	„	29	15	0	216	116	098	905
	29	15	0	„	29	22	30	217	098	079	893
	29	22	30	„	29	30	0	217	079	061	881
	29	30	0	„	29	37	30	217	061	042	869
	29	37	30	„	29	45	0	218	042	024	857
	29	45	0	„	29	52	30	218	024	005	845
	29	52	30	„	30	0	0	218	005	14·986	833
	30	0	0	„	30	7	30	17·219	14·986	14·968	22·821
	30	7	30	„	30	15	0	219	968	949	809
	30	15	0	„	30	22	30	219	949	930	797
	30	22	30	„	30	30	0	220	930	911	784
	30	30	0	„	30	37	30	220	911	892	772
	30	37	30	„	30	45	0	220	892	872	760
	30	45	0	„	30	52	30	221	872	853	748
	30	52	30	„	31	0	0	221	853	834	735
	31	0	0	„	31	7	30	17·221	14·834	14·814	22·723
	31	7	30	„	31	15	0	222	814	795	710
	31	15	0	„	31	22	30	222	795	775	698
	31	22	30	„	31	30	0	222	775	756	686
	31	30	0	„	31	37	30	223	756	736	673
	31	37	30	„	31	45	0	223	736	716	660
	31	45	0	„	31	52	30	223	716	697	648
	31	52	30	„	32	0	0	224	697	677	635

TABLE XXXI.—Graticules of maps.—Sides and Diagonals of Squares of $\frac{1}{8}$th of a Degree of Latitude and Longitude, on the Scale of 1 Inch to $\frac{1}{2}$ a mile.

Latitude.								Length in Inches.			
								m on Meridian.	*n* on Lower Parallel.	*p* on Upper Parallel.	*q* on Diagonal.
	°	′	″		°	′	″				
From	32	0	0	to	32	7	30	17·224	14·677	14·657	22·623
	32	7	30	„	32	15	0	224	657	637	610
	32	15	0	„	32	22	30	225	637	617	597
	32	22	30	„	32	30	0	225	617	597	584
	32	30	0	„	32	37	30	225	597	576	572
	32	37	30	„	32	45	0	226	576	556	559
	32	45	0	„	32	52	30	226	556	536	546
	32	52	30	„	33	0	0	226	536	515	533
	33	0	0	„	33	7	30	17·227	14·515	14·495	22·520
	33	7	30	„	33	15	0	227	495	474	507
	33	15	0	„	33	22	30	227	474	454	494
	33	22	30	„	33	30	0	228	454	433	481
	33	30	0	„	33	37	30	228	433	412	468
	33	37	30	„	33	45	0	228	412	391	455
	33	45	0	„	33	52	30	229	391	370	442
	33	52	30	„	34	0	0	229	370	349	429
	34	0	0	„	34	7	30	17·229	14·349	14·328	22·416
	34	7	30	„	34	15	0	230	328	307	402
	34	15	0	„	34	22	30	230	307	286	389
	34	22	30	„	34	30	0	231	286	265	376
	34	30	0	„	34	37	30	231	265	243	362
	34	37	30	„	34	45	0	231	243	222	349
	34	45	0	„	34	52	30	232	222	201	336
	34	52	30	„	35	0	0	232	201	179	322
	35	0	0	„	35	7	30	17·232	14·179	14·157	22·309
	35	7	30	„	35	15	0	233	157	136	295
	35	15	0	„	35	22	30	233	136	114	282
	35	22	30	„	35	30	0	233	114	092	268
	35	30	0	„	35	37	30	234	092	070	255
	35	37	30	„	35	45	0	234	070	048	241
	35	45	0	„	35	52	30	234	048	026	228
	35	52	30	„	36	0	0	235	026	004	214
	36	0	0	„	36	7	30	17·235	14·004	13·982	22·200
	36	7	30	„	36	15	0	235	13·982	960	187
	36	15	0	„	36	22	30	236	960	938	173
	36	22	30	„	36	30	0	236	938	915	159
	36	30	0	„	36	37	30	237	915	893	146
	36	37	30	„	36	45	0	237	893	871	132
	36	45	0	„	36	52	30	237	871	848	118
	36	52	30	„	37	0	0	238	848	825	104
	37	0	0	„	37	7	30	17·238	13·825	13·803	22·090
	37	7	30	„	37	15	0	238	803	780	076
	37	15	0	„	37	22	30	239	780	757	062
	37	22	30	„	37	30	0	239	757	734	048
	37	30	0	„	37	37	30	239	734	711	034
	37	37	30	„	37	45	0	240	711	688	020
	37	45	0	„	37	52	30	240	688	665	006
	37	52	30	„	38	0	0	241	665	642	21·992
	38	0	0	„	38	7	30	17·241	13·642	13·619	21·978
	38	7	30	„	38	15	0	241	619	596	964
	38	15	0	„	38	22	30	242	596	572	950
	38	22	30	„	38	30	0	242	572	549	936
	38	30	0	„	38	37	30	242	549	526	922
	38	37	30	„	38	45	0	243	526	502	907
	38	45	0	„	38	52	30	243	502	479	893
	38	52	30	„	39	0	0	243	479	455	879
	39	0	0	„	39	7	30	17·244	13·455	13·431	21·865
	39	7	30	„	39	15	0	244	431	407	850
	39	15	0	„	39	22	30	245	407	384	836
	39	22	30	„	39	30	0	245	384	360	822
	39	30	0	„	39	37	30	245	360	336	807
	39	37	30	„	39	45	0	246	336	312	793
	39	45	0	„	39	52	30	246	312	288	779
	39	52	30	„	40	0	0	246	288	263	764

TABLE XXXII.—Graticules of maps.—Sides and Diagonals of Squares of ¼th of a Degree of Latitude and Longitude, on the Scale of 1 Inch to 1 mile.

Latitude.	Length in Inches.			
	m on Meridian.	*n* on Lower Parallel.	*p* on Upper Parallel.	*q* on Diagonal.
° ′ ° ′				
From 0 0 to 0 15	17·176	17·290	17·290	24·371
0 15 „ 0 30	176	290	290	371
0 30 „ 0 45	176	290	289	371
0 45 „ 1 0	176	289	288	370
1 0 „ 1 15	176	288	286	369
1 15 „ 1 30	176	286	285	368
1 30 „ 1 45	176	285	282	367
1 45 „ 2 0	176	282	280	365
2 0 „ 2 15	17·176	17·280	17·277	24·363
2 15 „ 2 30	176	277	274	361
2 30 „ 2 45	176	274	271	359
2 45 „ 3 0	176	271	267	356
3 0 „ 3 15	176	267	263	354
3 15 „ 3 30	176	263	258	351
3 30 „ 3 45	176	258	254	347
3 45 „ 4 0	176	254	249	344
4 0 „ 4 15	17·177	17·249	17·243	24·340
4 15 „ 4 30	177	243	237	337
4 30 „ 4 45	177	237	231	332
4 45 „ 5 0	177	231	225	328
5 0 „ 5 15	177	225	218	323
5 15 „ 5 30	177	218	211	318
5 30 „ 5 45	177	211	204	314
5 45 „ 6 0	177	204	196	308
6 0 „ 6 15	17·178	17·196	17·188	24·303
6 15 „ 6 30	178	188	180	298
6 30 „ 6 45	178	180	171	292
6 45 „ 7 0	178	171	162	285
7 0 „ 7 15	178	162	153	279
7 15 „ 7 30	179	153	143	273
7 30 „ 7 45	179	143	134	266
7 45 „ 8 0	179	134	123	259
8 0 „ 8 15	17·179	17·123	17·113	24·252
8 15 „ 8 30	179	113	102	244
8 30 „ 8 45	180	102	091	237
8 45 „ 9 0	180	091	079	229
9 0 „ 9 15	180	079	067	221
9 15 „ 9 30	180	067	055	212
9 30 „ 9 45	180	055	042	204
9 45 „ 10 0	181	042	029	195
10 0 „ 10 15	17·181	17·029	17·016	24·186
10 15 „ 10 30	181	016	003	177
10 30 „ 10 45	182	003	16·989	168
10 45 „ 11 0	182	16·989	975	159
11 0 „ 11 15	182	975	960	148
11 15 „ 11 30	182	960	946	138
11 30 „ 11 45	183	946	930	128
11 45 „ 12 0	183	930	915	118
12 0 „ 12 15	17·183	16·915	16·899	24·107
12 15 „ 12 30	184	899	883	097
12 30 „ 12 45	184	883	867	085
12 45 „ 13 0	184	867	850	073
13 0 „ 13 15	185	850	833	062
13 15 „ 13 30	185	833	816	050
13 30 „ 13 45	185	816	798	037
13 45 „ 14 0	186	798	780	026

TABLE XXXII.—Graticules of maps.—Sides and Diagonals of Squares of ¼th of a Degree of Latitude and Longitude, on the Scale of 1 Inch to 1 mile.

Latitude.	Length in Inches.			
	m on Meridian.	*n* on Lower Parallel.	*p* on Upper Parallel.	*q* on Diagonal.
From 14° 0′ to 14° 15′	17·186	16·780	16·762	24·013
14 15 „ 14 30	186	762	743	000
14 30 „ 14 45	187	743	724	23·988
14 45 „ 15 0	187	724	705	974
15 0 „ 15 15	187	705	685	961
15 15 „ 15 30	188	685	666	948
15 30 „ 15 45	188	666	645	934
15 45 „ 16 0	188	645	625	920
16 0 „ 16 15	17·189	16·625	16·604	23·906
16 15 „ 16 30	189	604	583	892
16 30 „ 16 45	190	583	561	877
16 45 „ 17 0	190	561	540	862
17 0 „ 17 15	191	540	518	848
17 15 „ 17 30	191	518	495	833
17 30 „ 17 45	191	495	472	817
17 45 „ 18 0	192	472	449	801
18 0 „ 18 15	17·192	16·449	16·426	23·786
18 15 „ 18 30	193	426	402	770
18 30 „ 18 45	193	402	378	754
18 45 „ 19 0	194	378	354	738
19 0 „ 19 15	194	354	330	721
19 15 „ 19 30	195	330	305	705
19 30 „ 19 45	195	305	280	688
19 45 „ 20 0	195	280	254	670
20 0 „ 20 15	17·196	16·254	16·228	23·653
20 15 „ 20 30	196	228	202	635
20 30 „ 20 45	197	202	176	618
20 45 „ 21 0	197	176	149	600
21 0 „ 21 15	198	149	122	582
21 15 „ 21 30	198	122	095	564
21 30 „ 21 45	199	095	067	546
21 45 „ 22 0	199	067	039	527
22 0 „ 22 15	17·200	16·039	16·011	23·508
22 15 „ 22 30	201	011	15·982	490
22 30 „ 22 45	201	15·982	953	470
22 45 „ 23 0	202	953	924	451
23 0 „ 23 15	202	924	895	431
23 15 „ 23 30	203	895	865	412
23 30 „ 23 45	203	865	835	392
23 45 „ 24 0	204	835	804	372
24 0 „ 24 15	17·204	15·804	15·774	23·351
24 15 „ 24 30	205	774	743	331
24 30 „ 24 45	205	743	711	310
24 45 „ 25 0	206	711	680	289
25 0 „ 25 15	207	680	648	269
25 15 „ 25 30	207	648	616	247
25 30 „ 25 45	208	616	583	226
25 45 „ 26 0	208	583	550	204
26 0 „ 26 15	17·209	15·550	15·517	23·183
26 15 „ 26 30	209	517	484	161
26 30 „ 26 45	210	484	450	139
26 45 „ 27 0	211	450	416	117
27 0 „ 27 15	211	416	382	094
27 15 „ 27 30	212	382	348	072
27 30 „ 27 45	213	348	313	050
27 45 „ 28 0	213	313	278	027

TABLE XXXII.—Graticules of maps.—Sides and Diagonals of Squares of ¼th of a Degree of Latitude and Longitude, on the Scale of 1 Inch to 1 mile.

Latitude.						Length in Inches.			
						m on Meridian.	*n* on Lower Parallel.	*p* on Upper Parallel.	*q* on Diagonal.
	°	′		°	′				
From	28	0	to	28	15	17·214	15·278	15·242	23·004
	28	15	„	28	30	214	242	207	22·981
	28	30	„	28	45	215	207	171	958
	28	45	„	29	0	216	171	134	934
	29	0	„	29	15	216	134	098	910
	29	15	„	29	30	217	098	061	887
	29	30	„	29	45	218	061	024	863
	29	45	„	30	0	218	024	14·986	839
	30	0	„	30	15	17·219	14·986	14·949	22·815
	30	15	„	30	30	219	949	911	790
	30	30	„	30	45	220	911	872	766
	30	45	„	31	0	221	872	834	741
	31	0	„	31	15	221	834	795	716
	31	15	„	31	30	222	795	756	692
	31	30	„	31	45	223	756	716	667
	31	45	„	32	0	223	716	677	641
	32	0	„	32	15	17·224	14·677	14·637	22·616
	32	15	„	32	30	225	637	597	591
	32	30	„	32	45	226	597	556	566
	32	45	„	33	0	226	556	515	539
	33	0	„	33	15	227	515	474	514
	33	15	„	33	30	228	474	433	488
	33	30	„	33	45	228	433	391	461
	33	45	„	34	0	229	391	349	435
	34	0	„	34	15	17·230	14·349	14·307	22·409
	34	15	„	34	30	230	307	265	382
	34	30	„	34	45	231	265	222	356
	34	45	„	35	0	232	222	179	329
	35	0	„	35	15	232	179	136	302
	35	15	„	35	30	233	136	092	275
	35	30	„	35	45	234	092	048	248
	35	45	„	36	0	235	048	004	221
	36	0	„	36	15	17·235	14·004	13·960	22·194
	36	15	„	36	30	236	13·960	915	166
	36	30	„	36	45	237	915	871	139
	36	45	„	37	0	237	871	825	111
	37	0	„	37	15	238	825	780	083
	37	15	„	37	30	239	780	734	055
	37	30	„	37	45	240	734	688	027
	37	45	„	38	0	240	688	642	21·999
	38	0	„	38	15	17·241	13·642	13·596	21·971
	38	15	„	38	30	242	596	549	943
	38	30	„	38	45	243	549	502	915
	38	45	„	39	0	243	502	455	886
	39	0	„	39	15	244	455	407	858
	39	15	„	39	30	245	407	360	829
	39	30	„	39	45	245	360	312	800
	39	45	„	40	0	246	312	263	771

TABLE XXXIII.—Graticules of maps.—Sides and Diagonals of Squares of ½ of a Degree of Latitude and Longitude, on the Scale of 1 Inch to 4 miles.

Latitude.	Length in Inches. m on Meridian.	n on Lower Parallel.	p on Upper Parallel.	q on Diagonal.
° ′ ° ′				
From 0 0 to 0 30	8·588	8·645	8·645	12·186
0 30 „ 1 0	588	645	644	185
1 0 „ 1 30	588	644	642	184
1 30 „ 2 0	588	642	640	183
2 0 „ 2 30	588	640	637	181
2 30 „ 3 0	588	637	633	179
3 0 „ 3 30	588	633	629	176
3 30 „ 4 0	588	629	624	173
4 0 „ 4 30	588	624	619	169
4 30 „ 5 0	588	619	613	165
5 0 „ 5 30	8·589	8·613	8·606	12·161
5 30 „ 6 0	589	606	598	156
6 0 „ 6 30	589	598	590	150
6 30 „ 7 0	589	590	581	144
7 0 „ 7 30	589	581	572	138
7 30 „ 8 0	589	572	562	131
8 0 „ 8 30	590	562	551	124
8 30 „ 9 0	590	551	539	116
9 0 „ 9 30	590	539	527	108
9 30 „ 10 0	590	527	515	100
10 0 „ 10 30	8·591	8·515	8·501	12·091
10 30 „ 11 0	591	501	487	081
11 0 „ 11 30	591	487	473	071
11 30 „ 12 0	591	473	458	061
12 0 „ 12 30	592	458	442	050
12 30 „ 13 0	592	442	425	039
13 0 „ 13 30	592	425	408	028
13 30 „ 14 0	593	408	390	016
14 0 „ 14 30	593	390	372	003
14 30 „ 15 0	593	372	353	11·990
15 0 „ 15 30	8·594	8·353	8·333	11·977
15 30 „ 16 0	594	333	312	963
16 0 „ 16 30	595	312	291	949
16 30 „ 17 0	595	291	270	935
17 0 „ 17 30	595	270	248	920
17 30 „ 18 0	596	248	225	905
18 0 „ 18 30	596	225	201	889
18 30 „ 19 0	597	201	177	873
19 0 „ 19 30	597	177	152	856
19 30 „ 20 0	598	152	127	840
20 0 „ 20 30	8·598	8·127	8·101	11·822
20 30 „ 21 0	599	101	074	805
21 0 „ 21 30	599	074	047	786
21 30 „ 22 0	600	047	019	768
22 0 „ 22 30	600	019	7·991	749
22 30 „ 23 0	601	7·991	962	730
23 0 „ 23 30	601	962	932	711
23 30 „ 24 0	602	932	902	691
24 0 „ 24 30	602	902	871	670
24 30 „ 25 0	603	871	840	650
25 0 „ 25 30	8·603	7·840	7·808	11·629
25 30 „ 26 0	604	808	775	608
26 0 „ 26 30	605	775	742	586
26 30 „ 27 0	605	742	708	564
27 0 „ 27 30	606	708	674	542
27 30 „ 28 0	606	674	639	519
28 0 „ 28 30	607	639	603	496
28 30 „ 29 0	608	603	567	473
29 0 „ 29 30	608	567	530	449
29 30 „ 30 0	609	530	493	425

TABLE XXXIII.—Graticules of maps.—Sides and Diagonals of Squares of ½ of a Degree of Latitude and Longitude, on the Scale of 1 Inch to 4 miles.

Latitude.	Length in Inches.			
	m on Meridian.	*n* on Lower Parallel.	*p* on Upper Parallel.	*q* on Diagonal.
° ′ ° ′				
From 30 0 to 30 30	8·610	7·493	7·455	11·401
30 30 „ 31 0	610	455	417	377
31 0 „ 31 30	611	417	378	352
31 30 „ 32 0	612	378	338	327
32 0 „ 32 30	612	338	298	302
32 30 „ 33 0	613	298	258	276
33 0 „ 33 30	614	258	216	250
33 30 „ 34 0	614	216	175	224
34 0 „ 34 30	615	175	132	198
34 30 „ 35 0	616	132	090	171
35 0 „ 35 30	8·616	7·090	7·046	11·144
35 30 „ 36 0	617	046	002	117
36 0 „ 36 30	618	002	6·957	090
36 30 „ 37 0	619	6·957	913	063
37 0 „ 37 30	619	913	867	034
37 30 „ 38 0	620	867	821	007
38 0 „ 38 30	621	821	774	10·978
38 30 „ 39 0	621	774	727	949
39 0 „ 39 30	622	727	680	921
39 30 „ 40 0	623	680	632	893

TABLE XXXIV.—Graticules of maps.—Sides and Diagonals of Squares of ½ of a Degree of Latitude and Longitude, on the Scale of the Atlas of India or $\frac{1}{255561}$ of Nature.

Latitude.	Length in Inches.			
	m on Meridian.	*n* on Lower Parallel.	*p* on Upper Parallel.	*q* on Diagonal.
° ′ ° ′				
From 0 0 to 0 30	8·517	8·574	8·574	12·085
0 30 „ 1 0	517	574	573	084
1 0 „ 1 30	517	573	571	083
1 30 „ 2 0	517	571	569	082
2 0 „ 2 30	517	569	566	080
2 30 „ 3 0	517	566	562	078
3 0 „ 3 30	517	562	558	075
3 30 „ 4 0	517	558	553	072
4 0 „ 4 30	517	553	548	068
4 30 „ 5 0	517	548	542	064
5 0 „ 5 30	8·518	8·542	8·535	12·060
5 30 „ 6 0	518	535	527	056
6 0 „ 6 30	518	527	519	050
6 30 „ 7 0	518	519	510	044
7 0 „ 7 30	518	510	501	038
7 30 „ 8 0	518	501	491	031
8 0 „ 8 30	519	491	480	024
8 30 „ 9 0	519	480	468	016
9 0 „ 9 30	519	468	457	008
9 30 „ 10 0	519	457	445	000

TABLE XXXIV.—Graticules of maps.—Sides and Diagonals of Squares of $\frac{1}{2}$ of a Degree of Latitude and Longitude, on the Scale of the Atlas of India or $\frac{1}{255561}$ of Nature.

Latitude.						Length in Inches.			
						m on Meridian.	*n* on Lower Parallel.	*p* on Upper Parallel.	*q* on Diagonal.
	°	′		°	′				
From	10	0	to	10	30	8·520	8·445	8·431	11·991
	10	30	„	11	0	520	431	417	981
	11	0	„	11	30	520	417	403	971
	11	30	„	12	0	520	403	388	961
	12	0	„	12	30	521	388	372	950
	12	30	„	13	0	521	372	355	940
	13	0	„	13	30	521	355	339	929
	13	30	„	14	0	522	339	321	917
	14	0	„	14	30	522	321	303	904
	14	30	„	15	0	522	303	284	891
	15	0	„	15	30	8·523	8·284	8·264	11·878
	15	30	„	16	0	523	264	243	864
	16	0	„	16	30	524	243	222	850
	16	30	„	17	0	524	222	202	836
	17	0	„	17	30	524	202	180	822
	17	30	„	18	0	525	180	157	807
	18	0	„	18	30	525	157	133	791
	18	30	„	19	0	526	133	109	775
	19	0	„	19	30	526	109	085	758
	19	30	„	20	0	527	085	060	742
	20	0	„	20	30	8·527	8·060	8·034	11·724
	20	30	„	21	0	528	034	007	707
	21	0	„	21	30	528	007	7·980	689
	21	30	„	22	0	529	7·980	953	671
	22	0	„	22	30	529	953	925	652
	22	30	„	23	0	530	925	896	633
	23	0	„	23	30	530	896	866	614
	23	30	„	24	0	531	866	837	594
	24	0	„	24	30	531	837	806	574
	24	30	„	25	0	532	806	775	554
	25	0	„	25	30	8·532	7·775	7·743	11·533
	25	30	„	26	0	533	743	711	512
	26	0	„	26	30	534	711	678	490
	26	30	„	27	0	534	678	644	468
	27	0	„	27	30	535	644	611	447
	27	30	„	28	0	535	611	576	424
	28	0	„	28	30	536	576	540	401
	28	30	„	29	0	537	540	504	378
	29	0	„	29	30	537	504	468	354
	29	30	„	30	0	538	468	431	331
	30	0	„	30	30	8·539	7·431	7·393	11·307
	30	30	„	31	0	539	393	356	283
	31	0	„	31	30	540	356	317	258
	31	30	„	32	0	541	317	277	233
	32	0	„	32	30	541	277	238	209
	32	30	„	33	0	542	238	198	183
	33	0	„	33	30	543	198	156	157
	33	30	„	34	0	543	156	116	131
	34	0	„	34	30	544	116	073	105
	34	30	„	35	0	545	073	031	079
	35	0	„	35	30	8·545	7·031	6·988	11·052
	35	30	„	36	0	546	6·988	944	025
	36	0	„	36	30	547	944	900	10·998
	36	30	„	37	0	548	900	856	972
	37	0	„	37	30	548	856	810	943
	37	30	„	38	0	549	810	765	916
	38	0	„	38	30	550	765	718	887
	38	30	„	39	0	550	718	671	859
	39	0	„	39	30	551	671	625	831
	39	30	„	40	0	552	625	577	803

TABLE XXXV.—Graticules of maps.—Sides and Diagonals of Squares of 1 Degree of Latitude and Longitude, on the Scale of 1 Inch to 8 miles.

Latitude.				Length in Inches.			
				m on Meridian.	*n* on Lower Parallel.	*p* on Upper Parallel.	*q* on Diagonal.
	°		°				
From	0	to	1	8·588	8·645	8·644	12·185
	1	,,	2	588	644	640	183
	2	,,	3	588	640	633	180
	3	,,	4	588	633	624	174
	4	,,	5	588	624	613	167
	5	,,	6	589	613	598	158
	6	,,	7	589	598	581	147
	7	,,	8	589	581	562	134
	8	,,	9	590	562	539	120
	9	,,	10	590	539	515	104
	10	,,	11	8·591	8·515	8·487	12·086
	11	,,	12	591	487	458	066
	12	,,	13	592	458	425	045
	13	,,	14	593	425	390	022
	14	,,	15	593	390	353	11·997
	15	,,	16	594	353	312	970
	16	,,	17	595	312	270	942
	17	,,	18	596	270	225	912
	18	,,	19	596	225	177	881
	19	,,	20	597	177	127	848
	20	,,	21	8·598	8·127	8·074	11·813
	21	,,	22	599	074	019	777
	22	,,	23	600	019	7·962	740
	23	,,	24	601	7·962	902	701
	24	,,	25	603	902	840	660
	25	,,	26	604	840	775	618
	26	,,	27	605	775	708	575
	27	,,	28	606	708	639	530
	28	,,	29	607	639	567	484
	29	,,	30	609	567	493	437
	30	,,	31	8·610	7·493	7·417	11·389
	31	,,	32	611	417	338	339
	32	,,	33	613	338	258	289
	33	,,	34	614	258	175	237
	34	,,	35	615	175	090	184
	35	,,	36	617	090	002	131
	36	,,	37	618	002	6·913	076
	37	,,	38	620	6·913	821	021
	38	,,	39	621	821	727	10·964
	39	,,	40	623	727	632	907

TABLE XXXVI.—Graticules of maps.—Sides and Diagonals of Squares of 2 Degrees of Latitude and Longitude, on the Scale of 1 Inch to 12 miles.

Latitude.			Length in Inches.			
			m on Meridian.	*n* on Lower Parallel.	*p* on Upper Parallel.	*q* on Diagonal.
From	° 0	to ° 2	11·451	11·527	11·520	16·245
	2	„ 4	451	520	499	235
	4	„ 6	451	499	464	216
	6	„ 8	452	464	416	187
	8	„ 10	453	416	353	149
	10	„ 12	455	353	277	101
	12	„ 14	456	277	187	044
	14	„ 16	458	187	083	15·977
	16	„ 18	11·460	11·083	10·966	15·902
	18	„ 20	463	10·966	836	818
	20	„ 22	465	836	693	726
	22	„ 24	468	693	536	626
	24	„ 26	471	536	367	518
	26	„ 28	474	367	185	403
	28	„ 30	477	185	9·991	280
	30	„ 32	481	9·991	785	151
	32	„ 34	11·484	9·785	9·566	15·016
	34	„ 36	488	566	336	14·876
	36	„ 38	492	336	095	730
	38	„ 40	496	095	8·842	580
	40	„ 42	500	8·842	579	426
	42	„ 44	504	579	305	268
	44	„ 46	508	305	021	108

TABLE XXXVII.—Graticules of maps.—Sides and Diagonals of Squares of 2 Degrees of Latitude and Longitude, on the Scale of 1 Inch to 16 miles.

Latitude.			Length in Inches.			
			m on Meridian.	*n* on Lower Parallel.	*p* on Upper Parallel.	*q* on Diagonal.
From	° 0	to ° 2	8·588	8·645	8·640	12·184
	2	„ 4	588	640	624	177
	4	„ 6	588	624	598	162
	6	„ 8	589	598	562	140
	8	„ 10	590	562	515	111
	10	„ 12	591	515	458	076
	12	„ 14	592	458	390	033
	14	„ 16	594	390	312	11·983
	16	„ 18	8·595	8·312	8·225	11·927
	18	„ 20	597	225	127	864
	20	„ 22	599	127	019	795
	22	„ 24	601	019	7·902	720
	24	„ 26	603	7·902	775	639
	26	„ 28	606	775	639	552
	28	„ 30	608	639	493	460
	30	„ 32	611	493	338	364
	32	„ 34	8·613	7·338	7·175	11·262
	34	„ 36	616	175	002	157
	36	„ 38	619	002	6·821	048
	38	„ 40	622	6·821	632	10·935
	40	„ 42	625	632	434	819
	42	„ 44	628	434	229	701
	44	„ 46	631	229	016	581

TABLE XXXVIII.—Graticules of maps.—Sides and Diagonals of Squares of 2 Degrees of Latitude and Longitude, on the Scale of 1 Inch to 24 miles.

Latitude.				Length in Inches.			
				m on Meridian.	*n* on Lower Parallel.	*p* on Upper Parallel.	*q* on Diagonal.
	°		°				
From	0	to	2	5·725	5·763	5·760	8·123
	2	,,	4	725	760	750	118
	4	,,	6	726	750	732	108
	6	,,	8	726	732	708	094
	8	,,	10	727	708	676	074
	10	,,	12	727	676	638	050
	12	,,	14	728	638	593	022
	14	,,	16	729	593	542	7·989
	16	,,	18	5·730	5·542	5·483	7·951
	18	,,	20	731	483	418	909
	20	,,	22	733	418	346	863
	22	,,	24	734	346	268	813
	24	,,	26	735	268	183	759
	26	,,	28	737	183	093	701
	28	,,	30	739	093	4·995	640
	30	,,	32	740	4·995	892	576
	32	,,	34	5·742	4·892	4·783	7·508
	34	,,	36	744	783	668	438
	36	,,	38	746	668	547	365
	38	,,	40	748	547	421	290
	40	,,	42	750	421	289	213
	42	,,	44	752	289	153	134
	44	,,	46	754	153	011	054

TABLE XXXIX.—Graticules of maps.—Sides and Diagonals of Squares of 2 Degrees of Latitude and Longitude, on the Scale of 1 Inch to 32 miles.

Latitude.				Length in Inches.			
				m on Meridian.	*n* on Lower Parallel.	*p* on Upper Parallel.	*q* on Diagonal.
	°		°				
From	0	to	2	4·294	4·323	4·320	6·092
	2	,,	4	294	320	312	088
	4	,,	6	294	312	299	081
	6	,,	8	295	299	281	071
	8	,,	10	295	281	257	056
	10	,,	12	295	257	229	038
	12	,,	14	296	229	195	016
	14	,,	16	297	195	156	5·991
	16	,,	18	4·298	4·156	4·112	5·963
	18	,,	20	298	112	064	932
	20	,,	22	299	064	010	897
	22	,,	24	300	010	3·951	860
	24	,,	26	302	3·951	888	819
	26	,,	28	303	888	819	776
	28	,,	30	304	819	747	730
	30	,,	32	305	747	669	682
	32	,,	34	4·307	3·669	3·587	5·631
	34	,,	36	308	587	501	578
	36	,,	38	309	501	411	524
	38	,,	40	311	411	316	467
	40	,,	42	312	316	217	410
	42	,,	44	314	217	114	351
	44	,,	46	315	114	008	291

TABLE XL.—Graticules of maps.—Sides and Diagonals of Squares of 2 Degrees of Latitude and Longitude, on the Scale of 1 Inch to 48 miles.

Latitude.				Length in Inches.			
				m on Meridian.	*n* on Lower Parallel.	*p* on Upper Parallel.	*q* on Diagonal.
	°		°				
From	0	to	2	2·863	2·882	2·880	4·061
	2	,,	4	863	880	875	059
	4	,,	6	863	875	866	054
	6	,,	8	863	866	854	047
	8	,,	10	863	854	838	037
	10	,,	12	864	838	819	025
	12	,,	14	864	819	797	011
	14	,,	16	865	797	771	3·994
	16	,,	18	2·865	2·771	2·742	3·976
	18	,,	20	866	742	709	955
	20	,,	22	866	709	673	932
	22	,,	24	867	673	634	907
	24	,,	26	868	634	592	880
	26	,,	28	869	592	546	851
	28	,,	30	869	546	498	820
	30	,,	32	870	498	446	788
	32	,,	34	2·871	2·446	2·392	3·754
	34	,,	36	872	392	334	719
	36	,,	38	873	334	274	683
	38	,,	40	874	274	211	645
	40	,,	42	875	211	145	606
	42	,,	44	876	145	076	567
	44	,,	46	877	076	005	527

TABLE XLI.—Graticules of maps.—Sides and Diagonals of Squares of 2 Degrees of Latitude and Longitude, on the Scale of 1 Inch to 96 miles.

Latitude.				Length in Inches.			
				m on Meridian.	*n* on Lower Parallel.	*p* on Upper Parallel.	*q* on Diagonal.
	°		°				
From	0	to	2	1·431	1·441	1·440	2·031
	2	,,	4	431	440	437	029
	4	,,	6	431	437	433	027
	6	,,	8	432	433	427	023
	8	,,	10	432	427	419	019
	10	,,	12	432	419	410	013
	12	,,	14	432	410	398	005
	14	,,	16	432	398	385	1·997
	16	,,	18	1·433	1·385	1·371	1·988
	18	,,	20	433	371	355	977
	20	,,	22	433	355	337	966
	22	,,	24	433	337	317	953
	24	,,	26	434	317	296	940
	26	,,	28	434	296	273	925
	28	,,	30	435	273	249	910
	30	,,	32	435	249	223	894
	32	,,	34	1·436	1·223	1·196	1·877
	34	,,	36	436	196	167	859
	36	,,	38	436	167	137	841
	38	,,	40	437	137	105	822
	40	,,	42	437	105	072	803
	42	,,	44	438	072	038	783
	44	,,	46	438	038	003	763

TABLE XLII.—Rectangular Co-ordinates in Chains of the Corners of ⅛th Degree Squares, referred to the centre of the Degree as Origin.

Latitude.	N. and S. of Origin.	30′ 0″ Perpendicular.	30′ 0″ Meridian.	22′ 30″ Perpendicular.	22′ 30″ Meridian.	15′ 0″ Perpendicular.	15′ 0″ Meridian.	7′ 30″ Perpendicular.	7′ 30″ Meridian.	0′ 0″ Meridian.
		Distances in Arc E. or W. of Origin.								
40° 0′ 0″	North	2122·15	2765·29	1591·61	2762·68	1061·08	2760·82	530·54	2759·71	2759·33
52 30	North	2126·02	2075·43	1594·51	2072·83	1063·01	2070·97	531·50	2069·85	2069·48
45 0	North	2129·87	1385·58	1597·40	1382·98	1064·94	1381·12	532·47	1380·01	1379·64
37 30	North	2133·72	695·75	1600·29	693·15	1066·86	691·30	533·43	690·18	689·81
30 0	North	2137·55	5·93	1603·16	3·34	1068·77	1·48	534·39	0·37	ORIGIN
22 30	South	2141·37	683·87	1606·03	686·46	1070·69	688·31	535·34	689·43	689·80
15 0	South	2145·19	1373·66	1608·89	1376·25	1072·59	1378·10	536·30	1379·21	1379·58
7 30	South	2148·99	2063·43	1611·74	2066·01	1074·49	2067·87	537·25	2068·97	2069·34
39 0 0	South	2152·78	2753·19	1614·59	2755·77	1076·39	2757·62	538·20	2758·73	2759·10
39 0 0	North	2152·78	2764·77	1614·59	2762·19	1076·39	2760·34	538·20	2759·23	2758·86
52 30	North	2156·56	2075·03	1617·42	2072·45	1078·28	2070·60	539·14	2069·49	2069·12
45 0	North	2160·34	1385·30	1620·26	1382·72	1080·17	1380·88	540·09	1379·77	1379·40
37 30	North	2164·10	695·59	1623·08	693·01	1082·05	691·17	541·03	690·06	689·69
30 0	North	2167·85	5·89	1625·89	3·31	1083·93	1·47	541·96	0·37	ORIGIN
22 30	South	2171·59	683·80	1628·69	686·37	1085·80	688·21	542·90	689·31	689·68
15 0	South	2175·32	1373·47	1631·49	1376·04	1087·66	1377·87	543·83	1378·98	1379·34
7 30	South	2179·04	2063·12	1634·28	2065·69	1089·52	2067·53	544·76	2068·63	2068·99
38 0 0	South	2182·76	2752·76	1637·07	2755·32	1091·38	2757·16	545·69	2758·26	2758·63
38 0 0	North	2182·76	2764·26	1637·07	2761·70	1091·38	2759·86	545·69	2758·76	2758·39
52 30	North	2186·46	2074·63	1639·84	2072·07	1093·23	2070·24	546·61	2069·14	2068·77
45 0	North	2190·14	1385·02	1642·61	1382·46	1095·07	1380·63	547·54	1379·53	1379·17
37 30	North	2193·82	695·42	1645·37	692·86	1096·91	691·04	548·46	689·94	689·58
30 0	North	2197·49	5·84	1648·12	3·29	1098·75	1·46	549·37	0·37	ORIGIN
22 30	South	2201·15	683·73	1650·86	686·29	1100·58	688·10	550·29	689·20	689·56
15 0	South	2204·80	1373·29	1653·60	1375·83	1102·40	1377·65	551·20	1378·75	1379·11
7 30	South	2208·44	2062·83	1656·33	2065·37	1104·22	2067·19	552·11	2068·28	2068·64
37 0 0	South	2212·06	2752·35	1659·05	2754·90	1106·03	2756·71	553·02	2757·80	2758·16
37 0 0	North	2212·06	2763·74	1659·05	2761·20	1106·03	2759·38	553·02	2758·30	2757·93
52 30	North	2215·68	2074·23	1661·76	2071·70	1107·84	2069·88	553·92	2068·79	2068·43
45 0	North	2219·28	1384·73	1664·46	1382·20	1109·64	1380·39	554·82	1379·30	1378·94
37 30	North	2222·88	695·25	1667·16	692·72	1111·44	690·91	555·72	689·82	689·46
30 0	North	2226·46	5·78	1669·85	3·25	1113·23	1·45	556·62	0·36	ORIGIN
22 30	South	2230·04	683·68	1672·53	686·20	1115·02	688·00	557·51	689·09	689·45
15 0	South	2233·60	1373·12	1675·20	1375·64	1116·80	1377·44	558·40	1378·52	1378·88
7 30	South	2237·15	2062·54	1677·86	2065·06	1118·57	2066·86	559·29	2067·94	2068·30
36 0 0	South	2240·69	2751·96	1680·52	2754·47	1120·35	2756·27	560·17	2757·34	2757·70
36 0 0	North	2240·69	2763·22	1680·52	2760·70	1120·35	2758·91	560·17	2757·83	2757·47
52 30	North	2244·22	2073·82	1683·17	2071·32	1122·11	2069·52	561·06	2068·44	2068·08
45 0	North	2247·74	1384·44	1685·81	1381·93	1123·87	1380·14	561·94	1379·07	1378·71
37 30	North	2251·25	695·07	1688·44	692·57	1125·63	690·78	562·81	689·71	689·35
30 0	North	2254·75	5·71	1691·06	3·21	1127·38	1·43	563·69	0·36	ORIGIN
22 30	South	2258·24	683·63	1693·68	686·12	1129·12	687·91	564·56	688·98	689·33
15 0	South	2261·72	1372·96	1696·29	1375·45	1130·86	1377·23	565·43	1378·30	1378·65
7 30	South	2265·18	2062·27	1698·89	2064·76	1132·69	2066·53	566·30	2067·60	2067·96
35 0 0	South	2268·64	2751·57	1701·48	2754·05	1134·32	2755·83	567·16	2756·89	2757·25

TABLE XLII.—Rectangular Co-ordinates in Chains of the Corners of ⅛th Degree Squares, referred to the centre of the Degree as Origin.

Latitude. ° ′ ″	N. and S. of Origin.	Distances in Arc E. or W. of Origin. 30′ 0″ Perpendicular.	30′ 0″ Meridian.	22′ 30″ Perpendicular.	22′ 30″ Meridian.	15′ 0″ Perpendicular.	15′ 0″ Meridian.	7′ 30″ Perpendicular.	7′ 30″ Meridian.	0′ 0″ Meridian.
35 0 0	North	2268·64	2762·70	1701·48	2760·22	1134·32	2758·44	567·16	2757·38	2757·02
52 30	North	2272·08	2073·41	1704·06	2070·93	1136·04	2069·16	568·02	2068·10	2067·75
45 0	North	2275·52	1384·14	1706·64	1381·67	1137·76	1379·90	568·88	1378·84	1378·48
37 30	North	2278·94	694·88	1709·21	692·41	1139·47	690·65	569·74	689·59	689·23
30 0	North	2282·35	5·64	1711·76	3·18	1141·18	1·41	570·59	0·35	ORIGIN
22 30	South	2285·75	683·59	1714·31	686·05	1142·88	687·81	571·44	688·87	689·22
15 0	South	2289·14	1372·80	1716·86	1375·27	1144·57	1377·02	572·29	1378·08	1378·43
7 30	South	2292·52	2062·01	1719·39	2064·46	1146·26	2066·22	573·13	2067·27	2067·62
34 0 0	South	2295·89	2751·19	1721·92	2753·65	1147·95	2755·40	573·97	2756·45	2756·80
34 0 0	North	2295·89	2762·18	1721·92	2759·72	1147·95	2757·98	573·97	2756·92	2756·57
52 30	North	2299·25	2073·00	1724·44	2070·56	1149·62	2068·81	574·81	2067·76	2067·41
45 0	North	2302·60	1383·84	1726·95	1381·40	1151·30	1379·66	575·65	1378·61	1378·26
37 30	North	2305·93	694·70	1729·45	692·26	1152·97	690·52	576·48	689·47	689·12
30 0	North	2309·26	5·56	1731·94	3·13	1154·63	1·39	577·31	0·35	ORIGIN
22 30	South	2312·57	683·56	1734·43	685·99	1156·28	687·72	578·14	688·76	689·11
15 0	South	2315·87	1372·66	1736·90	1375·09	1157·94	1376·82	578·97	1377·86	1378·20
7 30	South	2319·16	2061·76	1739·37	2064·17	1159·58	2065·90	579·79	2066·94	2067·29
33 0 0	South	2322·44	2750·83	1741·83	2753·25	1161·22	2754·97	580·61	2756·01	2756·35
33 0 0	North	2322·44	2761·65	1741·83	2759·24	1161·22	2757·51	580·61	2756·48	2756·13
52 30	North	2325·71	2072·59	1744·28	2070·18	1162·86	2068·46	581·43	2067·42	2067·08
45 0	North	2328·97	1383·54	1746·73	1381·14	1164·49	1379·42	582·24	1378·38	1378·04
37 30	North	2332·22	694·50	1749·17	692·10	1166·11	690·39	583·06	689·36	689·01
30 0	North	2335·46	5·48	1751·59	3·08	1167·73	1·37	583·86	0·34	ORIGIN
22 30	South	2338·68	683·54	1754·01	685·92	1169·34	687·63	584·67	688·66	689·00
15 0	South	2341·90	1372·53	1756·42	1374·92	1170·95	1376·62	585·47	1377·64	1377·99
7 30	South	2345·10	2061·52	1758·82	2063·90	1172·55	2065·60	586·27	2066·62	2066·96
32 0 0	South	2348·29	2750·49	1761·22	2752·87	1174·14	2754·56	587·07	2755·58	2755·92
32 0 0	North	2348·29	2761·13	1761·22	2758·75	1174·14	2757·06	587·07	2756·04	2755·70
52 30	North	2351·47	2072·17	1763·60	2069·81	1175·73	2068·11	587·87	2067·09	2066·76
45 0	North	2354·64	1383·23	1765·98	1380·87	1177·32	1379·18	588·66	1378·16	1377·82
37 30	North	2357·80	694·30	1768·35	691·94	1178·90	690·25	589·45	689·24	688·91
30 0	North	2360·94	5·38	1770·71	3·02	1180·47	1·35	590·24	0·34	ORIGIN
22 30	South	2364·08	683·52	1773·06	685·87	1182·04	687·55	591·02	688·55	688·89
15 0	South	2367·20	1372·41	1775·40	1374·76	1183·60	1376·43	591·80	1377·44	1377·77
7 30	South	2370·32	2061·29	1777·74	2063·63	1185·16	2065·30	592·58	2066·30	2066·64
31 0 0	South	2373·42	2750·15	1780·07	2752·49	1186·71	2754·15	593·36	2755·15	2755·49
31 0 0	North	2373·42	2760·61	1780·07	2758·27	1186·71	2756·61	593·36	2755·61	2755·28
52 30	North	2376·51	2071·76	1782·38	2069·43	1188·25	2067·77	594·13	2066·77	2066·44
45 0	North	2379·59	1382·92	1784·69	1380·60	1189·79	1378·94	594·90	1377·94	1377·61
37 30	North	2382·66	694·10	1786·99	691·78	1191·33	690·12	595·66	689·13	688·80
30 0	North	2385·71	5·28	1789·28	2·97	1192·86	1·32	596·43	0·33	ORIGIN
22 30	South	2388·76	683·52	1791·57	685·83	1194·38	687·47	597·19	688·46	688·79
15 0	South	2391·79	1372·30	1793·84	1374·60	1195·90	1376·24	597·95	1377·23	1377·56
7 30	South	2394·81	2061·07	1796·11	2063·37	1197·41	2065·01	598·70	2065·99	2066·32
30 0 0	South	2397·82	2749·84	1798·37	2752·12	1198·91	2753·76	599·46	2754·74	2755·07

TABLE XLII.—Rectangular Co-ordinates in Chains of the Corners of ⅛th Degree Squares, referred to the centre of the Degree as Origin.

Latitude.	N. and S. of Origin.	Distances in Arc E. or W. of Origin. 30′ 0″		22′ 30″		15′ 0″		7′ 30″		0′ 0″
		Perpendicular.	Meridian.	Perpendicular.	Meridian.	Perpendicular.	Meridian.	Perpendicular.	Meridian.	Meridian.
° ′ ″										
30 0 0	North	2397·82	2760·09	1798·37	2757·80	1198·91	2756·17	599·46	2755·19	2754·86
52 30	North	2400·82	2071·34	1800·62	2069·06	1200·41	2067·43	600·21	2066·45	2066·13
45 0	North	2403·81	1382·61	1802·86	1380·33	1201·91	1378·70	600·95	1377·73	1377·40
37 30	North	2406·79	693·89	1805·09	691·61	1203·39	689·99	601·70	689·02	688·70
30 0	North	2409·75	5·18	1807·31	2·92	1204·88	1·30	602·44	0·32	ORIGIN
22 30	South	2412·71	683·52	1809·53	685·78	1206·35	687·39	603·18	688·36	688·68
15 0	South	2415·65	1372·20	1811·74	1374·45	1207·82	1376·06	603·91	1377·03	1377·35
7 30	South	2418·58	2060·87	1813·94	2063·12	1209·29	2064·73	604·65	2065·69	2066·01
29 0 0	South	2421·50	2749·53	1816·13	2751·77	1210·75	2753·37	605·38	2754·33	2754·65
29 0 0	North	2421·50	2759·57	1816·13	2757·33	1210·75	2755·73	605·38	2754·77	2754·45
52 30	North	2424·41	2070·93	1818·31	2068·69	1212·20	2067·10	606·10	2066·14	2065·82
45 0	North	2427·30	1382·29	1820·48	1380·06	1213·65	1378·47	606·83	1377·52	1377·20
37 30	North	2430·19	693·67	1822·64	691·46	1215·09	689·86	607·55	688·91	688·59
30 0	North	2433·06	5·07	1824·80	2·85	1216·53	1·27	608·27	0·32	ORIGIN
22 30	South	2435·92	683·53	1826·94	685·74	1217·96	687·32	608·98	688·27	688·58
15 0	South	2438·77	1372·11	1829·08	1374·31	1219·39	1375·89	609·69	1376·83	1377·15
7 30	South	2441·61	2060·68	1831·21	2062·88	1220·80	2064·45	610·40	2065·39	2065·71
28 0 0	South	2444·44	2749·24	1833·33	2751·43	1222·22	2753·00	611·11	2753·94	2754·25
28 0 0	North	2444·44	2759·06	1833·33	2756·87	1222·22	2755·30	611·11	2754·36	2754·05
52 30	North	2447·25	2070·51	1835·44	2068·33	1223·63	2066·77	611·81	2065·83	2065·52
45 0	North	2450·06	1381·98	1837·54	1379·80	1225·03	1378·25	612·51	1377·31	1377·00
37 30	North	2452·85	693·46	1839·64	691·28	1226·42	689·74	613·21	688·80	688·49
30 0	North	2455·63	4·95	1841·72	2·78	1227·81	1·24	613·91	0·31	ORIGIN
22 30	South	2458·40	683·55	1843·80	685·71	1229·20	687·25	614·60	688·17	688·48
15 0	South	2461·15	1372·03	1845·86	1374·19	1230·58	1375·72	615·29	1376·64	1376·95
7 30	South	2463·90	2060·51	1847·92	2062·65	1231·95	2064·18	615·97	2065·10	2065·41
27 0 0	South	2466·63	2748·97	1849·97	2751·11	1233·32	2752·63	616·66	2753·55	2753·85
27 0 0	North	2466·63	2758·55	1849·97	2756·40	1233·32	2754·88	616·66	2753·96	2753·66
52 30	North	2469·35	2070·10	1852·01	2067·96	1234·68	2066·45	617·34	2065·53	2065·23
45 0	North	2472·06	1381·66	1854·05	1379·53	1236·03	1378·02	618·02	1377·11	1376·81
37 30	North	2474·76	693·24	1856·07	691·12	1237·38	689·61	618·69	688·70	688·40
30 0	North	2477·45	4·82	1858·09	2·71	1238·72	1·21	619·36	0·30	ORIGIN
22 30	South	2480·12	683·58	1860·09	685·68	1240·06	687·18	620·03	688·08	688·39
15 0	South	2482·78	1371·97	1862·09	1374·07	1241·39	1375·56	620·70	1376·46	1376·76
7 30	South	2485·44	2060·34	1864·08	2062·44	1242·72	2063·93	621·36	2064·82	2065·12
26 0 0	South	2488·08	2748·71	1866·06	2750·80	1244·04	2752·28	622·02	2753·17	2753·47
26 0 0	North	2488·08	2758·04	1866·06	2755·95	1244·04	2754·47	622·02	2753·58	2753·28
52 30	North	2490·70	2069·69	1868·03	2067·61	1245·35	2066·13	622·68	2065·24	2064·94
45 0	North	2493·32	1381·34	1869·99	1379·27	1246·66	1377·80	623·33	1376·91	1376·62
37 30	North	2495·92	693·01	1871·94	690·95	1247·96	689·48	623·98	688·60	688·30
30 0	North	2498·51	4·69	1873·88	2·64	1249·26	1·17	624·63	0·29	ORIGIN
22 30	South	2501·09	683·61	1875·82	685·66	1250·55	687·12	625·27	688·00	688·29
15 0	South	2503·66	1371·91	1877·75	1373·95	1251·83	1375·41	625·92	1376·28	1376·57
7 30	South	2506·22	2060·20	1879·66	2062·23	1253·11	2063·68	626·55	2064·55	2064·84
25 0 0	South	2508·76	2748·47	1881·57	2750·49	1254·38	2751·94	627·19	2752·80	2753·09

TABLE XLII.—Rectangular Co-ordinates in Chains of the Corners of $\frac{1}{8}$th Degree Squares, referred to the centre of the Degree as Origin.

Latitude.	N. and S. of Origin.	Distances in Arc E. or W. of Origin.								
		30′ 0″		22′ 30″		15′ 0″		7′ 30″		0′ 0″
		Perpendicular.	Meridian.	Perpendicular.	Meridian.	Perpendicular.	Meridian.	Perpendicular.	Meridian.	Meridian.
° ′ ″										
25 0 0	North	2508·76	2757·54	1881·57	2755·51	1254·38	2754·07	627·19	2753·20	2752·91
52 30	North	2511·29	2069·27	1883·47	2067·26	1255·65	2065·82	627·82	2064·95	2064·67
45 0	North	2513·81	1381·02	1885·36	1379·02	1256·91	1377·58	628·45	1376·72	1376·43
37 30	North	2516·32	692·79	1887·24	690·78	1258·16	689·35	629·08	688·50	688·21
30 0	North	2518·82	4·56	1889·12	2·57	1259·41	1·14	629·71	0·29	ORIGIN
22 30	South	2521·30	683·66	1890·98	685·64	1260·65	687·06	630·33	687·92	688·20
15 0	South	2523·78	1371·86	1892·83	1373·84	1261·89	1375·26	630·94	1376·10	1376·39
7 30	South	2526·24	2060·06	1894·68	2062·03	1263·12	2063·44	631·56	2064·28	2064·56
24 0 0	South	2528·68	2748·24	1896·51	2750·20	1264·34	2751·61	632·17	2752·45	2752·73
24 0 0	North	2528·68	2757·04	1896·51	2755·08	1264·34	2753·67	632·17	2752·83	2752·55
52 30	North	2531·12	2068·87	1898·34	2066·91	1265·56	2065·52	632·78	2064·68	2064·40
45 0	North	2533·55	1380·71	1900·16	1378·76	1266·77	1377·37	633·39	1376·53	1376·25
37 30	North	2535·96	692·56	1901·97	690·61	1267·98	689·23	633·99	688·40	688·12
30 0	North	2538·36	4·42	1903·77	2·48	1269·18	1·10	634·59	0·28	ORIGIN
22 30	South	2540·75	683·71	1905·56	685·64	1270·37	687·01	635·19	687·84	688·11
15 0	South	2543·12	1371·83	1907·34	1373·74	1271·56	1375·12	635·78	1375·94	1376·21
7 30	South	2545·49	2059·94	1909·12	2061·84	1272·74	2063·21	636·37	2064·03	2064·30
23 0 0	South	2547·84	2748·03	1910·88	2749·93	1273·92	2751·29	636·96	2752·10	2752·38
23 0 0	North	2547·84	2756·55	1910·88	2754·65	1273·92	2753·29	636·96	2752·48	2752·20
52 30	North	2550·18	2068·46	1912·64	2066·57	1275·09	2065·22	637·55	2064·41	2064·14
45 0	North	2552·51	1380·39	1914·38	1378·50	1276·25	1377·16	638·13	1376·35	1376·08
37 30	North	2554·82	692·32	1916·12	690·45	1277·41	689·11	638·71	688·30	688·04
30 0	North	2557·13	4·27	1917·85	2·40	1278·56	1·07	639·28	0·27	ORIGIN
22 30	South	2559·42	683·77	1919·57	685·63	1279·71	686·96	639·86	687·76	688·02
15 0	South	2561·70	1371·81	1921·28	1373·65	1280·85	1374·98	640·43	1375·77	1376·04
7 30	South	2563·96	2059·83	1922·97	2061·68	1281·98	2062·99	640·99	2063·78	2064·04
22 0 0	South	2566·22	2747·84	1924·67	2749·68	1283·11	2750·99	641·56	2751·77	2752·04
22 0 0	North	2566·22	2756·06	1924·67	2754·23	1283·11	2752·92	641·56	2752·13	2751·87
52 30	North	2568·46	2068·06	1926·35	2066·24	1284·23	2064·93	642·12	2064·15	2063·89
45 0	North	2570·70	1380·07	1928·02	1378·25	1285·35	1376·95	642·67	1376·17	1375·91
37 30	North	2572·91	692·09	1929·68	690·28	1286·46	688·99	643·23	688·21	687·95
30 0	North	2575·12	4·12	1931·34	2·31	1287·56	1·03	643·78	0·26	ORIGIN
22 30	South	2577·32	683·84	1932·99	685·64	1288·66	686·92	644·33	687·69	687·94
15 0	South	2579·50	1371·79	1934·62	1373·58	1289·75	1374·85	644·87	1375·62	1375·87
7 30	South	2581·66	2059·73	1936·25	2061·51	1290·83	2062·78	645·42	2063·54	2063·79
21 0 0	South	2583·82	2747·67	1937·87	2749·43	1291·91	2750·70	645·96	2751·45	2751·71
21 0 0	North	2583·82	2755·59	1937·87	2753·82	1291·91	2752·56	645·96	2751·80	2751·55
52 30	North	2585·97	2067·67	1939·48	2065·90	1292·98	2064·65	646·49	2063·90	2063·64
45 0	North	2588·10	1379·75	1941·08	1378·00	1294·05	1376·75	647·03	1376·00	1375·75
37 30	North	2590·22	691·85	1942·67	690·11	1295·11	688·87	647·56	688·12	687·87
30 0	North	2592·33	3·96	1944·25	2·23	1296·17	0·99	648·08	0·25	ORIGIN
22 30	South	2594·43	683·92	1945·82	685·65	1297·21	686·88	648·61	687·62	687·86
15 0	South	2596·51	1371·79	1947·38	1373·51	1298·26	1374·73	649·13	1375·47	1375·71
7 30	South	2598·58	2059·66	1948·94	2061·36	1299·29	2062·58	649·65	2063·31	2063·56
20 0 0	South	2600·64	2747·51	1950·48	2749·20	1300·32	2750·42	650·16	2751·15	2751·39

TABLE XLII.—Rectangular Co-ordinates in Chains of the Corners of ⅛th Degree Squares, referred to the centre of the Degree as Origin.

Latitude.	N. and S. of Origin.	Distances in Arc E. or W. of Origin. 30′ 0″ Perpendicular.	30′ 0″ Meridian.	22′ 30″ Perpendicular.	22′ 30″ Meridian.	15′ 0″ Perpendicular.	15′ 0″ Meridian.	7′ 30″ Perpendicular.	7′ 30″ Meridian.	0′ 0″ Meridian.
° ′ ″										
20 0 0	North	2600·64	2755·12	1950·48	2753·42	1300·32	2752·20	650·16	2751·48	2751·23
52 30	North	2602·69	2067·27	1952·02	2065·58	1301·34	2064·38	650·67	2063·65	2063·41
45 0	North	2604·72	1379·44	1953·54	1377·76	1302·36	1376·56	651·18	1375·84	1375·60
37 30	North	2606·74	691·61	1955·06	689·95	1303·37	688·75	651·69	688·03	687·79
30 0	North	2608·76	3·80	1956·57	2·14	1304·38	0·95	652·19	0·24	ORIGIN
22 30	South	2610·75	684·01	1958·06	685·66	1305·38	686·84	652·69	687·55	687·79
15 0	South	2612·74	1371·80	1959·55	1373·45	1306·37	1374·62	653·18	1375·33	1375·56
7 30	South	2614·71	2059·59	1961·03	2061·22	1307·35	2062·39	653·68	2063·09	2063·33
19 0 0	South	2616·67	2747·37	1962·50	2749·00	1308·33	2750·16	654·17	2750·85	2751·08
19 0 0	North	2616·67	2754·65	1962·50	2753·02	1308·33	2751·87	654·17	2751·17	2750·94
52 30	North	2618·62	2066·89	1963·96	2065·27	1309·31	2064·11	654·65	2063·42	2063·19
45 0	North	2620·55	1379·13	1965·41	1377·52	1310·28	1376·37	655·14	1375·68	1375·45
37 30	North	2622·48	691·38	1966·86	689·77	1311·24	688·63	655·62	687·95	687·72
30 0	North	2624·39	3·63	1968·29	2·04	1312·19	0·91	656·10	0·23	ORIGIN
22 30	South	2626·28	684·10	1969·71	685·68	1313·14	686·81	656·57	687·49	687·71
15 0	South	2628·17	1371·82	1971·13	1373·40	1314·09	1374·52	657·04	1375·19	1375·41
7 30	South	2630·04	2059·54	1972·53	2061·10	1315·02	2062·22	657·51	2062·89	2063·11
18 0 0	South	2631·90	2747·24	1973·93	2748·79	1315·95	2749·91	657·98	2750·57	2750·79
18 0 0	North	2631·90	2754·20	1973·93	2752·65	1315·95	2751·54	657·98	2750·87	2750·65
52 30	North	2633·75	2066·50	1975·31	2064·96	1316·88	2063·86	658·44	2063·20	2062·98
45 0	North	2635·59	1378·82	1976·69	1377·28	1317·79	1376·19	658·90	1375·53	1375·31
37 30	North	2637·41	691·13	1978·06	689·61	1318·71	688·52	659·35	687·87	687·65
30 0	North	2639·22	3·46	1979·42	1·94	1319·61	0·87	659·81	0·22	ORIGIN
22 30	South	2641·02	684·20	1980·77	685·71	1320·51	686·78	660·26	687·43	687·64
15 0	South	2642·80	1371·85	1982·10	1373·35	1321·40	1374·42	660·70	1375·06	1375·27
7 30	South	2644·58	2059·50	1983·44	2060·99	1322·29	2062·05	661·15	2062·69	2062·90
17 0 0	South	2646·34	2747·14	1984·76	2748·62	1323·17	2749·67	661·59	2750·30	2750·52
17 0 0	North	2646·34	2753·76	1984·76	2752·28	1323·17	2751·22	661·59	2750·59	2750·38
52 30	North	2648·09	2066·13	1986·07	2064·66	1324·04	2063·61	662·02	2062·98	2062·77
45 0	North	2649·82	1378·51	1987·37	1377·05	1324·91	1376·01	662·46	1375·38	1375·17
37 30	North	2651·54	690·89	1988·66	689·45	1325·77	688·41	662·89	687·79	687·58
30 0	North	2653·26	3·29	1989·94	1·85	1326·63	0·82	663·31	0·21	ORIGIN
22 30	South	2654·95	684·31	1991·21	685·74	1327·48	686·76	663·74	687·37	687·58
15 0	South	2656·64	1371·90	1992·48	1373·31	1328·32	1374·33	664·16	1374·94	1375·14
7 30	South	2658·31	2059·48	1993·73	2060·89	1329·16	2061·89	664·58	2062·50	2062·70
16 0 0	South	2659·97	2747·05	1994·98	2748·45	1329·99	2749·45	664·99	2750·05	2750·25
16 0 0	North	2659·97	2753·32	1994·98	2751·92	1329·99	2750·92	664·99	2750·32	2750·12
52 30	North	2661·62	2065·76	1996·22	2064·37	1330·81	2063·38	665·41	2062·78	2062·58
45 0	North	2663·26	1378·20	1997·44	1376·82	1331·63	1375·84	665·81	1375·24	1375·05
37 30	North	2664·88	690·65	1998·66	689·28	1332·44	688·30	666·22	687·72	687·52
30 0	North	2666·49	3·11	1999·87	1·75	1333·24	0·78	666·62	0·19	ORIGIN
22 30	South	2668·08	684·43	2001·06	685·78	1334·04	686·74	667·02	687·32	687·51
15 0	South	2669·67	1371·95	2002·25	1373·29	1334·83	1374·25	667·42	1374·82	1375·02
7 30	South	2671·24	2059·47	2003·43	2060·80	1335·62	2061·75	667·81	2062·32	2062·51
15 0 0	South	2672·80	2746·98	2004·60	2748·30	1336·40	2749·25	668·20	2749·81	2750·00

TABLE XLII.—Rectangular Co-ordinates in Chains of the Corners of $\frac{1}{8}$th Degree Squares, referred to the centre of the Degree as Origin.

Latitude.	N. and S. of Origin.	Distances in Arc E. or W. of Origin.								
		30′ 0″		22′ 30″		15′ 0″		7′ 30″		0′ 0″
		Perpendicular.	Meridian.	Perpendicular.	Meridian.	Perpendicular.	Meridian.	Perpendicular.	Meridian.	Meridian.
° ′ ″										
15 0 0	North	2672·80	2752·90	2004·60	2751·58	1336·40	2750·64	668·20	2750·07	2749·88
52 30		2674·34	2065·40	2005·76	2064·08	1337·17	2063·15	668·59	2062·59	2062·40
45 0		2675·88	1377·90	2006·91	1376·60	1337·94	1375·67	668·97	1375·11	1374·93
37 30		2677·40	690·41	2008·05	689·12	1338·70	688·20	669·35	687·64	687·46
30 0		2678·91	2·93	2009·18	1·65	1339·45	0·73	669·73	0·18	ORIGIN
22 30	South	2680·40	684·55	2010·30	685·81	1340·20	686·73	670·10	687·27	687·45
15 0		2681·89	1372·02	2011·42	1373·28	1340·94	1374·18	670·47	1374·72	1374·90
7 30		2683·36	2059·48	2012·52	2060·73	1341·68	2061·62	670·84	2062·16	2062·34
14 0 0		2684·82	2746·93	2013·61	2748·17	1342·41	2749·06	671·20	2749·59	2749·77
14 0 0	North	2684·82	2752·49	2013·61	2751·25	1342·41	2750·36	671·20	2749·83	2749·65
52 30		2686·26	2065·04	2014·70	2063·81	1343·13	2062·93	671·57	2062·41	2062·23
45 0		2687·69	1377·60	2015·77	1376·38	1343·85	1375·51	671·92	1374·99	1374·81
37 30		2689·11	690·17	2016·83	688·96	1344·56	688·09	672·28	687·58	687·40
30 0		2690·52	2·74	2017·89	1·54	1345·26	0·69	672·63	0·17	ORIGIN
22 30	South	2691·91	684·68	2018·93	685·87	1345·96	686·72	672·98	687·23	687·40
15 0		2693·30	1372·09	2019·97	1373·27	1346·65	1374·11	673·32	1374·62	1374·79
7 30		2694·66	2059·50	2021·00	2060·67	1347·33	2061·50	673·67	2062·00	2062·17
13 0 0		2696·02	2746·90	2022·02	2748·06	1348·01	2748·88	674·01	2749·38	2749·55
13 0 0	North	2696·02	2752·09	2022·02	2750·93	1348·01	2750·10	674·01	2749·61	2749·44
52 30		2697·36	2064·69	2023·02	2063·55	1348·68	2062·73	674·34	2062·24	2062·07
45 0		2698·69	1377·31	2024·02	1376·17	1349·35	1375·36	674·67	1374·87	1374·71
37 30		2700·01	689·93	2025·01	688·80	1350·00	687·99	675·00	687·51	687·35
30 0		2701·32	2·55	2025·99	1·43	1350·66	0·64	675·33	0·16	ORIGIN
22 30	South	2702·60	684·82	2026·95	685·92	1351·30	686·71	675·65	687·19	687·34
15 0		2703·88	1372·18	2027·91	1373·28	1351·94	1374·06	675·97	1374·53	1374·68
7 30		2705·15	2059·54	2028·86	2060·62	1352·58	2061·39	676·29	2061·86	2062·01
12 0 0		2706·40	2746·88	2029·80	2747·96	1353·20	2748·73	676·60	2749·19	2749·34
12 0 0	North	2706·40	2751·70	2029·80	2750·62	1353·20	2749·86	676·60	2749·40	2749·24
52 30		2707·64	2064·35	2030·73	2063·29	1353·82	2062·53	676·91	2062·08	2061·92
45 0		2708·87	1377·02	2031·65	1375·96	1354·44	1375·21	677·22	1374·76	1374·61
37 30		2710·09	689·69	2032·57	688·64	1355·04	687·90	677·52	687·45	687·30
30 0		2711·29	2·36	2033·47	1·32	1355·65	0·59	677·82	0·15	ORIGIN
22 30	South	2712·48	684·96	2034·36	685·98	1356·24	686·71	678·12	687·15	687·30
15 0		2713·66	1372·28	2035·24	1373·29	1356·83	1374·01	678·41	1374·44	1374·59
7 30		2714·82	2059·58	2036·12	2060·58	1357·41	2061·30	678·71	2061·73	2061·87
11 0 0		2715·97	2746·89	2036·98	2747·88	1357·99	2748·58	678·99	2749·01	2749·15
11 0 0	North	2715·97	2751·32	2036·98	2750·33	1357·99	2749·62	678·99	2749·20	2749·06
52 30		2717·11	2064·02	2037·83	2063·05	1358·55	2062·35	679·28	2061·93	2061·79
45 0		2718·23	1376·73	2038·67	1375·76	1359·12	1375·07	679·56	1374·66	1374·52
37 30		2719·34	689·45	2039·51	688·49	1359·67	687·80	679·84	687·39	687·26
30 0		2720·44	2·16	2040·33	1·22	1360·22	0·54	680·11	0·14	ORIGIN
22 30	South	2721·53	685·11	2041·15	686·05	1360·77	686·72	680·38	687·12	687·25
15 0		2722·60	1372·38	2041·95	1373·31	1361·30	1373·97	680·65	1374·37	1374·50
7 30		2723·66	2059·65	2042·75	2060·56	1361·83	2061·22	680·92	2061·61	2061·74
10 0 0		2724·71	2746·91	2043·53	2747·81	1362·36	2748·46	681·18	2748·84	2748·97

TABLE XLII.—Rectangular Co-ordinates in Chains of the Corners of ⅛th Degree Squares, referred to the centre of the Degree as Origin.

Latitude.	N. and S. of Origin.	Distances in Arc E. or W. of Origin. 30′ 0″ Perpendicular.	30′ 0″ Meridian.	22′ 30″ Perpendicular.	22′ 30″ Meridian.	15′ 0″ Perpendicular.	15′ 0″ Meridian.	7′ 30″ Perpendicular.	7′ 30″ Meridian.	0′ 0″ Meridian.
° ′ ″										
10 0 0	North	2724·71	2750·96	2043·53	2750·05	1362·36	2749·41	681·18	2749·02	2748·89
52 30	North	2725·75	2063·70	2044·31	2062·81	1362·87	2062·17	681·44	2061·79	2061·66
45 0	North	2726·77	1376·45	2045·08	1375·57	1363·39	1374·94	681·69	1374·56	1374·44
37 30	North	2727·78	689·21	2045·84	688·33	1363·89	687·71	681·95	687·34	687·22
30 0	North	2728·78	1·97	2046·58	1·11	1364·39	0·49	682·19	0·12	ORIGIN
22 30	South	2729·76	685·27	2047·32	686·12	1364·88	686·73	682·44	687·09	687·21
15 0	South	2730·73	1372·50	2048·05	1373·34	1365·37	1373·94	682·68	1374·30	1374·42
7 30	South	2731·69	2059·73	2048·77	2060·56	1365·84	2061·15	682·92	2061·50	2061·62
9 0 0	South	2732·63	2746·95	2049·47	2747·76	1366·32	2748·35	683·16	2748·70	2748·82
9 0 0	North	2732·63	2750·61	2049·47	2749·79	1366·32	2749·21	683·16	2748·86	2748·74
52 30	North	2733·56	2063·39	2050·17	2062·58	1366·78	2062·01	683·39	2061·66	2061·55
45 0	North	2734·48	1376·18	2050·86	1375·38	1367·24	1374·82	683·62	1374·47	1374·36
37 30	North	2735·39	688·97	2051·54	688·19	1367·69	687·63	683·85	687·29	687·18
30 0	North	2736·28	1·77	2052·21	0·99	1368·14	0·44	684·07	0·11	ORIGIN
22 30	South	2737·16	685·43	2052·87	686·19	1368·58	686·74	684·29	687·07	687·17
15 0	South	2738·03	1372·63	2053·52	1373·38	1369·01	1373·92	684·51	1374·24	1374·34
7 30	South	2738·88	2059·82	2054·16	2060·56	1369·44	2061·09	684·72	2061·40	2061·51
8 0 0	South	2739·72	2747·01	2054·79	2747·73	1369·86	2748·25	684·93	2748·57	2748·67
8 0 0	North	2739·72	2750·27	2054·79	2749·54	1369·86	2749·02	684·93	2748·71	2748·60
52 30	North	2740·55	2063·09	2055·41	2062·37	1370·28	2061·86	685·14	2061·55	2061·45
45 0	North	2741·37	1375·91	2056·03	1375·20	1370·68	1374·70	685·34	1374·40	1374·30
37 30	North	2742·17	688·73	2056·63	688·04	1371·08	687·54	685·54	687·24	687·15
30 0	North	2742·96	1·56	2057·22	0·88	1371·48	0·39	685·74	0·10	ORIGIN
22 30	South	2743·73	685·60	2057·80	686·28	1371·87	686·76	685·93	687·05	687·14
15 0	South	2744·50	1372·77	2058·37	1373·43	1372·25	1373·90	686·12	1374·19	1374·28
7 30	South	2745·25	2059·93	2058·94	2060·58	1372·62	2061·04	686·31	2061·32	2061·41
7 0 0	South	2745·98	2747·08	2059·49	2747·72	1372·99	2748·18	686·50	2748·45	2748·54
7 0 0	North	2745·98	2749·95	2059·49	2749·30	1372·99	2748·85	686·50	2748·58	2748·49
52 30	North	2746·71	2062·79	2060·03	2062·17	1373·35	2061·72	686·68	2061·45	2061·36
45 0	North	2747·42	1375·65	2060·57	1375·03	1373·71	1374·59	686·86	1374·32	1374·24
37 30	North	2748·12	688·50	2061·09	687·89	1374·06	687·46	687·03	687·20	687·12
30 0	North	2748·80	1·36	2061·60	0·77	1374·40	0·34	687·20	0·09	ORIGIN
22 30	South	2749·48	685·78	2062·11	686·37	1374·74	686·78	687·37	687·03	687·11
15 0	South	2750·14	1372·92	2062·60	1373·48	1375·07	1373·90	687·53	1374·14	1374·22
7 30	South	2750·78	2060·05	2063·09	2060·61	1375·39	2061·01	687·70	2061·25	2061·33
6 0 0	South	2751·42	2747·18	2063·56	2747·73	1375·71	2748·12	687·85	2748·35	2748·43
6 0 0	North	2751·42	2749·64	2063·56	2749·08	1375·71	2748·70	687·85	2748·46	2748·38
52 30	North	2752·04	2062·51	2064·03	2061·98	1376·02	2061·59	688·01	2061·36	2061·28
45 0	North	2752·64	1375·39	2064·48	1374·86	1376·32	1374·49	688·16	1374·26	1374·19
37 30	North	2753·24	688·27	2064·93	687·76	1376·62	687·39	688·31	687·17	687·09
30 0	North	2753·82	1·15	2065·36	0·65	1376·91	0·29	688·45	0·07	ORIGIN
22 30	South	2754·38	685·96	2065·79	686·46	1377·19	686·81	688·60	687·02	687·09
15 0	South	2754·94	1373·07	2066·21	1373·55	1377·47	1373·90	688·74	1374·11	1374·17
7 30	South	2755·48	2060·18	2066·61	2060·65	1377·74	2060·99	688·87	2061·19	2061·26
5 0 0	South	2756·01	2747·29	2067·01	2747·74	1378·01	2748·07	689·00	2748·27	2748·34

TABLE XLII.—Rectangular Co-ordinates in Chains of the Corners of ⅛th Degree Squares, referred to the centre of the Degree as Origin.

Latitude.	N. and S. of Origin.	Distances in Arc E. or W. of Origin.								
		30′ 0″		22′ 30″		15′ 0″		7′ 30″		0′ 0″
° ′ ″		Perpendicular.	Meridian.	Perpendicular.	Meridian.	Perpendicular.	Meridian.	Perpendicular.	Meridian.	Meridian.
5 0 0	North	2756·01	2749·34	2067·01	2748·89	1378·01	2748·56	689·00	2748·36	2748·30
52 30		2756·53	2062·24	2067·40	2061·79	1378·26	2061·47	689·13	2061·28	2061·22
45 0		2757·03	1375·14	2067·77	1374·70	1378·52	1374·39	689·26	1374·20	1374·14
37 30		2757·52	688·04	2068·14	687·62	1378·76	687·31	689·38	687·13	687·07
30 0		2758·00	0·94	2068·50	0·53	1379·00	0·24	689·50	0·06	ORIGIN
22 30	South	2758·46	686·15	2068·85	686·56	1379·23	686·84	689·62	687·01	687·07
15 0		2758·91	1373·24	2069·18	1373·63	1379·46	1373·91	689·73	1374·08	1374·13
7 30		2759·35	2060·33	2069·51	2060·71	1379·68	2060·98	689·84	2061·14	2061·20
4 0 0		2759·78	2747·42	2069·83	2747·78	1379·89	2748·05	689·94	2748·21	2748·26
4 0 0	North	2759·78	2749·06	2069·83	2748·70	1379·89	2748·43	689·94	2748·28	2748·22
52 30		2760·19	2061·98	2070·14	2061·62	1380·09	2061·37	690·05	2061·22	2061·17
45 0		2760·59	1374·90	2070·44	1374·55	1380·29	1374·31	690·15	1374·16	1374·11
37 30		2760·97	687·82	2070·73	687·49	1380·49	687·24	690·24	687·10	687·05
30 0		2761·34	0·74	2071·01	0·41	1380·67	0·18	690·34	0·05	ORIGIN
22 30	South	2761·70	686·34	2071·28	686·66	1380·85	686·87	690·43	687·01	687·05
15 0		2762·05	1373·42	2071·54	1373·71	1381·03	1373·93	690·51	1374·06	1374·10
7 30		2762·38	2060·49	2071·79	2060·78	1381·19	2060·99	690·60	2061·11	2061·15
3 0 0		2762·70	2747·56	2072·03	2747·84	1381·35	2748·04	690·68	2748·16	2748·20
3 0 0	North	2762·70	2748·80	2072·03	2748·52	1381·35	2748·33	690·68	2748·21	2748·17
52 30		2763·01	2061·73	2072·26	2061·47	1381·51	2061·28	690·75	2061·16	2061·13
45 0		2763·30	1374·66	2072·48	1374·41	1381·65	1374·23	690·83	1374·12	1374·08
37 30		2763·59	687·59	2072·69	687·36	1381·79	687·18	690·90	687·08	687·04
30 0		2763·86	0·53	2072·89	0·30	1381·93	0·13	690·96	0·03	ORIGIN
22 30	South	2764·11	686·54	2073·08	686·76	1382·05	686·91	691·03	687·01	687·04
15 0		2764·35	1373·60	2073·26	1373·81	1382·18	1373·96	691·09	1374·05	1374·08
7 30		2764·58	2060·67	2073·44	2060·86	1382·29	2061·00	691·15	2061·09	2061·11
2 0 0		2764·80	2747·73	2073·60	2747·92	1382·40	2748·04	691·20	2748·12	2748·15
2 0 0	North	2764·80	2748·55	2073·60	2748·37	1382·40	2748·24	691·20	2748·16	2748·13
52 30		2765·00	2061·49	2073·75	2061·32	1382·50	2061·20	691·25	2061·12	2061·10
45 0		2765·19	1374·43	2073·89	1374·27	1382·59	1374·16	691·30	1374·09	1374·07
37 30		2765·36	687·37	2074·02	687·22	1382·68	687·12	691·34	687·05	687·03
30 0		2765·53	0·32	2074·15	0·18	1382·76	0·08	691·38	0·02	ORIGIN
22 30	South	2765·68	686·74	2074·26	686·87	1382·84	686·96	691·42	687·01	687·03
15 0		2765·82	1373·80	2074·36	1373·92	1382·91	1374·00	691·45	1374·05	1374·06
7 30		2765·94	2060·86	2074·46	2060·96	1382·97	2061·03	691·49	2061·08	2061·09
1 0 0		2766·05	2747·91	2074·54	2748·00	1383·03	2748·07	691·51	2748·11	2748·12
1 0 0	North	2766·05	2748·32	2074·54	2748·23	1383·03	2748·16	691·51	2748·12	2748·11
52 30		2766·15	2061·27	2074·61	2061·19	1383·07	2061·13	691·54	2061·10	2061·08
45 0		2766·24	1374·21	2074·68	1374·15	1383·12	1374·09	691·56	1374·07	1374·06
37 30		2766·31	687·16	2074·73	687·10	1383·15	687·06	691·58	687·04	687·03
30 0		2766·36	0·11	2074·77	0·06	1383·18	0·03	691·59	0·01	ORIGIN
22 30	South	2766·41	686·95	2074·81	686·98	1383·21	687·01	691·60	687·02	687·03
15 0		2766·44	1374·00	2074·83	1374·03	1383·22	1374·04	691·61	1374·05	1374·05
7 30		2766·46	2061·06	2074·85	2061·06	1383·23	2061·07	691·62	2061·08	2061·08
0 0 0		2766·47	2748·11	2074·85	2748·11	1383·24	2748·11	691·62	2748·11	2748·11

TABLE XLIII.—Convergency between Meridians 1 Mile apart measured on Parallels of Latitude.

Latitude.	0′	5′	10′	15′	20′	25′	30′	35′	40′	45′	50′	55′	60′
°	″	″	″	″	″	″	″	″	″	″	″	″	″
0	0·0	0·1	0·2	0·2	0·3	0·4	0·5	0·5	0·6	0·7	0·8	0·8	0·9
1	0·9	1·0	1·1	1·1	1·2	1·3	1·4	1·4	1·5	1·6	1·7	1·7	1·8
2	1·8	1·9	2·0	2·0	2·1	2·2	2·3	2·3	2·4	2·5	2·6	2·7	2·7
3	2·7	2·8	2·9	3·0	3·0	3·1	3·2	3·3	3·3	3·4	3·5	3·6	3·6
4	3·6	3·7	3·8	3·9	3·9	4·0	4·1	4·2	4·2	4·3	4·4	4·5	4·6
5	4·6	4·6	4·7	4·8	4·9	4·9	5·0	5·1	5·2	5·2	5·3	5·4	5·5
6	5·5	5·5	5·6	5·7	5·8	5·9	5·9	6·0	6·1	6·2	6·2	6·3	6·4
7	6·4	6·5	6·5	6·6	6·7	6·8	6·9	6·9	7·0	7·1	7·2	7·2	7·3
8	7·3	7·4	7·5	7·5	7·6	7·7	7·8	7·9	7·9	8·0	8·1	8·2	8·2
9	8·2	8·3	8·4	8·5	8·6	8·6	8·7	8·8	8·9	8·9	9·0	9·1	9·2
10	9·2	9·3	9·3	9·4	9·5	9·6	9·6	9·7	9·8	9·9	10·0	10·0	10·1
11	10·1	10·2	10·3	10·4	10·4	10·5	10·6	10·7	10·7	10·8	10·9	11·0	11·1
12	11·1	11·1	11·2	11·3	11·4	11·5	11·5	11·6	11·7	11·8	11·9	11·9	12·0
13	12·0	12·1	12·2	12·3	12·3	12·4	12·5	12·6	12·7	12·7	12·8	12·9	13·0
14	13·0	13·1	13·1	13·2	13·3	13·4	13·5	13·5	13·6	13·7	13·8	13·9	13·9
15	13·9	14·0	14·1	14·2	14·3	14·3	14·4	14·5	14·6	14·7	14·8	14·8	14·9
16	14·9	15·0	15·1	15·2	15·3	15·3	15·4	15·5	15·6	15·7	15·7	15·8	15·9
17	15·9	16·0	16·1	16·2	16·2	16·3	16·4	16·5	16·6	16·7	16·7	16·8	16·9
18	16·9	17·0	17·1	17·2	17·2	17·3	17·4	17·5	17·6	17·7	17·7	17·8	17·9
19	17·9	18·0	18·1	18·2	18·3	18·3	18·4	18·5	18·6	18·7	18·8	18·8	18·9
20	18·9	19·0	19·1	19·2	19·3	19·4	19·5	19·5	19·6	19·7	19·8	19·9	20·0
21	20·0	20·1	20·1	20·2	20·3	20·4	20·5	20·6	20·7	20·8	20·8	20·9	21·0
22	21·0	21·1	21·2	21·3	21·4	21·5	21·5	21·6	21·7	21·8	21·9	22·0	22·1
23	22·1	22·2	22·3	22·4	22·4	22·5	22·6	22·7	22·8	22·9	23·0	23·1	23·2
24	23·2	23·2	23·3	23·4	23·5	23·6	23·7	23·8	23·9	24·0	24·1	24·2	24·3
25	24·3	24·3	24·4	24·5	24·6	24·7	24·8	24·9	25·0	25·1	25·2	25·3	25·4
26	25·4	25·5	25·6	25·7	25·7	25·8	25·9	26·0	26·1	26·2	26·3	26·4	26·5
27	26·5	26·6	26·7	26·8	26·9	27·0	27·1	27·2	27·3	27·4	27·5	27·6	27·7
28	27·7	27·8	27·8	27·9	28·0	28·1	28·2	28·3	28·4	28·5	28·6	28·7	28·8
29	28·8	28·9	29·0	29·1	29·2	29·3	29·4	29·5	29·6	29·7	29·8	29·9	30·0
30	30·0	30·1	30·2	30·3	30·4	30·5	30·6	30·7	30·8	30·9	31·0	31·1	31·2
31	31·2	31·4	31·5	31·6	31·7	31·8	31·9	32·0	32·1	32·2	32·3	32·4	32·5
32	32·5	32·6	32·7	32·8	32·9	33·0	33·1	33·2	33·3	33·5	33·6	33·7	33·8
33	33·8	33·9	34·0	34·1	34·2	34·3	34·4	34·5	34·6	34·7	34·9	35·0	35·1
34	35·1	35·2	35·3	35·4	35·5	35·6	35·7	35·8	36·0	36·1	36·2	36·3	36·4
35	36·4	36·5	36·6	36·7	36·9	37·0	37·1	37·2	37·3	37·4	37·5	37·7	37·8
36	37·8	37·9	38·0	38·1	38·2	38·3	38·5	38·6	38·7	38·8	38·9	39·1	39·2
37	39·2	39·3	39·4	39·5	39·6	39·8	39·9	40·0	40·1	40·3	40·4	40·5	40·6
38	40·6	40·7	40·9	41·0	41·1	41·2	41·3	41·5	41·6	41·7	41·8	42·0	42·1
39	42·1	42·2	42·3	42·5	42·6	42·7	42·8	43·0	43·1	43·2	43·4	43·5	43·6

TABLE XLIV.—Lengths of Circular Arcs.

Degrees.	Arc.	Degrees.	Arc.	Degrees.	Arc.	Minutes.	Arc.	Seconds.	Arc.	Seconds.	Arc.	Seconds.	Arc.
1	0·0174533	61	1·0646508	121	2·1118484	1	0·0002909	1	0·0000048	·01	0·0000000	·61	0·0000030
2	0349066	62	0821041	122	1293017	2	05818	2	097	·02	1	·62	30
3	0523599	63	0995574	123	1467550	3	08727	3	145	·03	1	·63	31
4	0698132	64	1170107	124	1642083	4	11636	4	194	·04	2	·64	31
5	0872665	65	1344640	125	1816616	5	14544	5	242	·05	2	·65	32
6	0·1047198	66	1·1519173	126	2·1991149	6	0·0017453	6	0·0000291	·06	0·0000003	·66	0·0000032
7	1221730	67	1693706	127	2165681	7	20362	7	339	·07	3	·67	32
8	1396263	68	1868239	128	2340214	8	23271	8	388	·08	4	·68	33
9	1570796	69	2042772	129	2514747	9	26180	9	436	·09	4	·69	33
10	1745329	70	2217305	130	2689280	10	29089	10	485	·10	5	·70	34
11	0·1919862	71	1·2391838	131	2·2863813	11	0·0031998	11	0·0000533	·11	0·0000005	·71	0·0000034
12	2094395	72	2566371	132	3038346	12	34907	12	582	·12	6	·72	35
13	2268928	73	2740904	133	3212879	13	37815	13	630	·13	6	·73	35
14	2443461	74	2915436	134	3387412	14	40724	14	679	·14	7	·74	36
15	2617994	75	3089969	135	3561945	15	43633	15	727	·15	7	·75	36
16	0·2792527	76	1·3264502	136	2·3736478	16	0·0046542	16	0·0000776	·16	0·0000008	·76	0·0000037
17	2967060	77	3439035	137	3911011	17	49451	17	824	·17	8	·77	37
18	3141593	78	3613568	138	4085544	18	52360	18	873	·18	9	·78	38
19	3316126	79	3788101	139	4260077	19	55269	19	921	·19	9	·79	38
20	3490659	80	3962634	140	4434610	20	58178	20	970	·20	10	·80	39
21	0·3665191	81	1·4137167	141	2·4609142	21	0·0061087	21	0·0001018	·21	0·0000010	·81	0·0000039
22	3839724	82	4311700	142	4783675	22	63995	22	1067	·22	11	·82	40
23	4014257	83	4486233	143	4958208	23	66904	23	1115	·23	11	·83	40
24	4188790	84	4660766	144	5132741	24	69813	24	1164	·24	12	·84	41
25	4363323	85	4835299	145	5307274	25	72722	25	1212	·25	12	·85	41
26	0·4537856	86	1·5009832	146	2·5481807	26	0·0075631	26	0·0001261	·26	0·0000013	·86	0·0000042
27	4712389	87	5184364	147	5656340	27	78540	27	1309	·27	13	·87	42
28	4886922	88	5358897	148	5830873	28	81449	28	1357	·28	14	·88	43
29	5061455	89	5533430	149	6005406	29	84358	29	1406	·29	14	·89	43
30	5235988	90	5707963	150	6179939	30	87266	30	1454	·30	15	·90	44
31	0·5410521	91	1·5882496	151	2·6354472	31	0·0090175	31	0·0001503	·31	0·0000015	·91	0·0000044
32	5585054	92	6057029	152	6529005	32	93084	32	1551	·32	16	·92	45
33	5759587	93	6231562	153	6703538	33	95993	33	1600	·33	16	·93	45
34	5934119	94	6406095	154	6878070	34	98902	34	1648	·34	16	·94	46
35	6108652	95	6580628	155	7052603	35	0·0101811	35	1697	·35	17	·95	46
36	0·6283185	96	1·6755161	156	2·7227136	36	0·0104720	36	0·0001745	·36	0·0000017	·96	0·0000047
37	6457718	97	6929694	157	7401669	37	107629	37	1794	·37	18	·97	47
38	6632251	98	7104227	158	7576202	38	110538	38	1842	·38	18	·98	48
39	6806784	99	7278760	159	7750735	39	113446	39	1891	·39	19	·99	48
40	6981317	100	7453293	160	7925268	40	116355	40	1939	·40	19		
41	0·7155850	101	1·7627825	161	2·8099801	41	0·0119264	41	0·0001988	·41	0·0000020		
42	7330383	102	7802358	162	8274334	42	122173	42	2036	·42	20		
43	7504916	103	7976891	163	8448867	43	125082	43	2085	·43	21		
44	7679449	104	8151424	164	8623400	44	127991	44	2133	·44	21		
45	7853982	105	8325957	165	8797933	45	130900	45	2182	·45	22		
46	0·8028515	106	1·8500490	166	2·8972466	46	0·0133809	46	0·0002230	·46	0·0000022		
47	8203047	107	8675023	167	9146999	47	136717	47	2279	·47	23		
48	8377580	108	8849556	168	9321531	48	139626	48	2327	·48	23		
49	8552113	109	9024089	169	9496064	49	142535	49	2376	·49	24		
50	8726646	110	9198622	170	9670597	50	145444	50	2424	·50	24		
51	0·8901179	111	1·9373155	171	2·9845130	51	0·0148353	51	0·0002473	·51	0·0000025		
52	9075712	112	9547688	172	3·0019663	52	151262	52	2521	·52	25		
53	9250245	113	9722221	173	0194196	53	154171	53	2570	·53	26		
54	9424778	114	9896753	174	0368729	54	157080	54	2618	·54	26		
55	9599311	115	2·0071286	175	0543262	55	159989	55	2666	·55	27		
56	0·9773844	116	2·0245819	176	3·0717795	56	0·0162897	56	0·0002715	·56	0·0000027		
57	9948377	117	0420352	177	0892328	57	165806	57	2763	·57	28		
58	1·0122910	118	0594885	178	1066861	58	168715	58	2812	·58	28		
59	0297443	119	0769418	179	1241394	59	171624	59	2860	·59	29		
60	0471976	120	0943951	180	1415927	60	174533	60	2909	·60	29		

TABLE XLV.—For converting Feet into Miles.

Tens of Thousands.	Thousands. 0	1	2	3	4	5	6	7	8	9	Tens of Thousands.
0	Miles	0·1894	0·3788	0·5682	0·7576	0·9470	1·1364	1·3258	1·5152	1·7045	0
1	1·8939	2·0833	2·2727	2·4621	2·6515	2·8409	3·0303	3·2197	3·4091	3·5985	1
2	3·7879	3·9773	4·1667	4·3561	4·5455	4·7348	4·9242	5·1136	5·3030	5·4924	2
3	5·6818	5·8712	6·0606	6·2500	6·4394	6·6288	6·8182	7·0076	7·1970	7·3864	3
4	7·5758	7·7652	7·9545	8·1439	8·3333	8·5227	8·7121	8·9015	9·0909	9·2803	4
5	9·4697	9·6591	9·8485	10·0379	10·2273	10·4167	10·6061	10·7955	10·9848	11·1742	5
6	11·3636	11·5530	11·7424	11·9318	12·1212	12·3106	12·5000	12·6894	12·8788	13·0682	6
7	13·2576	13·4470	13·6364	13·8258	14·0152	14·2045	14·3939	14·5833	14·7727	14·9621	7
8	15·1515	15·3409	15·5303	15·7197	15·9091	16·0985	16·2879	16·4773	16·6667	16·8561	8
9	17·0455	17·2348	17·4242	17·6136	17·8030	17·9924	18·1818	18·3712	18·5606	18·7500	9
Hundreds.	Tens. 0	1	2	3	4	5	6	7	8	9	Hundreds.
0	Miles	0·0019	0·0038	0·0057	0·0076	0·0095	0·0114	0·0133	0·0152	0·0170	0
1	0·0189	0208	0227	0246	0265	0284	0303	0322	0341	0360	1
2	0379	0398	0417	0436	0455	0473	0492	0511	0530	0549	2
3	0568	0587	0606	0625	0644	0663	0682	0701	0720	0739	3
4	0758	0777	0795	0814	0833	0852	0871	0890	0909	0928	4
5	0947	0966	0985	1004	1023	1042	1061	1080	1098	1117	5
6	1136	1155	1174	1193	1212	1231	1250	1269	1288	1307	6
7	1326	1345	1364	1383	1402	1420	1439	1458	1477	1496	7
8	1515	1534	1553	1572	1591	1610	1629	1648	1667	1686	8
9	1705	1723	1742	1761	1780	1799	1818	1837	1856	1875	9
Units	...	·0002	·0004	·0006	·0008	·0009	·0011	·0013	·0015	·0017	Units

TABLE XLVI.—For converting Miles into Feet.

Tens.	Units. 0	1	2	3	4	5	6	7	8	9	Tens.
0	Feet	5280	10560	15840	21120	26400	31680	36960	42240	47520	0
1	52800	58080	63360	68640	73920	79200	84480	89760	95040	100320	1
2	105600	110880	116160	121440	126720	132000	137280	142560	147840	153120	2
3	158400	163680	168960	174240	179520	184800	190080	195360	200640	205920	3
4	211200	216480	221760	227040	232320	237600	242880	248160	253440	258720	4
5	264000	269280	274560	279840	285120	290400	295680	300960	306240	311520	5
6	316800	322080	327360	332640	337920	343200	348480	353760	359040	364320	6
7	369600	374880	380160	385440	390720	396000	401280	406560	411840	417120	7
8	422400	427680	432960	438240	443520	448800	454080	459360	464640	469920	8
9	475200	480480	485760	491040	496320	501600	506880	512160	517440	522720	9
Tenths.	Hundredths. 0	1	2	3	4	5	6	7	8	9	Tenths.
0	Feet	52·8	105·6	158·4	211·2	264·0	316·8	369·6	422·4	475·2	0
1	528·0	580·8	633·6	686·4	739·2	792·0	844·8	897·6	950·4	1003·2	1
2	1056·0	1108·8	1161·6	1214·4	1267·2	1320·0	1372·8	1425·6	1478·4	1531·2	2
3	1584·0	1636·8	1689·6	1742·4	1795·2	1848·0	1900·8	1953·6	2006·4	2059·2	3
4	2112·0	2164·8	2217·6	2270·4	2323·2	2376·0	2428·8	2481·6	2534·4	2587·2	4
5	2640·0	2692·8	2745·6	2798·4	2851·2	2904·0	2956·8	3009·6	3062·4	3115·2	5
6	3168·0	3220·8	3273·6	3326·4	3379·2	3432·0	3484·8	3537·6	3590·4	3643·2	6
7	3696·0	3748·8	3801·6	3854·4	3907·2	3960·0	4012·8	4065·6	4118·4	4171·2	7
8	4224·0	4276·8	4329·6	4382·4	4435·2	4488·0	4540·8	4593·6	4646·4	4699·2	8
9	4752·0	4804·8	4857·6	4910·4	4963·2	5016·0	5068·8	5121·6	5174·4	5227·2	9

TABLE XLVII.—For converting Links into Feet.

Tens of Thousands.	Thousands.										Tens of Thousands.
	0	1	2	3	4	5	6	7	8	9	
0	Feet	660	1320	1980	2640	3300	3960	4620	5280	5940	0
1	6600	7260	7920	8580	9240	9900	10560	11220	11880	12540	1
2	13200	13860	14520	15180	15840	16500	17160	17820	18480	19140	2
3	19800	20460	21120	21780	22440	23100	23760	24420	25080	25740	3
4	26400	27060	27720	28380	29040	29700	30360	31020	31680	32340	4
5	33000	33660	34320	34980	35640	36300	36960	37620	38280	38940	5
6	39600	40260	40920	41580	42240	42900	43560	44220	44880	45540	6
7	46200	46860	47520	48180	48840	49500	50160	50820	51480	52140	7
8	52800	53460	54120	54780	55440	56100	56760	57420	58080	58740	8
9	59400	60060	60720	61380	62040	62700	63360	64020	64680	65340	9
Hundreds.	Tens.										Hundreds.
	0	1	2	3	4	5	6	7	8	9	
0	Feet	6·6	13·2	19·8	26·4	33·0	39·6	46·2	52·8	59·4	0
1	66·0	72·6	79·2	85·8	92·4	99·0	105·6	112·2	118·8	125·4	1
2	132·0	138·6	145·2	151·8	158·4	165·0	171·6	178·2	184·8	191·4	2
3	198·0	204·6	211·2	217·8	224·4	231·0	237·6	244·2	250·8	257·4	3
4	264·0	270·6	277·2	283·8	290·4	297·0	303·6	310·2	316·8	323·4	4
5	330·0	336·6	343·2	349·8	356·4	363·0	369·6	376·2	382·8	389·4	5
6	396·0	402·6	409·2	415·8	422·4	429·0	435·6	442·2	448·8	455·4	6
7	462·0	468·6	475·2	481·8	488·4	495·0	501·6	508·2	514·8	521·4	7
8	528·0	534·6	541·2	547·8	554·4	561·0	567·6	574·2	580·8	587·4	8
9	594·0	600·6	607·2	613·8	620·4	627·0	633·6	640·2	646·8	653·4	9
Units	...	·66	1·32	1·98	2·64	3·30	3·96	4·62	5·28	5·94	Units

TABLE XLVIII.—For converting Feet into Links.

Tens of Thousands.	Thousands.										Tens of Thousands.
	0	1	2	3	4	5	6	7	8	9	
0	Links	1515·2	3030·3	4545·5	6060·6	7575·8	9090·9	10606·1	12121·2	13636·4	0
1	15151·5	16666·7	18181·8	19697·0	21212·1	22727·3	24242·4	25757·6	27272·7	28787·9	1
2	30303·0	31818·2	33333·3	34848·5	36363·6	37878·8	39393·9	40909·1	42424·2	43939·4	2
3	45454·5	46969·7	48484·8	50000·0	51515·2	53030·3	54545·5	56060·6	57575·8	59090·9	3
4	60606·1	62121·2	63636·4	65151·5	66666·7	68181·8	69697·0	71212·1	72727·3	74242·4	4
5	75757·6	77272·7	78787·9	80303·0	81818·2	83333·3	84848·5	86363·6	87878·8	89393·9	5
6	90909·1	92424·2	93939·4	95454·5	96969·7	98484·8	100000·0	101515·2	103030·3	104545·5	6
7	106060·6	107575·8	109090·9	110606·1	112121·2	113636·4	115151·5	116666·7	118181·8	119697·0	7
8	121212·1	122727·3	124242·4	125757·6	127272·7	128787·9	130303·0	131818·2	133333·3	134848·5	8
9	136363·6	137878·8	139393·9	140909·1	142424·2	143939·4	145454·5	146969·7	148484·8	150000·0	9
Hundreds.	Tons.										Hundreds.
	0	1	2	3	4	5	6	7	8	9	
0	Links	15·2	30·3	45·5	60·6	75·8	90·9	106·1	121·2	136·4	0
1	151·5	166·7	181·8	197·0	212·1	227·3	242·4	257·6	272·7	287·9	1
2	303·0	318·2	333·3	348·5	363·6	378·8	393·9	409·1	424·2	439·4	2
3	454·5	469·7	484·8	500·0	515·2	530·3	545·5	560·6	575·8	590·9	3
4	606·1	621·2	636·4	651·5	666·7	681·8	697·0	712·1	727·3	742·4	4
5	757·6	772·7	787·9	803·0	818·2	833·3	848·5	863·6	878·8	893·9	5
6	909·1	924·2	939·4	954·5	969·7	984·8	1000·0	1015·2	1030·3	1045·5	6
7	1060·6	1075·8	1090·9	1106·1	1121·2	1136·4	1151·5	1166·7	1181·8	1197·0	7
8	1212·1	1227·3	1242·4	1257·6	1272·7	1287·9	1303·0	1318·2	1333·3	1348·5	8
9	1363·6	1378·8	1393·9	1409·1	1424·2	1439·4	1454·5	1469·7	1484·8	1500·0	9
Units	...	1·5	3·0	4·5	6·1	7·6	9·1	10·6	12·1	13·6	Units

TABLE XLIX.—Gauss's Sum and Difference Logarithms.

A.	B.										C.									
	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9
0·00	0·3*103	*053	*003	9953	9903	9854	9804	9754	9705	9655	0·30103	0153	0203	0253	0303	0354	0404	0454	0505	0555
0·01	0·29606	9556	9507	9458	9409	9359	9310	9261	9212	9163	0606	0656	0707	0758	0809	0859	0910	0961	1012	1063
0·02	9115	9066	9017	8968	8920	8871	8822	8774	8726	8677	1115	1166	1217	1268	1320	1371	1422	1474	1526	1577
0·03	8629	8581	8532	8484	8436	8388	8340	8292	8245	8197	1629	1681	1732	1784	1836	1888	1940	1992	2045	2097
0·04	8149	8101	8054	8006	7959	7911	7864	7817	7769	7722	2149	2201	2254	2306	2359	2411	2464	2517	2569	2622
0·05	7675	7628	7581	7534	7487	7440	7393	7346	7300	7253	2675	2728	2781	2834	2887	2940	2993	3046	3100	3153
0·06	7207	7160	7114	7067	7021	6974	6928	6882	6836	6790	3207	3260	3314	3367	3421	3474	3528	3582	3636	3690
0·07	6744	6698	6652	6606	6560	6515	6469	6423	6378	6332	3744	3798	3852	3906	3960	4015	4069	4123	4178	4232
0·08	6287	6242	6196	6151	6106	6061	6016	5970	5926	5881	4287	4342	4396	4451	4506	4561	4616	4670	4726	4781
0·09	5836	5791	5746	5701	5657	5612	5568	5523	5479	5434	4836	4891	4946	5001	5057	5112	5168	5223	5279	5334
0·10	0·25390	5346	5302	5258	5214	5170	5126	5082	5038	4994	0·35390	5446	5502	5558	5614	5670	5726	5782	5838	5894
0·11	4950	4907	4863	4819	4776	4733	4689	4646	4603	4559	5950	6007	6063	6119	6176	6233	6289	6346	6403	6459
0·12	4516	4473	4430	4387	4344	4301	4258	4216	4173	4130	6516	6573	6630	6687	6744	6801	6858	6916	6973	7030
0·13	4088	4045	4003	3960	3918	3875	3833	3791	3749	3707	7088	7145	7203	7260	7318	7375	7433	7491	7549	7607
0·14	3665	3623	3581	3539	3497	3455	3414	3372	3330	3289	7665	7723	7781	7839	7897	7955	8014	8072	8130	8189
0·15	3247	3206	3165	3123	3082	3041	3000	2959	2918	2877	8247	8306	8365	8423	8482	8541	8600	8659	8718	8777
0·16	2836	2795	2754	2713	2673	2632	2591	2551	2510	2470	8836	8895	8954	9013	9073	9132	9191	9251	9310	9370
0·17	2430	2389	2349	2309	2269	2229	2189	2149	2109	2069	9430	9489	9549	9609	9669	9729	9789	9849	9909	9969
0·18	2029	1989	1949	1910	1870	1831	1791	1752	1712	1673	0·40029	0089	0149	0210	0270	0331	0391	0452	0512	0573
0·19	1634	1595	1556	1516	1477	1438	1399	1361	1322	1283	0634	0695	0756	0816	0877	0938	0999	1061	1122	1183
0·20	0·21244	1206	1167	1128	1090	1052	1013	*975	*937	*898	0·41244	1306	1367	1428	1490	1552	1613	1675	1737	1798
0·21	*860	*822	*784	*746	*708	*670	*632	*594	*557	*519	1860	1922	1984	2046	2108	2170	2232	2294	2357	2419
0·22	*481	*444	*406	*369	*331	*294	*257	*220	*182	*145	2481	2544	2606	2669	2731	2794	2857	2920	2982	3045
0·23	*108	*071	*034	9997	9960	9923	9887	9850	9813	9777	3108	3171	3234	3297	3360	3423	3487	3550	3613	3677
0·24	0·19740	9704	9667	9631	9595	9558	9522	9486	9450	9414	3740	3804	3867	3931	3995	4058	4122	4186	4250	4314
0·25	9378	9342	9306	9270	9234	9198	9163	9127	9091	9056	4378	4442	4506	4570	4634	4698	4763	4827	4891	4956
0·26	9020	8985	8949	8914	8879	8844	8808	8773	8738	8703	5020	5085	5149	5214	5279	5344	5408	5473	5538	5603
0·27	8668	8633	8599	8564	8529	8494	8460	8425	8390	8356	5668	5733	5799	5864	5929	5994	6060	6125	6190	6256
0·28	8322	8287	8253	8218	8184	8150	8116	8082	8048	8014	6322	6387	6453	6518	6584	6650	6716	6782	6848	6914
0·29	7980	7946	7912	7878	7845	7811	7777	7744	7710	7677	6980	7046	7112	7178	7245	7311	7377	7444	7510	7577
0·30	0·17643	7610	7577	7544	7510	7477	7444	7411	7378	7345	0·47643	7710	7777	7844	7910	7977	8044	8111	8178	8245
0·31	7312	7279	7247	7214	7181	7148	7116	7083	7051	7018	8312	8379	8447	8514	8581	8648	8716	8783	8851	8918
0·32	6986	6954	6921	6889	6857	6825	6793	6761	6729	6697	8986	9054	9121	9189	9257	9325	9393	9461	9529	9597
0·33	6665	6633	6601	6569	6538	6506	6474	6443	6411	6380	9665	9733	9801	9869	9938	*006	*074	*143	*211	*280
0·34	6349	6317	6286	6255	6224	6192	6161	6130	6099	6068	0·50349	0417	0486	0555	0624	0692	0761	0830	0899	0968
0·35	6037	6007	5976	5945	5914	5884	5853	5822	5792	5761	1037	1107	1176	1245	1314	1384	1453	1522	1592	1661
0·36	5731	5701	5670	5640	5610	5580	5550	5520	5489	5460	1731	1801	1870	1940	2010	2080	2150	2220	2289	2360
0·37	5430	5400	5370	5340	5310	5281	5251	5221	5192	5162	2430	2500	2570	2640	2710	2781	2851	2921	2992	3062
0·38	5133	5104	5074	5045	5016	4986	4957	4928	4899	4870	3133	3204	3274	3345	3416	3486	3557	3628	3699	3770
0·39	4841	4812	4783	4755	4726	4697	4668	4640	4611	4583	3841	3912	3983	4055	4126	4197	4268	4340	4411	4483
0·40	0·14554	4526	4497	4469	4441	4412	4384	4356	4328	4300	0·54554	4626	4697	4769	4841	4912	4984	5056	5128	5200
0·41	4272	4244	4216	4188	4160	4132	4104	4077	4049	4021	5272	5344	5416	5488	5560	5632	5704	5777	5849	5921
0·42	3994	3966	3939	3911	3884	3857	3829	3802	3775	3748	5994	6066	6139	6211	6284	6357	6429	6502	6575	6648
0·43	3721	3694	3667	3640	3613	3586	3559	3532	3505	3479	6721	6794	6867	6940	7013	7086	7159	7232	7305	7379
0·44	3452	3425	3399	3372	3346	3319	3293	3267	3240	3214	7452	7525	7599	7672	7746	7819	7893	7967	8040	8114
0·45	3188	3162	3136	3110	3084	3058	3032	3006	2980	2954	8188	8262	8336	8410	8484	8558	8632	8706	8780	8854
0·46	2928	2903	2877	2851	2826	2800	2775	2749	2724	2698	8928	9003	9077	9151	9226	9300	9375	9449	9524	9598
0·47	2673	2648	2622	2597	2572	2547	2522	2497	2472	2447	9673	9748	9822	9897	9972	*047	*122	*197	*272	*347
0·48	2422	2397	2372	2348	2323	2298	2274	2249	2224	2200	0·60422	0497	0572	0648	0723	0798	0874	0949	1024	1100
0·49	2175	2151	2127	2102	2078	2054	2030	2005	1981	1957	1175	1251	1327	1402	1478	1554	1630	1705	1781	1857
0·50	0·11933	1909	1885	1861	1837	1814	1790	1766	1742	1719	0·61933	2009	2085	2161	2237	2314	2390	2466	2542	2619
0·51	1695	1671	1648	1624	1601	1577	1554	1531	1507	1484	2695	2771	2848	2924	3001	3077	3154	3231	3307	3384
0·52	1461	1438	1415	1392	1368	1345	1323	1300	1277	1254	3461	3538	3615	3692	3768	3845	3923	4000	4077	4154
0·53	1231	1208	1186	1163	1140	1118	1095	1073	1050	1028	4231	4308	4386	4463	4540	4618	4695	4773	4850	4928
0·54	1005	*983	*960	*938	*916	*894	*872	*849	*827	*805	5005	5083	5160	5238	5316	5394	5472	5549	5627	5705
0·55	*783	*761	*739	*718	*696	*674	*652	*630	*609	*587	5783	5861	5939	6018	6096	6174	6252	6330	6409	6487
0·56	*565	*544	*522	*501	*479	*458	*437	*415	*394	*373	6565	6644	6722	6801	6879	6958	7037	7115	7194	7273
0·57	*351	*330	*309	*288	*267	*246	*225	*204	*183	*162	7351	7430	7509	7588	7667	7746	7825	7904	7983	8062
0·58	*141	*120	*100	*079	*058	*038	*017	9996	9976	9955	8141	8220	8300	8379	8458	8538	8617	8696	8776	8855
0·59	0·09935	9914	9894	9874	9853	9833	9813	9793	9773	9752	8935	9014	9094	9174	9253	9333	9413	9493	9573	9652
	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9

Note.—The symbol * denotes a cypher and calls attention to a change in the leading numeral.

TABLE XLIX.—Gauss's Sum and Difference Logarithms.

A.	B.										C.									
	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9
0·60	0·09732	9712	9692	9672	9652	9632	9612	9593	9573	9553	0·69732	9812	9892	9972	*052	*132	*212	*293	*373	*453
0·61	9533	9514	9494	9474	9455	9435	9416	9396	9377	9357	0·70533	0614	0694	0774	0855	0935	1016	1096	1177	1257
0·62	9338	9319	9299	9280	9261	9242	9223	9204	9184	9165	1338	1419	1499	1580	1661	1742	1823	1904	1984	2065
0·63	9146	9127	9108	9090	9071	9052	9033	9014	8996	8977	2146	2227	2308	2390	2471	2552	2633	2714	2796	2877
0·64	8958	8940	8921	8902	8884	8865	8847	8829	8810	8792	2958	3040	3121	3202	3284	3365	3447	3529	3610	3692
0·65	8774	8755	8737	8719	8701	8683	8664	8646	8628	8610	3774	3855	3937	4019	4101	4183	4264	4346	4428	4510
0·66	8592	8574	8557	8539	8521	8503	8485	8468	8450	8432	4592	4674	4757	4839	4921	5003	5085	5168	5250	5332
0·67	8415	8397	8379	8362	8344	8327	8309	8292	8275	8257	5415	5497	5579	5662	5744	5827	5909	5992	6075	6157
0·68	8240	8223	8206	8188	8171	8154	8137	8120	8103	8086	6240	6323	6406	6488	6571	6654	6737	6820	6903	6986
0·69	8069	8052	8035	8018	8001	7985	7968	7951	7934	7918	7069	7152	7235	7318	7401	7485	7568	7651	7734	7818
0·70	0·07901	7884	7868	7851	7835	7818	7802	7785	7769	7753	0·77901	7984	8068	8151	8235	8318	8402	8485	8569	8653
0·71	7736	7720	7704	7687	7671	7655	7639	7623	7607	7591	8736	8820	8904	8987	9071	9155	9239	9323	9407	9491
0·72	7575	7559	7543	7527	7511	7495	7479	7463	7448	7432	9575	9659	9743	9827	9911	9995	*079	*163	*248	*332
0·73	7416	7400	7385	7369	7354	7338	7322	7307	7291	7276	0·80416	0500	0585	0669	0754	0838	0922	1007	1091	1176
0·74	7261	7245	7230	7215	7199	7184	7169	7154	7138	7123	1261	1345	1430	1515	1599	1684	1769	1854	1938	2023
0·75	7108	7093	7078	7063	7048	7033	7018	7003	6988	6973	2108	2193	2278	2363	2448	2533	2618	2703	2788	2873
0·76	6959	6944	6929	6914	6900	6885	6870	6856	6841	6827	2959	3044	3129	3214	3300	3385	3470	3556	3641	3727
0·77	6812	6798	6783	6769	6754	6740	6725	6711	6697	6683	3812	3898	3983	4069	4154	4240	4325	4411	4497	4583
0·78	6668	6654	6640	6626	6612	6597	6583	6569	6555	6541	4668	4754	4840	4926	5012	5097	5183	5269	5355	5441
0·79	6527	6513	6500	6486	6472	6458	6444	6430	6417	6403	5527	5613	5700	5786	5872	5958	6044	6130	6217	6303
0·80	0·06389	6376	6362	6348	6335	6321	6308	6294	6281	6267	0·86389	6476	6562	6648	6735	6821	6908	6994	7081	7167
0·81	6254	6240	6227	6214	6200	6187	6174	6161	6147	6134	7254	7340	7427	7514	7600	7687	7774	7861	7947	8034
0·82	6121	6108	6095	6082	6069	6056	6043	6030	6017	6004	8121	8208	8295	8382	8469	8556	8643	8730	8817	8904
0·83	5991	5978	5965	5952	5939	5927	5914	5901	5889	5876	8991	9078	9165	9252	9339	9427	9514	9601	9689	9776
0·84	5863	5851	5838	5825	5813	5800	5788	5775	5763	5751	9863	9951	*038	*125	*213	*300	*388	*475	*563	*651
0·85	5738	5726	5714	5701	5689	5677	5664	5652	5640	5628	0·90738	0826	0914	1001	1089	1177	1264	1352	1440	1528
0·86	5616	5604	5591	5579	5567	5555	5543	5531	5519	5508	1616	1704	1791	1879	1967	2055	2143	2231	2319	2408
0·87	5496	5484	5472	5460	5448	5436	5425	5413	5401	5390	2496	2584	2672	2760	2848	2936	3025	3113	3201	3290
0·88	5378	5366	5355	5343	5332	5320	5308	5297	5286	5274	3378	3466	3555	3643	3732	3820	3908	3997	4086	4174
0·89	5263	5251	5240	5229	5217	5206	5195	5183	5172	5161	4263	4351	4440	4529	4617	4706	4795	4883	4972	5061
0·90	0·05150	5139	5127	5116	5105	5094	5083	5072	5061	5050	0·95150	5239	5327	5416	5505	5594	5683	5772	5861	5950
0·91	5039	5028	5017	5006	4995	4985	4974	4963	4952	4941	6039	6128	6217	6306	6395	6485	6574	6663	6752	6841
0·92	4931	4920	4909	4898	4888	4877	4867	4856	4845	4835	6931	7020	7109	7198	7288	7377	7467	7556	7645	7735
0·93	4824	4814	4803	4793	4782	4772	4762	4751	4741	4731	7824	7914	8003	8093	8182	8272	8362	8451	8541	8631
0·94	4720	4710	4700	4689	4679	4669	4659	4649	4639	4628	8720	8810	8900	8989	9079	9169	9259	9349	9439	9528
0·95	4618	4608	4598	4588	4578	4568	4558	4548	4538	4528	9618	9708	9798	9888	9978	*068	*158	*248	*338	*428
0·96	4519	4509	4499	4489	4479	4469	4460	4450	4440	4430	1·00519	0609	0699	0789	0879	0969	1060	1150	1240	1330
0·97	4421	4411	4401	4392	4382	4373	4363	4353	4344	4334	1421	1511	1601	1692	1782	1873	1963	2053	2144	2234
0·98	4325	4315	4306	4297	4287	4278	4268	4259	4250	4240	2325	2415	2506	2597	2687	2778	2868	2959	3050	3140
0·99	4231	4222	4213	4203	4194	4185	4176	4167	4157	4148	3231	3322	3413	3503	3594	3685	3776	3867	3957	4048
1·00	0·04139	4130	4121	4112	4103	4094	4085	4076	4067	4058	1·04139	4230	4321	4412	4503	4594	4685	4776	4867	4958
1·01	4049	4040	4032	4023	4014	4005	3996	3987	3979	3970	5049	5140	5232	5323	5414	5505	5596	5687	5779	5870
1·02	3961	3953	3944	3935	3926	3918	3909	3901	3892	3883	5961	6053	6144	6235	6326	6418	6509	6601	6692	6783
1·03	3875	3866	3858	3849	3841	3832	3824	3816	3807	3799	6875	6966	7058	7149	7241	7332	7424	7516	7607	7699
1·04	3790	3782	3774	3765	3757	3749	3741	3732	3724	3716	7790	7882	7974	8065	8157	8249	8341	8432	8524	8616
1·05	3708	3700	3691	3683	3675	3667	3659	3651	3643	3635	8708	8800	8891	8983	9075	9167	9259	9351	9443	9535
1·06	3627	3619	3611	3603	3595	3587	3579	3571	3563	3555	9627	9719	9811	9903	9995	*087	*179	*271	*363	*455
1·07	3548	3540	3532	3524	3516	3509	3501	3493	3485	3478	1·10548	0640	0732	0824	0916	1009	1101	1193	1285	1378
1·08	3470	3462	3455	3447	3439	3432	3424	3417	3409	3401	1470	1562	1655	1747	1839	1932	2024	2117	2209	2301
1·09	3394	3386	3379	3371	3364	3357	3349	3342	3334	3327	2394	2486	2579	2671	2764	2857	2949	3042	3134	3227
1·10	0·03320	3312	3305	3298	3290	3283	3276	3268	3261	3254	1·13320	3412	3505	3598	3690	3783	3876	3968	4061	4154
1·11	3247	3240	3232	3225	3218	3211	3204	3197	3190	3183	4247	4340	4432	4525	4618	4711	4804	4897	4990	5083
1·12	3175	3168	3161	3154	3147	3140	3133	3126	3120	3113	5175	5268	5361	5454	5547	5640	5733	5826	5920	6013
1·13	3106	3099	3092	3085	3078	3071	3065	3058	3051	3044	6106	6199	6292	6385	6478	6571	6665	6758	6851	6944
1·14	3037	3031	3024	3017	3011	3004	2997	2991	2984	2977	7037	7131	7224	7317	7411	7504	7597	7691	7784	7877
1·15	2971	2964	2957	2951	2944	2938	2931	2925	2918	2912	7971	8064	8157	8251	8344	8438	8531	8625	8718	8812
1·16	2905	2899	2892	2886	2879	2873	2867	2860	2854	2848	8905	8999	9092	9186	9279	9373	9467	9560	9654	9748
1·17	2841	2835	2829	2822	2816	2810	2803	2797	2791	2785	9841	9935	*029	*122	*216	*310	*403	*497	*591	*685
1·18	2779	2772	2766	2760	2754	2748	2742	2735	2729	2723	1·20779	0872	0966	1060	1154	1248	1342	1435	1529	1623
1·19	2717	2711	2705	2699	2693	2687	2681	2675	2669	2663	1717	1811	1905	1999	2093	2187	2281	2375	2469	2563
	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9

TABLE XLIX.—Gauss's Sum and Difference Logarithms.

A.	B.										C.									
	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9
1·20	0·02657	2651	2645	2639	2634	2628	2622	2616	2610	2604	1·22657	2751	2845	2939	3034	3128	3222	3316	3410	3504
1·21	2599	2593	2587	2581	2575	2570	2564	2558	2552	2547	3599	3693	3787	3881	3975	4070	4164	4258	4352	4447
1·22	2541	2535	2530	2524	2518	2513	2507	2502	2496	2490	4541	4635	4730	4824	4918	5013	5107	5202	5296	5390
1·23	2485	2479	2474	2468	2463	2457	2452	2446	2441	2435	5485	5579	5674	5768	5863	5957	6052	6146	6241	6335
1·24	2430	2424	2419	2414	2408	2403	2397	2392	2387	2381	6430	6524	6619	6714	6808	6903	6997	7092	7187	7281
1·25	2376	2371	2365	2360	2355	2350	2344	2339	2334	2329	7376	7471	7565	7660	7755	7850	7944	8039	8134	8229
1·26	2323	2318	2313	2308	2303	2297	2292	2287	2282	2277	8323	8418	8513	8608	8703	8797	8892	8987	9082	9177
1·27	2272	2267	2262	2257	2252	2246	2241	2236	2231	2226	9272	9367	9462	9557	9652	9746	9841	9936	*031	*126
1·28	2221	2216	2211	2207	2202	2197	2192	2187	2182	2177	1·30221	0316	0411	0507	0602	0697	0792	0887	0982	1077
1·29	2172	2167	2162	2158	2153	2148	2143	2138	2133	2129	1172	1267	1362	1458	1553	1648	1743	1838	1933	2029
1·30	0·02124	2119	2114	2110	2105	2100	2095	2091	2086	2081	1·32124	2219	2314	2410	2505	2600	2695	2791	2886	2981
1·31	2077	2072	2067	2063	2058	2053	2049	2044	2040	2035	3077	3172	3267	3363	3458	3553	3649	3744	3840	3935
1·32	2030	2026	2021	2017	2012	2008	2003	1999	1994	1990	4030	4126	4221	4317	4412	4508	4603	4699	4794	4890
1·33	1985	1981	1976	1972	1967	1963	1959	1954	1950	1945	4985	5081	5176	5272	5367	5463	5559	5654	5750	5845
1·34	1941	1937	1932	1928	1924	1919	1915	1911	1906	1902	5941	6037	6132	6228	6324	6419	6515	6611	6706	6802
1·35	1898	1894	1889	1885	1881	1877	1872	1868	1864	1860	6898	6994	7089	7185	7281	7377	7472	7568	7664	7760
1·36	1856	1851	1847	1843	1839	1835	1831	1827	1822	1818	7856	7951	8047	8143	8239	8335	8431	8527	8622	8718
1·37	1814	1810	1806	1802	1798	1794	1790	1786	1782	1778	8814	8910	9006	9102	9198	9294	9390	9486	9582	9678
1·38	1774	1770	1766	1762	1758	1754	1750	1746	1742	1738	9774	9870	9966	*062	*158	*254	*350	*446	*542	*638
1·39	1734	1730	1726	1722	1719	1715	1711	1707	1703	1699	1·40734	0830	0926	1022	1119	1215	1311	1407	1503	1599
1·40	0·01695	1692	1688	1684	1680	1676	1673	1669	1665	1661	1·41695	1792	1888	1984	2080	2176	2273	2369	2465	2561
1·41	1658	1654	1650	1646	1643	1639	1635	1632	1628	1624	2658	2754	2850	2946	3043	3139	3235	3332	3428	3524
1·42	1621	1617	1613	1610	1606	1602	1599	1595	1591	1588	3621	3717	3813	3910	4006	4102	4199	4295	4391	4488
1·43	1584	1581	1577	1574	1570	1566	1563	1559	1556	1552	4584	4681	4777	4874	4970	5066	5163	5259	5356	5452
1·44	1549	1545	1542	1538	1535	1531	1528	1525	1521	1518	5549	5645	5742	5838	5935	6031	6128	6225	6321	6418
1·45	1514	1511	1507	1504	1501	1497	1494	1490	1487	1484	6514	6611	6707	6804	6901	6997	7094	7190	7287	7384
1·46	1480	1477	1474	1470	1467	1464	1460	1457	1454	1450	7480	7577	7674	7770	7867	7964	8060	8157	8254	8350
1·47	1447	1444	1441	1437	1434	1431	1428	1424	1421	1418	8447	8544	8641	8737	8834	8931	9028	9124	9221	9318
1·48	1415	1412	1408	1405	1402	1399	1396	1393	1389	1386	9415	9512	9608	9705	9802	9899	9996	*093	*189	*286
1·49	1383	1380	1377	1374	1371	1368	1364	1361	1358	1355	1·50383	0480	0577	0674	0771	0868	0964	1061	1158	1255
1·50	0·01352	1349	1346	1343	1340	1337	1334	1331	1328	1325	1·51352	1449	1546	1643	1740	1837	1934	2031	2128	2225
1·51	1322	1319	1316	1313	1310	1307	1304	1301	1298	1295	2322	2419	2516	2613	2710	2807	2904	3001	3098	3195
1·52	1292	1289	1286	1283	1280	1278	1275	1272	1269	1266	3292	3389	3486	3583	3680	3778	3875	3972	4069	4166
1·53	1263	1260	1257	1255	1252	1249	1246	1243	1240	1238	4263	4360	4457	4555	4652	4749	4846	4943	5040	5138
1·54	1235	1232	1229	1226	1224	1221	1218	1215	1213	1210	5235	5332	5429	5526	5624	5721	5818	5915	6013	6110
1·55	1207	1204	1202	1199	1196	1193	1191	1188	1185	1183	6207	6304	6402	6499	6596	6693	6791	6888	6985	7083
1·56	1180	1177	1175	1172	1169	1167	1164	1161	1159	1156	7180	7277	7375	7472	7569	7667	7764	7861	7959	8056
1·57	1153	1151	1148	1146	1143	1140	1138	1135	1133	1130	8153	8251	8348	8446	8543	8640	8738	8835	8933	9030
1·58	1128	1125	1122	1120	1117	1115	1112	1110	1107	1105	9128	9225	9322	9420	9517	9615	9712	9810	9907	*005
1·59	1102	1100	1097	1095	1092	1090	1087	1085	1082	1080	1·60102	0200	0297	0395	0492	0590	0687	0785	0882	0980
1·60	0·01077	1075	1073	1070	1068	1065	1063	1060	1058	1056	1·61077	1175	1273	1370	1468	1565	1663	1760	1858	1956
1·61	1053	1051	1048	1046	1044	1041	1039	1037	1034	1032	2053	2151	2248	2346	2444	2541	2639	2737	2834	2932
1·62	1030	1027	1025	1022	1020	1018	1016	1013	1011	1009	3030	3127	3225	3322	3420	3518	3616	3713	3811	3909
1·63	1006	1004	1002	0999	0997	0995	0993	0990	0988	0986	4006	4104	4202	4299	4397	4495	4593	4690	4788	4886
1·64	0984	0981	0979	0977	0975	0973	0970	0968	0966	0964	4984	5081	5179	5277	5375	5473	5570	5668	5766	5864
1·65	0962	0959	0957	0955	0953	0951	0948	0946	0944	0942	5962	6059	6157	6255	6353	6451	6548	6646	6744	6842
1·66	0940	0938	0936	0933	0931	0929	0927	0925	0923	0921	6940	7038	7136	7233	7331	7429	7527	7625	7723	7821
1·67	0919	0917	0915	0912	0910	0908	0906	0904	0902	0900	7919	8017	8115	8212	8310	8408	8506	8604	8702	8800
1·68	0898	0896	0894	0892	0890	0888	0886	0884	0882	0880	8898	8996	9094	9192	9290	9388	9486	9584	9682	9780
1·69	0878	0876	0874	0872	0870	0868	0866	0864	0862	0860	9878	9976	*074	*172	*270	*368	*466	*564	*662	*760
1·70	0·00858	0856	0854	0852	0850	0848	0846	0844	0842	0841	1·70858	0956	1054	1152	1250	1348	1446	1544	1642	1741
1·71	0839	0837	0835	0833	0831	0829	0827	0825	0823	0822	1839	1937	2035	2133	2231	2329	2427	2525	2623	2722
1·72	0820	0818	0816	0814	0812	0810	0809	0807	0805	0803	2820	2918	3016	3114	3212	3310	3409	3507	3605	3703
1·73	0801	0799	0798	0796	0794	0792	0790	0789	0787	0785	3801	3899	3998	4096	4194	4292	4390	4489	4587	4685
1·74	0783	0781	0780	0778	0776	0774	0773	0771	0769	0767	4783	4881	4980	5078	5176	5274	5373	5471	5569	5667
1·75	0766	0764	0762	0760	0759	0757	0755	0753	0752	0750	5766	5864	5962	6060	6159	6257	6355	6453	6552	6650
1·76	0748	0747	0745	0743	0741	0740	0738	0736	0735	0733	6748	6847	6945	7043	7141	7240	7338	7436	7535	7633
1·77	0731	0730	0728	0726	0725	0723	0721	0720	0718	0716	7731	7830	7928	8026	8125	8223	8321	8420	8518	8616
1·78	0715	0713	0712	0710	0708	0707	0705	0703	0702	0700	8715	8813	8912	9010	9108	9207	9305	9403	9502	9600
1·79	0699	0697	0696	0694	0692	0691	0689	0688	0686	0684	9699	9797	9896	9994	*092	*191	*289	*388	*486	*584
	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9

TABLE XLIX.—Gauss's Sum and Difference Logarithms.

A.	B.										C.									
	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9
1·80	0·00683	0681	0680	0678	0677	0675	0674	0672	0671	0669	1·80683	0781	0880	0978	1077	1175	1274	1372	1471	1569
1·81	0667	0666	0664	0663	0661	0660	0658	0657	0655	0654	1667	1766	1864	1963	2061	2160	2258	2357	2455	2554
1·82	0652	0651	0649	0648	0646	0645	0644	0642	0641	0639	2652	2751	2849	2948	3046	3145	3244	3342	3441	3539
1·83	0638	0636	0635	0633	0632	0630	0629	0628	0626	0625	3638	3736	3835	3933	4032	4130	4229	4328	4426	4525
1·84	0623	0622	0620	0619	0618	0616	0615	0613	0612	0611	4623	4722	4820	4919	5018	5116	5215	5313	5412	5511
1·85	0609	0608	0606	0605	0604	0602	0601	0599	0598	0597	5609	5708	5806	5905	6004	6102	6201	6299	6398	6497
1·86	0595	0594	0593	0591	0590	0589	0587	0586	0585	0583	6595	6694	6793	6891	6990	7089	7187	7286	7385	7483
1·87	0582	0581	0579	0578	0577	0575	0574	0573	0571	0570	7582	7681	7779	7878	7977	8075	8174	8273	8371	8470
1·88	0569	0567	0566	0565	0564	0562	0561	0560	0558	0557	8569	8667	8766	8865	8964	9062	9161	9260	9358	9457
1·89	0556	0555	0553	0552	0551	0550	0548	0547	0546	0545	9556	9655	9753	9852	9951	*050	*148	*247	*346	*445
1·90	0·00543	0542	0541	0540	0538	0537	0536	0535	0533	0532	1·90543	0642	0741	0840	0938	1037	1136	1235	1333	1432
1·91	0531	0530	0529	0527	0526	0525	0524	0523	0521	0520	1531	1630	1729	1827	1926	2025	2124	2223	2321	2420
1·92	0519	0518	0517	0515	0514	0513	0512	0511	0510	0508	2519	2618	2717	2815	2914	3013	3112	3211	3310	3408
1·93	0507	0506	0505	0504	0503	0502	0500	0499	0498	0497	3507	3606	3705	3804	3903	4002	4100	4199	4298	4397
1·94	0496	0495	0494	0492	0491	0490	0489	0488	0487	0486	4496	4595	4694	4792	4891	4990	5089	5188	5287	5386
1·95	0485	0483	0482	0481	0480	0479	0478	0477	0476	0475	5485	5583	5682	5781	5880	5979	6078	6177	6276	6375
1·96	0474	0473	0471	0470	0469	0468	0467	0466	0465	0464	6474	6573	6671	6770	6869	6968	7067	7166	7265	7364
1·97	0463	0462	0461	0460	0459	0458	0457	0456	0454	0453	7463	7562	7661	7760	7859	7958	8057	8156	8254	8353
1·98	0452	0451	0450	0449	0448	0447	0446	0445	0444	0443	8452	8551	8650	8749	8848	8947	9046	9145	9244	9343
1·99	0442	0441	0440	0439	0438	0437	0436	0435	0434	0433	9442	9541	9640	9739	9838	9937	*036	*135	*234	*333

A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.
2·00	0·00432	2·00432	2·40	0·00173	2·40173	2·80	0·00069	2·80069	3·20	0·00027	3·20027
2·01	0422	1422	2·41	0169	1169	2·81	0067	1067	3·21	0027	1027
2·02	0413	2413	2·42	0165	2165	2·82	0066	2066	3·22	0026	2026
2·03	0403	3403	2·43	0161	3161	2·83	0064	3064	3·23	0026	3026
2·04	0394	4394	2·44	0157	4157	2·84	0063	4063	3·24	0025	4025
2·05	0385	5385	2·45	0154	5154	2·85	0061	5061	3·25	0024	5024
2·06	0377	6377	2·46	0150	6150	2·86	0060	6060	3·26	0024	6024
2·07	0368	7368	2·47	0147	7147	2·87	0059	7059	3·27	0023	7023
2·08	0360	8360	2·48	0144	8144	2·88	0057	8057	3·28	0023	8023
2·09	0352	9352	2·49	0140	9140	2·89	0056	9056	3·29	0022	9022
2·10	0·00344	2·10344	2·50	0·00137	2·50137	2·90	0·00055	2·90055	3·30	0·00022	3·30022
2·11	0336	1336	2·51	0134	1134	2·91	0053	1053	3·31	0021	1021
2·12	0328	2328	2·52	0131	2131	2·92	0052	2052	3·32	0021	2021
2·13	0321	3321	2·53	0128	3128	2·93	0051	3051	3·33	0020	3020
2·14	0313	4313	2·54	0125	4125	2·94	0050	4050	3·34	0020	4020
2·15	0306	5306	2·55	0122	5122	2·95	0049	5049	3·35	0019	5019
2·16	0299	6299	2·56	0119	6119	2·96	0048	6048	3·36	0019	6019
2·17	0293	7293	2·57	0117	7117	2·97	0047	7047	3·37	0019	7019
2·18	0286	8286	2·58	0114	8114	2·98	0045	8045	3·38	0018	8018
2·19	0280	9280	2·59	0111	9111	2·99	0044	9044	3·39	0018	9018
2·20	0·00273	2·20273	2·60	0·00109	2·60109	3·00	0·00043	3·00043	3·4	0·00017	3·40017
2·21	0267	1267	2·61	0106	1106	3·01	0042	1042	3·5	0014	50014
2·22	0261	2261	2·62	0104	2104	3·02	0041	2041	3·6	0011	60011
2·23	0255	3255	2·63	0102	3102	3·03	0041	3041	3·7	0009	70009
2·24	0249	4249	2·64	0099	4099	3·04	0040	4040	3·8	0007	80007
2·25	0244	5244	2·65	0097	5097	3·05	0039	5039	3·9	0005	90005
2·26	0238	6238	2·66	0095	6095	3·06	0038	6038	4·0	0004	4·00004
2·27	0233	7233	2·67	0093	7093	3·07	0037	7037	4·1	0003	10003
2·28	0227	8227	2·68	0091	8091	3·08	0036	8036	4·2	0003	20003
2·29	0222	9222	2·69	0089	9089	3·09	0035	9035	4·3	0002	30002
2·30	0·00217	2·30217	2·70	0·00087	2·70087	3·10	0·00034	3·10034	4·4	0·00002	4·40002
2·31	0212	1212	2·71	0085	1085	3·11	0034	1034	4·5	0001	50001
2·32	0207	2207	2·72	0083	2083	3·12	0033	2033	4·6	0001	60001
2·33	0203	3203	2·73	0081	3081	3·13	0032	3032	4·7	0001	70001
2·34	0198	4198	2·74	0079	4079	3·14	0031	4031	4·8	0001	80001
2·35	0194	5194	2·75	0077	5077	3·15	0031	5031	4·9	0·00001	90001
2·36	0189	6189	2·76	0075	6075	3·16	0030	6030	5·0	0·00000	5·00000
2·37	0185	7185	2·77	0074	7074	3·17	0029	7029			
2·38	0181	8181	2·78	0072	8072	3·18	0029	8029			
2·39	0177	9177	2·79	0070	9070	3·19	0028	9028			

TABLE L.—Common Logarithms to 4 places of Decimals.

No.	Log.	No.	Log.	No.	Log.	No.	Log.	No.	Log.	No.	Log.	No.	Log.
100	·0000	160	·2041	220	·3424	280	·4472	340	·5315	400	·6021	460	·6628
101	·0043	161	·2068	221	·3444	281	·4487	341	·5328	401	·6031	461	·6637
102	·0086	162	·2095	222	·3464	282	·4502	342	·5340	402	·6042	462	·6646
103	·0128	163	·2122	223	·3483	283	·4518	343	·5353	403	·6053	463	·6656
104	·0170	164	·2148	224	·3502	284	·4533	344	·5366	404	·6064	464	·6665
105	·0212	165	·2175	225	·3522	285	·4548	345	·5378	405	·6075	465	·6675
106	·0253	166	·2201	226	·3541	286	·4564	346	·5391	406	·6085	466	·6684
107	·0294	167	·2227	227	·3560	287	·4579	347	·5403	407	·6096	467	·6693
108	·0334	168	·2253	228	·3579	288	·4594	348	·5416	408	·6107	468	·6702
109	·0374	169	·2279	229	·3598	289	·4609	349	·5428	409	·6117	469	·6712
110	·0414	170	·2304	230	·3617	290	·4624	350	·5441	410	·6128	470	·6721
111	·0453	171	·2330	231	·3636	291	·4639	351	·5453	411	·6138	471	·6730
112	·0492	172	·2355	232	·3655	292	·4654	352	·5465	412	·6149	472	·6739
113	·0531	173	·2380	233	·3674	293	·4669	353	·5478	413	·6160	473	·6749
114	·0569	174	·2405	234	·3692	294	·4683	354	·5490	414	·6170	474	·6758
115	·0607	175	·2430	235	·3711	295	·4698	355	·5502	415	·6180	475	·6767
116	·0645	176	·2455	236	·3729	296	·4713	356	·5515	416	·6191	476	·6776
117	·0682	177	·2480	237	·3747	297	·4728	357	·5527	417	·6201	477	·6785
118	·0719	178	·2504	238	·3766	298	·4742	358	·5539	418	·6212	478	·6794
119	·0755	179	·2529	239	·3784	299	·4757	359	·5551	419	·6222	479	·6803
120	·0792	180	·2553	240	·3802	300	·4771	360	·5563	420	·6232	480	·6812
121	·0828	181	·2577	241	·3820	301	·4786	361	·5575	421	·6243	481	·6821
122	·0864	182	·2601	242	·3838	302	·4800	362	·5587	422	·6253	482	·6830
123	·0899	183	·2625	243	·3856	303	·4814	363	·5599	423	·6263	483	·6839
124	·0934	184	·2648	244	·3874	304	·4829	364	·5611	424	·6274	484	·6848
125	·0969	185	·2672	245	·3892	305	·4843	365	·5623	425	·6284	485	·6857
126	·1004	186	·2695	246	·3909	306	·4857	366	·5635	426	·6294	486	·6866
127	·1038	187	·2718	247	·3927	307	·4871	367	·5647	427	·6304	487	·6875
128	·1072	188	·2742	248	·3945	308	·4886	368	·5658	428	·6314	488	·6884
129	·1106	189	·2765	249	·3962	309	·4900	369	·5670	429	·6325	489	·6893
130	·1139	190	·2788	250	·3979	310	·4914	370	·5682	430	·6335	490	·6902
131	·1173	191	·2810	251	·3997	311	·4928	371	·5694	431	·6345	491	·6911
132	·1206	192	·2833	252	·4014	312	·4942	372	·5705	432	·6355	492	·6920
133	·1239	193	·2856	253	·4031	313	·4955	373	·5717	433	·6365	493	·6928
134	·1271	194	·2878	254	·4048	314	·4969	374	·5729	434	·6375	494	·6937
135	·1303	195	·2900	255	·4065	315	·4983	375	·5740	435	·6385	495	·6946
136	·1335	196	·2923	256	·4082	316	·4997	376	·5752	436	·6395	496	·6955
137	·1367	197	·2945	257	·4099	317	·5011	377	·5763	437	·6405	497	·6964
138	·1399	198	·2967	258	·4116	318	·5024	378	·5775	438	·6415	498	·6972
139	·1430	199	·2989	259	·4133	319	·5038	379	·5786	439	·6425	499	·6981
140	·1461	200	·3010	260	·4150	320	·5052	380	·5798	440	·6435	500	·6990
141	·1492	201	·3032	261	·4166	321	·5065	381	·5809	441	·6444	501	·6998
142	·1523	202	·3054	262	·4183	322	·5079	382	·5821	442	·6454	502	·7007
143	·1553	203	·3075	263	·4200	323	·5092	383	·5832	443	·6464	503	·7016
144	·1584	204	·3096	264	·4216	324	·5105	384	·5843	444	·6474	504	·7024
145	·1614	205	·3118	265	·4232	325	·5119	385	·5855	445	·6484	505	·7033
146	·1644	206	·3139	266	·4249	326	·5132	386	·5866	446	·6493	506	·7042
147	·1673	207	·3160	267	·4265	327	·5145	387	·5877	447	·6503	507	·7050
148	·1703	208	·3181	268	·4281	328	·5159	388	·5888	448	·6513	508	·7059
149	·1732	209	·3201	269	·4298	329	·5172	389	·5899	449	·6522	509	·7067
150	·1761	210	·3222	270	·4314	330	·5185	390	·5911	450	·6532	510	·7076
151	·1790	211	·3243	271	·4330	331	·5198	391	·5922	451	·6542	511	·7084
152	·1818	212	·3263	272	·4346	332	·5211	392	·5933	452	·6551	512	·7093
153	·1847	213	·3284	273	·4362	333	·5224	393	·5944	453	·6561	513	·7101
154	·1875	214	·3304	274	·4378	334	·5237	394	·5955	454	·6571	514	·7110
155	·1903	215	·3324	275	·4393	335	·5250	395	·5966	455	·6580	515	·7118
156	·1931	216	·3345	276	·4409	336	·5263	396	·5977	456	·6590	516	·7126
157	·1959	217	·3365	277	·4425	337	·5276	397	·5988	457	·6599	517	·7135
158	·1987	218	·3385	278	·4440	338	·5289	398	·5999	458	·6609	518	·7143
159	·2014	219	·3404	279	·4456	339	·5302	399	·6010	459	·6618	519	·7152

TABLE L.—Common Logarithms to 4 places of Decimals.

No.	Log.	No.	Log.	No.	Log.	No.	Log.	No.	Log.	No.	Log.	No.	Log.	No.	Log.
520	·7160	580	·7634	640	·8062	700	·8451	760	·8808	820	·9138	880	·9445	940	·9731
521	·7168	581	·7642	641	·8069	701	·8457	761	·8814	821	·9143	881	·9450	941	·9736
522	·7177	582	·7649	642	·8075	702	·8463	762	·8820	822	·9149	882	·9455	942	·9741
523	·7185	583	·7657	643	·8082	703	·8470	763	·8825	823	·9154	883	·9460	943	·9745
524	·7193	584	·7664	644	·8089	704	·8476	764	·8831	824	·9159	884	·9465	944	·9750
525	·7202	585	·7672	645	·8096	705	·8482	765	·8837	825	·9165	885	·9469	945	·9754
526	·7210	586	·7679	646	·8102	706	·8488	766	·8842	826	·9170	886	·9474	946	·9759
527	·7218	587	·7686	647	·8109	707	·8494	767	·8848	827	·9175	887	·9479	947	·9764
528	·7226	588	·7694	648	·8116	708	·8500	768	·8854	828	·9180	888	·9484	948	·9768
529	·7235	589	·7701	649	·8122	709	·8506	769	·8859	829	·9186	889	·9489	949	·9773
530	·7243	590	·7709	650	·8129	710	·8513	770	·8865	830	·9191	890	·9494	950	·9777
531	·7251	591	·7716	651	·8136	711	·8519	771	·8871	831	·9196	891	·9499	951	·9782
532	·7259	592	·7723	652	·8142	712	·8525	772	·8876	832	·9201	892	·9504	952	·9786
533	·7267	593	·7731	653	·8149	713	·8531	773	·8882	833	·9206	893	·9509	953	·9791
534	·7275	594	·7738	654	·8156	714	·8537	774	·8887	834	·9212	894	·9513	954	·9795
535	·7284	595	·7745	655	·8162	715	·8543	775	·8893	835	·9217	895	·9518	955	·9800
536	·7292	596	·7752	656	·8169	716	·8549	776	·8899	836	·9222	896	·9523	956	·9805
537	·7300	597	·7760	657	·8176	717	·8555	777	·8904	837	·9227	897	·9528	957	·9809
538	·7308	598	·7767	658	·8182	718	·8561	778	·8910	838	·9232	898	·9533	958	·9814
539	·7316	599	·7774	659	·8189	719	·8567	779	·8915	839	·9238	899	·9538	959	·9818
540	·7324	600	·7782	660	·8195	720	·8573	780	·8921	840	·9243	900	·9542	960	·9823
541	·7332	601	·7789	661	·8202	721	·8579	781	·8927	841	·9248	901	·9547	961	·9827
542	·7340	602	·7796	662	·8209	722	·8585	782	·8932	842	·9253	902	·9552	962	·9832
543	·7348	603	·7803	663	·8215	723	·8591	783	·8938	843	·9258	903	·9557	963	·9836
544	·7356	604	·7810	664	·8222	724	·8597	784	·8943	844	·9263	904	·9562	964	·9841
545	·7364	605	·7818	665	·8228	725	·8603	785	·8949	845	·9269	905	·9566	965	·9845
546	·7372	606	·7825	666	·8235	726	·8609	786	·8954	846	·9274	906	·9571	966	·9850
547	·7380	607	·7832	667	·8241	727	·8615	787	·8960	847	·9279	907	·9576	967	·9854
548	·7388	608	·7839	668	·8248	728	·8621	788	·8965	848	·9284	908	·9581	968	·9859
549	·7396	609	·7846	669	·8254	729	·8627	789	·8971	849	·9289	909	·9586	969	·9863
550	·7404	610	·7853	670	·8261	730	·8633	790	·8976	850	·9294	910	·9590	970	·9868
551	·7412	611	·7860	671	·8267	731	·8639	791	·8982	851	·9299	911	·9595	971	·9872
552	·7419	612	·7868	672	·8274	732	·8645	792	·8987	852	·9304	912	·9600	972	·9877
553	·7427	613	·7875	673	·8280	733	·8651	793	·8993	853	·9309	913	·9605	973	·9881
554	·7435	614	·7882	674	·8287	734	·8657	794	·8998	854	·9315	914	·9609	974	·9886
555	·7443	615	·7889	675	·8293	735	·8663	795	·9004	855	·9320	915	·9614	975	·9890
556	·7451	616	·7896	676	·8299	736	·8669	796	·9009	856	·9325	916	·9619	976	·9894
557	·7459	617	·7903	677	·8306	737	·8675	797	·9015	857	·9330	917	·9624	977	·9899
558	·7466	618	·7910	678	·8312	738	·8681	798	·9020	858	·9335	918	·9628	978	·9903
559	·7474	619	·7917	679	·8319	739	·8686	799	·9025	859	·9340	919	·9633	979	·9908
560	·7482	620	·7924	680	·8325	740	·8692	800	·9031	860	·9345	920	·9638	980	·9912
561	·7490	621	·7931	681	·8331	741	·8698	801	·9036	861	·9350	921	·9643	981	·9917
562	·7497	622	·7938	682	·8338	742	·8704	802	·9042	862	·9355	922	·9647	982	·9921
563	·7505	623	·7945	683	·8344	743	·8710	803	·9047	863	·9360	923	·9652	983	·9926
564	·7513	624	·7952	684	·8351	744	·8716	804	·9053	864	·9365	924	·9657	984	·9930
565	·7520	625	·7959	685	·8357	745	·8722	805	·9058	865	·9370	925	·9661	985	·9934
566	·7528	626	·7966	686	·8363	746	·8727	806	·9063	866	·9375	926	·9666	986	·9939
567	·7536	627	·7973	687	·8370	747	·8733	807	·9069	867	·9380	927	·9671	987	·9943
568	·7543	628	·7980	688	·8376	748	·8739	808	·9074	868	·9385	928	·9675	988	·9948
569	·7551	629	·7987	689	·8382	749	·8745	809	·9079	869	·9390	929	·9680	989	·9952
570	·7559	630	·7993	690	·8388	750	·8751	810	·9085	870	·9395	930	·9685	990	·9956
571	·7566	631	·8000	691	·8395	751	·8756	811	·9090	871	·9400	931	·9689	991	·9961
572	·7574	632	·8007	692	·8401	752	·8762	812	·9096	872	·9405	932	·9694	992	·9965
573	·7582	633	·8014	693	·8407	753	·8768	813	·9101	873	·9410	933	·9699	993	·9969
574	·7589	634	·8021	694	·8414	754	·8774	814	·9106	874	·9415	934	·9703	994	·9974
575	·7597	635	·8028	695	·8420	755	·8779	815	·9112	875	·9420	935	·9708	995	·9978
576	·7604	636	·8035	696	·8426	756	·8785	816	·9117	876	·9425	936	·9713	996	·9983
577	·7612	637	·8041	697	·8432	757	·8791	817	·9122	877	·9430	937	·9717	997	·9987
578	·7619	638	·8048	698	·8439	758	·8797	818	·9128	878	·9435	938	·9722	998	·9991
579	·7627	639	·8055	699	·8445	759	·8802	819	·9133	879	·9440	939	·9727	999	·9996

TABLE LI.—Common Logarithms to 5 places of Decimals.

No.	Logarithm. 0	1	2	3	4	5	6	7	8	9
100	00000	043	087	130	173	217	260	303	346	389
101	432	475	518	561	604	647	689	732	775	817
102	860	903	945	988	*30	*72	115	157	199	242
103	01284	326	368	410	452	494	536	578	620	662
104	703	745	787	828	870	912	953	995	*36	*78
105	02119	160	202	243	284	325	366	407	449	490
106	531	572	612	653	694	735	776	816	857	898
107	938	979	*19	*60	100	141	181	222	262	302
108	03342	383	423	463	503	543	583	623	663	703
109	743	782	822	862	902	941	981	*21	*60	100
110	04139	179	218	258	297	336	376	415	454	493
111	532	571	610	650	689	727	766	805	844	883
112	922	961	999	*38	*77	115	154	192	231	269
113	05308	346	385	423	461	500	538	576	614	652
114	690	729	767	805	843	881	918	956	994	*32
115	06070	108	145	183	221	258	296	333	371	408
116	446	483	521	558	595	633	670	707	744	781
117	819	856	893	930	967	*04	*41	*78	115	151
118	07188	225	262	298	335	372	408	445	482	518
119	555	591	628	664	700	737	773	809	846	882
120	918	954	990	*27	*63	*99	135	171	207	243
121	08279	314	350	386	422	458	493	529	565	600
122	636	672	707	743	778	814	849	884	920	955
123	991	*26	*61	*96	132	167	202	237	272	307
124	09342	377	412	447	482	517	552	587	621	656
125	691	726	760	795	830	864	899	934	968	*03
126	10037	072	106	140	175	209	243	278	312	346
127	380	415	449	483	517	551	585	619	653	687
128	721	755	789	823	857	890	924	958	992	*25
129	11059	093	126	160	193	227	261	294	327	361
130	394	428	461	494	528	561	594	628	661	694
131	727	760	793	826	860	893	926	959	992	*24
132	12057	090	123	156	189	222	254	287	320	352
133	385	418	450	483	516	548	581	613	646	678
134	710	743	775	808	840	872	905	937	969	*01
135	13033	066	098	130	162	194	226	258	290	322
136	354	386	418	450	481	513	545	577	609	640
137	672	704	735	767	799	830	862	893	925	956
138	988	*19	*51	*82	114	145	176	208	239	270
139	14301	333	364	395	426	457	489	520	551	582
140	613	644	675	706	737	768	799	829	860	891
141	922	953	983	*14	*45	*76	106	137	168	198
142	15229	259	290	320	351	381	412	442	473	503
143	534	564	594	625	655	685	715	746	776	806
144	836	866	897	927	957	987	*17	*47	*77	107
145	16137	167	197	227	256	286	316	346	376	406
146	435	465	495	524	554	584	613	643	673	702
147	732	761	791	820	850	879	909	938	967	997
148	17026	056	085	114	143	173	202	231	260	289
149	319	348	377	406	435	464	493	522	551	580
150	609	638	667	696	725	754	782	811	840	869
151	898	926	955	984	*13	*41	*70	*99	127	156
152	18184	213	241	270	298	327	355	384	412	441
153	469	498	526	554	583	611	639	667	696	724
154	752	780	808	837	865	893	921	949	977	*05
155	19033	061	089	117	145	173	201	229	257	285
156	312	340	368	396	424	451	479	507	535	562
157	590	618	645	673	700	728	756	783	811	838
158	866	893	921	948	976	*03	*30	*58	*85	112
159	20140	167	194	222	249	276	303	330	358	385
160	412	439	466	493	520	548	575	602	629	656
161	683	710	737	763	790	817	844	871	898	925
162	952	978	*05	*32	*59	*85	112	139	165	192
163	21219	245	272	299	325	352	378	405	431	458
164	484	511	537	564	590	617	643	669	696	722
	0	1	2	3	4	5	6	7	8	9

No.	Logarithm. 0	1	2	3	4	5	6	7	8	9
165	21748	775	801	827	854	880	906	932	958	985
166	22011	037	063	089	115	141	167	194	220	246
167	272	298	324	350	376	401	427	453	479	505
168	531	557	583	608	634	660	686	712	737	763
169	789	814	840	866	891	917	943	968	994	*19
170	23045	070	096	121	147	172	198	223	249	274
171	300	325	350	376	401	426	452	477	502	528
172	553	578	603	629	654	679	704	729	754	779
173	805	830	855	880	905	930	955	980	*05	*30
174	24055	080	105	130	155	180	204	229	254	279
175	304	329	353	378	403	428	452	477	502	527
176	551	576	601	625	650	674	699	724	748	773
177	797	822	846	871	895	920	944	969	993	*18
178	25042	066	091	115	139	164	188	212	237	261
179	285	310	334	358	382	406	431	455	479	503
180	527	551	575	600	624	648	672	696	720	744
181	768	792	816	840	864	888	912	935	959	983
182	26007	031	055	079	102	126	150	174	198	221
183	245	269	293	316	340	364	387	411	435	458
184	482	505	529	553	576	600	623	647	670	694
185	717	741	764	788	811	834	858	881	905	928
186	951	975	998	*21	*45	*68	*91	114	138	161
187	27184	207	231	254	277	300	323	346	370	393
188	416	439	462	485	508	531	554	577	600	623
189	646	669	692	715	738	761	784	807	830	852
190	875	898	921	944	967	989	*12	*35	*58	*81
191	28103	126	149	171	194	217	240	262	285	307
192	330	353	375	398	421	443	466	488	511	533
193	556	578	601	623	646	668	691	713	735	758
194	780	803	825	847	870	892	914	937	959	981
195	29003	026	048	070	092	115	137	159	181	203
196	226	248	270	292	314	336	358	380	403	425
197	447	469	491	513	535	557	579	601	623	645
198	667	688	710	732	754	776	798	820	842	863
199	885	907	929	951	973	994	*16	*38	*60	*81
200	30103	125	146	168	190	211	233	255	276	298
201	320	341	363	384	406	428	449	471	492	514
202	535	557	578	600	621	643	664	685	707	728
203	750	771	792	814	835	856	878	899	920	942
204	963	984	*06	*27	*48	*69	*91	112	133	154
205	31175	197	218	239	260	281	302	323	345	366
206	387	408	429	450	471	492	513	534	555	576
207	597	618	639	660	681	702	723	744	765	785
208	806	827	848	869	890	911	931	952	973	994
209	32015	035	056	077	098	118	139	160	181	201
210	222	243	263	284	305	325	346	366	387	408
211	428	449	469	490	510	531	552	572	593	613
212	634	654	675	695	715	736	756	777	797	818
213	838	858	879	899	919	940	960	980	*01	*21
214	33041	062	082	102	122	143	163	183	203	224
215	244	264	284	304	325	345	365	385	405	425
216	445	465	486	506	526	546	566	586	606	626
217	646	666	686	706	726	746	766	786	806	826
218	846	866	885	905	925	945	965	985	*05	*25
219	34044	064	084	104	124	143	163	183	203	223
220	242	262	282	301	321	341	361	380	400	420
221	439	459	479	498	518	537	557	577	596	616
222	635	655	674	694	713	733	753	772	792	811
223	830	850	869	889	908	928	947	967	986	*05
224	35025	044	064	083	102	122	141	160	180	199
225	218	238	257	276	295	315	334	353	372	392
226	411	430	449	468	488	507	526	545	564	583
227	603	622	641	660	679	698	717	736	755	774
228	793	813	832	851	870	889	908	927	946	965
229	35984	*03	*21	*40	*59	*78	*97	116	135	154
	0	1	2	3	4	5	6	7	8	9

Pro. Parts.

D.	44	42
1	4·4	4·2
2	8·8	8·4
3	13·2	12·6
4	17·6	16·8
5	22·0	21·0
6	26·4	25·2
7	30·8	29·4
8	35·2	33·6
9	39·6	37·8

D.	40	38
1	4·0	3·8
2	8·0	7·6
3	12·0	11·4
4	16·0	15·2
5	20·0	19·0
6	24·0	22·8
7	28·0	26·6
8	32·0	30·4
9	36·0	34·2

D.	36	34
1	3·6	3·4
2	7·2	6·8
3	10·8	10·2
4	14·4	13·6
5	18·0	17·0
6	21·6	20·4
7	25·2	23·8
8	28·8	27·2
9	32·4	30·6

D.	32	30
1	3·2	3·0
2	6·4	6·0
3	9·6	9·0
4	12·8	12·0
5	16·0	15·0
6	19·2	18·0
7	22·4	21·0
8	25·6	24·0
9	28·8	27·0

D.	28	26
1	2·8	2·6
2	5·6	5·2
3	8·4	7·8
4	11·2	10·4
5	14·0	13·0
6	16·8	15·6
7	19·6	18·2
8	22·4	20·8
9	25·2	23·4

D.	24	22
1	2·4	2·2
2	4·8	4·4
3	7·2	6·6
4	9·6	8·8
5	12·0	11·0
6	14·4	13·2
7	16·8	15·4
8	19·2	17·6
9	21·6	19·8

D.	20	19
1	2·0	1·9
2	4·0	3·8
3	6·0	5·7
4	8·0	7·6
5	10·0	9·5
6	12·0	11·4
7	14·0	13·3
8	16·0	15·2
9	18·0	17·1

TABLE LI.—Common Logarithms to 5 places of Decimals.

No.	Logarithm. 0	1	2	3	4	5	6	7	8	9
230	36173	192	211	229	248	267	286	305	324	342
231	361	380	399	418	436	455	474	493	511	530
232	549	568	586	605	624	642	661	680	698	717
233	736	754	773	791	810	829	847	866	884	903
234	922	940	959	977	996	*14	*33	*51	*70	*88
235	37107	125	144	162	181	199	218	236	254	273
236	291	310	328	346	365	383	401	420	438	457
237	475	493	511	530	548	566	585	603	621	639
238	658	676	694	712	731	749	767	785	803	822
239	840	858	876	894	912	931	949	967	985	*03
240	38021	039	057	075	093	112	130	148	166	184
241	202	220	238	256	274	292	310	328	346	364
242	382	399	417	435	453	471	489	507	525	543
243	561	578	596	614	632	650	668	686	703	721
244	739	757	775	792	810	828	846	863	881	899
245	917	934	952	970	987	*05	*23	*41	*58	*76
246	39094	111	129	146	164	182	199	217	235	252
247	270	287	305	322	340	358	375	393	410	428
248	445	463	480	498	515	533	550	568	585	602
249	620	637	655	672	690	707	724	742	759	777
250	794	811	829	846	863	881	898	915	933	950
251	967	985	*02	*19	*37	*54	*71	*88	106	123
252	40140	157	175	192	209	226	243	261	278	295
253	312	329	346	364	381	398	415	432	449	466
254	483	500	518	535	552	569	586	603	620	637
255	654	671	688	705	722	739	756	773	790	807
256	824	841	858	875	892	909	926	943	960	976
257	993	*10	*27	*44	*61	*78	*95	111	128	145
258	41162	179	196	212	229	246	263	280	296	313
259	330	347	363	380	397	414	430	447	464	481
260	497	514	531	547	564	581	597	614	631	647
261	664	681	697	714	731	747	764	780	797	814
262	830	847	863	880	896	913	929	946	963	979
263	996	*12	*29	*45	*62	*78	*95	111	127	144
264	42160	177	193	210	226	243	259	275	292	308
265	325	341	357	374	390	406	423	439	455	472
266	488	504	521	537	553	570	586	602	619	635
267	651	667	684	700	716	732	749	765	781	797
268	813	830	846	862	878	894	911	927	943	959
269	975	991	*08	*24	*40	*56	*72	*88	104	120
270	43136	152	169	185	201	217	233	249	265	281
271	297	313	329	345	361	377	393	409	425	441
272	457	473	489	505	521	537	553	569	584	600
273	616	632	648	664	680	696	712	727	743	759
274	775	791	807	823	838	854	870	886	902	917
275	933	949	965	981	996	*12	*28	*44	*59	*75
276	44091	107	122	138	154	170	185	201	217	232
277	248	264	279	295	311	326	342	358	373	389
278	404	420	436	451	467	483	498	514	529	545
279	560	576	592	607	623	638	654	669	685	700
280	716	731	747	762	778	793	809	824	840	855
281	871	886	902	917	932	948	963	979	994	*10
282	45025	040	056	071	086	102	117	133	148	163
283	179	194	209	225	240	255	271	286	301	317
284	332	347	362	378	393	408	423	439	454	469
285	484	500	515	530	545	561	576	591	606	621
286	637	652	667	682	697	712	728	743	758	773
287	788	803	818	834	849	864	879	894	909	924
288	939	954	969	984	*00	*15	*30	*45	*60	*75
289	46090	105	120	135	150	165	180	195	210	225
290	240	255	270	285	300	315	330	345	359	374
291	389	404	419	434	449	464	479	494	509	523
292	538	553	568	583	598	613	627	642	657	672
293	687	702	716	731	746	761	776	790	805	820
294	835	850	864	879	894	909	923	938	953	967
	0	1	2	3	4	5	6	7	8	9

No.	Logarithm. 0	1	2	3	4	5	6	7	8	9
295	46982	997	*12	*26	*41	*56	*70	*85	100	114
296	47129	144	159	173	188	202	217	232	246	261
297	276	290	305	319	334	349	363	378	392	407
298	422	436	451	465	480	494	509	524	538	553
299	567	582	596	611	625	640	654	669	683	698
300	712	727	741	756	770	784	799	813	828	842
301	857	871	885	900	914	929	943	958	972	986
302	48001	015	029	044	058	073	087	101	116	130
303	144	159	173	187	202	216	230	244	259	273
304	287	302	316	330	344	359	373	387	401	416
305	430	444	458	473	487	501	515	530	544	558
306	572	586	601	615	629	643	657	671	686	700
307	714	728	742	756	770	785	799	813	827	841
308	855	869	883	897	911	926	940	954	968	982
309	996	*10	*24	*38	*52	*66	*80	*94	108	122
310	49136	150	164	178	192	206	220	234	248	262
311	276	290	304	318	332	346	360	374	388	402
312	415	429	443	457	471	485	499	513	527	541
313	554	568	582	596	610	624	638	651	665	679
314	693	707	721	734	748	762	776	790	803	817
315	831	845	859	872	886	900	914	927	941	955
316	969	982	996	*10	*24	*37	*51	*65	*79	*92
317	50106	120	133	147	161	174	188	202	215	229
318	243	256	270	284	297	311	325	338	352	365
319	379	393	406	420	433	447	461	474	488	501
320	515	529	542	556	569	583	596	610	623	637
321	651	664	678	691	705	718	732	745	759	772
322	786	799	813	826	840	853	866	880	893	907
323	920	934	947	961	974	987	*01	*14	*28	*41
324	51055	068	081	095	108	121	135	148	162	175
325	188	202	215	228	242	255	268	282	295	308
326	322	335	348	362	375	388	402	415	428	441
327	455	468	481	495	508	521	534	548	561	574
328	587	601	614	627	640	654	667	680	693	706
329	720	733	746	759	772	786	799	812	825	838
330	851	865	878	891	904	917	930	943	957	970
331	983	996	*09	*22	*35	*48	*61	*75	*88	101
332	52114	127	140	153	166	179	192	205	218	231
333	244	257	270	284	297	310	323	336	349	362
334	375	388	401	414	427	440	453	466	479	492
335	504	517	530	543	556	569	582	595	608	621
336	634	647	660	673	686	699	711	724	737	750
337	763	776	789	802	815	827	840	853	866	879
338	892	905	917	930	943	956	969	982	994	*07
339	53020	033	046	058	071	084	097	110	122	135
340	148	161	173	186	199	212	224	237	250	263
341	275	288	301	314	326	339	352	364	377	390
342	403	415	428	441	453	466	479	491	504	517
343	529	542	555	567	580	593	605	618	631	643
344	656	668	681	694	706	719	732	744	757	769
345	782	794	807	820	832	845	857	870	882	895
346	908	920	933	945	958	970	983	995	*08	*20
347	54033	045	058	070	083	095	108	120	133	145
348	158	170	183	195	208	220	233	245	258	270
349	283	295	307	320	332	345	357	370	382	394
350	407	419	432	444	456	469	481	494	506	518
351	531	543	555	568	580	593	605	617	630	642
352	654	667	679	691	704	716	728	741	753	765
353	777	790	802	814	827	839	851	864	876	888
354	900	913	925	937	949	962	974	986	998	*11
355	55023	035	047	060	072	084	096	108	121	133
356	145	157	169	182	194	206	218	230	242	255
357	267	279	291	303	315	328	340	352	364	376
358	388	400	413	425	437	449	461	473	485	497
359	509	522	534	546	558	570	582	594	606	618
	0	1	2	3	4	5	6	7	8	9

Pro. Parts.

D.	18	17
1	1·8	1·7
2	3·6	3·4
3	5·4	5·1
4	7·2	6·8
5	9·0	8·5
6	10·8	10·2
7	12·6	11·9
8	14·4	13·6
9	16·2	15·3

D.	16	15
1	1·6	1·5
2	3·2	3·0
3	4·8	4·5
4	6·4	6·0
5	8·0	7·5
6	9·6	9·0
7	11·2	10·5
8	12·8	12·0
9	14·4	13·5

D.	14	13
1	1·4	1·3
2	2·8	2·6
3	4·2	3·9
4	5·6	5·2
5	7·0	6·5
6	8·4	7·8
7	9·8	9·1
8	11·2	10·4
9	12·6	11·7

D.	12	11
1	1·2	1·1
2	2·4	2·2
3	3·6	3·3
4	4·8	4·4
5	6·0	5·5
6	7·2	6·6
7	8·4	7·7
8	9·6	8·8
9	10·8	9·9

TABLE LI.—Common Logarithms to 5 places of Decimals.

No.	0	1	2	3	4	5	6	7	8	9	No.	0	1	2	3	4	5	6	7	8	9
360	55630	642	654	666	678	691	703	715	727	739	425	62839	849	859	870	880	890	900	910	921	931
361	751	763	775	787	799	811	823	835	847	859	426	941	951	961	972	982	992	*02	*12	*22	*33
362	871	883	895	907	919	931	943	955	967	979	427	63043	053	063	073	083	094	104	114	124	134
363	991	*03	*15	*27	*38	*50	*62	*74	*86	*98	428	144	155	165	175	185	195	205	215	225	236
364	56110	122	134	146	158	170	182	194	205	217	429	246	256	266	276	286	296	306	317	327	337
365	229	241	253	265	277	289	301	312	324	336	430	347	357	367	377	387	397	407	417	428	438
366	348	360	372	384	396	407	419	431	443	455	431	448	458	468	478	488	498	508	518	528	538
367	467	478	490	502	514	526	538	549	561	573	432	548	558	568	579	589	599	609	619	629	639
368	585	597	608	620	632	644	656	667	679	691	433	649	659	669	679	689	699	709	719	729	739
369	703	714	726	738	750	761	773	785	797	808	434	749	759	769	779	789	799	809	819	829	839
370	820	832	844	855	867	879	891	902	914	926	435	849	859	869	879	889	899	909	919	929	939
371	937	949	961	972	984	996	*08	*19	*31	*43	436	949	959	969	979	988	998	*08	*18	*28	*38
372	57054	066	078	089	101	113	124	136	148	159	437	64048	058	068	078	088	098	108	118	128	137
373	171	183	194	206	217	229	241	252	264	276	438	147	157	167	177	187	197	207	217	227	237
374	287	299	310	322	334	345	357	368	380	392	439	246	256	266	276	286	296	306	316	326	335
375	403	415	426	438	449	461	473	484	496	507	440	345	355	365	375	385	395	404	414	424	434
376	519	530	542	553	565	576	588	600	611	623	441	444	454	464	473	483	493	503	513	523	532
377	634	646	657	669	680	692	703	715	726	738	442	542	552	562	572	582	591	601	611	621	631
378	749	761	772	784	795	807	818	830	841	852	443	640	650	660	670	680	689	699	709	719	729
379	864	875	887	898	910	921	933	944	955	967	444	738	748	758	768	777	787	797	807	816	826
380	978	990	*01	*13	*24	*35	*47	*58	*70	*81	445	836	846	856	865	875	885	895	904	914	924
381	58092	104	115	127	138	149	161	172	184	195	446	933	943	953	963	972	982	992	*02	*11	*21
382	206	218	229	240	252	263	274	286	297	309	447	65031	040	050	060	070	079	089	099	108	118
383	320	331	343	354	365	377	388	399	410	422	448	128	137	147	157	167	176	186	196	205	215
384	433	444	456	467	478	490	501	512	524	535	449	225	234	244	254	263	273	283	292	302	312
385	546	557	569	580	591	602	614	625	636	647	450	321	331	341	350	360	369	379	389	398	408
386	659	670	681	692	704	715	726	737	749	760	451	418	427	437	447	456	466	475	485	495	504
387	771	782	794	805	816	827	838	850	861	872	452	514	523	533	543	552	562	571	581	591	600
388	883	894	906	917	928	939	950	961	973	984	453	610	619	629	639	648	658	667	677	686	696
389	995	*06	*17	*28	*40	*51	*62	*73	*84	*95	454	706	715	725	734	744	753	763	772	782	792
390	59106	118	129	140	151	162	173	184	195	207	455	801	811	820	830	839	849	858	868	877	887
391	218	229	240	251	262	273	284	295	306	318	456	896	906	916	925	935	944	954	963	973	982
392	329	340	351	362	373	384	395	406	417	428	457	992	*01	*11	*20	*30	*39	*49	*58	*68	*77
393	439	450	461	472	483	494	506	517	528	539	458	66087	096	106	115	124	134	143	153	162	172
394	550	561	572	583	594	605	616	627	638	649	459	181	191	200	210	219	229	238	247	257	266
395	660	671	682	693	704	715	726	737	748	759	460	276	285	295	304	314	323	332	342	351	361
396	770	780	791	802	813	824	835	846	857	868	461	370	380	389	398	408	417	427	436	445	455
397	879	890	901	912	923	934	945	956	966	977	462	464	474	483	492	502	511	521	530	539	549
398	988	999	*10	*21	*32	*43	*54	*65	*76	*86	463	558	567	577	586	596	605	614	624	633	642
399	60097	108	119	130	141	152	163	173	184	195	464	652	661	671	680	689	699	708	717	727	736
400	206	217	228	239	249	260	271	282	293	304	465	745	755	764	773	783	792	801	811	820	829
401	314	325	336	347	358	369	379	390	401	412	466	839	848	857	867	876	885	894	904	913	922
402	423	433	444	455	466	477	487	498	509	520	467	932	941	950	960	969	978	987	997	*06	*15
403	531	541	552	563	574	584	595	606	617	627	468	67025	034	043	052	062	071	080	089	099	108
404	638	649	660	670	681	692	703	713	724	735	469	117	127	136	145	154	164	173	182	191	201
405	746	756	767	778	788	799	810	821	831	842	470	210	219	228	237	247	256	265	274	284	293
406	853	863	874	885	895	906	917	927	938	949	471	302	311	321	330	339	348	357	367	376	385
407	959	970	981	991	*02	*13	*23	*34	*45	*55	472	394	403	413	422	431	440	449	459	468	477
408	61066	077	087	098	109	119	130	140	151	162	473	486	495	504	514	523	532	541	550	560	569
409	172	183	194	204	215	225	236	247	257	268	474	578	587	596	605	614	624	633	642	651	660
410	278	289	300	310	321	331	342	352	363	374	475	669	679	688	697	706	715	724	733	742	752
411	384	395	405	416	426	437	448	458	469	479	476	761	770	779	788	797	806	815	825	834	843
412	490	500	511	521	532	542	553	563	574	584	477	852	861	870	879	888	897	906	916	925	934
413	595	606	616	627	637	648	658	669	679	690	478	943	952	961	970	979	988	997	*06	*15	*24
414	700	711	721	731	742	752	763	773	784	794	479	68034	043	052	061	070	079	088	097	106	115
415	805	815	826	836	847	857	868	878	888	899	480	124	133	142	151	160	169	178	187	196	205
416	909	920	930	941	951	962	972	982	993	*03	481	215	224	233	242	251	260	269	278	287	296
417	62014	024	034	045	055	066	076	086	097	107	482	305	314	323	332	341	350	359	368	377	386
418	118	128	138	149	159	170	180	190	201	211	483	395	404	413	422	431	440	449	458	467	476
419	221	232	242	252	263	273	284	294	304	315	484	485	494	502	511	520	529	538	547	556	565
420	325	335	346	356	366	377	387	397	408	418	485	574	583	592	601	610	619	628	637	646	655
421	428	439	449	459	469	480	490	500	511	521	486	664	673	681	690	699	708	717	726	735	744
422	531	542	552	562	572	583	593	603	613	624	487	753	762	771	780	789	797	806	815	824	833
423	634	644	655	665	675	685	696	706	716	726	488	842	851	860	869	878	886	895	904	913	922
424	737	747	757	767	778	788	798	808	818	829	489	931	940	949	958	966	975	984	993	*02	*11
	0	1	2	3	4	5	6	7	8	9		0	1	2	3	4	5	6	7	8	9

Pro. Parts.

D.	12	11	10	9	8
1	1·2	1·1	1·0	0·9	0·8
2	2·4	2·2	2·0	1·8	1·6
3	3·6	3·3	3·0	2·7	2·4
4	4·8	4·4	4·0	3·6	3·2
5	6·0	5·5	5·0	4·5	4·0
6	7·2	6·6	6·0	5·4	4·8
7	8·4	7·7	7·0	6·3	5·6
8	9·6	8·8	8·0	7·2	6·4
9	10·8	9·9	9·0	8·1	7·2

TABLE LI.—Common Logarithms to 5 places of Decimals.

No.	Logarithm. 0	1	2	3	4	5	6	7	8	9
490	69020	028	037	046	055	064	073	082	090	099
491	108	117	126	135	144	152	161	170	179	188
492	197	205	214	223	232	241	249	258	267	276
493	285	294	302	311	320	329	338	346	355	364
494	373	381	390	399	408	417	425	434	443	452
495	461	469	478	487	496	504	513	522	531	539
496	548	557	566	574	583	592	601	609	618	627
497	636	644	653	662	671	679	688	697	705	714
498	723	732	740	749	758	767	775	784	793	801
499	810	819	827	836	845	854	862	871	880	888
500	897	906	914	923	932	940	949	958	966	975
501	984	992	*01	*10	*18	*27	*36	*44	*53	*62
502	70070	079	088	096	105	114	122	131	140	148
503	157	165	174	183	191	200	209	217	226	234
504	243	252	260	269	278	286	295	303	312	321
505	329	338	346	355	364	372	381	389	398	406
506	415	424	432	441	449	458	467	475	484	492
507	501	509	518	526	535	544	552	561	569	578
508	586	595	603	612	621	629	638	646	655	663
509	672	680	689	697	706	714	723	731	740	749
510	757	766	774	783	791	800	808	817	825	834
511	842	851	859	868	876	885	893	902	910	919
512	927	935	944	952	961	969	978	986	995	*03
513	71012	020	029	037	046	054	063	071	079	088
514	096	105	113	122	130	139	147	155	164	172
515	181	189	198	206	214	223	231	240	248	257
516	265	273	282	290	299	307	315	324	332	341
517	349	357	366	374	383	391	399	408	416	425
518	433	441	450	458	466	475	483	492	500	508
519	517	525	533	542	550	559	567	575	584	592
520	600	609	617	625	634	642	650	659	667	675
521	684	692	700	709	717	725	734	742	750	759
522	767	775	784	792	800	809	817	825	834	842
523	850	858	867	875	883	892	900	908	917	925
524	933	941	950	958	966	975	983	991	999	*08
525	72016	024	032	041	049	057	066	074	082	090
526	099	107	115	123	132	140	148	156	165	173
527	181	189	198	206	214	222	230	239	247	255
528	263	272	280	288	296	304	313	321	329	337
529	346	354	362	370	378	387	395	403	411	419
530	428	436	444	452	460	469	477	485	493	501
531	509	518	526	534	542	550	558	567	575	583
532	591	599	607	616	624	632	640	648	656	665
533	673	681	689	697	705	713	722	730	738	746
534	754	762	770	779	787	795	803	811	819	827
535	835	843	852	860	868	876	884	892	900	908
536	916	925	933	941	949	957	965	973	981	989
537	997	*06	*14	*22	*30	*38	*46	*54	*62	*70
538	73078	086	094	102	111	119	127	135	143	151
539	159	167	175	183	191	199	207	215	223	231
540	239	247	255	263	272	280	288	296	304	312
541	320	328	336	344	352	360	368	376	384	392
542	400	408	416	424	432	440	448	456	464	472
543	480	488	496	504	512	520	528	536	544	552
544	560	568	576	584	592	600	608	616	624	632
545	640	648	656	664	672	679	687	695	703	711
546	719	727	735	743	751	759	767	775	783	791
547	799	807	815	823	830	838	846	854	862	870
548	878	886	894	902	910	918	926	933	941	949
549	957	965	973	981	989	997	*05	*13	*20	*28
550	74036	044	052	060	068	076	084	092	099	107
551	115	123	131	139	147	155	162	170	178	186
552	194	202	210	218	225	233	241	249	257	265
553	273	280	288	296	304	312	320	327	335	343
554	351	359	367	374	382	390	398	406	414	421
	0	1	2	3	4	5	6	7	8	9

No.	Logarithm. 0	1	2	3	4	5	6	7	8	9
555	74429	437	445	453	461	468	476	484	492	500
556	507	515	523	531	539	547	554	562	570	578
557	586	593	601	609	617	624	632	640	648	656
558	663	671	679	687	695	702	710	718	726	733
559	741	749	757	764	772	780	788	796	803	811
560	819	827	834	842	850	858	865	873	881	889
561	896	904	912	920	927	935	943	950	958	966
562	974	981	989	997	*05	*12	*20	*28	*35	*43
563	75051	059	066	074	082	089	097	105	113	120
564	128	136	143	151	159	166	174	182	189	197
565	205	213	220	228	236	243	251	259	266	274
566	282	289	297	305	312	320	328	335	343	351
567	358	366	374	381	389	397	404	412	420	427
568	435	442	450	458	465	473	481	488	496	504
569	511	519	526	534	542	549	557	565	572	580
570	587	595	603	610	618	626	633	641	648	656
571	664	671	679	686	694	702	709	717	724	732
572	740	747	755	762	770	778	785	793	800	808
573	815	823	831	838	846	853	861	868	876	884
574	891	899	906	914	921	929	937	944	952	959
575	967	974	982	989	997	*05	*12	*20	*27	*35
576	76042	050	057	065	072	080	087	095	103	110
577	118	125	133	140	148	155	163	170	178	185
578	193	200	208	215	223	230	238	245	253	260
579	268	275	283	290	298	305	313	320	328	335
580	343	350	358	365	373	380	388	395	403	410
581	418	425	433	440	448	455	462	470	477	485
582	492	500	507	515	522	530	537	545	552	559
583	567	574	582	589	597	604	612	619	626	634
584	641	649	656	664	671	678	686	693	701	708
585	716	723	730	738	745	753	760	768	775	782
586	790	797	805	812	819	827	834	842	849	856
587	864	871	879	886	893	901	908	916	923	930
588	938	945	953	960	967	975	982	989	997	*04
589	77012	019	026	034	041	048	056	063	070	078
590	085	093	100	107	115	122	129	137	144	151
591	159	166	173	181	188	195	203	210	217	225
592	232	240	247	254	262	269	276	283	291	298
593	305	313	320	327	335	342	349	357	364	371
594	379	386	393	401	408	415	422	430	437	444
595	452	459	466	474	481	488	495	503	510	517
596	525	532	539	546	554	561	568	576	583	590
597	597	605	612	619	627	634	641	648	656	663
598	670	677	685	692	699	706	714	721	728	735
599	743	750	757	764	772	779	786	793	801	808
600	815	822	830	837	844	851	859	866	873	880
601	887	895	902	909	916	924	931	938	945	952
602	960	967	974	981	988	996	*03	*10	*17	*25
603	78032	039	046	053	061	068	075	082	089	097
604	104	111	118	125	132	140	147	154	161	168
605	176	183	190	197	204	211	219	226	233	240
606	247	254	262	269	276	283	290	297	305	312
607	319	326	333	340	347	355	362	369	376	383
608	390	398	405	412	490	426	433	440	447	455
609	462	469	476	483	490	497	504	512	519	526
610	533	540	547	554	561	569	576	583	590	597
611	604	611	618	625	633	640	647	654	661	668
612	675	682	689	696	704	711	718	725	732	739
613	746	753	760	767	774	781	789	796	803	810
614	817	824	831	838	845	852	859	866	873	880
615	888	895	902	909	916	923	930	937	944	951
616	958	965	972	979	986	993	*00	*07	*14	*21
617	79029	036	043	050	057	064	071	078	085	092
618	099	106	113	120	127	134	141	148	155	162
619	169	176	183	190	197	204	211	218	225	232
	0	1	2	3	4	5	6	7	8	9

Pro. Parts.

D.	9	D.	8	D.	7
1	0·9	1	0·8	1	0·7
2	1·8	2	1·6	2	1·4
3	2·7	3	2·4	3	2·1
4	3·6	4	3·2	4	2·8
5	4·5	5	4·0	5	3·5
6	5·4	6	4·8	6	4·2
7	6·3	7	5·6	7	4·9
8	7·2	8	6·4	8	5·6
9	8·1	9	7·2	9	6·3

TABLE LI.—Common Logarithms to 5 places of Decimals.

No.	Logarithm. 0	1	2	3	4	5	6	7	8	9
620	79239	246	253	260	267	274	281	288	295	302
621	309	316	323	330	337	344	351	358	365	372
622	379	386	393	400	407	414	421	428	435	442
623	449	456	463	470	477	484	491	498	505	511
624	518	525	532	539	546	553	560	567	574	581
625	588	595	602	609	616	623	630	637	644	650
626	657	664	671	678	685	692	699	706	713	720
627	727	734	741	748	754	761	768	775	782	789
628	796	803	810	817	824	831	837	844	851	858
629	865	872	879	886	893	900	906	913	920	927
630	934	941	948	955	962	969	975	982	989	996
631	80003	010	017	024	030	037	044	051	058	065
632	072	079	085	092	099	106	113	120	127	134
633	140	147	154	161	168	175	182	188	195	202
634	209	216	223	229	236	243	250	257	264	271
635	277	284	291	298	305	312	318	325	332	339
636	346	353	359	366	373	380	387	393	400	407
637	414	421	428	434	441	448	455	462	468	475
638	482	489	496	502	509	516	523	530	536	543
639	550	557	564	570	577	584	591	598	604	611
640	618	625	632	638	645	652	659	665	672	679
641	686	693	699	706	713	720	726	733	740	747
642	754	760	767	774	781	787	794	801	808	814
643	821	828	835	841	848	855	862	868	875	882
644	889	895	902	909	916	922	929	936	943	949
645	956	963	969	976	983	990	996	*03	*10	*17
646	81023	030	037	043	050	057	064	070	077	084
647	090	097	104	111	117	124	131	137	144	151
648	158	164	171	178	184	191	198	204	211	218
649	224	231	238	245	251	258	265	271	278	285
650	291	298	305	311	318	325	331	338	345	351
651	358	365	371	378	385	391	398	405	411	418
652	425	431	438	445	451	458	465	471	478	485
653	491	498	505	511	518	525	531	538	544	551
654	558	564	571	578	584	591	598	604	611	617
655	624	631	637	644	651	657	664	671	677	684
656	690	697	704	710	717	723	730	737	743	750
657	757	763	770	776	783	790	796	803	809	816
658	823	829	836	842	849	856	862	869	875	882
659	889	895	902	908	915	921	928	935	941	948
660	954	961	968	974	981	987	994	*00	*07	*14
661	82020	027	033	040	046	053	060	066	073	079
662	086	092	099	105	112	119	125	132	138	145
663	151	158	164	171	178	184	191	197	204	210
664	217	223	230	236	243	249	256	263	269	276
665	282	289	295	302	308	315	321	328	334	341
666	347	354	360	367	373	380	387	393	400	406
667	413	419	426	432	439	445	452	458	465	471
668	478	484	491	497	504	510	517	523	530	536
669	543	549	556	562	569	575	582	588	595	601
670	607	614	620	627	633	640	646	653	659	666
671	672	679	685	692	698	705	711	718	724	730
672	737	743	750	756	763	769	776	782	789	795
673	802	808	814	821	827	834	840	847	853	860
674	866	872	879	885	892	898	905	911	918	924
675	930	937	943	950	956	963	969	975	982	988
676	995	*01	*08	*14	*20	*27	*33	*40	*46	*52
677	83059	065	072	078	085	091	097	104	110	117
678	123	129	136	142	149	155	161	168	174	181
679	187	193	200	206	213	219	225	232	238	245
680	251	257	264	270	276	283	289	296	302	308
681	315	321	327	334	340	347	353	359	366	372
682	378	385	391	398	404	410	417	423	429	436
683	442	448	455	461	467	474	480	487	493	499
684	506	512	518	525	531	537	544	550	556	563
	0	1	2	3	4	5	6	7	8	9

No.	Logarithm. 0	1	2	3	4	5	6	7	8	9
685	83569	575	582	588	594	601	607	613	620	626
686	632	639	645	651	658	664	670	677	683	689
687	696	702	708	715	721	727	734	740	746	753
688	759	765	771	778	784	790	797	803	809	816
689	822	828	835	841	847	853	860	866	872	879
690	885	891	897	904	910	916	923	929	935	942
691	948	954	960	967	973	979	985	992	998	*04
692	84011	017	023	029	036	042	048	055	061	067
693	073	080	086	092	098	105	111	117	123	130
694	136	142	148	155	161	167	173	180	186	192
695	198	205	211	217	223	230	236	242	248	255
696	261	267	273	280	286	292	298	305	311	317
697	323	330	336	342	348	354	361	367	373	379
698	386	392	398	404	410	417	423	429	435	442
699	448	454	460	466	473	479	485	491	497	504
700	510	516	522	528	535	541	547	553	559	566
701	572	578	584	590	597	603	609	615	621	628
702	634	640	646	652	658	665	671	677	683	689
703	696	702	708	714	720	726	733	739	745	751
704	757	763	770	776	782	788	794	800	807	813
705	819	825	831	837	844	850	856	862	868	874
706	880	887	893	899	905	911	917	924	930	936
707	942	948	954	960	967	973	979	985	991	997
708	85003	009	016	022	028	034	040	046	052	058
709	065	071	077	083	089	095	101	107	114	120
710	126	132	138	144	150	156	163	169	175	181
711	187	193	199	205	211	217	224	230	236	242
712	248	254	260	266	272	278	285	291	297	303
713	309	315	321	327	333	339	345	352	358	364
714	370	376	382	388	394	400	406	412	418	425
715	431	437	443	449	455	461	467	473	479	485
716	491	497	503	509	516	522	528	534	540	546
717	552	558	564	570	576	582	588	594	600	606
718	612	618	625	631	637	643	649	655	661	667
719	673	679	685	691	697	703	709	715	721	727
720	733	739	745	751	757	763	769	775	781	788
721	794	800	806	812	818	824	830	836	842	848
722	854	860	866	872	878	884	890	896	902	908
723	914	920	926	932	938	944	950	956	962	968
724	974	980	986	992	998	*04	*10	*16	*22	*28
725	86034	040	046	052	058	064	070	076	082	088
726	094	100	106	112	118	124	130	136	141	147
727	153	159	165	171	177	183	189	195	201	207
728	213	219	225	231	237	243	249	255	261	267
729	273	279	285	291	297	303	308	314	320	326
730	332	338	344	350	356	362	368	374	380	386
731	392	398	404	410	415	421	427	433	439	445
732	451	457	463	469	475	481	487	493	499	504
733	510	516	522	528	534	540	546	552	558	564
734	570	576	581	587	593	599	605	611	617	623
735	629	635	641	646	652	658	664	670	676	682
736	688	694	700	705	711	717	723	729	735	741
737	747	753	759	764	770	776	782	788	794	800
738	806	812	817	823	829	835	841	847	853	859
739	864	870	876	882	888	894	900	906	911	917
740	923	929	935	941	947	953	958	964	970	976
741	982	988	994	999	*05	*11	*17	*23	*29	*35
742	87040	046	052	058	064	070	075	081	087	093
743	099	105	111	116	122	128	134	140	146	151
744	157	163	169	175	181	186	192	198	204	210
745	216	221	227	233	239	245	251	256	262	268
746	274	280	286	291	297	303	309	315	320	326
747	332	338	344	349	355	361	367	373	379	384
748	390	396	402	408	413	419	425	431	437	442
749	448	454	460	466	471	477	483	489	495	500
	0	1	2	3	4	5	6	7	8	9

Pro. Parts.

D.	7	D.	6	D.	5
1	0·7	1	0·6	1	0·5
2	1·4	2	1·2	2	1·0
3	2·1	3	1·8	3	1·5
4	2·8	4	2·4	4	2·0
5	3·5	5	3·0	5	2·5
6	4·2	6	3·6	6	3·0
7	4·9	7	4·2	7	3·5
8	5·6	8	4·8	8	4·0
9	6·3	9	5·4	9	4·5

TABLE LI.—Common Logarithms to 5 places of Decimals.

No.	Logarithm 0	1	2	3	4	5	6	7	8	9	No.	Logarithm 0	1	2	3	4	5	6	7	8	9
750	87506	512	518	523	529	535	541	547	552	558	815	91116	121	126	132	137	142	148	153	158	164
751	564	570	576	581	587	593	599	604	610	616	816	169	174	180	185	190	196	201	206	212	217
752	622	628	633	639	645	651	656	662	668	674	817	222	228	233	238	243	249	254	259	265	270
753	679	685	691	697	703	708	714	720	726	731	818	275	281	286	291	297	302	307	312	318	323
754	737	743	749	754	760	766	772	777	783	789	819	328	334	339	344	350	355	360	365	371	376
755	795	800	806	812	818	823	829	835	841	846	820	381	387	392	397	403	408	413	418	424	429
756	852	858	864	869	875	881	887	892	898	904	821	434	440	445	450	455	461	466	471	477	482
757	910	915	921	927	933	938	944	950	955	961	822	487	492	498	503	508	514	519	524	529	535
758	967	973	978	984	990	996	*01	*07	*13	*18	823	540	545	551	556	561	566	572	577	582	587
759	88024	030	036	041	047	053	058	064	070	076	824	593	598	603	609	614	619	624	630	635	640
760	081	087	093	098	104	110	116	121	127	133	825	645	651	656	661	666	672	677	682	687	693
761	138	144	150	156	161	167	173	178	184	190	826	698	703	709	714	719	724	730	735	740	745
762	195	201	207	213	218	224	230	235	241	247	827	751	756	761	766	772	777	782	787	793	798
763	252	258	264	270	275	281	287	292	298	304	828	803	808	814	819	824	829	834	840	845	850
764	309	315	321	326	332	338	343	349	355	360	829	855	861	866	871	876	882	887	892	897	903
765	366	372	377	383	389	395	400	406	412	417	830	908	913	918	924	929	934	939	944	950	955
766	423	429	434	440	446	451	457	463	468	474	831	960	965	971	976	981	986	991	997	*02	*07
767	480	485	491	497	502	508	513	519	525	530	832	92012	018	023	028	033	038	044	049	054	059
768	536	542	547	553	559	564	570	576	581	587	833	065	070	075	080	085	091	096	101	106	111
769	593	598	604	610	615	621	627	632	638	643	834	117	122	127	132	137	143	148	153	158	163
770	649	655	660	666	672	677	683	689	694	700	835	169	174	179	184	189	195	200	205	210	215
771	705	711	717	722	728	734	739	745	750	756	836	221	226	231	236	241	247	252	257	262	267
772	762	767	773	779	784	790	795	801	807	812	837	273	278	283	288	293	298	304	309	314	319
773	818	824	829	835	840	846	852	857	863	868	838	324	330	335	340	345	350	355	361	366	371
774	874	880	885	891	897	902	908	913	919	925	839	376	381	387	392	397	402	407	412	418	423
775	930	936	941	947	953	958	964	969	975	981	840	428	433	438	443	449	454	459	464	469	474
776	986	992	997	*03	*09	*14	*20	*25	*31	*37	841	480	485	490	495	500	505	511	516	521	526
777	89042	048	053	059	064	070	076	081	087	092	842	531	536	542	547	552	557	562	567	572	578
778	098	104	109	115	120	126	131	137	143	148	843	583	588	593	598	603	609	614	619	624	629
779	154	159	165	170	176	182	187	193	198	204	844	634	639	645	650	655	660	665	670	675	681
780	209	215	221	226	232	237	243	248	254	260	845	686	691	696	701	706	711	716	722	727	732
781	265	271	276	282	287	293	298	304	310	315	846	737	742	747	752	758	763	768	773	778	783
782	321	326	332	337	343	348	354	360	365	371	847	788	793	799	804	809	814	819	824	829	834
783	376	382	387	393	398	404	409	415	421	426	848	840	845	850	855	860	865	870	875	881	886
784	432	437	443	448	454	459	465	470	476	481	849	891	896	901	906	911	916	921	927	932	937
785	487	492	498	504	509	515	520	526	531	537	850	942	947	952	957	962	967	973	978	983	988
786	542	548	553	559	564	570	575	581	586	592	851	993	998	*03	*08	*13	*18	*24	*29	*34	*39
787	597	603	609	614	620	625	631	636	642	647	852	93044	049	054	059	064	069	075	080	085	090
788	653	658	664	669	675	680	686	691	697	702	853	095	100	105	110	115	120	125	131	136	141
789	708	713	719	724	730	735	741	746	752	757	854	146	151	156	161	166	171	176	181	186	192
790	763	768	774	779	785	790	796	801	807	812	855	197	202	207	212	217	222	227	232	237	242
791	818	823	829	834	840	845	851	856	862	867	856	247	252	258	263	268	273	278	283	288	293
792	873	878	883	889	894	900	905	911	916	922	857	298	303	308	313	318	323	328	334	339	344
793	927	933	938	944	949	955	960	966	971	977	858	349	354	359	364	369	374	379	384	389	394
794	982	988	993	998	*04	*09	*15	*20	*26	*31	859	399	404	409	414	420	425	430	435	440	445
795	90037	042	048	053	059	064	069	075	080	086	860	450	455	460	465	470	475	480	485	490	495
796	091	097	102	108	113	119	124	129	135	140	861	500	505	510	515	520	526	531	536	541	546
797	146	151	157	162	168	173	179	184	189	195	862	551	556	561	566	571	576	581	586	591	596
798	200	206	211	217	222	227	233	238	244	249	863	601	606	611	616	621	626	631	636	641	646
799	255	260	266	271	276	282	287	293	298	304	864	651	656	661	666	671	676	682	687	692	697
800	309	314	320	325	331	336	342	347	352	358	865	702	707	712	717	722	727	732	737	742	747
801	363	369	374	380	385	390	396	401	407	412	866	752	757	762	767	772	777	782	787	792	797
802	417	423	428	434	439	445	450	455	461	466	867	802	807	812	817	822	827	832	837	842	847
803	472	477	482	488	493	499	504	509	515	520	868	852	857	862	867	872	877	882	887	892	897
804	526	531	536	542	547	553	558	563	569	574	869	902	907	912	917	922	927	932	937	942	947
805	580	585	590	596	601	607	612	617	623	628	870	952	957	962	967	972	977	982	987	992	997
806	634	639	644	650	655	660	666	671	677	682	871	94002	007	012	017	022	027	032	037	042	047
807	687	693	698	703	709	714	720	725	730	736	872	052	057	062	067	072	077	082	086	091	096
808	741	747	752	757	763	768	773	779	784	789	873	101	106	111	116	121	126	131	136	141	146
809	795	800	806	811	816	822	827	832	838	843	874	151	156	161	166	171	176	181	186	191	196
810	849	854	859	865	870	875	881	886	891	897	875	201	206	211	216	221	226	231	236	240	245
811	902	907	913	918	924	929	934	940	945	950	876	250	255	260	265	270	275	280	285	290	295
812	956	961	966	972	977	982	988	993	998	*04	877	300	305	310	315	320	325	330	335	340	345
813	91009	014	020	025	030	036	041	046	052	057	878	349	354	359	364	369	374	379	384	389	394
814	062	068	073	078	084	089	094	100	105	110	879	399	404	409	414	419	424	429	433	438	443
	0	1	2	3	4	5	6	7	8	9		0	1	2	3	4	5	6	7	8	9

Pro. Parts.

D.	6	D.	5	D.	4
1	0·6	1	0·5	1	0·4
2	1·2	2	1·0	2	0·8
3	1·8	3	1·5	3	1·2
4	2·4	4	2·0	4	1·6
5	3·0	5	2·5	5	2·0
6	3·6	6	3·0	6	2·4
7	4·2	7	3·5	7	2·8
8	4·8	8	4·0	8	3·2
9	5·4	9	4·5	9	3·6

TABLE LI.—Common Logarithms to 5 places of Decimals.

No.	Logarithm. 0	1	2	3	4	5	6	7	8	9
880	94448	453	458	463	468	473	478	483	488	493
881	498	503	507	512	517	522	527	532	537	542
882	547	552	557	562	567	571	576	581	586	591
883	596	601	606	611	616	621	626	630	635	640
884	645	650	655	660	665	670	675	680	685	689
885	694	699	704	709	714	719	724	729	734	738
886	743	748	753	758	763	768	773	778	783	787
887	792	797	802	807	812	817	822	827	832	836
888	841	846	851	856	861	866	871	876	880	885
889	890	895	900	905	910	915	919	924	929	934
890	939	944	949	954	959	963	968	973	978	983
891	988	993	998	*02	*07	*12	*17	*22	*27	*32
892	95036	041	046	051	056	061	066	071	075	080
893	085	090	095	100	105	109	114	119	124	129
894	134	139	143	148	153	158	163	168	173	177
895	182	187	192	197	202	207	211	216	221	226
896	231	236	240	245	250	255	260	265	270	274
897	279	284	289	294	299	303	308	313	318	323
898	328	332	337	342	347	352	357	361	366	371
899	376	381	386	390	395	400	405	410	415	419
900	424	429	434	439	444	448	453	458	463	468
901	472	477	482	487	492	497	501	506	511	516
902	521	525	530	535	540	545	550	554	559	564
903	569	574	578	583	588	593	598	602	607	612
904	617	622	626	631	636	641	646	650	655	660
905	665	670	674	679	684	689	694	698	703	708
906	713	718	722	727	732	737	742	746	751	756
907	761	766	770	775	780	785	789	794	799	804
908	809	813	818	823	828	832	837	842	847	852
909	856	861	866	871	875	880	885	890	895	899
910	904	909	914	918	923	928	933	938	942	947
911	952	957	961	966	971	976	980	985	990	995
912	999	*04	*09	*14	*19	*23	*28	*33	*38	*42
913	96047	052	057	061	066	071	076	080	085	090
914	095	099	104	109	114	118	123	128	133	137
915	142	147	152	156	161	166	171	175	180	185
916	190	194	199	204	209	213	218	223	227	232
917	237	242	246	251	256	261	265	270	275	280
918	284	289	294	298	303	308	313	317	322	327
919	332	336	341	346	350	355	360	365	369	374
920	379	384	388	393	398	402	407	412	417	421
921	426	431	435	440	445	450	454	459	464	468
922	473	478	483	487	492	497	501	506	511	515
923	520	525	530	534	539	544	548	553	558	562
924	567	572	577	581	586	591	595	600	605	609
925	614	619	624	628	633	638	642	647	652	656
926	661	666	670	675	680	685	689	694	699	703
927	708	713	717	722	727	731	736	741	745	750
928	755	759	764	769	774	778	783	788	792	797
929	802	806	811	816	820	825	830	834	839	844
930	848	853	858	862	867	872	876	881	886	890
931	895	900	904	909	914	918	923	928	932	937
932	942	946	951	956	960	965	970	974	979	984
933	988	993	997	*02	*07	*11	*16	*21	*25	*30
934	97035	039	044	049	053	058	063	067	072	077
935	081	086	090	095	100	104	109	114	118	123
936	128	132	137	142	146	151	155	160	165	169
937	174	179	183	188	192	197	202	206	211	216
938	220	225	230	234	239	243	248	253	257	262
939	267	271	276	280	285	290	294	299	304	308

No.	Logarithm. 0	1	2	3	4	5	6	7	8	9
940	97313	317	322	327	331	336	340	345	350	354
941	359	364	368	373	377	382	387	391	396	400
942	405	410	414	419	424	428	433	437	442	447
943	451	456	460	465	470	474	479	483	488	493
944	497	502	506	511	516	520	525	529	534	539
945	543	548	552	557	562	566	571	575	580	585
946	589	594	598	603	607	612	617	621	626	630
947	635	640	644	649	653	658	663	667	672	676
948	681	685	690	695	699	704	708	713	717	722
949	727	731	736	740	745	749	754	759	763	768
950	772	777	782	786	791	795	800	804	809	813
951	818	823	827	832	836	841	845	850	855	859
952	864	868	873	877	882	886	891	896	900	905
953	909	914	918	923	928	932	937	941	946	950
954	955	959	964	968	973	978	982	987	991	996
955	98000	005	009	014	019	023	028	032	037	041
956	046	050	055	059	064	068	073	078	082	087
957	091	096	100	105	109	114	118	123	127	132
958	137	141	146	150	155	159	164	168	173	177
959	182	186	191	195	200	204	209	214	218	223
960	227	232	236	241	245	250	254	259	263	268
961	272	277	281	286	290	295	299	304	308	313
962	318	322	327	331	336	340	345	349	354	358
963	363	367	372	376	381	385	390	394	399	403
964	408	412	417	421	426	430	435	439	444	448
965	453	457	462	466	471	475	480	484	489	493
966	498	502	507	511	516	520	525	529	534	538
967	543	547	552	556	561	565	570	574	579	583
968	588	592	597	601	605	610	614	619	623	628
969	632	637	641	646	650	655	659	664	668	673
970	677	682	686	691	695	700	704	709	713	717
971	722	726	731	735	740	744	749	753	758	762
972	767	771	776	780	784	789	793	798	802	807
973	811	816	820	825	829	834	838	843	847	851
974	856	860	865	869	874	878	883	887	892	896
975	900	905	909	914	918	923	927	932	936	941
976	945	949	954	958	963	967	972	976	981	985
977	989	994	998	*03	*07	*12	*16	*21	*25	*29
978	99034	038	043	047	052	056	061	065	069	074
979	078	083	087	092	096	100	105	109	114	118
980	123	127	131	136	140	145	149	154	158	162
981	167	171	176	180	185	189	193	198	202	207
982	211	216	220	224	229	233	238	242	247	251
983	255	260	264	269	273	277	282	286	291	295
984	300	304	308	313	317	322	326	330	335	339
985	344	348	352	357	361	366	370	374	379	383
986	388	392	396	401	405	410	414	419	423	427
987	432	436	441	445	449	454	458	463	467	471
988	476	480	484	489	493	498	502	506	511	515
989	520	524	528	533	537	542	546	550	555	559
990	564	568	572	577	581	585	590	594	599	603
991	607	612	616	621	625	629	634	638	642	647
992	651	656	660	664	669	673	677	682	686	691
993	695	699	704	708	712	717	721	726	730	734
994	739	743	747	752	756	760	765	769	774	778
995	782	787	791	795	800	804	808	813	817	822
996	826	830	835	839	843	848	852	856	861	865
997	870	874	878	883	887	891	896	900	904	909
998	913	917	922	926	930	935	939	944	948	952
999	957	961	965	970	974	978	983	987	991	996

Pro. Parts.

D.	5
1	0·5
2	1·0
3	1·5
4	2·0
5	2·5
6	3·0
7	3·5
8	4·0
9	4·5

D.	4
1	0·4
2	0·8
3	1·2
4	1·6
5	2·0
6	2·4
7	2·8
8	3·2
9	3·6

TABLE LII.—Logarithmic Sines and Cosines to 5 places of Decimals.

	0°		1°		2°		3°		4°		
′	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	′
0	Inf. neg.	10·00000	8·24186	9·99993	8·54282	9·99974	8·71880	9·99940	8·84358	9·99894	60
1	6·46373	0	24903	93	54642	73	72120	40	84539	93	59
2	76476	0	25609	93	54999	73	72359	39	84718	92	58
3	94085	0	26304	93	55354	72	72597	38	84897	91	57
4	7·06579	0	26988	92	55705	72	72834	38	85075	91	56
5	16270	0	27661	92	56054	71	73069	37	85252	90	55
6	24188	0	28324	92	56400	71	73303	36	85429	89	54
7	30882	0	28977	92	56743	70	73535	36	85605	88	53
8	36682	0	29621	92	57084	70	73767	35	85780	87	52
9	41797	0	30255	91	57421	69	73997	34	85955	86	51
10	46373	0	30879	91	57757	69	74226	34	86128	85	50
11	7·50512	10·00000	8·31495	9·99991	8·58089	9·99968	8·74454	9·99933	8·86301	9·99884	49
12	54291	0	32103	90	58419	68	74680	32	86474	83	48
13	57767	0	32702	90	58747	67	74906	32	86645	82	47
14	60985	0	33292	90	59072	67	75130	31	86816	81	46
15	63982	0	33875	90	59395	67	75353	30	86987	80	45
16	66784	0	34450	89	59715	66	75575	29	87156	79	44
17	69417	9·99999	35018	89	60033	66	75795	29	87325	79	43
18	71900	99	35578	89	60349	65	76015	28	87494	78	42
19	74248	99	36131	89	60662	64	76234	27	87661	77	41
20	76475	99	36678	88	60973	64	76451	26	87829	76	40
21	7·78594	9·99999	8·37217	9·99988	8·61282	9·99963	8·76667	9·99926	8·87995	9·99875	39
22	80615	99	37750	88	61589	63	76883	25	88161	74	38
23	82545	99	38276	87	61894	62	77097	24	88326	73	37
24	84393	99	38796	87	62196	62	77310	23	88490	72	36
25	86166	99	39310	87	62497	61	77522	23	88654	71	35
26	87870	99	39818	86	62795	61	77733	22	88817	70	34
27	89509	99	40320	86	63091	60	77943	21	88980	69	33
28	91088	99	40816	86	63385	60	78152	20	89142	68	32
29	92612	98	41307	85	63678	59	78360	20	89304	67	31
30	94084	98	41792	85	63968	59	78568	19	89464	66	30
31	7·95508	9·99998	8·42272	9·99985	8·64256	9·99958	8·78774	9·99918	8·89625	9·99865	29
32	96887	98	42746	84	64543	58	78979	17	89784	64	28
33	98223	98	43216	84	64827	57	79183	17	89943	63	27
34	99520	98	43680	84	65110	56	79386	16	90102	62	26
35	8·00779	98	44139	83	65391	56	79588	15	90260	61	25
36	02002	98	44594	83	65670	55	79789	14	90417	60	24
37	03192	97	45044	83	65947	55	79990	13	90574	59	23
38	04350	97	45489	82	66223	54	80189	13	90730	58	22
39	05478	97	45930	82	66497	54	80388	12	90885	57	21
40	06578	97	46366	82	66769	53	80585	11	91040	56	20
41	8·07650	9·99997	8·46799	9·99981	8·67039	9·99952	8·80782	9·99910	8·91195	9·99855	19
42	08696	97	47226	81	67308	52	80978	09	91349	54	18
43	09718	97	47650	81	67575	51	81173	09	91502	53	17
44	10717	96	48069	80	67841	51	81367	08	91655	52	16
45	11693	96	48485	80	68104	50	81560	07	91807	51	15
46	12647	96	48896	79	68367	49	81752	06	91959	50	14
47	13581	96	49304	79	68627	49	81944	05	92110	48	13
48	14495	96	49708	79	68886	48	82134	04	92261	47	12
49	15391	96	50108	78	69144	48	82324	04	92411	46	11
50	16268	95	50504	78	69400	47	82513	03	92561	45	10
51	8·17128	9·99995	8·50897	9·99977	8·69654	9·99946	8·82701	9·99902	8·92710	9·99844	9
52	17971	95	51287	77	69907	46	82888	01	92859	43	8
53	18798	95	51673	77	70159	45	83075	00	93007	42	7
54	19610	95	52055	76	70409	44	83261	9·99899	93154	41	6
55	20407	94	52434	76	70658	44	83446	98	93301	40	5
56	21189	94	52810	75	70905	43	83630	98	93448	39	4
57	21958	94	53183	75	71151	42	83813	97	93594	38	3
58	22713	94	53552	74	71395	42	83996	96	93740	37	2
59	23456	94	53919	74	71638	41	84177	95	93885	36	1
60	24186	93	54282	74	71880	40	84358	94	94030	34	0
′	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	′
	89°		88°		87°		86°		85°		

TABLE LII.—Logarithmic Sines and Cosines to 5 places of Decimals.

	5°		6°		7°		8°		9°		
′	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	′
0	8·94030	9·99834	9·01923	9·99761	9·08589	9·99675	9·14356	9·99575	9·19433	9·99462	60
1	94174	33	02043	60	08692	74	14445	74	19513	60	59
2	94317	32	02163	59	08795	72	14535	72	19592	58	58
3	94461	31	02283	57	08897	70	14624	70	19672	56	57
4	94603	30	02402	56	08999	69	14714	68	19751	54	56
5	94746	29	02520	55	09101	67	14803	66	19830	52	55
6	94887	28	02639	53	09202	66	14891	65	19909	50	54
7	95029	27	02757	52	09304	64	14980	63	19988	48	53
8	95170	25	02874	51	09405	63	15069	61	20067	46	52
9	95310	24	02992	49	09506	61	15157	59	20145	44	51
10	95450	23	03109	48	09606	59	15245	57	20223	42	50
11	8·95589	9·99822	9·03226	9·99747	9·09707	9·99658	9·15333	9·99556	9·20302	9·99440	49
12	95728	21	03342	45	09807	56	15421	54	20380	38	48
13	95867	20	03458	44	09907	55	15508	52	20458	36	47
14	96005	19	03574	42	10006	53	15596	50	20535	34	46
15	96143	17	03690	41	10106	51	15683	48	20613	32	45
16	96280	16	03805	40	10205	50	15770	46	20691	29	44
17	96417	15	03920	38	10304	48	15857	45	20768	27	43
18	96553	14	04034	37	10402	47	15944	43	20845	25	42
19	96689	13	04149	36	10501	45	16030	41	20922	23	41
20	96825	12	04262	34	10599	43	16116	39	20999	21	40
21	8·96960	9·99810	9·04376	9·99733	9·10697	9·99642	9·16203	9·99537	9·21076	9·99419	39
22	97095	09	04490	31	10795	40	16289	35	21153	17	38
23	97229	08	04603	30	10893	38	16374	33	21229	15	37
24	97363	07	04715	28	10990	37	16460	32	21306	13	36
25	97496	06	04828	27	11087	35	16545	30	21382	11	35
26	97629	04	04940	26	11184	33	16631	28	21458	09	34
27	97762	03	05052	24	11281	32	16716	26	21534	07	33
28	97894	02	05164	23	11377	30	16801	24	21610	04	32
29	98026	01	05275	21	11474	29	16886	22	21685	02	31
30	98157	00	05386	20	11570	27	16970	20	21761	00	30
31	8·98288	9·99798	9·05497	9·99718	9·11666	9·99625	9·17055	9·99518	9·21836	9·99398	29
32	98419	97	05607	17	11761	24	17139	17	21912	96	28
33	98549	96	05717	16	11857	22	17223	15	21987	94	27
34	98679	95	05827	14	11952	20	17307	13	22062	92	26
35	98808	93	05937	13	12047	18	17391	11	22137	90	25
36	98937	92	06046	11	12142	17	17474	09	22211	88	24
37	99066	91	06155	10	12236	15	17558	07	22286	85	23
38	99194	90	06264	08	12331	13	17641	05	22361	83	22
39	99322	88	06372	07	12425	12	17724	03	22435	81	21
40	99450	87	06481	05	12519	10	17807	01	22509	79	20
41	8·99577	9·99786	9·06589	9·99704	9·12612	9·99608	9·17890	9·99499	9·22583	9·99377	19
42	99704	85	06696	02	12706	07	17973	97	22657	75	18
43	99830	83	06804	01	12799	05	18055	95	22731	72	17
44	99956	82	06911	9·99699	12892	03	18137	94	22805	70	16
45	9·00082	81	07018	98	12985	01	18220	92	22878	68	15
46	00207	80	07124	96	13078	00	18302	90	22952	66	14
47	00332	78	07231	95	13171	9·99598	18383	88	23025	64	13
48	00456	77	07337	93	13263	96	18465	86	23098	62	12
49	00581	76	07442	92	13355	95	18547	84	23171	59	11
50	00704	75	07548	90	13447	93	18628	82	23244	57	10
51	9·00828	9·99773	9·07653	9·99689	9·13539	9·99591	9·18709	9·99480	9·23317	9·99355	9
52	00951	72	07758	87	13630	89	18790	78	23390	53	8
53	01074	71	07863	86	13722	88	18871	76	23462	51	7
54	01196	69	07968	84	13813	86	18952	74	23535	48	6
55	01318	68	08072	83	13904	84	19033	72	23607	46	5
56	01440	67	08176	81	13994	82	19113	70	23679	44	4
57	01561	65	08280	80	14085	81	19193	68	23752	42	3
58	01682	64	08383	78	14175	79	19273	66	23823	40	2
59	01803	63	08486	77	14266	77	19353	64	23895	37	1
60	01923	61	08589	75	14356	75	19433	62	23967	35	0
′	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	′
	84°		83°		82°		81°		80°		

TABLE LII.—Logarithmic Sines and Cosines to 5 places of Decimals.

	10°		11°		12°		13°		14°		
′	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	′
0	9·23967	9·99335	9·28060	9·99195	9·31788	9·99040	9·35209	9·98872	9·38368	9·98690	60
1	24039	33	28125	92	31847	38	35263	69	38418	87	59
2	24110	31	28190	90	31907	35	35318	67	38469	84	58
3	24181	28	28254	87	31966	32	35373	64	38519	81	57
4	24253	26	28319	85	32025	30	35427	61	38570	78	56
5	24324	24	28384	82	32084	27	35481	58	38620	75	55
6	24395	22	28448	80	32143	24	35536	55	38670	71	54
7	24466	19	28512	77	32202	22	35590	52	38721	68	53
8	24536	17	28577	75	32261	19	35644	49	38771	65	52
9	24607	15	28641	72	32319	16	35698	46	38821	62	51
10	24677	13	28705	70	32378	13	35752	43	38871	59	50
11	9·24748	9·99310	9·28769	9·99167	9·32437	9·99011	9·35806	9·98840	9·38921	9·98656	49
12	24818	08	28833	65	32495	08	35860	37	38971	52	48
13	24888	06	28896	62	32553	05	35914	34	39021	49	47
14	24958	04	28960	60	32612	02	35968	31	39071	46	46
15	25028	01	29024	57	32670	00	36022	28	39121	43	45
16	25098	9·99299	29087	55	32728	9·98997	36075	25	39170	40	44
17	25168	97	29150	52	32786	94	36129	22	39220	36	43
18	25237	94	29214	50	32844	91	36182	19	39270	33	42
19	25307	92	29277	47	32902	89	36236	16	39319	30	41
20	25376	90	29340	45	32960	86	36289	13	39369	27	40
21	9·25445	9·99288	9·29403	9·99142	9·33018	9·98983	9·36342	9·98810	9·39418	9·98623	39
22	25514	85	29466	40	33075	80	36395	07	39467	20	38
23	25583	83	29529	37	33133	78	36449	04	39517	17	37
24	25652	81	29591	35	33190	75	36502	01	39566	14	36
25	25721	78	29654	32	33248	72	36555	9·98798	39615	10	35
26	25790	76	29716	30	33305	69	36608	95	39664	07	34
27	25858	74	29779	27	33362	67	36660	92	39713	04	33
28	25927	71	29841	24	33420	64	36713	89	39762	01	32
29	25995	69	29903	22	33477	61	36766	86	39811	9·98597	31
30	26063	67	29966	19	33534	58	36819	83	39860	94	30
31	9·26131	9·99264	9·30028	9·99117	9·33591	9·98955	9·36871	9·98780	9·39909	9·98591	29
32	26199	62	30090	14	33647	53	36924	77	39958	88	28
33	26267	60	30151	12	33704	50	36976	74	40006	84	27
34	26335	57	30213	09	33761	47	37028	71	40055	81	26
35	26403	55	30275	06	33818	44	37081	68	40103	78	25
36	26470	52	30336	04	33874	41	37133	65	40152	74	24
37	26538	50	30398	01	33931	38	37185	62	40200	71	23
38	26605	48	30459	9·99099	33987	36	37237	59	40249	68	22
39	26672	45	30521	96	34043	33	37289	56	40297	65	21
40	26739	43	30582	93	34100	30	37341	53	40346	61	20
41	9·26806	9·99241	9·30643	9·99091	9·34156	9·98927	9·37393	9·98750	9·40394	9·98558	19
42	26873	38	30704	88	34212	24	37445	46	40442	55	18
43	26940	36	30765	86	34268	21	37497	43	40490	51	17
44	27007	33	30826	83	34324	19	37549	40	40538	48	16
45	27073	31	30887	80	34380	16	37600	37	40586	45	15
46	27140	29	30947	78	34436	13	37652	34	40634	41	14
47	27206	26	31008	75	34491	10	37703	31	40682	38	13
48	27273	24	31068	72	34547	07	37755	28	40730	35	12
49	27339	21	31129	70	34602	04	37806	25	40778	31	11
50	27405	19	31189	67	34658	01	37858	22	40825	28	10
51	9·27471	9·99217	9·31250	9·99064	9·34713	9·98898	9·37909	9·98719	9·40873	9·98525	9
52	27537	14	31310	62	34769	96	37960	15	40921	21	8
53	27602	12	31370	59	34824	93	38011	12	40968	18	7
54	27668	09	31430	56	34879	90	38062	09	41016	15	6
55	27734	07	31490	54	34934	87	38113	06	41063	11	5
56	27799	04	31549	51	34989	84	38164	03	41111	08	4
57	27864	02	31609	48	35044	81	38215	00	41158	05	3
58	27930	00	31669	46	35099	78	38266	9·98697	41205	01	2
59	27995	9·99197	31728	43	35154	75	38317	94	41252	9·98498	1
60	28060	95	31788	40	35209	72	38368	90	41300	94	0
′	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	′
	79°		78°		77°		76°		75°		

TABLE LII.—Logarithmic Sines and Cosines to 5 places of Decimals.

	15°		16°		17°		18°		19°		
′	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	′
0	9·41300	9·98494	9·44034	9·98284	9·46594	9·98060	9·48998	9·97821	9·51264	9·97567	60
1	41347	91	44078	81	46635	56	49037	17	51301	63	59
2	41394	88	44122	77	46676	52	49076	12	51338	58	58
3	41441	84	44166	73	46717	48	49115	08	51374	54	57
4	41488	81	44210	70	46758	44	49153	04	51411	50	56
5	41535	77	44253	66	46800	40	49192	00	51447	45	55
6	41582	74	44297	62	46841	36	49231	9·97796	51484	41	54
7	41628	71	44341	59	46882	32	49269	92	51520	36	53
8	41675	67	44385	55	46923	29	49308	88	51557	32	52
9	41722	64	44428	51	46964	25	49347	84	51593	28	51
10	41768	60	44472	48	47005	21	49385	79	51629	23	50
11	9·41815	9·98457	9·44516	9·98244	9·47045	9·98017	9·49424	9·97775	9·51666	9·97519	49
12	41861	53	44559	40	47086	13	49462	71	51702	15	48
13	41908	50	44602	37	47127	09	49500	67	51738	10	47
14	41954	47	44646	33	47168	05	49539	63	51774	06	46
15	42001	43	44689	29	47209	01	49577	59	51811	01	45
16	42047	40	44733	26	47249	9·97997	49615	54	51847	9·97497	44
17	42093	36	44776	22	47290	93	49654	50	51883	92	43
18	42140	33	44819	18	47330	89	49692	46	51919	88	42
19	42186	29	44862	15	47371	86	49730	42	51955	84	41
20	42232	26	44905	11	47411	82	49768	38	51991	79	40
21	9·42278	9·98422	9·44948	9·98207	9·47452	9·97978	9·49806	9·97734	9·52027	9·97475	39
22	42324	19	44992	04	47492	74	49844	29	52063	70	38
23	42370	15	45035	00	47533	70	49882	25	52099	66	37
24	42416	12	45077	9·98196	47573	66	49920	21	52135	61	36
25	42461	09	45120	92	47613	62	49958	17	52171	57	35
26	42507	05	45163	89	47654	58	49996	13	52207	53	34
27	42553	02	45206	85	47694	54	50034	08	52242	48	33
28	42599	9·98398	45249	81	47734	50	50072	04	52278	44	32
29	42644	95	45292	77	47774	46	50110	00	52314	39	31
30	42690	91	45334	74	47814	42	50148	9·97696	52350	35	30
31	9·42735	9·98388	9·45377	9·98170	9·47854	9·97938	9·50185	9·97691	9·52385	9·97430	29
32	42781	84	45419	66	47894	34	50223	87	52421	26	28
33	42826	81	45462	62	47934	30	50261	83	52456	21	27
34	42872	77	45504	59	47974	26	50298	79	52492	17	26
35	42917	73	45547	55	48014	22	50336	74	52527	12	25
36	42962	70	45589	51	48054	18	50374	70	52563	08	24
37	43008	66	45632	47	48094	14	50411	66	52598	03	23
38	43053	63	45674	44	48133	10	50449	62	52634	9·97399	22
39	43098	59	45716	40	48173	06	50486	57	52669	94	21
40	43143	56	45758	36	48213	02	50523	53	52705	90	20
41	9·43188	9·98352	9·45801	9·98132	9·48252	9·97898	9·50561	9·97649	9·52740	9·97385	19
42	43233	49	45843	29	48292	94	50598	45	52775	81	18
43	43278	45	45885	25	48332	90	50635	40	52811	76	17
44	43323	42	45927	21	48371	86	50673	36	52846	72	16
45	43367	38	45969	17	48411	82	50710	32	52881	67	15
46	43412	34	46011	13	48450	78	50747	28	52916	63	14
47	43457	31	46053	10	48490	74	50784	23	52951	58	13
48	43502	27	46095	06	48529	70	50821	19	52986	53	12
49	43546	24	46136	02	48568	66	50858	15	53021	49	11
50	43591	20	46178	9·98098	48607	61	50896	10	53056	44	10
51	9·43635	9·98317	9·46220	9·98094	9·48647	9·97857	9·50933	9·97606	9·53092	9·97340	9
52	43680	13	46262	90	48686	53	50970	02	53126	35	8
53	43724	09	46303	87	48725	49	51007	9·97597	53161	31	7
54	43769	06	46345	83	48764	45	51043	93	53196	26	6
55	43813	02	46386	79	48803	41	51080	89	53231	22	5
56	43857	9·98299	46428	75	48842	37	51117	84	53266	17	4
57	43901	95	46469	71	48881	33	51154	80	53301	12	3
58	43946	91	46511	67	48920	29	51191	76	53336	08	2
59	43990	88	46552	63	48959	25	51227	71	53370	03	1
60	44034	84	46594	60	48998	21	51264	67	53405	9·97299	0
′	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	′
	74°		73°		72°		71°		70°		

TABLE LII.—Logarithmic Sines and Cosines to 5 places of Decimals.

	20°		21°		22°		23°		24°		
′	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	′
0	9·53405	9·97299	9·55433	9·97015	9·57358	9·96717	9·59188	9·96403	9·60931	9·96073	60
1	440	294	466	010	389	711	218	397	960	067	59
2	475	289	499	005	420	706	247	392	988	062	58
3	509	285	532	001	451	701	277	387	9·61016	056	57
4	544	280	564	9·96996	482	696	307	381	045	050	56
5	578	276	597	991	514	691	336	376	073	045	55
6	613	271	630	986	545	686	366	370	101	039	54
7	647	266	663	981	576	681	396	365	129	034	53
8	682	262	695	976	607	676	425	360	158	028	52
9	716	257	728	971	638	670	455	354	186	022	51
10	751	252	761	966	669	665	484	349	214	017	50
11	9·53785	9·97248	9·55793	9·96962	9·57700	9·96660	9·59514	9·96343	9·61242	9·96011	49
12	819	243	826	957	731	655	543	338	270	005	48
13	854	238	858	952	762	650	573	333	298	000	47
14	888	234	891	947	793	645	602	327	326	9·95994	46
15	922	229	923	942	824	640	632	322	354	988	45
16	957	224	956	937	855	634	661	316	382	982	44
17	991	220	988	932	885	629	690	311	411	977	43
18	9·54025	215	9·56021	927	916	624	720	305	438	971	42
19	059	210	053	922	947	619	749	300	466	965	41
20	093	206	085	917	978	614	778	294	494	960	40
21	9·54127	9·97201	9·56118	9·96912	9·58008	9·96608	9·59808	9·96289	9·61522	9·95954	39
22	161	196	150	907	039	603	837	284	550	948	38
23	195	192	182	903	070	598	866	278	578	942	37
24	229	187	215	898	101	593	895	273	606	937	36
25	263	182	247	893	131	588	924	267	634	931	35
26	297	178	279	888	162	582	954	262	662	925	34
27	331	173	311	883	192	577	983	256	689	920	33
28	365	168	343	878	223	572	9·60012	251	717	914	32
29	399	163	375	873	253	567	041	245	745	908	31
30	433	159	408	868	284	562	070	240	773	902	30
31	9·54466	9·97154	9·56440	9·96863	9·58314	9·96556	9·60099	9·96234	9·61800	9·95897	29
32	500	149	472	858	345	551	128	229	828	891	28
33	534	145	504	853	375	546	157	223	856	885	27
34	567	140	536	848	406	541	186	218	883	879	26
35	601	135	568	843	436	535	215	212	911	873	25
36	635	130	599	838	467	530	244	207	939	868	24
37	668	126	631	833	497	525	273	201	966	862	23
38	702	121	663	828	527	520	302	196	994	856	22
39	735	116	695	823	557	514	331	190	9·62021	850	21
40	769	111	727	818	588	509	359	185	049	844	20
41	9·54802	9·97107	9·56759	9·96813	9·58618	9·96504	9·60388	9·96179	9·62076	9·95839	19
42	836	102	790	808	648	498	417	174	104	833	18
43	869	097	822	803	678	493	446	168	131	827	17
44	903	092	854	798	709	488	474	162	159	821	16
45	936	087	886	793	739	483	503	157	186	815	15
46	969	083	917	788	769	477	532	151	214	810	14
47	9·55003	078	949	783	799	472	561	146	241	804	13
48	036	073	980	778	829	467	589	140	268	798	12
49	069	068	9·57012	772	859	461	618	135	296	792	11
50	102	063	044	767	889	456	646	129	323	786	10
51	9·55136	9·97059	9·57075	9·96762	9·58919	9·96451	9·60675	9·96123	9·62350	9·95780	9
52	169	054	107	757	949	445	704	118	377	775	8
53	202	049	138	752	979	440	732	112	405	769	7
54	235	044	169	747	9·59009	435	761	107	432	763	6
55	268	039	201	742	039	429	789	101	459	757	5
56	301	035	232	737	069	424	818	095	486	751	4
57	334	030	264	732	098	419	846	090	513	745	3
58	367	025	295	727	128	413	875	084	541	739	2
59	400	020	326	722	158	408	903	079	568	733	1
60	433	015	358	717	188	403	931	073	595	728	0
′	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	′
	69°		68°		67°		66°		65°		

TABLE LII.—Logarithmic Sines and Cosines to 5 places of Decimals.

	25°		26°		27°		28°		29°		
′	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	′
0	9·62595	9·95728	9·64184	9·95366	9·65705	9·94988	9·67161	9·94593	9·68557	9·94182	60
1	622	722	210	360	729	982	185	587	580	175	59
2	649	716	236	354	754	975	208	580	603	168	58
3	676	710	262	348	779	969	232	573	625	161	57
4	703	704	288	341	804	962	256	567	648	154	56
5	730	698	313	335	828	956	280	560	671	147	55
6	757	692	339	329	853	949	303	553	694	140	54
7	784	686	365	323	878	943	327	546	716	133	53
8	811	680	391	317	902	936	350	540	739	126	52
9	838	674	417	310	927	930	374	533	762	119	51
10	865	668	442	304	952	923	398	526	784	112	50
11	9·62892	9·95663	9·64468	9·95298	9·65976	9·94917	9·67421	9·94519	9·68807	9·94105	49
12	918	657	494	292	9·66001	911	445	513	829	098	48
13	945	651	519	286	025	904	468	506	852	090	47
14	972	645	545	279	050	898	492	499	875	083	46
15	999	639	571	273	075	891	515	492	897	076	45
16	9·63026	633	596	267	099	885	539	485	920	069	44
17	052	627	622	261	124	878	562	479	942	062	43
18	079	621	647	254	148	871	586	472	965	055	42
19	106	615	673	248	173	865	609	465	987	048	41
20	133	609	698	242	197	858	633	458	9·69010	041	40
21	9·63159	9·95603	9·64724	9·95236	9·66221	9·94852	9·67656	9·94451	9·69032	9·94034	39
22	186	597	749	229	246	845	680	445	055	027	38
23	213	591	775	223	270	839	703	438	077	020	37
24	239	585	800	217	295	832	726	431	100	012	36
25	266	579	826	211	319	826	750	424	122	005	35
26	292	573	851	204	343	819	773	417	144	9·93998	34
27	319	567	877	198	368	813	796	410	167	991	33
28	345	561	902	192	392	806	820	404	189	984	32
29	372	555	927	185	416	799	843	397	212	977	31
30	398	549	953	179	441	793	866	390	234	970	30
31	9·63425	9·95543	9·64978	9·95173	9·66465	9·94786	9·67890	9·94383	9·69256	9·93963	29
32	451	537	9·65003	167	489	780	913	376	279	955	28
33	478	531	029	160	513	773	936	369	301	948	27
34	504	525	054	154	537	767	959	362	323	941	26
35	531	519	079	148	562	760	982	355	345	934	25
36	557	513	104	141	586	753	9·68006	349	368	927	24
37	583	507	130	135	610	747	029	342	390	920	23
38	610	500	155	129	634	740	052	335	412	912	22
39	636	494	180	122	658	734	075	328	434	905	21
40	662	488	205	116	682	727	098	321	456	898	20
41	9·63689	9·95482	9·65230	9·95110	9·66706	9·94720	9·68121	9·94314	9·69479	9·93891	19
42	715	476	255	103	731	714	144	307	501	884	18
43	741	470	281	097	755	707	167	300	523	876	17
44	767	464	306	090	779	700	190	293	545	869	16
45	794	458	331	084	803	694	213	286	567	862	15
46	820	452	356	078	827	687	237	279	589	855	14
47	846	446	381	071	851	680	260	273	611	847	13
48	872	440	406	065	875	674	283	266	633	840	12
49	898	434	431	059	899	667	305	259	655	833	11
50	924	427	456	052	922	660	328	252	677	826	10
51	9·63950	9·95421	9·65481	9·95046	9·66946	9·94654	9·68351	9·94245	9·69699	9·93819	9
52	976	415	506	039	970	647	374	238	721	811	8
53	9·64002	409	531	033	994	640	397	231	743	804	7
54	028	403	556	027	9·67018	634	420	224	765	797	6
55	054	397	580	020	042	627	443	217	787	789	5
56	080	391	605	014	066	620	466	210	809	782	4
57	106	384	630	007	090	614	489	203	831	775	3
58	132	378	655	001	113	607	512	196	853	768	2
59	158	372	680	9·94995	137	600	534	189	875	760	1
60	184	366	705	988	161	593	557	182	897	753	0
′	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	′
	64°		63°		62°		61°		60°		

TABLE LII.—Logarithmic Sines and Cosines to 5 places of Decimals.

	30°		31°		32°		33°		34°		
′	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	′
0	9·69897	9·93753	9·71184	9·93307	9·72421	9·92842	9·73611	9·92359	9·74756	9·91857	60
1	919	746	205	299	441	834	630	351	775	849	59
2	941	738	226	291	461	826	650	343	794	840	58
3	963	731	247	284	482	818	669	335	812	832	57
4	984	724	268	276	502	810	689	326	831	823	56
5	9·70006	717	289	269	522	803	708	318	850	815	55
6	028	709	310	261	542	795	727	310	868	806	54
7	050	702	331	253	562	787	747	302	887	798	53
8	072	695	352	246	582	779	766	293	906	789	52
9	093	687	373	238	602	771	785	285	924	781	51
10	115	680	393	230	622	763	805	277	943	772	50
11	9·70137	9·93673	9·71414	9·93223	9·72643	9·92755	9·73824	9·92269	9·74961	9·91763	49
12	159	665	435	215	663	747	843	260	980	755	48
13	180	658	456	207	683	739	863	252	999	746	47
14	202	650	477	200	703	731	882	244	9·75017	738	46
15	224	643	498	192	723	723	901	235	036	729	45
16	245	636	519	184	743	715	921	227	054	720	44
17	267	628	539	177	763	707	940	219	073	712	43
18	288	621	560	169	783	699	959	211	091	703	42
19	310	614	581	161	803	691	978	202	110	695	41
20	332	606	602	154	823	683	997	194	128	686	40
21	9·70353	9·93599	9·71622	9·93146	9·72843	9·92675	9·74017	9·92186	9·75147	9·91677	39
22	375	591	643	138	863	667	036	177	165	669	38
23	396	584	664	131	883	659	055	169	184	660	37
24	418	577	685	123	902	651	074	161	202	651	36
25	439	569	705	115	922	643	093	152	221	643	35
26	461	562	726	108	942	635	113	144	239	634	34
27	482	554	747	100	962	627	132	136	258	625	33
28	504	547	767	092	982	619	151	127	276	617	32
29	525	539	788	084	9·73002	611	170	119	294	608	31
30	547	532	809	077	022	603	189	111	313	599	30
31	9·70568	9·93525	9·71829	9·93069	9·73041	9·92595	9·74208	9·92102	9·75331	9·91591	29
32	590	517	850	061	061	587	227	094	350	582	28
33	611	510	870	053	081	579	246	086	368	573	27
34	633	502	891	046	101	571	265	077	386	565	26
35	654	495	911	038	121	563	284	069	405	556	25
36	675	487	932	030	140	555	303	060	423	547	24
37	697	480	952	022	160	546	322	052	441	538	23
38	718	472	973	014	180	538	341	044	459	530	22
39	739	465	994	007	200	530	360	035	478	521	21
40	761	457	9·72014	9·92999	219	522	379	027	496	512	20
41	9·70782	9·93450	9·72034	9·92991	9·73239	9·92514	9·74398	9·92018	9·75514	9·91504	19
42	803	442	055	983	259	506	417	010	533	495	18
43	824	435	075	976	278	498	436	002	551	486	17
44	846	427	096	968	298	490	455	9·91993	569	477	16
45	867	420	116	960	318	482	474	985	587	469	15
46	888	412	137	952	337	473	493	976	605	460	14
47	909	405	157	944	357	465	512	968	624	451	13
48	931	397	177	936	377	457	531	959	642	442	12
49	952	390	198	929	396	449	549	951	660	433	11
50	973	382	218	921	416	441	568	942	678	425	10
51	9·70994	9·93375	9·72238	9·92913	9·73435	9·92433	9·74587	9·91934	9·75696	9·91416	9
52	9·71015	367	259	905	455	425	606	925	714	407	8
53	036	360	279	897	474	416	625	917	733	398	7
54	058	352	299	889	494	408	644	908	751	389	6
55	079	344	320	881	513	400	662	900	769	381	5
56	100	337	340	874	533	392	681	891	787	372	4
57	121	329	360	866	552	384	700	883	805	363	3
58	142	322	381	858	572	376	719	874	823	354	2
59	163	314	401	850	591	367	737	866	841	345	1
60	184	307	421	842	611	359	756	857	859	336	0
′	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	′
	59°		58°		57°		56°		55°		

TABLE LII.—Logarithmic Sines and Cosines to 5 places of Decimals.

	35°		36°		37°		38°		39°		
′	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	′
0	9·75859	9·91336	9·76922	9·90796	9·77946	9·90235	9·78934	9·89653	9·79887	9·89050	60
1	877	328	939	787	963	225	950	643	903	040	59
2	895	319	957	777	980	216	967	633	918	030	58
3	913	310	974	768	997	206	983	624	934	020	57
4	931	301	991	759	9·78013	197	999	614	950	009	56
5	949	292	9·77009	750	030	187	9·79015	604	965	9·88999	55
6	967	283	026	741	047	178	031	594	981	989	54
7	985	274	043	731	063	168	047	584	996	978	53
8	9·76003	266	061	722	080	159	063	574	9·80012	968	52
9	021	257	078	713	097	149	079	564	027	958	51
10	039	248	095	704	113	139	095	554	043	948	50
11	9·76057	9·91239	9·77112	9·90694	9·78130	9·90130	9·79111	9·89544	9·80058	9·88937	49
12	075	230	130	685	147	120	128	534	074	927	48
13	093	221	147	676	163	111	144	524	089	917	47
14	111	212	164	667	180	101	160	514	105	906	46
15	129	203	181	657	197	091	176	504	120	896	45
16	146	194	199	648	213	082	192	495	136	886	44
17	164	185	216	639	230	072	208	485	151	875	43
18	182	176	233	630	246	063	224	475	166	865	42
19	200	167	250	620	263	053	240	465	182	855	41
20	218	158	268	611	280	043	256	455	197	844	40
21	9·76236	9·91149	9·77285	9·90602	9·78296	9·90034	9·79272	9·89445	9·80213	9·88834	39
22	253	141	302	592	313	024	288	435	228	824	38
23	271	132	319	583	329	014	304	425	244	813	37
24	289	123	336	574	346	005	319	415	259	803	36
25	307	114	353	565	362	9·89995	335	405	274	793	35
26	324	105	370	555	379	985	351	395	290	782	34
27	342	096	387	546	395	976	367	385	305	772	33
28	360	087	405	537	412	966	383	375	320	761	32
29	378	078	422	527	428	956	399	364	336	751	31
30	395	069	439	518	445	947	415	354	351	741	30
31	9·76413	9·91060	9·77456	9·90509	9·78461	9·89937	9·79431	9·89344	9·80366	9·88730	29
32	431	051	473	499	478	927	447	334	382	720	28
33	448	042	490	490	494	918	463	324	397	709	27
34	466	033	507	480	510	908	478	314	412	699	26
35	484	023	524	471	527	898	494	304	428	688	25
36	501	014	541	462	543	888	510	294	443	678	24
37	519	005	558	452	560	879	526	284	458	668	23
38	537	9·90996	575	443	576	869	542	274	473	657	22
39	554	987	592	434	592	859	558	264	489	647	21
40	572	978	609	424	609	849	573	254	504	636	20
41	9·76590	9·90969	9·77626	9·90415	9·78625	9·89840	9·79589	9·89244	9·80519	9·88626	19
42	607	960	643	405	642	830	605	233	534	615	18
43	625	951	660	396	658	820	621	223	550	605	17
44	642	942	677	386	674	810	636	213	565	594	16
45	660	933	694	377	691	801	652	203	580	584	15
46	677	924	711	368	707	791	668	193	595	573	14
47	695	915	728	358	723	781	684	183	610	563	13
48	712	906	744	349	739	771	699	173	625	552	12
49	730	896	761	339	756	761	715	162	641	542	11
50	747	887	778	330	772	752	731	152	656	531	10
51	9·76765	9·90878	9·77795	9·90320	9·78788	9·89742	9·79746	9·89142	9·80671	9·88521	9
52	782	869	812	311	805	732	762	132	686	510	8
53	800	860	829	301	821	722	778	122	701	499	7
54	817	851	846	292	837	712	793	112	716	489	6
55	835	842	862	282	853	702	809	101	731	478	5
56	852	832	879	273	869	693	825	091	746	468	4
57	870	823	896	263	886	683	840	081	762	457	3
58	887	814	913	254	902	673	856	071	777	447	2
59	904	805	930	244	918	663	872	060	792	436	1
60	922	796	946	235	934	653	887	050	807	425	0
′	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	′
	54°		53°		52°		51°		50°		

TABLE LII.—Logarithmic Sines and Cosines to 5 places of Decimals.

	40°		41°		42°		43°		44°		
′	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	′
0	9·80807	9·88425	9·81694	9·87778	9·82551	9·87107	9·83378	9·86413	9·84177	9·85693	60
1	822	415	709	767	565	096	392	401	190	681	59
2	837	404	723	756	579	085	405	389	203	669	58
3	852	394	738	745	593	073	419	377	216	657	57
4	867	383	752	734	607	062	432	366	229	645	56
5	882	372	767	723	621	050	446	354	242	632	55
6	897	362	781	712	635	039	459	342	255	620	54
7	912	351	796	701	649	028	473	330	269	608	53
8	927	340	810	690	663	016	486	318	282	596	52
9	942	330	825	679	677	005	500	306	295	583	51
10	957	319	839	668	691	9·86993	513	295	308	571	50
11	9·80972	9·88308	9·81854	9·87657	9·82705	9·86982	9·83527	9·86283	9·84321	9·85559	49
12	987	298	868	646	719	970	540	271	334	547	48
13	9·81002	287	882	635	733	959	554	259	347	534	47
14	017	276	897	624	747	947	567	247	360	522	46
15	032	266	911	613	761	936	581	235	373	510	45
16	047	255	926	601	775	924	594	223	385	497	44
17	061	244	940	590	788	913	608	211	398	485	43
18	076	234	955	579	802	902	621	200	411	473	42
19	091	223	969	568	816	890	634	188	424	460	41
20	106	212	983	557	830	879	648	176	437	448	40
21	9·81121	9·88201	9·81998	9·87546	9·82844	9·86867	9·83661	9·86164	9·84450	9·85436	39
22	136	191	9·82012	535	858	855	674	152	463	423	38
23	151	180	026	524	872	844	688	140	476	411	37
24	166	169	041	513	885	832	701	128	489	399	36
25	180	158	055	501	899	821	715	116	502	386	35
26	195	148	069	490	913	809	728	104	515	374	34
27	210	137	084	479	927	798	741	092	528	361	33
28	225	126	098	468	941	786	755	080	540	349	32
29	240	115	112	457	955	775	768	068	553	337	31
30	254	105	126	446	968	763	781	056	566	324	30
31	9·81269	9·88094	9·82141	9·87434	9·82982	9·86752	9·83795	9·86044	9·84579	9·85312	29
32	284	083	155	423	996	740	808	032	592	299	28
33	299	072	169	412	9·83010	728	821	020	605	287	27
34	314	061	184	401	023	717	834	008	618	274	26
35	328	051	198	390	037	705	848	9·85996	630	262	25
36	343	040	212	378	051	694	861	984	643	250	24
37	358	029	226	367	065	682	874	972	656	237	23
38	372	018	240	356	078	670	887	960	669	225	22
39	387	007	255	345	092	659	901	948	682	212	21
40	402	9·87996	269	334	106	647	914	936	694	200	20
41	9·81417	9·87985	9·82283	9·87322	9·83120	9·86635	9·83927	9·85924	9·84707	9·85187	19
42	431	975	297	311	133	624	940	912	720	175	18
43	446	964	311	300	147	612	954	900	733	162	17
44	461	953	326	288	161	600	967	888	745	150	16
45	475	942	340	277	174	589	980	876	758	137	15
46	490	931	354	266	188	577	993	864	771	125	14
47	505	920	368	255	202	565	9·84006	851	784	112	13
48	519	909	382	243	215	554	020	839	796	100	12
49	534	898	396	232	229	542	033	827	809	087	11
50	549	887	410	221	242	530	046	815	822	074	10
51	9·81563	9·87877	9·82424	9·87209	9·83256	9·86518	9·84059	9·85803	9·84835	9·85062	9
52	578	866	439	198	270	507	072	791	847	049	8
53	592	855	453	187	283	495	085	779	860	037	7
54	607	844	467	175	297	483	098	766	873	024	6
55	622	833	481	164	310	472	112	754	885	012	5
56	636	822	495	153	324	460	125	742	898	9·84999	4
57	651	811	509	141	338	448	138	730	911	986	3
58	665	800	523	130	351	436	151	718	923	974	2
59	680	789	537	119	365	425	164	706	936	961	1
60	694	778	551	107	378	413	177	693	949	949	0
′	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.	Sin.	′
	49°		48°		47°		46°		45°		

TABLE LIII.—Azimuth and Apparent Altitude of Polaris computed with North Polar Distance 1° 17′, and Mean Refraction.

Hour Angle before or after Culmination.	Latitude 0°.				Latitude 2°.			
	Azimuth.	Correction for Increment of 10″ in N.P.D.	Apparent Altitude.	Correction for Increment of 10″ in N.P.D.	Azimuth.	Correction for Increment of 10″ in N.P.D.	Apparent Altitude.	Correction for Increment of 10″ in N.P.D.
h m	° ′ ″	″	° ′ ″	″	° ′ ″	″	° ′ ″	″
0 15	0 5 2	+ 0·65	1 37 24	+ 9·98	0 5 3	+ 0·65	3 29 53	+ 9·98
0 30	0 10 3	1·31	1 36 58	9·91	0 10 4	1·31	3 29 25	9·91
0 45	0 15 1	1·95	1 36 13	9·81	0 15 3	1·96	3 28 37	9·81
1 0	0 19 56	2·59	1 35 13	9·66	0 19 58	2·60	3 27 31	9·66
1 15	0 24 45	3·22	1 33 52	9·47	0 24 47	3·23	3 26 8	9·47
1 30	0 29 28	3·83	1 32 17	9·24	0 29 31	3·84	3 24 25	9·24
1 45	0 34 4	4·42	1 30 24	8·97	0 34 6	4·44	3 22 27	8·97
2 0	0 38 30	5·00	1 28 17	8·66	0 38 33	5·02	3 20 10	8·66
2 15	0 42 47	5·56	1 25 53	8·31	0 42 50	5·58	3 17 38	8·31
2 30	0 46 53	6·09	1 23 12	7·93	0 46 56	6·11	3 14 48	7·93
2 45	0 50 46	6·60	1 20 16	7·52	0 50 50	6·62	3 11 44	7·52
3 0	0 54 27	7·07	1 17 9	7·07	0 54 31	7·09	3 8 27	7·07
3 20	0 58 59	7·66	1 12 38	6·43	0 59 3	7·68	3 3 41	6·42
3 40	1 3 5	8·19	1 7 46	5·73	1 3 9	8·21	2 58 36	5·73
4 0	1 6 41	8·66	1 2 34	5·00	1 6 45	8·68	2 53 15	4·99
4 20	1 9 47	9·06	0 57 7	4·23	1 9 51	9·08	2 47 42	4·22
4 40	1 12 21	9·40	0 51 42	3·42	1 12 25	9·42	2 41 50	3·41
5 0	1 14 23	9·66	0 46 13	2·59	1 14 26	9·68	2 35 51	2·58
5 20	1 15 50	9·85	0 40 42	1·74	1 15 53	9·87	2 29 43	1·73
Elong.	1 17 0	10·00	0 29 25	0·00	1 17 3	10·01	2 17 13	0·01
	h m s	s			h m s	s		
Elong. at	6 0 0	0·00			5 59 49	− 0·02		
					° ′ ″	″		
6 40	...	...	...	...	1 15 52	+ 9·86	2 4 35	− 1·75
7 0	...	...	...	...	1 14 24	9·67	1 58 27	2·60
7 20	...	...	...	...	1 12 23	9·41	1 52 35	3·43
7 40	...	...	...	...	1 9 48	9·07	1 47 2	4·24
8 0	...	...	...	...	1 6 42	8·67	1 41 40	5·01
8 20	...	...	...	...	1 3 5	8·20	1 36 31	5·74
8 40	...	...	...	...	0 59 0	7·67	1 31 42	6·43
9 0	...	...	...	...	0 54 27	7·08	1 27 12	7·07
9 15	...	...	...	...	0 50 47	6·60	1 24 5	7·52
9 30	...	...	...	...	0 46 53	6·09	1 21 13	7·93
9 45	...	...	...	...	0 42 47	5·56	1 18 32	8·31
10 0	...	...	...	...	0 38 30	5·00	1 16 9	8·66
10 15	...	...	...	...	0 34 3	4·42	1 13 57	8·97
10 30	...	...	...	...	0 29 28	3·83	1 12 1	9·24
10 45	...	...	...	...	0 24 45	3·22	1 10 26	9·47
11 0	...	...	...	...	0 19 56	2·59	1 9 6	9·66
11 15	...	...	...	...	0 15 1	1·95	1 8 2	9·81
11 30	...	...	...	...	0 10 3	1·31	1 7 20	9·91
11 45	...	...	...	...	0 5 2	0·65	1 6 50	9·98

TABLE LIII.—Azimuth and Apparent Altitude of Polaris computed with North Polar Distance 1° 17′, and Mean Refraction.

Hour Angle before or after Culmination.	Latitude 4°.				Latitude 6°.			
	Azimuth.	Correction for Increment of 10″ in N.P.D.	Apparent Altitude.	Correction for Increment of 10″ in N.P.D.	Azimuth.	Correction for Increment of 10″ in N.P.D.	Apparent Altitude.	Correction for Increment of 10″ in N.P.D.
h m	° ′ ″	″	° ′ ″	″	° ′ ″	″	° ′ ″	″
0 15	0 5 3	+ 0·66	5 26 2	+ 9·98	0 5 5	+ 0·66	7 23 52	+ 9·98
0 30	0 10 6	1·32	5 25 33	9·91	0 10 8	1·32	7 23 23	9·91
0 45	0 15 5	1·96	5 24 45	9·81	0 15 9	1·97	7 22 34	9·81
1 0	0 20 1	2·61	5 23 38	9·66	0 20 5	2·62	7 21 26	9·66
1 15	0 24 51	3·24	5 22 12	9·47	0 24 57	3·25	7 20 0	9·47
1 30	0 29 35	3·86	5 20 28	9·24	0 29 42	3·87	7 18 14	9·23
1 45	0 34 12	4·45	5 18 26	8·97	0 34 19	4·47	7 16 11	8·96
2 0	0 38 39	5·03	5 16 7	8·66	0 38 48	5·05	7 13 51	8·65
2 15	0 42 57	5·59	5 13 30	8·31	0 43 6	5·61	7 11 13	8·30
2 30	0 47 3	6·13	5 10 39	7·93	0 47 14	6·15	7 8 19	7·92
2 45	0 50 58	6·64	5 7 32	7·51	0 51 9	6·66	7 5 10	7·51
3 0	0 54 39	7·12	5 4 10	7·06	0 54 51	7·14	7 1 46	7·06
3 20	0 59 12	7·71	4 59 20	6·42	0 59 24	7·73	6 56 53	6·41
3 40	1 3 17	8·24	4 54 9	5·72	1 3 31	8·26	6 51 38	5·72
4 0	1 6 54	8·71	4 48 39	4·99	1 7 8	8·73	6 46 3	4·98
4 20	1 10 0	9·11	4 42 52	4·21	1 10 15	9·13	6 40 11	4·21
4 40	1 12 34	9·44	4 36 52	3·40	1 12 49	9·46	6 34 5	3·40
5 0	1 14 35	9·70	4 30 38	2·57	1 14 50	9·72	6 27 47	2·57
5 20	1 16 2	9·89	4 24 17	1·72	1 16 17	9·91	6 21 20	1·72
Elong.	1 17 11	10·03	4 11 26	0·02	1 17 25	10·06	6 8 23	0·02
	h m s	s			h m s	s		
Elong. at	5 59 38	− 0·05			5 59 28	− 0·07		
	° ′ ″	″			° ′ ″	″		
6 40	1 16 0	+ 9·88	3 58 21	− 1·75	1 16 13	+ 9·89	5 55 7	− 1·76
7 0	1 14 32	9·69	3 52 4	2·60	1 14 44	9·70	5 48 41	2·61
7 20	1 12 30	9·42	3 45 56	3·43	1 12 42	9·43	5 42 25	3·44
7 40	1 9 55	9·09	3 40 1	4·24	1 10 6	9·10	5 36 21	4·25
8 0	1 6 48	8·68	3 34 19	5·01	1 6 59	8·69	5 30 32	5·02
8 20	1 3 11	8·21	3 28 54	5·74	1 3 20	8·22	5 25 1	5·75
8 40	0 59 4	7·67	3 23 47	6·44	0 59 13	7·68	5 19 48	6·44
9 0	0 54 31	7·08	3 19 3	7·08	0 54 40	7·09	5 14 59	7·08
9 15	0 50 50	6·61	3 15 47	7·52	0 50 58	6·61	5 11 37	7·53
9 30	0 46 56	6·10	3 12 43	7·94	0 47 3	6·10	5 8 31	7·94
9 45	0 42 50	5·57	3 9 54	8·32	0 42 56	5·57	5 5 39	8·32
10 0	0 38 33	5·01	3 7 20	8·66	0 38 38	5·01	5 3 5	8·67
10 15	0 34 6	4·43	3 5 5	8·97	0 34 11	4·43	5 0 45	8·98
10 30	0 29 30	3·83	3 3 5	9·24	0 29 34	3·83	4 58 45	9·24
10 45	0 24 47	3·22	3 1 24	9·47	0 24 50	3·22	4 57 1	9·47
11 0	0 19 57	2·59	2 59 59	9·66	0 20 0	2·59	4 55 37	9·66
11 15	0 15 2	1·95	2 58 54	9·81	0 15 4	1·95	4 54 31	9·81
11 30	0 10 4	1·31	2 58 6	9·91	0 10 5	1·31	4 53 42	9·92
11 45	0 5 2	0·65	2 57 40	9·98	0 5 3	0·65	4 53 14	9·98

TABLE LIII.—Azimuth and Apparent Altitude of Polaris computed with North Polar Distance 1° 17′, and Mean Refraction.

Hour Angle before or after Culmination.	Latitude 8°.				Latitude 10°.			
	Azimuth.	Correction for Increment of 10″ in N.P.D.	Apparent Altitude.	Correction for Increment of 10″ in N.P.D.	Azimuth.	Correction for Increment of 10″ in N.P.D.	Apparent Altitude.	Correction for Increment of 10″ in N.P.D.
h m	° ′ ″	″	° ′ ″	″	° ′ ″	″	° ′ ″	″
0 15	0 5 6	+ 0·67	9 22 29	+ 9·98	0 5 8	+ 0·67	11 21 32	+ 9·98
0 30	0 10 11	1·33	9 22 0	9·91	0 10 15	1·34	11 21 3	9·91
0 45	0 15 13	1·98	9 21 11	9·81	0 15 19	2·00	11 20 14	9·81
1 0	0 20 11	2·64	9 20 3	9·66	0 20 19	2·65	11 19 5	9·66
1 15	0 25 4	3·27	9 18 36	9·47	0 25 14	3·30	11 17 38	9·47
1 30	0 29 51	3·90	9 16 49	9·23	0 30 2	3·92	11 15 52	9·23
1 45	0 34 30	4·50	9 14 46	8·96	0 34 43	4·53	11 13 47	8·96
2 0	0 38 59	5·09	9 12 24	8·65	0 39 14	5·12	11 11 25	8·65
2 15	0 43 19	5·65	9 9 46	8·30	0 43 35	5·69	11 8 46	8·30
2 30	0 47 28	6·19	9 6 50	7·92	0 47 45	6·23	11 5 51	7·92
2 45	0 51 24	6·70	9 3 40	7·50	0 51 43	6·75	11 2 39	7·50
3 0	0 55 7	7·19	9 0 15	7·05	0 55 27	7·23	10 59 14	7·05
3 20	0 59 41	7·78	8 55 20	6·41	1 0 3	7·83	10 54 18	6·40
3 40	1 3 49	8·31	8 50 4	5·71	1 4 12	8·37	10 49 0	5·71
4 0	1 7 27	8·79	8 44 26	4·98	1 7 51	8·84	10 43 22	4·97
4 20	1 10 34	9·19	8 38 32	4·20	1 10 59	9·24	10 37 26	4·19
4 40	1 13 9	9·52	8 32 24	3·39	1 13 34	9·58	10 31 16	3·38
5 0	1 15 10	9·78	8 26 4	2·56	1 15 36	9·84	10 24 54	2·55
5 20	1 16 37	9·97	8 19 34	1·71	1 17 3	10·02	10 18 23	1·70
Elong.	1 17 45	10·10	8 6 35	0·03	1 18 11	10·16	10 5 25	0·04
	h m s	s			h m s	s		
Elong. at	5 59 17	− 0·09			5 59 6	− 0·12		
	° ′ ″	″			° ′ ″	″		
6 40	1 16 32	+ 9·94	7 53 9	− 1·76	1 16 57	+ 10·00	9 51 52	− 1·77
7 0	1 15 3	9·75	7 46 41	2·61	1 15 27	9·80	9 45 23	2·62
7 20	1 12 59	9·48	7 40 22	3·44	1 13 22	9·53	9 39 2	3·45
7 40	1 10 23	9·14	7 34 16	4·25	1 10 45	9·19	9 32 54	4·26
8 0	1 7 14	8·73	7 28 23	5·02	1 7 35	8·77	9 27 0	5·03
8 20	1 3 35	8·26	7 22 48	5·75	1 3 54	8·29	9 21 24	5·76
8 40	0 59 27	7·72	7 17 34	6·45	0 59 45	7·75	9 16 8	6·45
9 0	0 54 52	7·12	7 12 42	7·09	0 55 8	7·15	9 11 15	7·09
9 15	0 51 9	6·64	7 9 18	7·53	0 51 24	6·66	9 7 51	7·53
9 30	0 47 13	6·13	7 6 10	7·95	0 47 27	6·15	9 4 41	7·95
9 45	0 43 5	5·59	7 3 17	8·33	0 43 18	5·62	9 1 47	8·33
10 0	0 38 47	5·03	7 0 40	8·67	0 38 58	5·05	8 59 10	8·67
10 15	0 34 18	4·45	6 58 20	8·98	0 34 28	4·47	8 56 50	8·98
10 30	0 29 40	3·85	6 56 18	9·24	0 29 49	3·86	8 54 46	9·24
10 45	0 24 55	3·23	6 54 33	9·47	0 25 3	3·25	8 53 1	9·47
11 0	0 20 4	2·60	6 53 7	9·66	0 20 10	2·61	8 51 35	9·66
11 15	0 15 8	1·96	6 52 0	9·81	0 15 12	1·97	8 50 26	9·81
11 30	0 10 7	1·31	6 51 11	9·92	0 10 10	1·32	8 49 38	9·92
11 45	0 5 4	0·65	6 50 43	9·98	0 5 6	0·66	8 49 9	9·98

TABLE LIII.—Azimuth and Apparent Altitude of Polaris computed with North Polar Distance 1° 17′, and Mean Refraction.

Hour Angle before or after Culmination.	Latitude 12°.				Latitude 14°.			
	Azimuth.	Correction for Increment of 10″ in N.P.D.	Apparent Altitude.	Correction for Increment of 10″ in N.P.D.	Azimuth.	Correction for Increment of 10″ in N.P.D.	Apparent Altitude.	Correction for Increment of 10″ in N.P.D.
h m	° ′ ″	″	° ′ ″	″	° ′ ″	″	° ′ ″	″
0 15	0 5 10	+ 0·68	13 20 51	+ 9·98	0 5 13	+ 0·69	15 20 19	+ 9·98
0 30	0 10 20	1·35	13 20 21	9·91	0 10 25	1·36	15 19 49	9·91
0 45	0 15 26	2·01	13 19 32	9·81	0 15 34	2·03	15 19 1	9·81
1 0	0 20 28	2·67	13 18 24	9·66	0 20 39	2·70	15 17 52	9·66
1 15	0 25 25	3·32	13 16 56	9·47	0 25 39	3·36	15 16 23	9·47
1 30	0 30 16	3·95	13 15 10	9·23	0 30 32	3·99	15 14 37	9·23
1 45	0 34 58	4·56	13 13 4	8·96	0 35 17	4·61	15 12 32	8·96
2 0	0 39 32	5·16	13 10 42	8·65	0 39 53	5·22	15 10 10	8·65
2 15	0 43 55	5·73	13 8 3	8·30	0 44 18	5·79	15 7 29	8·30
2 30	0 48 7	6·27	13 5 7	7·92	0 48 32	6·34	15 4 33	7·91
2 45	0 52 6	6·79	13 1 56	7·50	0 52 33	6·86	15 1 22	7·49
3 0	0 55 51	7·28	12 58 29	7·05	0 56 20	7·36	14 57 55	7·04
3 20	1 0 30	7·88	12 53 32	6·40	1 1 1	7·96	14 52 58	6·39
3 40	1 4 40	8·42	12 48 13	5·70	1 5 13	8·51	14 47 38	5·70
4 0	1 8 20	8·90	12 42 35	4·96	1 8 55	8·99	14 41 59	4·96
4 20	1 11 29	9·30	12 36 38	4·18	1 12 6	9·40	14 36 2	4·18
4 40	1 14 6	9·64	12 30 27	3·37	1 14 43	9·74	14 29 51	3·37
5 0	1 16 8	9·90	12 24 4	2·54	1 16 46	10·00	14 23 27	2·53
5 20	1 17 35	10·08	12 17 32	1·69	1 18 14	10·18	14 16 55	1·68
Elong.	1 18 43	10·23	12 4 37	0·05	1 19 21	10·31	14 4 1	0·06
	h m s	s			h m s	s		
Elong. at	5 58 55	− 0·14			5 58 43	− 0·17		
	° ′ ″	″			° ′ ″	″		
6 40	1 17 28	+ 10·05	11 50 58	− 1·78	1 18 5	+ 10·14	13 50 17	− 1·79
7 0	1 15 57	9·85	11 44 27	2·63	1 16 33	9·94	13 43 46	2·64
7 20	1 13 51	9·58	11 38 6	3·46	1 14 26	9·66	13 37 25	3·47
7 40	1 11 12	9·23	11 31 57	4·27	1 11 45	9·31	13 31 15	4·27
8 0	1 8 1	8·81	11 26 2	5·04	1 8 32	8·89	13 25 20	5·04
8 20	1 4 19	8·33	11 20 26	5·77	1 4 48	8·40	13 19 43	5·77
8 40	1 0 7	7·79	11 15 9	6·45	1 0 35	7·85	13 14 26	6·46
9 0	0 55 29	7·18	11 10 15	7·09	0 55 54	7·24	13 9 31	7·10
9 15	0 51 43	6·69	11 6 50	7·53	0 52 7	6·75	13 6 6	7·54
9 30	0 47 45	6·18	11 3 41	7·95	0 48 6	6·23	13 2 56	7·95
9 45	0 43 34	5·64	11 0 46	8·33	0 43 53	5·68	13 0 2	8·33
10 0	0 39 12	5·07	10 58 8	8·67	0 39 30	5·11	12 57 24	8·67
10 15	0 34 40	4·49	10 55 47	8·98	0 34 56	4·52	12 55 3	8·98
10 30	0 30 0	3·88	10 53 44	9·24	0 30 13	3·91	12 52 59	9·24
10 45	0 25 12	3·26	10 51 59	9·47	0 25 23	3·29	12 51 14	9·47
11 0	0 20 17	2·62	10 50 32	9·66	0 20 26	2·64	12 49 48	9·66
11 15	0 15 17	1·98	10 49 24	9·81	0 15 24	1·99	12 48 39	9·81
11 30	0 10 14	1·32	10 48 35	9·92	0 10 18	1·33	12 47 50	9·92
11 45	0 5 8	0·66	10 48 6	9·98	0 5 10	0·67	12 47 21	9·98

TABLE LIII.—Azimuth and Apparent Altitude of Polaris computed with North Polar Distance 1° 17′, and Mean Refraction.

Hour Angle before or after Culmination.	Latitude 16°.				Latitude 18°.			
	Azimuth.	Correction for Increment of 10″ in N.P.D.	Apparent Altitude.	Correction for Increment of 10″ in N.P.D.	Azimuth.	Correction for Increment of 10″ in N.P.D.	Apparent Altitude.	Correction for Increment of 10″ in N.P.D.
h m	° ′ ″	″	° ′ ″	″	° ′ ″	″	° ′ ″	″
0 15	0 5 16	+ 0·69	17 19 55	+ 9·98	0 5 20	+ 0·70	19 19 35	+ 9·98
0 30	0 10 31	1·38	17 19 25	9·91	0 10 39	1·39	19 19 5	9·91
0 45	0 15 44	2·06	17 18 36	9·80	0 15 55	2·08	19 18 16	9·80
1 0	0 20 52	2·73	17 17 27	9·65	0 21 6	2·76	19 17 6	9·65
1 15	0 25 55	3·39	17 15 58	9·46	0 26 13	3·43	19 15 38	9·46
1 30	0 30 50	4·04	17 14 12	9·23	0 31 12	4·08	19 13 52	9·23
1 45	0 35 38	4·66	17 12 7	8·95	0 36 3	4·71	19 11 46	8·95
2 0	0 40 17	5·27	17 9 43	8·64	0 40 45	5·33	19 9 23	8·64
2 15	0 44 45	5·86	17 7 4	8·29	0 45 16	5·92	19 6 43	8·29
2 30	0 49 1	6·41	17 4 8	7·91	0 49 35	6·48	19 3 46	7·90
2 45	0 53 5	6·94	17 0 55	7·49	0 53 41	7·01	19 0 34	7·48
3 0	0 56 54	7·43	16 57 28	7·04	0 57 33	7·51	18 57 6	7·03
3 20	1 1 37	8·05	16 52 31	6·39	1 2 19	8·13	18 52 9	6·38
3 40	1 5 52	8·60	16 47 11	5·69	1 6 36	8·69	18 46 48	5·69
4 0	1 9 36	9·08	16 41 31	4·95	1 10 22	9·17	18 41 8	4·95
4 20	1 12 48	9·49	16 35 33	4·17	1 13 36	9·59	18 35 10	4·17
4 40	1 15 26	9·83	16 29 21	3·36	1 16 16	9·93	18 28 58	3·36
5 0	1 17 30	10·09	16 22 58	2·53	1 18 21	10·19	18 22 34	2·52
5 20	1 18 58	10·28	16 16 25	1·68	1 19 50	10·38	18 16 1	1·67
Elong.	1 20 6	10·41	16 3 35	0·06	1 20 58	10·52	18 3 14	0·07
	h m s	s			h m s	s		
Elong. at	5 58 32	− 0·19			5 58 20	− 0·22		
	° ′ ″	″			° ′ ″	″		
6 40	1 18 48	+ 10·24	15 49 46	− 1·79	1 19 38	+ 10·33	17 49 21	− 1·80
7 0	1 17 15	10·03	15 43 14	2·64	1 18 3	10·12	17 42 49	2·65
7 20	1 15 6	9·75	15 36 53	3·47	1 15 53	9·83	17 36 27	3·48
7 40	1 12 24	9·39	15 30 42	4·28	1 13 9	9·47	17 30 17	4·28
8 0	1 9 9	8·96	15 24 47	5·05	1 9 52	9·04	17 24 22	5·05
8 20	1 5 23	8·47	15 19 10	5·78	1 6 3	8·54	17 18 44	5·78
8 40	1 1 7	7·92	15 13 53	6·46	1 1 44	7·98	17 13 27	6·47
9 0	0 56 23	7·30	15 8 58	7·10	0 56 58	7·36	17 8 32	7·11
9 15	0 52 34	6·80	15 5 33	7·54	0 53 6	6·86	17 5 6	7·55
9 30	0 48 31	6·28	15 2 23	7·96	0 49 1	6·33	17 1 57	7·96
9 45	0 44 16	5·73	14 59 28	8·34	0 44 43	5·77	16 59 1	8·34
10 0	0 39 50	5·15	14 56 50	8·68	0 40 14	5·19	16 56 24	8·68
10 15	0 35 14	4·56	14 54 29	8·98	0 35 35	4·59	16 54 2	8·98
10 30	0 30 29	3·94	14 52 26	9·25	0 30 47	3·97	16 51 59	9·25
10 45	0 25 36	3·31	14 50 40	9·48	0 25 51	3·34	16 50 13	9·48
11 0	0 20 36	2·66	14 49 13	9·66	0 20 49	2·68	16 48 47	9·66
11 15	0 15 32	2·01	14 48 5	9·81	0 15 41	2·02	16 47 39	9·81
11 30	0 10 23	1·34	14 47 16	9·92	0 10 30	1·35	16 46 50	9·92
11 45	0 5 12	0·67	14 46 47	9·98	0 5 15	0·68	16 46 21	9·98

TABLE LIII.—Azimuth and Apparent Altitude of Polaris computed with North Polar Distance 1° 17′, and Mean Refraction.

Hour Angle before or after Culmination.	Latitude 20°. Azimuth.	Correction for Increment of 10″ in N.P.D.	Apparent Altitude.	Correction for Increment of 10″ in N.P.D.	Latitude 22°. Azimuth.	Correction for Increment of 10″ in N.P.D.	Apparent Altitude.	Correction for Increment of 10″ in N.P.D.
h m	° ′ ″	″	° ′ ″	″	° ′ ″	″	° ′ ″	″
0 15	0 5 24	+ 0·71	21 19 18	+ 9·98	0 5 29	+ 0·72	23 19 4	+ 9·98
0 30	0 10 47	1·41	21 18 48	9·91	0 10 56	1·44	23 18 35	9·91
0 45	0 16 7	2·11	21 17 58	9·80	0 16 21	2·15	23 17 45	9·80
1 0	0 21 23	2·80	21 16 50	9·65	0 21 41	2·85	23 16 36	9·65
1 15	0 26 33	3·48	21 15 22	9·46	0 26 56	3·54	23 15 8	9·46
1 30	0 31 36	4·14	21 13 34	9·23	0 32 3	4·21	23 13 20	9·23
1 45	0 36 31	4·78	21 11 29	8·95	0 37 2	4·86	23 11 14	8·95
2 0	0 41 16	5·41	21 9 6	8·64	0 41 51	5·49	23 8 52	8·64
2 15	0 45 50	6·01	21 6 25	8·29	0 46 30	6·10	23 6 11	8·29
2 30	0 50 13	6·58	21 3 28	7·90	0 50 56	6·67	23 3 13	7·90
2 45	0 54 22	7·12	21 0 16	7·48	0 55 8	7·22	23 0 0	7·48
3 0	0 58 17	7·62	20 56 48	7·03	0 59 6	7·74	22 56 33	7·02
3 20	1 3 6	8·25	20 51 50	6·38	1 4 0	8·38	22 51 34	6·37
3 40	1 7 26	8·82	20 46 29	5·68	1 8 23	8·94	22 46 14	5·67
4 0	1 11 15	9·31	20 40 49	4·94	1 12 15	9·44	22 40 33	4·93
4 20	1 14 31	9·73	20 34 51	4·16	1 15 33	9·86	22 34 34	4·15
4 40	1 17 13	10·07	20 28 38	3·35	1 18 17	10·22	22 28 21	3·34
5 0	1 19 19	10·34	20 22 14	2·51	1 20 24	10·48	22 21 57	2·50
5 20	1 20 49	10·53	20 15 41	1·66	1 21 55	10·67	22 15 23	1·65
Elong.	1 21 57	10·65	20 2 57	0·08	1 23 3	10·79	22 2 44	0·09
	h m s	s			h m s	s		
Elong. at	5 58 8	− 0·24			5 57 56	− 0·27		
	° ′ ″	″			° ′ ″	″		
6 40	1 20 35	+ 10·47	19 49 0	− 1·81	1 21 39	+ 10·60	21 48 43	− 1·82
7 0	1 18 59	10·25	19 42 28	2·66	1 20 2	10·39	21 42 10	2·67
7 20	1 16 47	9·96	19 36 5	3·49	1 17 48	10·09	21 35 48	3·50
7 40	1 14 1	9·59	19 29 55	4·29	1 14 59	9·72	21 29 37	4·30
8 0	1 10 41	9·16	19 24 0	5·06	1 11 36	9·27	21 23 43	5·07
8 20	1 6 49	8·65	19 18 23	5·79	1 7 41	8·76	21 18 4	5·80
8 40	1 2 27	8·08	19 13 5	6·47	1 3 15	8·18	21 12 47	6·48
9 0	0 57 37	7·45	19 8 10	7·11	0 58 21	7·54	21 7 53	7·11
9 15	0 53 42	6·94	19 4 45	7·55	0 54 23	7·03	21 4 28	7·55
9 30	0 49 34	6·41	19 1 35	7·96	0 50 12	6·48	21 1 18	7·96
9 45	0 45 13	5·84	18 58 41	8·34	0 45 48	5·91	20 58 23	8·34
10 0	0 40 41	5·25	18 56 2	8·68	0 41 12	5·32	20 55 45	8·68
10 15	0 35 59	4·65	18 53 42	8·98	0 36 26	4·70	20 53 24	8·98
10 30	0 31 8	4·02	18 51 38	9·25	0 31 31	4·06	20 51 21	9·25
10 45	0 26 8	3·38	18 49 52	9·48	0 26 28	3·41	20 49 35	9·48
11 0	0 21 3	2·71	18 48 25	9·66	0 21 19	2·75	20 48 8	9·66
11 15	0 15 52	2·05	18 47 18	9·81	0 16 4	2·07	20 47 0	9·81
11 30	0 10 37	1·37	18 46 29	9·92	0 10 45	1·38	20 46 11	9·92
11 45	0 5 19	0·69	18 46 0	9·98	0 5 23	0·69	20 45 43	9·98

TABLE LIII.—Azimuth and Apparent Altitude of Polaris computed with North Polar Distance 1° 17′, and Mean Refraction.

Hour Angle before or after Culmination.	Latitude 24°.				Latitude 26°.			
	Azimuth.	Correction for Increment of 10″ in N.P.D.	Apparent Altitude.	Correction for Increment of 10″ in N.P.D.	Azimuth.	Correction for Increment of 10″ in N.P.D.	Apparent Altitude.	Correction for Increment of 10″ in N.P.D.
h m	° ′ ″	″	° ′ ″	″	° ′ ″	″	° ′ ″	″
0 15	0 5 34	+ 0·73	25 18 53	+ 9·98	0 5 40	+ 0·75	27 18 42	+ 9·98
0 30	0 11 7	1·46	25 18 23	9·91	0 11 18	1·49	27 18 12	9·91
0 45	0 16 37	2·18	25 17 33	9·80	0 16 54	2·22	27 17 23	9·80
1 0	0 22 2	2·89	25 16 24	9·65	0 22 25	2·95	27 16 14	9·65
1 15	0 27 21	3·59	25 14 55	9·46	0 27 50	3·66	27 14 45	9·46
1 30	0 32 34	4·27	25 13 8	9·23	0 33 7	4·36	27 12 58	9·22
1 45	0 37 37	4·93	25 11 2	8·95	0 38 16	5·03	27 10 52	8·94
2 0	0 42 31	5·57	25 8 39	8·64	0 43 15	5·68	27 8 28	8·63
2 15	0 47 13	6·19	25 5 58	8·28	0 48 2	6·31	27 5 46	8·28
2 30	0 51 43	6·77	25 3 1	7·89	0 52 37	6·91	27 2 50	7·89
2 45	0 56 0	7·33	24 59 47	7·47	0 56 58	7·48	26 59 36	7·47
3 0	1 0 2	7·85	24 56 20	7·02	1 1 3	8·01	26 56 8	7·01
3 20	1 4 59	8·50	24 51 21	6·37	1 6 6	8·67	26 51 10	6·36
3 40	1 9 27	9·07	24 46 0	5·67	1 10 37	9·25	26 45 48	5·66
4 0	1 13 22	9·58	24 40 18	4·92	1 14 36	9·76	26 40 6	4·92
4 20	1 16 43	10·00	24 34 20	4·14	1 18 0	10·19	26 34 8	4·14
4 40	1 19 28	10·36	24 28 7	3·33	1 20 48	10·56	26 27 55	3·32
5 0	1 21 37	10·63	24 21 42	2·49	1 22 59	10·83	26 21 29	2·49
5 20	1 23 9	10·82	24 15 9	1·64	1 24 32	11·02	26 14 56	1·63
Elong.	1 24 17	10·95	24 2 33	0·10	1 25 40	11·13	26 2 24	0·11
	h m s	s			h m s	s		
Elong. at	5 57 43	− 0·30			5 57 30	− 0·33		
	° ′ ″	″			° ′ ″	″		
6 40	1 22 52	+ 10·74	23 48 26	− 1·83	1 24 12	+ 10·93	25 48 13	− 1·84
7 0	1 21 12	10·52	23 41 55	2·68	1 22 31	10·71	25 41 42	2·69
7 20	1 18 56	10·22	23 35 33	3·51	1 20 12	10·40	25 35 19	3·51
7 40	1 16 4	9·84	23 29 22	4·31	1 17 17	10·01	25 29 9	4·31
8 0	1 12 38	9·39	23 23 27	5·08	1 13 47	9·55	25 23 13	5·08
8 20	1 8 39	8·87	23 17 50	5·80	1 9 45	9·02	25 17 36	5·81
8 40	1 4 10	8·28	23 12 32	6·48	1 5 10	8·42	25 12 19	6·49
9 0	0 59 11	7·63	23 7 38	7·12	1 0 7	7·76	25 7 25	7·12
9 15	0 55 10	7·11	23 4 13	7·56	0 56 2	7·23	25 4 0	7·56
9 30	0 50 55	6·56	23 1 2	7·97	0 51 43	6·67	25 0 50	7·97
9 45	0 46 27	5·98	22 58 9	8·34	0 47 10	6·08	24 57 56	8·35
10 0	0 41 47	5·38	22 55 30	8·68	0 42 26	5·47	24 55 18	8·69
10 15	0 36 57	4·76	22 53 9	8·98	0 37 32	4·84	24 52 57	8·99
10 30	0 31 58	4·11	22 51 5	9·25	0 32 28	4·18	24 50 53	9·26
10 45	0 26 51	3·45	22 49 21	9·48	0 27 16	3·51	24 49 8	9·48
11 0	0 21 37	2·78	22 47 54	9·66	0 21 57	2·83	24 47 42	9·67
11 15	0 16 17	2·10	22 46 46	9·81	0 16 32	2·13	24 46 34	9·81
11 30	0 10 54	1·40	22 45 57	9·92	0 11 4	1·42	24 45 45	9·92
11 45	0 5 28	0·70	22 45 28	9·98	0 5 33	0·71	24 45 16	9·98

TABLE LIII.—Azimuth and Apparent Altitude of Polaris computed with North Polar Distance 1° 17′, and Mean Refraction.

Hour Angle before or after Culmination.	Latitude 28°.				Latitude 30°.			
	Azimuth.	Correction for Increment of 10″ in N.P.D.	Apparent Altitude.	Correction for Increment of 10″ in N.P.D.	Azimuth.	Correction for Increment of 10″ in N.P.D.	Apparent Altitude.	Correction for Increment of 10″ in N.P.D.
h m	° ′ ″	″	° ′ ″	″	° ′ ″	″	° ′ ″	″
0 15	0 5 46	+ 0·76	29 18 34	+ 9·98	0 5 54	+ 0·78	31 18 26	+ 9·98
0 30	0 11 31	1·52	29 18 4	9·91	0 11 45	1·55	31 17 56	9·91
0 45	0 17 13	2·27	29 17 14	9·80	0 17 34	2·31	31 17 6	9·80
1 0	0 22 50	3·01	29 16 5	9·65	0 23 18	3·07	31 15 57	9·65
1 15	0 28 21	3·74	29 14 36	9·46	0 28 56	3·81	31 14 28	9·46
1 30	0 33 45	4·44	29 12 48	9·22	0 34 26	4·53	31 12 40	9·22
1 45	0 39 0	5·13	29 10 42	8·94	0 39 47	5·23	31 10 34	8·94
2 0	0 44 4	5·80	29 8 18	8·63	0 44 58	5·91	31 8 9	8·63
2 15	0 48 56	6·44	29 5 37	8·27	0 49 56	6·56	31 5 28	8·27
2 30	0 53 36	7·04	29 2 40	7·88	0 54 42	7·18	31 2 31	7·88
2 45	0 58 1	7·62	28 59 26	7·46	0 59 12	7·77	30 59 17	7·46
3 0	1 2 12	8·16	28 55 58	7·01	1 3 27	8·32	30 55 49	7·00
3 20	1 7 19	8·83	28 50 58	6·36	1 8 41	9·00	30 50 49	6·35
3 40	1 11 56	9·42	28 45 37	5·66	1 13 23	9·60	30 45 28	5·65
4 0	1 15 59	9·95	28 39 55	4·91	1 17 30	10·13	30 39 45	4·90
4 20	1 19 26	10·39	28 33 57	4·13	1 21 1	10·58	30 33 46	4·12
4 40	1 22 17	10·75	28 27 43	3·31	1 23 55	10·95	30 27 33	3·30
5 0	1 24 30	11·03	28 21 18	2·48	1 26 10	11·23	30 21 7	2·47
5 20	1 26 3	11·22	28 14 43	1·62	1 27 45	11·42	30 14 33	1·61
Elong.	1 27 13	11·33	28 2 16	0·12	1 28 55	11·55	30 2 10	0·13
	h m s	s			h m s	s		
Elong. at	5 57 16	− 0·35			5 57 2	− 0·39		
	° ′ ″	″			° ′ ″	″		
6 40	1 25 42	+ 11·13	27 48 1	− 1·85	1 27 22	+ 11·32	29 47 50	− 1·86
7 0	1 23 58	10·89	27 41 30	2·70	1 25 36	11·08	29 41 19	2·71
7 20	1 21 37	10·57	27 35 7	3·52	1 23 11	10·75	29 34 56	3·53
7 40	1 18 38	10·18	27 28 57	4·32	1 20 9	10·35	29 28 46	4·33
8 0	1 15 5	9·71	27 23 2	5·09	1 16 30	9·87	29 22 51	5·10
8 20	1 10 57	9·17	27 17 25	5·81	1 12 18	9·32	29 17 14	5·82
8 40	1 6 18	8·56	27 12 7	6·49	1 7 33	8·70	29 11 57	6·50
9 0	1 1 9	7·89	27 7 13	7·13	1 2 18	8·02	29 7 2	7·13
9 15	0 57 0	7·35	27 3 49	7·57	0 58 4	7·47	29 3 39	7·57
9 30	0 52 36	6·78	27 0 39	7·98	0 53 35	6·89	29 0 29	7·98
9 45	0 47 59	6·18	26 57 44	8·35	0 48 53	6·28	28 57 35	8·35
10 0	0 43 10	5·56	26 55 6	8·69	0 43 58	5·65	28 54 57	8·69
10 15	0 38 10	4·91	26 52 45	8·99	0 38 53	4·99	28 52 36	8·99
10 30	0 33 1	4·25	26 50 43	9·26	0 33 38	4·32	28 50 32	9·26
10 45	0 27 43	3·56	26 48 57	9·48	0 28 14	3·62	28 48 48	9·48
11 0	0 22 19	2·87	26 47 31	9·67	0 22 44	2·92	28 47 21	9·67
11 15	0 16 49	2·17	26 46 23	9·81	0 17 8	2·20	28 46 14	9·81
11 30	0 11 15	1·45	26 45 34	9·92	0 11 28	1·47	28 45 25	9·92
11 45	0 5 38	0·73	26 45 5	9·98	0 5 45	0·74	28 44 56	9·98

TABLE LIII.—Azimuth and Apparent Altitude of Polaris computed with North Polar Distance 1° 17′, and Mean Refraction.

Hour Angle before or after Culmination.	Latitude 32°.				Latitude 34°.			
	Azimuth.	Correction for Increment of 10″ in N.P.D.	Apparent Altitude.	Correction for Increment of 10″ in N.P.D.	Azimuth.	Correction for Increment of 10″ in N.P.D.	Apparent Altitude.	Correction for Increment of 10″ in N.P.D.
h m	° ′ ″	″	° ′ ″	″	° ′ ″	″	° ′ ″	″
0 15	0 6 1	+ 0·80	33 18 18	+ 9·98	0 6 10	+ 0·82	35 18 12	+ 9·98
0 30	0 12 1	1·59	33 17 49	9·91	0 12 19	1·63	35 17 42	9·91
0 45	0 17 58	2·37	33 16 59	9·80	0 18 24	2·43	35 16 52	9·80
1 0	0 23 50	3·15	33 15 49	9·65	0 24 24	3·22	35 15 42	9·65
1 15	0 29 35	3·91	33 14 20	9·46	0 30 18	4·00	35 14 13	9·46
1 30	0 35 12	4·65	33 12 33	9·22	0 36 3	4·76	35 12 25	9·22
1 45	0 40 40	5·36	33 10 26	8·94	0 41 39	5·50	35 10 20	8·94
2 0	0 45 58	6·06	33 8 2	8·63	0 47 4	6·21	35 7 55	8·62
2 15	0 51 3	6·73	33 5 20	8·27	0 52 16	6·89	35 5 13	8·26
2 30	0 55 54	7·36	33 2 22	7·88	0 57 14	7·54	35 2 15	7·87
2 45	1 0 30	7·96	32 59 9	7·45	1 1 57	8·16	34 59 1	7·45
3 0	1 4 51	8·53	32 55 40	6·99	1 6 23	8·74	34 55 32	6·99
3 20	1 10 11	9·22	32 50 40	6·34	1 11 51	9·45	34 50 33	6·33
3 40	1 14 59	9·84	32 45 18	5·64	1 16 45	10·08	34 45 10	5·63
4 0	1 19 11	10·38	32 39 36	4·89	1 21 3	10·63	34 39 27	4·88
4 20	1 22 47	10·84	32 33 37	4·11	1 24 43	11·10	34 33 27	4·10
4 40	1 25 44	11·21	32 27 22	3·29	1 27 44	11·48	34 27 14	3·28
5 0	1 28 1	11·50	32 20 57	2·46	1 30 4	11·77	34 20 48	2·45
5 20	1 29 38	11·69	32 14 23	1·60	1 31 42	11·97	34 14 13	1·59
Elong.	1 30 48	11·80	32 2 4	0·14	1 32 53	12·07	34 2 1	0·15
	h m s	s			h m s	s		
Elong. at	5 56 48	− 0·42			5 56 32	− 0·45		
	° ′ ″	″			° ′ ″	″		
6 40	1 29 12	+ 11·58	31 47 41	− 1·87	1 31 13	+ 11·84	33 47 31	− 1·88
7 0	1 27 23	11·33	31 41 8	2·72	1 29 22	11·59	33 40 59	2·73
7 20	1 24 55	11·00	31 34 47	3·54	1 26 49	11·24	33 34 37	3·55
7 40	1 21 48	10·58	31 28 36	4·34	1 23 38	10·82	33 28 27	4·35
8 0	1 18 5	10·09	31 22 41	5·11	1 19 50	10·31	33 22 32	5·12
8 20	1 13 47	9·53	31 17 5	5·83	1 15 26	9·73	33 16 56	5·84
8 40	1 8 56	8·89	31 11 48	6·51	1 10 28	9·08	33 11 39	6·52
9 0	1 3 35	8·19	31 6 53	7·14	1 4 59	8·37	33 6 45	7·14
9 15	0 59 15	7·63	31 3 29	7·58	1 0 33	7·80	33 3 21	7·58
9 30	0 54 40	7·04	31 0 20	7·98	0 55 53	7·19	33 0 11	7·99
9 45	0 49 52	6·42	30 57 26	8·35	0 50 58	6·55	32 57 18	8·36
10 0	0 44 52	5·77	30 54 48	8·69	0 45 51	5·89	32 54 40	8·70
10 15	0 39 40	5·10	30 52 27	8·99	0 40 32	5·20	32 52 20	8·99
10 30	0 34 18	4·41	30 50 24	9·26	0 35 4	4·50	32 50 17	9·26
10 45	0 28 48	3·70	30 48 39	9·48	0 29 26	3·78	32 48 32	9·48
11 0	0 23 11	2·98	30 47 13	9·67	0 23 42	3·04	32 47 5	9·67
11 15	0 17 29	2·25	30 46 6	9·81	0 17 51	2·29	32 45 57	9·81
11 30	0 11 41	1·50	30 45 17	9·92	0 11 57	1·53	32 45 9	9·92
11 45	0 5 51	0·75	30 44 48	9·98	0 5 59	0·77	32 44 40	9·98

TABLE LIII.—Azimuth and Apparent Altitude of Polaris computed with North Polar Distance 1° 17′, and Mean Refraction.

Hour Angle before or after Culmination.	Latitude 36°.				Latitude 38°.			
	Azimuth.	Correction for Increment of 10″ in N.P.D.	Apparent Altitude.	Correction for Increment of 10″ in N.P.D.	Azimuth.	Correction for Increment of 10″ in N.P.D.	Apparent Altitude.	Correction for Increment of 10″ in N.P.D.
h m	° ′ ″	″	° ′ ″	″	° ′ ″	″	° ′ ″	″
0 15	0 6 20	+ 0·84	37 18 6	+ 9·98	0 6 30	+ 0·87	39 18 1	+ 9·98
0 30	0 12 38	1·67	37 17 36	9·91	0 12 59	1·72	39 17 31	9·91
0 45	0 18 52	2·49	37 16 46	9·80	0 19 24	2·57	39 16 41	9·80
1 0	0 25 2	3·30	37 15 36	9·65	0 25 44	3·41	39 15 31	9·65
1 15	0 31 5	4·10	37 14 8	9·45	0 31 57	4·23	39 14 1	9·45
1 30	0 36 59	4·88	37 12 20	9·21	0 38 1	5·03	39 12 13	9·21
1 45	0 42 43	5·63	37 10 13	8·93	0 43 55	5·81	39 10 6	8·93
2 0	0 48 16	6·36	37 7 48	8·62	0 49 37	6·56	39 7 43	8·61
2 15	0 53 36	7·06	37 5 7	8·26	0 55 6	7·28	39 5 1	8·25
2 30	0 58 42	7·72	37 2 8	7·87	1 0 20	7·96	39 2 2	7·86
2 45	1 3 32	8·35	36 58 54	7·44	1 5 17	8·61	38 58 48	7·44
3 0	1 8 5	8·95	36 55 25	6·98	1 9 58	9·22	38 55 18	6·98
3 20	1 13 41	9·67	36 50 25	6·33	1 15 42	9·96	38 50 17	6·32
3 40	1 18 42	10·32	36 45 2	5·63	1 20 51	10·63	38 44 55	5·62
4 0	1 23 6	10·88	36 39 19	4·88	1 25 22	11·20	38 39 12	4·87
4 20	1 26 51	11·36	36 33 19	4·09	1 29 13	11·69	38 33 12	4·08
4 40	1 29 56	11·74	36 27 6	3·27	1 32 22	12·08	38 26 57	3·26
5 0	1 32 19	12·04	36 20 39	2·43	1 34 48	12·39	38 20 32	2·42
5 20	1 33 59	12·24	36 14 5	1·57	1 36 31	12·59	38 13 57	1·56
Elong.	1 35 11	12·37	36 1 58	0·16	1 37 43	12·70	38 1 54	0·18
	h m s	s			h m s	s		
Elong. at	5 56 16	− 0·48			5 55 59	− 0·52		
	° ′ ″	″			° ′ ″	″		
6 40	1 33 28	+ 12·10	35 47 22	− 1·90	1 35 56	+ 12·44	37 47 14	− 1·91
7 0	1 31 33	11·84	35 40 50	2·74	1 33 57	12·16	37 40 42	2·75
7 20	1 28 56	11·49	35 34 28	3·56	1 31 16	11·80	37 34 20	3·57
7 40	1 25 40	11·05	35 28 19	4·36	1 27 54	11·35	37 28 11	4·37
8 0	1 21 46	10·53	35 22 24	5·12	1 23 53	10·81	37 22 16	5·13
8 20	1 17 15	9·94	35 16 47	5·84	1 19 15	10·21	37 16 39	5·85
8 40	1 12 9	9·27	35 11 31	6·52	1 14 1	9·52	37 11 24	6·53
9 0	1 6 32	8·54	35 6 38	7·15	1 8 15	8·77	37 6 30	7·15
9 15	1 2 0	7·96	35 3 13	7·59	1 3 36	8·17	37 3 6	7·59
9 30	0 57 12	7·34	35 0 4	7·99	0 58 40	7·53	36 59 57	8·00
9 45	0 52 11	6·69	34 57 10	8·36	0 53 31	6·86	36 57 3	8·37
10 0	0 46 56	6·01	34 54 33	8·70	0 48 8	6·17	36 54 26	8·71
10 15	0 41 30	5·31	34 52 12	9·00	0 42 33	5·45	36 52 7	9·00
10 30	0 35 53	4·59	34 50 10	9·27	0 36 48	4·71	36 50 4	9·27
10 45	0 30 8	3·86	34 48 25	9·49	0 30 54	3·96	36 48 19	9·49
11 0	0 24 15	3·10	34 46 59	9·67	0 24 52	3·18	36 46 53	9·67
11 15	0 18 17	2·34	34 45 51	9·81	0 18 45	2·40	36 45 45	9·81
11 30	0 12 14	1·56	34 45 3	9·92	0 12 32	1·60	36 44 57	9·92
11 45	0 6 8	0·78	34 44 34	9·98	0 6 17	0·80	36 44 28	9·98

TABLE LIII.—Azimuth and Apparent Altitude of Polaris computed with North Polar Distance 1° 17′, and Mean Refraction.

Hour Angle before or after Culmination.	Latitude 40°. Azimuth.	Correction for Increment of 10″ in N.P.D.	Apparent Altitude.	Correction for Increment of 10″ in N.P.D.
h m	° ′ ″	″	° ′ ″	″
0 15	0 6 42	+ 0·89	41 17 56	+ 9·98
0 30	0 13 22	1·77	41 17 26	9·91
0 45	0 19 59	2·64	41 16 36	9·80
1 0	0 26 30	3·51	41 15 26	9·65
1 15	0 32 54	4·35	41 13 56	9·45
1 30	0 39 9	5·18	41 12 9	9·21
1 45	0 45 13	5·98	41 10 2	8·93
2 0	0 51 6	6·75	41 7 37	8·61
2 15	0 56 44	7·49	41 4 55	8·25
2 30	1 2 7	8·19	41 1 56	7·86
2 45	1 7 14	8·86	40 58 41	7·43
3 0	1 12 2	9·48	40 55 12	6·97
3 20	1 17 56	10·25	40 50 11	6·31
3 40	1 23 14	10·93	40 44 48	5·61
4 0	1 27 52	11·52	40 39 5	4·86
4 20	1 31 49	12·02	40 33 4	4·07
4 40	1 35 3	12·42	40 26 49	3·25
5 0	1 37 33	12·73	40 20 24	2·41
5 20	1 39 18	12·94	40 13 49	1·55
Elong.	1 40 31	13·06	40 1 52	0·19
	h m s	s		
Elong. at	5 55 41	− 0·56		
	° ′ ″	″		
6 40	1 38 39	+ 12·77	39 47 6	− 1·92
7 0	1 36 37	12·48	39 40 34	2·76
7 20	1 33 51	12·11	39 34 12	3·58
7 40	1 30 22	11·64	39 28 3	4·38
8 0	1 26 14	11·09	39 22 9	5·14
8 20	1 21 27	10·47	39 16 32	5·86
8 40	1 16 5	9·76	39 11 16	6·54
9 0	1 10 9	8·99	39 6 24	7·16
9 15	1 5 21	8·37	39 3 0	7·60
9 30	1 0 18	7·72	38 59 51	8·00
9 45	0 54 59	7·03	38 56 57	8·37
10 0	0 49 27	6·32	38 54 20	8·71
10 15	0 43 44	5·59	38 52 0	9·00
10 30	0 37 49	4·83	38 49 57	9·27
10 45	0 31 45	4·05	38 48 13	9·49
11 0	0 25 33	3·26	38 46 47	9·67
11 15	0 19 15	2·46	38 45 39	9·81
11 30	0 12 53	1·64	38 44 52	9·92
11 45	0 6 27	0·82	38 44 23	9·98

TABLE LIV.—Elements of Circumpolar Stars for 1st January 1887.

No.	Star's Name.	Magnitude.	Mean Right Ascension Jan. 1, 1887.	Annual Precession in Right Ascension.	Secular Variation of Precession in Right Ascension.	$\frac{d^3\alpha}{dt^3}$	Annual Proper Motion in Right Ascension.	Mean Declination Jan. 1, 1887.	Annual Procession in Declination.	Secular Variation of Precession in Declination.	$\frac{d^3\delta}{dt^3}$	Annual Proper Motion in Declination.
			h m s	s	s	s	s	° ′ ″	″	″	″	″
1	Bradley 48	6	0 31 16·47	+ 4·345	+ 0·382	+ 11	−0·049	81 52 10·37	+19·866	+0·078	− 12	+0·08
2	Bradley 74	6	0 44 21·27	+ 5·195	+ 0·580	− 5	+0·037	83 5 36·37	+19·679	+0·137	− 11	−0·03
3	Bradley 65	6	0 52 22·97	+14·034	+ 8·566	+ 661	+0·061	88 25 2·22	+19·532	+0·455	− 21	−0·03
4	Ursæ Minoris 2	5	0 53 26·44	+ 7·134	+ 1·395	+ 36	+0·066	85 39 1·98	+19·510	+0·232	− 5	0·00
5	Bradley 95	6	0 57 9·04	+ 8·534	+ 2·186	+ 78	−0·171	86 32 35·71	+19·433	+0·299	+ 7	+0·02
6	Ursæ Min. α	2	1 17 20 *	...	...	...	...	88 42 21 *	...	...	...	...
7	Piazzi II. 60	6	2 21 17·41	+ 8·032	+ 0·667	− 16	−0·002	81 8 35·68	+16·361	+0·670	− 7	+0·07
8	Bradley 402	6	3 5 40·99	+13·146	+ 1·623	− 11	...	84 30 30·78	+13·824	+1·383	− 4	−0·12
9	Groom. 642	6	3 29 37·05	+19·404	+ 3·269	− 5	+0·136	86 17 20·70	+12·234	+2·237	− 41	−0·06
10	Groom. 750	6	4 1 22·48	+17·070	+ 1·802	− 14	+0·057	85 15 20·96	+ 9·922	+2·159	− 78	+0·05
11	Groom. 766	6	4 2 5·92	+13·334	+ 0·998	− 20	+0·072	83 31 46·07	+ 9·867	+1·689	− 27	+0·02
12	Groom. 774	6	4 5 13·87	+12·713	+ 0·861	− 30	...	83 3 53·73	+ 9·628	+1·622	+ 44	...
13	Groom. 856	6	4 39 13·87	+10·997	+ 0·404	+ 16	...	81 0 13·50	+ 6·922	+1·502	− 2	...
14	Radcliffe 1311	7·6	4 51 49·14	+20·517	+ 1·475	− 73	...	85 48 33·84	+ 5·878	+2·858	− 43	...
15	Groom. 944	6	5 25 51·75	+18·611	+ 0·576	− 73	...	85 8 13·06	+ 2·976	+2·683	− 21	...
16	Groom. 1004	6	6 2 22·23	+26·703	− 0·098	− 177	+0·289	86 45 43·96	− 0·207	+3·894	− 11	−0·10
17	Cephei 51 Hev.	5	6 47 17 *	...	...	...	...	87 13 17 *	...	...	...	...
18	Piazzi VI. 292	5	7 7 14·60	+12·960	− 0·502	+ 23	+0·009	82 37 33·22	− 5·800	+1·812	− 21	−0·02
19	Groom. 1119	6	7 43 20·29	+69·783	−32·092	−2121	−0·323	88 58 0·15	− 8·739	+9·163	+652	+0·01
20	Groom. 1359	6	7 49 46·15	+15·133	− 1·247	+ 10	...	84 22 53·54	− 9·241	+1·963	+ 54	...
21	Groom. 1418	6	8 21 47·13	+16·762	− 2·168	+ 11	...	85 27 4·68	−11·629	+1·996	+ 50	...
22	Groom. 1431	6	8 25 52·26	+11·391	− 0·889	0	...	82 38 10·66	−11·919	+1·341	+ 11	...
23	Piazzi IX. 37	4·5	9 20 53·47	+ 9·025	− 0·786	+ 21	−0·063	81 49 27·22	−15·412	+0·849	+ 27	−0·04
24	Bradley 1399	5·6	10 13 6·11	+ 9·710	− 1·574	+ 53	−0·079	84 49 29·60	−17·911	+0·645	+ 14	−0·05
25	Piazzi X. 22	5·6	10 17 13·03	+ 7·885	− 0·929	+ 43	−0·106	83 7 56·74	−18·070	+0·506	+ 9	−0·07
26	Groom. 1782	6	11 23 50·98	+ 4·520	− 0·396	+ 18	...	81 44 55·60	−19·804	+0·112	+ 12	...
27	Groom. 1845	6	11 54 23·93	+ 3·290	− 0·226	+ 2	...	81 29 0·79	−20·047	+0·020	+ 9	...
28	Groom. 1850	6	11 59 3·13	+ 3·156	− 0·474	+ 57	...	86 12 46·54	−20·053	+0·011	0	...
29	Groom. 1858	6	12 5 53·96	+ 2·816	− 0·183	− 4	...	82 20 19·85	−20·047	−0·002	− 14	...
30	Bradley 1672	6	12 14 18·53	+ 0·217	+ 0·880	− 71	−0·152	88 19 35·12	−20·014	+0·007	− 12	+0·07
31	Groom. 1892	6	12 20 18·95	+ 1·936	− 0·071	− 20	...	84 3 16·67	−19·974	−0·016	− 14	...
32	Groom. 1923	6	12 37 37·16	+ 0·897	+ 0·127	− 5	...	84 15 50·49	−19·783	−0·013	− 5	...
33	Groom. 1927	6	12 41 33·68	+ 1·507	+ 0·009	− 21	...	81 14 26·27	−19·724	−0·031	+ 11	...
34	Bradley 1730	5·6	12 48 10·51	+ 0·403	+ 0·212	0	−0·006	84 1 55·67	−19·611	−0·004	+ 5	+0·02
35	Bradley 1731	5·6	12 48 18·22	+ 0·399	+ 0·212	0	−0·017	84 1 38·12	−19·609	−0·004	− 11	+0·04
36	Groom. 2006	7	13 6 29·46	− 9·487	+ 6·755	− 770	...	88 15 20·75	−19·215	+0·404	+ 82	...
37	Groom. 2007	6	13 19 14·04	− 2·492	+ 0·914	− 50	...	85 20 42·64	−18·866	+0·131	+ 5	...
38	Piazzi XIII. 263	6	13 45 35·16	− 2·001	+ 0·535	− 27	−0·023	83 19 8·81	−17·962	+0·138	− 12	−0·09
39	Groom. 2196	5	14 57 58·07	− 4·533	+ 0·695	− 16	...	82 58 34·01	−14·305	+0·470	+ 25	...
40	Groom. 2213	6	15 3 6·82	− 6·678	+ 1·146	− 46	...	84 23 15·83	−13·986	+0·704	+ 27	...
41	Groom. 2283	6	15 13 53·22	−21·481	+ 7·298	− 136	...	87 39 56·63	−13·295	+2·351	+114	...
42	Lalan. (F) 2774	7·6	16 0 0·37	−12·058	+ 1·741	− 22	...	85 37 27·44	−10·026	+1·527	+ 69	...
43	Ursæ Min. ε	4·5	16 57 34 *	...	...	...	...	82 13 18 *	...	...	...	...
44	Ursæ Min. δ	4·5	18 8 46 *	...	...	...	...	86 36 39 *	...	...	...	...
45	Ursæ Minoris 24	6	18 12 37·51	−22·321	− 0·474	+ 142	+0·085	86 59 27·04	+ 1·104	+3·250	+ 12	+0·01
46	Radcliffe 4208	7·6	18 51 47·88	−18·629	− 1·455	+ 65	...	86 33 50·69	+ 4·494	+2·646	− 42	...
47	Ursæ Min. λ	6·7	19 36 48 *	...	...	...	...	88 57 36 *	...	...	...	...
48	Cephei 24 Hev.	5	20 10 7·28	−50·194	−25·542	− 770	...	88 47 15·71	+10·784	+6·167	−444	...
49	Groom. 3212	6·7	20 15 46·21	− 8·114	− 1·056	− 9	...	84 20 14·77	+11·197	+0·977	− 11	...
50	Draconis 75	6	20 35 17·71	− 3·530	− 0·393	+ 2	+0·005	81 2 6·74	+12·572	+0·396	0	0·00
51	Radcliffe 4976	6·7	20 40 17·25	− 5·549	− 0·748	+ 5	...	83 13 56·44	+12·909	+0·614	+ 7	...
52	Draconis 76	6	20 50 42·93	− 4·022	− 0·530	+ 5	+0·006	82 6 42·84	+13·594	+0·425	− 20	0·00
53	Groom. 3548	6	21 22 2·44	−11·104	− 3·161	− 107	...	86 34 4·14	+15·476	+1·023	− 66	...
54	Bradley 2935	7	22 2 14·55	− 1·804	− 0·421	− 9	...	82 19 32·46	+17·464	+0·122	− 30	...
55	Groom. 3709	6	22 2 21·44	− 1·801	− 0·421	− 14	+0·017	82 19 35·91	+17·469	+0·122	− 39	−0·03
56	Bradley 2993	5·6	22 22 11·45	− 4·020	− 1·261	− 37	+0·076	85 32 19·19	+18·255	+0·235	+ 2	+0·01
57	Bradley 3038	5	22 47 54·03	− 0·093	− 0·231	− 9	+0·006	82 33 14·67	+19·069	−0·004	− 9	+0·05
58	Bradley 3058	5·6	22 55 16·27	− 0·325	− 0·317	+ 12	+0·069	83 44 29·08	+19·258	+0·005	+ 9	+0·05
59	Bradley 3147	6	23 27 49·67	− 0·156	− 0·561	− 12	+0·080	86 41 2·10	+19·856	−0·005	+ 9	0·00
60	Bradley 3194	6·7	23 54 10·75	+ 2·577	+ 0·297	+ 9	+0·021	86 4 37·93	+20·047	−0·018	− 28	...

* See Nautical Almanac.

TABLE LV.—Values of $\frac{2 \operatorname{Sin}^2 \frac{1}{2} t}{\operatorname{Sin} 1''}$ for the Reduction of Circum-meridian Observations for Latitude.

Seconds.	Hour Angles in Time.																			
	0m	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m	11m	12m	13m	14m	15m	16m	17m	18m	19m
0	0	2	8	18	31	49	71	96	126	159	196	238	283	332	385	442	502	567	636	708
1	0	2	8	18	32	49	71	97	126	160	197	238	283	333	386	443	504	568	637	710
2	0	2	8	18	32	50	71	97	127	160	198	239	284	333	387	444	505	569	638	711
3	0	2	8	18	32	50	72	98	127	161	198	240	285	334	387	445	506	571	639	712
4	0	2	8	18	32	50	72	98	128	161	199	240	286	335	388	446	507	572	641	713
5	0	2	9	19	33	51	73	99	128	162	200	241	287	336	389	447	508	573	642	715
6	0	2	9	19	33	51	73	99	129	163	200	242	287	337	390	448	509	574	643	716
7	0	2	9	19	33	51	73	99	129	163	201	243	288	338	391	449	510	575	644	717
8	0	3	9	19	34	52	74	100	130	164	202	243	289	339	392	450	511	576	645	718
9	0	3	9	19	34	52	74	100	130	164	202	244	290	339	393	451	512	577	646	720
10	0	3	9	20	34	52	75	101	131	165	203	245	291	340	394	452	513	578	648	721
11	0	3	9	20	34	53	75	101	131	166	204	246	291	341	395	452	514	579	649	722
12	0	3	10	20	35	53	75	102	132	166	204	246	292	342	396	453	515	581	650	723
13	0	3	10	20	35	53	76	102	133	167	205	247	293	343	397	454	516	582	651	725
14	0	3	10	21	35	54	76	103	133	167	206	248	294	344	398	455	517	583	652	726
15	0	3	10	21	35	54	77	103	134	168	206	248	295	345	399	456	518	584	654	727
16	0	3	10	21	36	54	77	104	134	169	207	249	295	345	400	457	519	585	655	728
17	0	3	10	21	36	55	78	104	135	169	208	250	296	346	400	458	520	586	656	730
18	0	3	10	21	36	55	78	105	135	170	208	251	297	347	401	459	521	587	657	731
19	0	3	11	22	37	55	78	105	136	170	209	251	298	348	402	460	523	589	658	732
20	0	3	11	22	37	56	79	106	136	171	210	252	299	349	403	461	524	590	660	733
21	0	4	11	22	37	56	79	106	137	172	210	253	299	350	404	462	525	591	661	735
22	0	4	11	22	37	57	80	107	137	172	211	254	300	351	405	463	526	592	662	736
23	0	4	11	22	38	57	80	107	138	173	212	254	301	352	406	464	527	593	663	737
24	0	4	11	23	38	57	80	108	139	173	212	255	302	352	407	465	528	594	664	739
25	0	4	11	23	38	58	81	108	139	174	213	256	303	353	408	466	529	595	666	740
26	0	4	12	23	39	58	81	108	140	175	214	257	303	354	409	468	530	596	667	741
27	0	4	12	23	39	58	82	109	140	175	214	257	304	355	410	469	531	598	668	742
28	0	4	12	24	39	59	82	109	141	176	215	258	305	356	411	470	532	599	669	744
29	0	4	12	24	39	59	83	110	141	177	216	259	306	357	412	471	533	600	670	745
30	0	4	12	24	40	59	83	110	142	177	216	260	307	358	413	472	534	601	672	746
31	1	5	12	24	40	60	83	111	142	178	217	260	308	359	414	473	535	602	673	747
32	1	5	13	25	40	60	84	111	143	178	218	261	308	360	415	474	537	603	674	749
33	1	5	13	25	41	60	84	112	144	179	219	262	309	360	416	475	538	604	675	750
34	1	5	13	25	41	61	85	112	144	180	219	263	310	361	416	476	539	606	676	751
35	1	5	13	25	41	61	85	113	145	180	220	263	311	362	417	477	540	607	678	753
36	1	5	13	25	42	62	86	113	145	181	221	264	312	363	418	478	541	608	679	754
37	1	5	13	26	42	62	86	114	146	182	221	265	312	364	419	479	542	609	680	755
38	1	5	14	26	42	62	86	114	146	182	222	266	313	365	420	480	543	610	681	756
39	1	5	14	26	42	63	87	115	147	183	223	266	314	366	421	481	544	611	683	758
40	1	5	14	26	43	63	87	115	147	183	223	267	315	367	422	482	545	613	684	759
41	1	6	14	27	43	63	88	116	148	184	224	268	316	368	423	483	546	614	685	760
42	1	6	14	27	43	64	88	116	149	185	225	269	317	368	424	484	547	615	686	762
43	1	6	14	27	44	64	89	117	149	185	225	269	317	369	425	485	548	616	687	763
44	1	6	15	27	44	65	89	117	150	186	226	270	318	370	426	486	550	617	689	764
45	1	6	15	28	44	65	89	118	150	187	227	271	319	371	427	487	551	618	690	765
46	1	6	15	28	45	65	90	118	151	187	228	272	320	372	428	488	552	619	691	767
47	1	6	15	28	45	66	90	119	151	188	228	273	321	373	429	489	553	621	692	768
48	1	6	15	28	45	66	91	119	152	189	229	273	322	374	430	490	554	622	694	769
49	1	6	16	29	46	66	91	120	153	189	230	274	322	375	431	491	555	623	695	771
50	1	7	16	29	46	67	92	120	153	190	230	275	323	376	432	492	556	624	696	772
51	1	7	16	29	46	67	92	121	154	190	231	276	324	377	433	493	557	625	697	773
52	1	7	16	29	47	68	93	121	154	191	232	276	325	377	434	494	558	626	699	774
53	2	7	16	30	47	68	93	122	155	192	233	277	326	378	435	495	559	628	700	776
54	2	7	17	30	47	68	93	123	156	192	233	278	327	379	436	496	561	629	701	777
55	2	7	17	30	47	69	94	123	156	193	234	279	328	380	437	497	562	630	702	778
56	2	7	17	30	48	69	94	124	157	194	235	280	328	381	438	498	563	631	703	780
57	2	7	17	31	48	70	95	124	157	194	235	280	329	382	439	499	564	632	705	781
58	2	8	17	31	48	70	95	125	158	195	236	281	330	383	440	500	565	634	706	782
59	2	8	17	31	49	70	96	125	158	196	237	282	331	384	441	501	566	635	707	784

TABLE LVI.—Factors for Bessel's Probable Error Formulæ.

n	$\frac{0{\cdot}6745}{\sqrt{(n-1)}}$	$\frac{0{\cdot}6745}{\sqrt{n(n-1)}}$	n	$\frac{0{\cdot}6745}{\sqrt{(n-1)}}$	$\frac{0{\cdot}6745}{\sqrt{n(n-1)}}$
			51	0·0954	0·0134
2	0·6745	0·4769	52	·0944	·0131
3	·4769	·2754	53	·0935	·0128
4	·3894	·1947	54	·0926	·0126
5	·3372	·1508	55	·0918	·0124
6	0·3016	0·1231	56	0·0909	0·0122
7	·2754	·1041	57	·0901	·0119
8	·2549	·0901	58	·0893	·0117
9	·2385	·0795	59	·0886	·0115
10	·2248	·0711	60	·0878	·0113
11	0·2133	0·0643	61	0·0871	0·0111
12	·2034	·0587	62	·0864	·0110
13	·1947	·0540	63	·0857	·0108
14	·1871	·0500	64	·0850	·0106
15	·1803	·0465	65	·0843	·0105
16	0·1742	0·0435	66	0·0837	0·0103
17	·1686	·0409	67	·0830	·0101
18	·1636	·0386	68	·0824	·0100
19	·1590	·0365	69	·0818	·0098
20	·1547	·0346	70	·0812	·0097
21	0·1508	0·0329	71	0·0806	0·0096
22	·1472	·0314	72	·0800	·0094
23	·1438	·0300	73	·0795	·0093
24	·1406	·0287	74	·0789	·0092
25	·1377	·0275	75	·0784	·0091
26	0·1349	0·0265	76	0·0779	0·0089
27	·1323	·0255	77	·0774	·0088
28	·1298	·0245	78	·0769	·0087
29	·1275	·0237	79	·0764	·0086
30	·1253	·0229	80	·0759	·0085
31	0·1231	0·0221	81	0·0754	0·0084
32	·1211	·0214	82	·0749	·0083
33	·1192	·0208	83	·0745	·0082
34	·1174	·0201	84	·0740	·0081
35	·1157	·0196	85	·0736	·0080
36	0·1140	0·0190	86	0·0732	0·0079
37	·1124	·0185	87	·0727	·0078
38	·1109	·0180	88	·0723	·0077
39	·1094	·0175	89	·0719	·0076
40	·1080	·0171	90	·0715	·0075
41	0·1066	0·0167	91	0·0711	0·0075
42	·1053	·0163	92	·0707	·0074
43	·1041	·0159	93	·0703	·0073
44	·1029	·0155	94	·0699	·0072
45	·1017	·0152	95	·0696	·0071
46	0·1005	0·0148	96	0·0692	0·0071
47	·0994	·0145	97	·0688	·0070
48	·0984	·0142	98	·0685	·0069
49	·0974	·0139	99	·0681	·0068
50	·0964	·0136	100	·0678	·0068

TABLE LVII.—Quadrilateral Surfaces of 15′ in Latitude and in Longitude on the Terrestrial Ellipsoid.

Latitude.	Area in Square Miles.	Latitude.	Area in Square Miles.	Latitude.	Area in Square Miles.
° ′ ° ′		° ′ ° ′		° ′ ° ′	
0 0 to 0 15	296·973	14 0 to 14 15	288·223	27 0 to 27 15	265·042
0 15 „ 0 30	296·967	14 15 „ 14 30	287·912	27 15 „ 27 30	264·459
0 30 „ 0 45	296·957	14 30 „ 14 45	287·595	27 30 „ 27 45	263·872
0 45 „ 1 0	296·940	14 45 „ 15 0	287·273	27 45 „ 28 0	263·279
1 0 „ 1 15	296·918	15 0 „ 15 15	286·946	28 0 „ 28 15	262·682
1 15 „ 1 30	296·891	15 15 „ 15 30	286·613	28 15 „ 28 30	262·079
1 30 „ 1 45	296·857	15 30 „ 15 45	286·275	28 30 „ 28 45	261·472
1 45 „ 2 0	296·819	15 45 „ 16 0	285·932	28 45 „ 29 0	260·860
2 0 „ 2 15	296·775	16 0 „ 16 15	285·583	29 0 „ 29 15	260·242
2 15 „ 2 30	296·725	16 15 „ 16 30	285·229	29 15 „ 29 30	259·620
2 30 „ 2 45	296·671	16 30 „ 16 45	284·869	29 30 „ 29 45	258·993
2 45 „ 3 0	296·610	16 45 „ 17 0	284·504	29 45 „ 30 0	258·361
3 0 „ 3 15	296·544	17 0 „ 17 15	284·135	30 0 „ 30 15	257·723
3 15 „ 3 30	296·472	17 15 „ 17 30	283·759	30 15 „ 30 30	257·081
3 30 „ 3 45	296·396	17 30 „ 17 45	283·379	30 30 „ 30 45	256·435
3 45 „ 4 0	296·313	17 45 „ 18 0	282·992	30 45 „ 31 0	255·783
4 0 „ 4 15	296·225	18 0 „ 18 15	282·601	31 0 „ 31 15	255·126
4 15 „ 4 30	296·132	18 15 „ 18 30	282·205	31 15 „ 31 30	254·465
4 30 „ 4 45	296·032	18 30 „ 18 45	281·802	31 30 „ 31 45	253·798
4 45 „ 5 0	295·928	18 45 „ 19 0	281·396	31 45 „ 32 0	253·127
5 0 „ 5 15	295·818	19 0 „ 19 15	280·983	32 0 „ 32 15	252·451
5 15 „ 5 30	295·702	19 15 „ 19 30	280·566	32 15 „ 32 30	251·770
5 30 „ 5 45	295·582	19 30 „ 19 45	280·142	32 30 „ 32 45	251·084
5 45 „ 6 0	295·455	19 45 „ 20 0	279·714	32 45 „ 33 0	250·394
6 0 „ 6 15	295·323	20 0 „ 20 15	279·281	33 0 „ 33 15	249·699
6 15 „ 6 30	295·186	20 15 „ 20 30	278·842	33 15 „ 33 30	248·999
6 30 „ 6 45	295·043	20 30 „ 20 45	278·398	33 30 „ 33 45	248·294
6 45 „ 7 0	294·894	20 45 „ 21 0	277·949	33 45 „ 34 0	247·584
7 0 „ 7 15	294·741	21 0 „ 21 15	277·494	34 0 „ 34 15	246·870
7 15 „ 7 30	294·581	21 15 „ 21 30	277·035	34 15 „ 34 30	246·151
7 30 „ 7 45	294·417	21 30 „ 21 45	276·570	34 30 „ 34 45	245·427
7 45 „ 8 0	294·247	21 45 „ 22 0	276·100	34 45 „ 35 0	244·699
8 0 „ 8 15	294·071	22 0 „ 22 15	275·625	35 0 „ 35 15	243·965
8 15 „ 8 30	293·890	22 15 „ 22 30	275·144	35 15 „ 35 30	243·228
8 30 „ 8 45	293·703	22 30 „ 22 45	274·659	35 30 „ 35 45	242·485
8 45 „ 9 0	293·511	22 45 „ 23 0	274·168	35 45 „ 36 0	241·738
9 0 „ 9 15	293·313	23 0 „ 23 15	273·672	36 0 „ 36 15	240·986
9 15 „ 9 30	293·110	23 15 „ 23 30	273·171	36 15 „ 36 30	240·230
9 30 „ 9 45	292·902	23 30 „ 23 45	272·665	36 30 „ 36 45	239·468
9 45 „ 10 0	292·688	23 45 „ 24 0	272·153	36 45 „ 37 0	238·703
10 0 „ 10 15	292·469	24 0 „ 24 15	271·637	37 0 „ 37 15	237·933
10 15 „ 10 30	292·244	24 15 „ 24 30	271·116	37 15 „ 37 30	237·158
10 30 „ 10 45	292·014	24 30 „ 24 45	270·589	37 30 „ 37 45	236·378
10 45 „ 11 0	291·778	24 45 „ 25 0	270·057	37 45 „ 38 0	235·594
11 0 „ 11 15	291·537	25 0 „ 25 15	269·520	38 0 „ 38 15	234·806
11 15 „ 11 30	291·291	25 15 „ 25 30	268·978	38 15 „ 38 30	234·013
11 30 „ 11 45	291·039	25 30 „ 25 45	268·431	38 30 „ 38 45	233·215
11 45 „ 12 0	290·782	25 45 „ 26 0	267·878	38 45 „ 39 0	232·413
12 0 „ 12 15	290·519	26 0 „ 26 15	267·321	39 0 „ 39 15	231·606
12 15 „ 12 30	290·251	26 15 „ 26 30	266·759	39 15 „ 39 30	230·795
12 30 „ 12 45	289·977	26 30 „ 26 45	266·192	39 30 „ 39 45	229·980
12 45 „ 13 0	289·699	26 45 „ 27 0	265·619	39 45 „ 40 0	229·160
13 0 „ 13 15	289·414				
13 15 „ 13 30	289·124				
13 30 „ 13 45	288·829				
13 45 „ 14 0	288·529				

TABLE LVIII.—Semi-diurnal and Semi-nocturnal Arcs, showing the time of the rising and setting of the Sun, Moon, or Equatorial Stars.

Latitude.	Declination.														Latitude.
	0°	2°	4°	6°	8°	10°	12°	14°	16°	18°	20°	22°	23°	23° 27′	
°	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 0	6 0	6 0	6 0	6 1	6 1	6 1	6 1	6 1	6 1	6 1	6 2	6 2	6 2	1
2	6 0	6 0	6 1	6 1	6 1	6 1	6 2	6 2	6 2	6 3	6 3	6 3	6 3	6 3	2
3	6 0	6 0	6 1	6 1	6 2	6 2	6 3	6 3	6 3	6 4	6 4	6 5	6 5	6 5	3
4	6 0	6 1	6 1	6 2	6 2	6 3	6 3	6 4	6 5	6 5	6 6	6 6	6 7	6 7	4
5	6 0	6 1	6 1	6 2	6 3	6 4	6 4	6 5	6 6	6 7	6 7	6 8	6 9	6 9	5
6	6 0	6 1	6 2	6 3	6 3	6 4	6 5	6 6	6 7	6 8	6 9	6 10	6 10	6 10	6
7	6 0	6 1	6 2	6 3	6 4	6 5	6 6	6 7	6 8	6 9	6 10	6 11	6 12	6 12	7
8	6 0	6 1	6 2	6 3	6 5	6 6	6 7	6 8	6 8	6 10	6 12	6 13	6 14	6 14	8
9	6 0	6 1	6 3	6 4	6 5	6 6	6 8	6 9	6 10	6 12	6 13	6 15	6 15	6 16	9
10	6 0	6 1	6 3	6 4	6 6	6 7	6 9	6 10	6 12	6 13	6 15	6 16	6 17	6 18	10
11	6 0	6 2	6 3	6 5	6 6	6 8	6 9	6 11	6 13	6 14	6 16	6 18	6 19	6 19	11
12	6 0	6 2	6 3	6 5	6 7	6 9	6 10	6 12	6 14	6 16	6 18	6 20	6 21	6 21	12
13	6 0	6 2	6 4	6 6	6 7	6 9	6 11	6 13	6 15	6 17	6 19	6 21	6 22	6 23	13
14	6 0	6 2	6 4	6 6	6 8	6 10	6 12	6 14	6 16	6 19	6 21	6 23	6 24	6 25	14
15	6 0	6 2	6 4	6 6	6 9	6 11	6 13	6 15	6 18	6 20	6 22	6 25	6 26	6 27	15
16	6 0	6 2	6 5	6 7	6 9	6 12	6 14	6 16	6 19	6 21	6 24	6 27	6 28	6 29	16
17	6 0	6 2	6 5	6 7	6 10	6 12	6 15	6 17	6 20	6 23	6 26	6 28	6 30	6 31	17
18	6 0	6 3	6 5	6 8	6 10	6 13	6 16	6 19	6 21	6 24	6 27	6 30	6 32	6 32	18
19	6 0	6 3	6 6	6 8	6 11	6 14	6 17	6 20	6 23	6 26	6 29	6 32	6 34	6 34	19
20	6 0	6 3	6 6	6 9	6 12	6 15	6 18	6 21	6 24	6 27	6 30	6 34	6 36	6 36	20
21	6 0	6 3	6 6	6 9	6 12	6 16	6 19	6 22	6 25	6 29	6 32	6 36	6 38	6 38	21
22	6 0	6 3	6 6	6 10	6 13	6 16	6 20	6 23	6 27	6 30	6 34	6 38	6 40	6 40	22
23	6 0	6 3	6 7	6 10	6 14	6 17	6 21	6 24	6 28	6 32	6 36	6 39	6 42	6 42	23
24	6 0	6 4	6 7	6 11	6 14	6 18	6 22	6 25	6 29	6 33	6 37	6 41	6 44	6 45	24
25	6 0	6 4	6 7	6 11	6 15	6 19	6 23	6 27	6 31	6 35	6 39	6 43	6 46	6 47	25
26	6 0	6 4	6 8	6 12	6 16	6 20	6 24	6 28	6 32	6 36	6 41	6 45	6 48	6 49	26
27	6 0	6 4	6 8	6 12	6 16	6 21	6 25	6 29	6 34	6 38	6 43	6 48	6 50	6 51	27
28	6 0	6 4	6 9	6 13	6 17	6 22	6 26	6 30	6 35	6 40	6 45	6 50	6 52	6 53	28
29	6 0	6 4	6 9	6 13	6 18	6 22	6 27	6 32	6 37	6 42	6 47	6 52	6 54	6 56	29
30	6 0	6 5	6 9	6 14	6 19	6 23	6 28	6 33	6 38	6 43	6 49	6 54	6 57	6 58	30
31	6 0	6 5	6 10	6 14	6 19	6 24	6 29	6 34	6 40	6 45	6 51	6 56	6 59	7 0	31
32	6 0	6 5	6 10	6 15	6 20	6 25	6 31	6 36	6 41	6 47	6 53	6 58	7 2	7 3	32
33	6 0	6 5	6 10	6 16	6 21	6 26	6 32	6 37	6 43	6 49	6 55	7 1	7 4	7 5	33
34	6 0	6 5	6 11	6 16	6 22	6 27	6 33	6 39	6 45	6 51	6 57	7 3	7 7	7 8	34
35	6 0	6 6	6 11	6 17	6 23	6 28	6 34	6 40	6 46	6 53	6 59	7 6	7 9	7 11	35
36	6 0	6 6	6 12	6 18	6 23	6 29	6 36	6 42	6 48	6 55	7 1	7 8	7 12	7 14	36
37	6 0	6 6	6 12	6 18	6 24	6 31	6 37	6 43	6 50	6 57	7 4	7 11	7 15	7 16	37
38	6 0	6 6	6 13	6 19	6 25	6 32	6 38	6 45	6 52	6 59	7 6	7 14	7 17	7 19	38
39	6 0	6 6	6 13	6 20	6 26	6 33	6 40	6 47	6 54	7 1	7 9	7 16	7 20	7 22	39
40	6 0	6 7	6 13	6 20	6 27	6 34	6 41	6 48	6 56	7 3	7 11	7 19	7 23	7 25	40
Dates corresponding to Sun's Declination.	Sep. 22, Mar. 20	,, 27, ,, 15	Oct. 3, ,, 10	,, 8, ,, 5	,, 13, Feb. 28	,, 19, ,, 23	,, 24, ,, 17	,, 30, ,, 12	Nov. 6, ,, 5	,, 13, Jan. 29	,, 21, ,, 21	Dec. 2, ,, 10	,, 10, ,, 2	December 21	S. Declination.
	Sep. 22, Mar. 20	,, 17, ,, 25	,, 12, ,, 30	,, 7, Apr. 4	,, 1, ,, 10	Aug. 27, ,, 15	,, 21, ,, 21	,, 15, ,, 27	,, 8, May 4	,, 1, ,, 11	July 23, ,, 20	,, 11, ,, 31	,, 2, June 9	June 21	N. Declination.

TABLE LIX.—Corrections for reducing Apparent to Mean Solar Time.

Day of Month.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
	m	m	m	m	m	m	m	m	m	m	m	m
1	+ 4	+ 14	+ 12	+ 4	− 3	− 2	+ 4	+ 6	− 0	− 10	− 16	− 11
2	4	14	12	4	3	2	4	6	1	11	16	10
3	4	14	12	3	3	2	4	6	1	11	16	10
4	5	14	12	3	3	2	4	6	1	11	16	9
5	5	14	12	3	3	2	4	6	2	12	16	9
6	6	14	11	2	4	2	4	6	2	12	16	9
7	6	14	11	2	4	1	5	5	2	12	16	8
8	7	14	11	2	4	1	5	5	3	13	16	8
9	7	14	11	2	4	1	5	5	3	13	16	7
10	8	14	10	1	4	1	5	5	3	13	16	7
11	8	14	10	1	4	1	5	5	4	13	16	6
12	8	14	10	1	4	0	5	5	4	14	16	6
13	9	14	10	0	4	0	5	5	4	14	16	5
14	9	14	9	0	4	0	6	4	5	14	15	5
15	9	14	9	0	4	0	6	4	5	14	15	4
16	10	14	9	0	4	0	6	4	5	14	15	4
17	10	14	8	− 1	4	+ 1	6	4	6	15	15	3
18	11	14	8	1	4	1	6	4	6	15	15	3
19	11	14	8	1	4	1	6	3	6	15	14	3
20	11	14	8	1	4	1	6	3	7	15	14	2
21	11	14	7	1	4	2	6	3	7	15	14	2
22	12	14	7	2	4	2	6	3	7	16	14	1
23	12	14	7	2	3	2	6	2	8	16	13	1
24	12	14	6	2	3	2	6	2	8	16	13	0
25	12	13	6	2	3	2	6	2	9	16	13	0
26	13	13	6	2	3	3	6	2	9	16	12	+ 1
27	13	13	5	2	3	3	6	1	9	16	12	1
28	13	13	5	3	3	3	6	1	10	16	12	2
29	13	13	5	3	3	3	6	1	10	16	11	2
30	13	...	4	3	3	3	6	0	10	16	11	3
31	14	...	4	...	3	...	6	0	...	16	...	3

TABLE LX.—Showing Links to be subtracted from each Chain, in an ascending or descending line, in order to reduce it to the Horizontal Measure.

Deg.	Links.	Deg.	Links.	Deg.	Links.	Deg.	Links.	Deg.	Links.	Deg.	Links.
1	0·02	6	0·55	11	1·84	16	3·87	21	6·64	26	10·12
2	0·06	7	0·75	12	2·19	17	4·37	22	7·28	27	10·90
3	0·14	8	0·97	13	2·56	18	4·89	23	7·95	28	11·71
4	0·24	9	1·23	14	2·97	19	5·45	24	8·65	29	12·54
5	0·38	10	1·52	15	3·41	20	6·03	25	9·37	30	13·40

TABLE LXI.—For the conversion of Versts and Kilometres into Miles and *vice versâ*.

Versts.	Miles.	Kilometres.	Miles.	Miles.	Versts.	Kilometres.
1	0·6629	1	0·6214	1	1·5086	1·6093
2	1·3258	2	1·2428	2	3·0171	3·2187
3	1·9886	3	1·8641	3	4·5257	4·8280
4	2·6515	4	2·4855	4	6·0343	6·4373
5	3·3144	5	3·1069	5	7·5429	8·0466
6	3·9773	6	3·7283	6	9·0514	9·6560
7	4·6402	7	4·3496	7	10·5600	11·2653
8	5·3030	8	4·9710	8	12·0686	12·8746
9	5·9659	9	5·5924	9	13·5771	14·4840
10	6·6288	10	6·2138	10	15·0857	16·0933

1 Mile = 1·6093296 Kilometres.

1 Verst = 3500 Feet.

TABLE LXII.—For the conversion of French into English Measures.

Measure of Length.	Measure of Weight or Mass.
1 Millimetre = ·039370432 Inches or about $\frac{1}{25}$ inch.	1 Milligramme = ·015432349 Grains.
1 Centimetre = ·39370432 ,,	1 Centigramme = ·15432349 ,,
1 Decimetre = 3·9370432 ,,	1 Decigramme = 1·5432349 ,,
1 Metre = 39·370432* ,, or 3·2809 ft. nearly.	1 Gramme = 15·432349 ,,
1 Kilometre = 39370·432 ,, or 1093·6 yds. ,,	1 Kilogramme = 15432·349 ,, or 2·20462125 lbs. Avoir.

Measure of Volume.
The Litre used for liquids = 1 cubic decimetre = 1·76168 Imperial pints.

TABLE LXIII.—For the conversion of English into French Measures.

Measure of Length.	Measure of Weight or Mass.
1 Inch = 2·5399772 Centimetres.	1 Grain = ·064799 Grammes.
1 Foot = 30·4797264 ,,	1 oz. Avoir. = 28·34954 ,,
1 Yard = 91·4391792 ,,	1 lb. ,, = 453·59265 ,,
1 Mile = 1·6093296 Kilometres.	1 Ton = 1016·05 Kilogrammes.

Measure of Volume.
1 Pint = ·5676400 Litres.
1 Gallon = 4·54112 ,,
1 Bushel = 36·32896 ,,

* See "Comparison of the Standards of Lengths," by Captain A. R. Clarke, R.E., 1866, page 280.

ADDENDUM AND CORRIGENDUM SLIP.

Third Edition Auxiliary Tables of the Survey of India Department.

Page 17. At the bottom of the page two values of the Latitude, Longitude and Azimuth of the deduced Station **B** are given. It should be noted that the upper value (358° 15′ 39″·269) is the directly computed Azimuth of Bhaorása at Handiapáro, and that the lower value (358° 15′ 39″·269) although opposite the name of Párdho is the Azimuth of Bhaorása at Handiapáro computed thus:—

		° ′ ″
Azimuth of Párdho at Handiapáro directly computed	=	52 45 30·345
Spherical Angle at Handiapáro between Párdho and Bhaorása	= −	54 29 51·076
Azimuth of Bhaorása at Handiapáro	=	358 15 39·269

Page 18. The *Mean* Azimuths at the bottom of the page are obtained as follows:—

		°	′	″
Azimuth at Kingriáli of Maláni = *B*	=	306	48	32
Angle at Kingriáli between Maláni and Shadau	= +	60	14	15
Azimuth at Kingriáli of Shadau resulting	=	7	2	47
„ „ directly computed above	=	7	2	49
Mean Azimuth	=	7	2	48

The Mean Azimuth at Kingriáli of Maláni is obtained in a similar manner from the directly computed Azimuth of Shadau by making use of the angle 60° 14′ 15″ with opposite sign.

Page 32. In the Example of Computation of Clinometric Heights the sign of (i − s) in line (7) appears to have given rise to errors; it has been understood by some computers that in this table i has been assumed as the height of plane-table = 4 feet, and s as the level of ground = 0 feet; this assumption is not in accordance with the foot-note. As however the table has proved misleading, it should be noted that in the four examples given the signal (s) is 4 feet higher than the instrument (i), say i = 4 feet, s = 8 feet.

Page 37. Add to Table XXII after the words "a few degrees of zero" as follows:—

Correction for Refraction to an observed altitude is subtractive, to an observed Zenith Distance additive. In computing the *amount* of the Refraction, the following rules hold:—Enter column 1 with the nearest Altitude, and take out Refraction from column 2. If nearest altitude is *less* than the actual altitude, *subtract* from the Refraction the correction from column 3; if *greater, add* it: if the Barometer reads *higher* than 30 inches, *add* correction from 4th column; if *lower, subtract* it: if Thermometer reads *higher* than 50°, *subtract* correction from 5th column; if *lower, add* it.

„ Add to Table XXIII as follows:—Parallax is always additive to *altitudes.*

Page 40. Erase 7th and 8th lines and *substitute*

In setting for a star on (or very near) the meridian it should be remembered that in North Latitudes

zenith distance = co-latitude − N.P.D. for stars at Upper Culmination,

„ = co-latitude + N.P.D. „ Lower „

a negative result signifies that the star is south of the zenith.

Note that on pages 60, 63, 73, 75, 79, 80 and 81 and wherever else the symbol *t* is used to express time it must be remembered that before making use of time intervals in Spherical Triangles, they must be reduced to Arc measures by multiplying by 15.

Where *t* is used as an argument in a Table (as LV for example) the arrangement of the Table is such that time intervals and not arc measures are to be understood.

Page 63, Table LV. For the formula therein given for finding the latitude, *substitute* the following :—

If $\lambda' =$ true co-latitude,

$\zeta =$ „ meridian zenith distance (negative when south),

$\zeta_0 =$ an observed ex-meridian zenith distance (negative when south) corrected for refraction, and in the case of the sun or a planet also for semi-diameter and parallax,

$p =$ north polar distance of sun or star,

$\lambda'_0 =$ an approximate value of λ',

$= \zeta_0 + p$ for Upper Culmination and $\zeta_0 - p$ for Lower,

$t =$ hour angle reduced to arc,

then $\zeta = \zeta_0 - Am$ for Upper Culmination,

$\zeta_0 + Am$ „ Lower „

where $A = \dfrac{\sin \lambda'_0 \sin p}{\sin \zeta_0}$ and $m = 2 \dfrac{\sin^2 \frac{1}{2} t}{\sin 1''}$, regard being had to the *sign* of $\sin \zeta_0$,

and $\lambda' = \zeta + p$ for Upper Culmination,

$\zeta - p$ „ Lower „

Page 77. The para. two-thirds down the page commencing "The same solution * * * * *" should read not as at present but as follows :—"The same solution will apply to two altitudes of the sun and the elapsed time, provided this elapsed interval be reckoned in *mean* time.* The declination of the sun may be considered constant."

„ Foot of page.

For $\lambda_0 = \delta \pm \zeta_0$ write

$\lambda'_0 = \zeta_0 + p$ for stars at Upper Culmination,

$\zeta_0 - p$ „ Lower „

where λ'_0 is the approximate co-latitude and p the north polar distance for the mean of the times, the true meridian distance ζ is given by the expression

$$\zeta = \zeta_0 - A\,m, \text{ where } A = \frac{\sin \lambda'_0 \sin p}{\sin \zeta_0},$$ regard being had to the *sign* of $\sin \zeta_0$,

and the co-latitude $= \zeta + p$ for stars at Upper Culmination,

$\zeta - p$ „ Lower „

ζ and ζ_0 being considered negative when south.

Page 77. FOOTNOTE. * Though this is not rigorous it is sufficiently correct for all practical purposes, the change in interval due to equation of time being too small to be worth notice. It should be noticed that the formulæ above given are applicable to north Latitude only.

Pages 78 and 79. Substitute the following as the 3rd Method. *Given the time and latitude approximately.* Observe the angles M_1 and M_2 between the referring mark and two circumpolar stars at their respective elongations, selecting stars which are nearly in opposition or nearly in conjunction and will attain their maximum elongations nearly at the same time, and noting that the angles M_1 and M_2 are always obtained by subtracting the readings of the referring mark from those of the first and second star respectively.

Let the azimuths from north (negative if towards the west) of the two stars in order of observation be A_1 and A_2 and their declinations δ_1 and δ_2,

Then $$M_1 - M_2 = A_1 - A_2,$$

and $$\tan \tfrac{1}{2}(A_1 + A_2) = \tan \tfrac{1}{2}(A_1 - A_2) \tan \tfrac{1}{2}(\delta_1 + \delta_2) \tan \tfrac{1}{2}(\delta_2 - \delta_1).$$

The azimuth of the referring mark from north will be

$$A_1 - M_1 \text{ or } A_2 - M_2,$$

a negative result showing that the mark falls to the west of north.

EXAMPLE.—Observations for Azimuth were made at Dehra New Observatory on the 4th June 1886, to δ Ursæ Minoris at Eastern Elongation and Cephei 51 (Hev.) at Western Elongation. The observed angles were:—

Between Referring Mark and δ Ursæ Minoris $= M_1 = + 3° 56' 53''$

Between Referring Mark and 51 Cephei $= M_2 = - 3° 11' 46''$

$$M_1 - M_2 = A_1 - A_2 = + 7° 8' 39''$$

$$\delta_1 = 86° 36' 42''$$

$$\delta_2 = 87° 13' 20''$$

$\tfrac{1}{2}(A_1 - A_2)$	$= + 3° 34' 20''$	Log tan	$\bar{2}\cdot7953791$
$\tfrac{1}{2}(\delta_1 + \delta_2)$	$= + 86 55 1$	„	$1\cdot2687218$
$\tfrac{1}{2}(\delta_2 - \delta_1)$	$= + 0 18 19$	„	$\bar{3}\cdot7265767$

Sum = Log tan $\tfrac{1}{2}(A_1 + A_2) = + \bar{3}\cdot7906776$

$\tfrac{1}{2}(A_1 + A_2) = + 0° 21' 14''$

$\tfrac{1}{2}(A_1 - A_2) = + 3 34 20$

$A_1 = + 3 55 34$

$A_2 = - 3 13 6$

Azimuth of R. M. from north $= A_1 - M_1 = - 0 1 19$

„ „ $= A_2 - M_2 = - 0 1 20$

Page 82. For the para. "There are two triangles * * * must be neglected," read "There are two triangles fulfilling the given conditions, one of which may however make c either greater than 180° or negative and must therefore be neglected."

The foot-note to the Star Charts following page 86 which were originally published in 1873 is wrong. Some Stars whose names are under-lined no longer find place in the Nautical Almanac, whilst several Nautical Almanac Stars are not under-lined on the Chart.

DEHRA DÚN,
4th January, 1889.

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