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OF

SURVEYING:



INCLUDING A DESCRIPTION OF THE INSTRUMENTS
AND THE NECESSARY TABLES

48,920.



BY CHARLES DAVIES,

PROFESSOR OF MATHEMATICS IN THE MILITARY ACADEMY, AND
AUTHOR OF THE COMMON SCHOOL ARITHMETIC, ELEMENTS
OF DESCRIPTIVE GEOMETRY, AND A TREATISE ON
SHADOWS AND PERSPECTIVE.

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1835.

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ELEMENTS OF SURVEYING.



P R E F A C E .

THE Elements of Surveying, published by the author in 1830, was designed especially as a text-book for the Military Academy, and in its preparation little regard was had to the supposed wants of other Institutions.

It was not the aim of the author to make it so elementary as to admit of its introduction into academies and schools, and he did not, therefore, anticipate for it an extensive circulation.

It has been received, however, with more favor than was anticipated, and this circumstance has induced the author to re-write the entire work. In doing so, he has endeavored to make it both plain and practical.

It has been the intention to begin with the very elements of the subject, and to combine those elements in the simplest manner, so as to render the higher branches of plane-surveying comparatively easy.

All the instruments needed for plotting have been carefully described; and the uses of those required for the measurement of angles are fully explained.

The conventional signs adopted by the Topographical Bureau, and which are now used by the United States Engineers in all their charts and maps, are given in plates 5 and 6.

Should these signs be generally adopted in the country, it would give entire uniformity to all maps and delineations of ground, and would establish a kind of language by which all the peculiarities of soil and surface could be accurately represented.

An account is also given of the manner of surveying the public lands; and although the method is simple, it has, nevertheless, been productive of great results, by defining, with mathematical precision, the boundaries of lands in the new States, and thus settling their titles on an indisputable basis.

The method was originated by Col. Jared Mansfield, whose great acquirements in science introduced him to the notice of President Jefferson, by whom he was appointed surveyor-general of the North-Western Territory.

May it be permitted to one of his pupils, and a graduate of the Military Academy, further to add, that at the organization of the institution in 1812, he was appointed Professor of Natural and Experimental Philosophy. This situation he filled for sixteen years, when he withdrew from the academy to spend the evening of his life in retirement and study. His pupils, who had listened to his instructions with delight, who honored his learning and wisdom, and had been brought near to him by his kind and simple manners, have placed his portrait in the public library, that the institution might possess an enduring memorial of one of its brightest ornaments and distinguished benefactors.

Military Academy,
West Point, 1835.

CONTENTS.

INTRODUCTION.

CHAPTER I.

	Page
Of Logarithms,	9
Table of Logarithms,	11
Multiplication by Logarithms,	16
Division by Logarithms,	17
Arithmetical Complement,	18

CHAPTER II.

Description of Instruments,	19
Of the Dividers,	20
Ruler and Triangle,	ib.
Scale of Equal Parts,	21
Diagonal Scale of Equal Parts,	22
Scale of Chords,	23
Semicircular Protractor,	24
Sectoral Scale of Equal Parts,	25
Gunter's Scale,	26
Solution of Problems,	27

CHAPTER III.

Plane Trigonometry,	32
Table of Logarithmic Signs,	35
Solution of Right-angled Triangles,	47

ELEMENTS OF SURVEYING.

CHAPTER I.

Definitions and Introductory Remarks,	49
---	----

CHAPTER II

	Page
Of the Measurement and Calculation of Lines and Angles,	51
To Measure a Horizontal Line,	52
Of the Theodolite,	53
Heights and Distances,	64
Of Measurements with the Tape or Chain,	72
Surveying Cross,	74

CHAPTER III.

Of the Content of Ground,	77
Of Laying Out and Dividing Land,	87

CHAPTER IV.

Surveying with the Compass,	89
Of the Compass,	90
Field Notes,	94
Traverse Table,	96
Of Balancing the Work,	98
Of the Double Meridian Distances of the Courses,	100
Of the Area,	102
First Method of Plotting,	105
Second Method of Plotting,	ib.
Method of Surveying the Public Lands,	114
Variation of the Needle,	115
Of the Plain-Table,	121

CHAPTER V.

Of Levelling,	125
Of the Level,	128
Of the Levelling Staves,	131

CHAPTER VI.

Of the Contour of Ground,	136
-------------------------------------	-----

CHAPTER VII.

Of Surveying Harbours,	147
To Fix the Principal Points,	ib.
Manner of Using the Compass,	151
Of the Circular Protractor,	153
First Method of Plotting,	154
Second Method of Plotting,	155
Surveying a Harbour for the purpose of determining the depth of water, &c.	156

INTRODUCTION.

CHAPTER I.

Of Logarithms.

1. The nature and properties of the logarithms in common use, will be readily understood, by considering attentively the different powers of the number 10. They are,

$$\begin{aligned}10^0 &= 1 \\10^1 &= 10 \\10^2 &= 100 \\10^3 &= 1000 \\10^4 &= 10000 \\10^5 &= 100000 \\&\&c. \quad \&c.\end{aligned}$$

It is plain, that the *indices* or *exponents* 0, 1, 2, 3, 4, 5, &c. form an arithmetical series of which the common difference is 1; and that the numbers 1, 10, 100, 1000, 10000, 100000, &c. form a geometrical series of which the common ratio is 10. The number 10, is called the *base* of the system of logarithms; and the *indices*, 0, 1, 2, 3, 4, 5, &c., are the logarithms of the numbers which are produced by raising 10 to the powers denoted by those indices.

2. Let a denote the base of the system of logarithms, m any exponent, and \mathcal{M} the corresponding number: we shall then have,

$$a^m = \mathcal{M}$$

in which m is the logarithm of \mathcal{M} .

If we take a second exponent n , and let \mathcal{N} denote the corresponding number, we shall have,

$$a^n = \mathcal{N}$$

in which n is the logarithm of \mathcal{N} .

If now, we multiply the first of these equations by the second, member by member, we have

$$a^m \times a^n = a^{m+n} = \mathcal{M} \times \mathcal{N};$$

but since a is the base of the system, $m+n$ is the logarithm $\mathcal{M} \times \mathcal{N}$; hence,

The sum of the logarithms of any two numbers is equal to the logarithm of their product.

Therefore, *the addition of logarithms corresponds to the multiplication of their numbers.*

3. If we divide the equations by each other, member by member, we have,

$$\frac{a^m}{a^n} = a^{m-n} = \frac{\mathcal{M}}{\mathcal{N}};$$

but since a is the base of the system, $m-n$ is the logarithm of $\frac{\mathcal{M}}{\mathcal{N}}$ hence :

If one number be divided by another, the logarithm of the quotient will be equal to the logarithm of the dividend diminished by that of the divisor.

Therefore, *the subtraction of logarithms corresponds to the division of their numbers.*

4. Let us examine further the equations

$$\begin{aligned} 10^0 &= 1 \\ 10^1 &= 10 \\ 10^2 &= 100 \\ 10^3 &= 1000 \\ &\&c. \quad \&c. \end{aligned}$$

It is plain that the logarithm of 1 is 0, and that the logarithms of all the numbers between 1 and 10, are greater than 0 and less than 1. They are generally expressed by decimal fractions : thus,

$$\log 2 = 0.301030.$$

The logarithms of all numbers greater than 10 and less than 100, are greater than 1 and less than 2, and are generally expressed by 1 and a decimal fraction : thus,

$$\log 50 = 1.698970.$$

The logarithms of numbers greater than 100 and less than 1000, are greater than 2 and less than 3, and are generally expressed by uniting 2 with a decimal fraction ; thus,

$$\log 126 = 2.100371.$$

The part of the logarithm which stands on the left of the decimal point, is called the *characteristic* of the logarithm.

The characteristic is always *one less than the places of integer figures in the number whose logarithm is taken.*

Thus, in the first case, for numbers between 1 and 10, there is but one place of figures, and the characteristic is 0. For numbers between 10 and 100, there are two places of figures, and the characteristic is 1; and similarly for other numbers.

TABLE OF LOGARITHMS.

5. A table of logarithms, is a table in which are written the logarithms of all numbers between 1 and some other given number. The logarithms of all numbers between 1 and 10,000 are written in the annexed table.

6. The first column on the left of each page of the table, is the column of numbers, and is designated by the letter \mathcal{N} ; the logarithms of these numbers are placed directly opposite them, and on the same horizontal line.

To find, from the table, the logarithm of any number.

7. If the number is less than 100, look on the first page of the table, along the column of numbers under \mathcal{N} , until the number is found: the number directly opposite, in the column designated log, is the logarithm sought. Thus,

$$\log 9 = 0.954243.$$

When the number is greater than 100, and less than 10,000.

8. Since the characteristic of every logarithm is less by unity than the places of integer figures in its corresponding number (Art. 4), its value is known by a simple inspection of the number whose logarithm is sought. Hence, it has not been deemed necessary to write the characteristics in the table.

To obtain the decimal part of the logarithm, find, in the column of numbers, the first three figures of the given number. Then, pass across the page, along a horizontal line, into the columns marked 0, 1, 2, 3, 4, 5, &c., until you come to the column which is designated by the fourth figure of the given number: at this place there are four figures of the required logarithm. To the four figures so found, two figures taken from the column marked 0, are to be prefixed. If the four figures thus found, stand opposite to a row of six figures in the column marked 0, the two figures from this column, which are to be prefixed, are the first two on the left hand: but if

the four figures found are opposite a line of only four figures, you are then to ascend the column till you come to the line of six figures; the two figures, at the left hand, are to be prefixed, and then the decimal part of the logarithm is obtained; to which prefix the characteristic, and you have the entire logarithm sought. For example,

$$\log 1122 = 3.049993$$

$$\log 8979 = 3.953228$$

In several of the columns, designated 0, 1, 2, 3, 4, &c., small dots are found. When the logarithm falls at such places, a cipher must be written for each of the dots, and the two figures, from the column 0, which are to be prefixed, are then found in the horizontal line directly below.

Thus, $\log 2188 = 3.340047$

the two dots being changed into two ciphers, and the 34 to be taken from the column 0, is found in the horizontal line directly below.

The two figures from the column 0, must also be taken from the horizontal line below, *if any dots shall have been passed over*, in passing along the horizontal line: thus,

$$\log 3098 = 3.491081$$

the 49 from the column 0, being taken from the line 310.

When the number exceeds 10,000, or is expressed by five or more figures.

9. Consider all the figures, after the fourth from the left hand, as ciphers. Find from the table the logarithm of the first four figures, and to it prefix a characteristic less by unity than all the places of figures in the given number. Take from the last column on the right of the page, marked *D*, the number on the same horizontal line with the logarithm, and multiply this number by the figures that have been considered as ciphers: then cut off from the right hand as many places for decimals as there are figures in the multiplier, and add the product so obtained to the first logarithm, and the sum will be the logarithm sought.

Let it be required, for example, to find the logarithm of 672887.

$$\log 672800 = 5.827886$$

the characteristic being 5, since there are six places of figures. The corresponding number, in the column *D* is 65, which

and a decimal, such as 36.78, it may be put under the form $\frac{3678}{100}$. But since a fraction is equal to the quotient obtained by dividing the numerator by the denominator, its logarithm will be equal to the logarithm of the numerator minus the logarithm of the denominator. Therefore,

$$\log \frac{3678}{100} = \log 3678 - \log 100 = 3.565612 - 2 = 1.565612$$

from which we see, that a mixed number may be treated as though it were entire, except in fixing the value of the characteristic, which is always *one less than the number of the integer figures*.

12. The logarithm of a decimal fraction is also readily found. For,

$$\log 0.8 = \log \frac{8}{10} = \log 8 - 1 = -1 + \log 8. \quad \text{But,}$$

$$\log 8 = 0.903090$$

which is positive and less than 1. Therefore,

$$\log 0.8 = -1 + 0.903090 = -1.903090$$

in which, however, *the minus sign belongs only to the characteristic*. Hence it appears, that the logarithm of tenths is the same as the logarithm of the corresponding whole number, excepting, that the characteristic instead of being 0, is -1 .

If the fraction were of the form 0.06 it might be written $\frac{06}{100}$; taking the logarithms, we have,

$$\log \frac{06}{100} = \log 06 - 2 = -2 + \log 06 = -2.778151$$

in which the minus sign, as before, belongs only to the characteristic. If the decimal were 0.006 its logarithm would be the same as before, excepting the characteristic, which would be -3 . It is, indeed, evident, that the negative characteristic will always be one greater than the number of ciphers between the decimal point and the first significant figure. Therefore, the logarithm of a decimal fraction is found, *by considering it as a whole number, and then prefixing to the decimal part of its logarithm a negative characteristic greater by unity than the number of ciphers between the decimal point and the first significant figure*.

That we may not, for a moment, suppose the negative sign to belong to the whole logarithm, when in fact it belongs only to the characteristic, we place the sign above the characteristic, thus,

$$\log 0.8 = \bar{1}.903090, \text{ and } \log 0.06 = \bar{2}.778151.$$

EXAMPLES.

log 2756	.	.	.	is	.	.	.	3.440279
log 3270	.	.	.	is	.	.	.	3.514548
log 287.965	.	.	.	is	.	.	.	2.459340
log 1.004	.	.	.	is	.	.	.	0.001734
log 0.002	.	.	.	is	.	.	.	$\bar{3}.301030$
log 0.000678	.	.	.	is	.	.	.	$\bar{4}.831230$

To find in the table, the number answering to a given logarithm.

13. Search in the columns of logarithms for the decimal part of the given logarithm, and if it can be exactly found, set down the corresponding number. Then, if the characteristic of the given logarithm is positive, point off from the left of the number found, one more place for whole numbers than there are units in the characteristic of the given logarithm, and treat the figures to the right as decimals.

If the characteristic of the given logarithm is 0, there will be one place of whole numbers; if it is -1 , the number will be entirely decimal; if it is -2 , there will be one cipher between the decimal point and the first significant figure; if it is -3 , there will be two, &c

The number whose logarithm is 1.492481, is found at page 5, and is 31.08.

But when the decimal part of the logarithm cannot be exactly found in the table, take the number answering to the nearest less logarithm; take also from the table the corresponding difference in the column *D*. Then, subtract this less logarithm from the given logarithm, and having annexed any number of ciphers to the remainder, divide it by the difference taken from the column *D*, and annex the quotient to the number answering to the less logarithm: this gives the required number, nearly. This rule, like that for finding the logarithm of a number when the places of figures exceed four, supposes the numbers to be proportional to their corresponding logarithms.

1. Find the number answering to the logarithm 1.532708.

Given logarithm is	.	.	.	1.532708
Next less tabular logarithm is				1.532627
Their difference is	.	.	.	<u>81</u>

The number corresponding to the tabular logarithm is 34.09
 And the tabular difference is 128 :
 and, 128)81.00(63

The 63 being annexed to the tabular number 34.09 gives 34.0963 for the number answering to the logarithm 1.532708.

2. Required the number answering to the logarithm 3.233568.

The given logarithm is 3.233568

Next less tabular logarithm of 1712 is 3.233504

Their difference is 64

Tabular difference . 253)64.00(25

Hence the number sought, is 1712.25, marking four places for integers since the characteristic is 3.

MULTIPLICATION BY LOGARITHMS.

14. When it is required to multiply numbers by means of their logarithms, we first find from the table the logarithms of the numbers to be multiplied; we next add these logarithms together, and their sum is the logarithm of the product of the numbers (Art. 2).

The term *sum* is to be understood in its algebraic sense; therefore, if any of the logarithms have negative characteristics, the difference between their sum and that of the positive characteristics, is to be taken, and the sign of the greater prefixed.

EXAMPLES.

1. Multiply 23.14 by 5.062.

$$\log 23.14 = 1.364363$$

$$\log 5.062 = 0.704322.$$

$$\text{Product } 117.1347 \dots \underline{2.068685}$$

2. Multiply 3.902, 597.16 and 0.0314728 together.

$$\log 3.902 = 0.591287$$

$$\log 597.16 = 2.776091$$

$$\log 0.0314728 = \bar{2}.497936$$

$$\text{Product } 73.3354 \dots \underline{1.865314}$$

Here the $\bar{2}$ cancels the +2, and the 1 carried from the decimal part is set down.

3. Multiply 3.586, 2.1046, 0.8372, and 0.0294, together.

$$\log 3.586 = 0.554610$$

$$\log 2.1046 = 0.323170$$

$$\log 0.8372 = \bar{1}.922829$$

$$\log 0.0294 = \bar{2}.468347$$

$$\text{Product } 0.1857615 \quad . \quad . \quad \underline{\underline{\bar{1}.268956.}}$$

In this example the 2, carried from the decimal part, cancels $\bar{2}$, and there remains $\bar{1}$ to be set down.

DIVISION OF NUMBERS BY LOGARITHMS.

15. When it is required to divide numbers by means of their logarithms, we have only to recollect, that the subtraction of logarithms corresponds to the division of their numbers (Art. 3). Hence, if we find the logarithm of the dividend, and from it subtract the logarithm of the divisor, the remainder will be the logarithm of the quotient.

This additional caution may be added. The difference of the logarithms, as here used, means the *algebraic difference*; so that, if the logarithm of the divisor have a negative characteristic its sign must be changed to positive, after diminishing it by the unit, if any, carried in the subtraction from the decimal part of the logarithm. Or, if the characteristic of the logarithm of the dividend is negative, it must be treated as a negative number.

EXAMPLES.

1. To divide 24163 by 4567.

$$\log 24163 = 4.383151$$

$$\log 4567 = 3.659631$$

$$\text{Quotient } 5.29078 \quad . \quad . \quad \underline{\underline{0.723520.}}$$

2. To divide 0.6314 by .007241

$$\log 0.6314 = \bar{2}.800305$$

$$\log 0.007241 = \bar{3}.859799$$

$$\text{Quotient } . \quad . \quad 8.7198 \quad . \quad . \quad \underline{\underline{0.940506}}$$

Here, 1 carried from the decimal part to the $\bar{3}$ changes it to $\bar{2}$, which being taken from $\bar{2}$, leaves 0 for the characteristic.

3. To divide 37.149 by 523.76

$$\log 37.149 = 1.569947$$

$$\log 523.76 = 2.719133$$

$$\text{Quotient } . \quad 0.0709274 \quad . \quad \underline{\underline{\bar{2}.858104}}$$

4. To divide 0.7438 by 12.9476

$$\log 0.7438 = \bar{1}.871456$$

$$\log 12.9476 = 1.112189$$

$$\text{Quotient } 0.057447 \quad . \quad . \quad \underline{\underline{2.759267}}$$

Here, the 1 taken from $\bar{1}$, gives $\bar{2}$ for a result, as set down.

ARITHMETICAL COMPLEMENT.

16. The *Arithmetical complement* of a logarithm is the number which remains after subtracting this logarithm from 10.

$$\text{Thus } . \quad . \quad 10 - 9.274687 = 0.725313.$$

Hence, 0.725313 is the arithmetical complement of 9.274687.

17 We will now show that, *the difference between two logarithms is truly found, by adding to the first logarithm the arithmetical complement of the logarithm to be subtracted, and then diminishing the sum by 10.*

Let a = the first logarithm

b = the logarithm to be subtracted

and $c = 10 - b$ = the arithmetical complement of b .

Now the difference between the two logarithms will be expressed by $a - b$.

But, from the equation $c = 10 - b$, we have

$$c - 10 = -b$$

hence, if we place for $-b$ its value, we shall have

$$a - b = a + c - 10$$

which agrees with the enunciation.

When we wish the arithmetical complement of a logarithm, we may write it directly from the table, *by subtracting the left hand figure from 9, then proceeding to the right, subtract each figure from 9 till we reach the last significant figure, which must be taken from 10: this will be the same as taking the logarithm from 10.*

EXAMPLES.

1. From 3.274107 take 2.104729.

By common method.

$$3.274107$$

$$2.104729$$

its ar. comp.

$$\text{Diff. } \underline{\underline{1.169378}}$$

subtracting 10.

By arith. comp.

$$3.274107$$

$$7.895271$$

$$\text{Sum } \underline{\underline{1.169378}} \text{ after}$$

Hence, to perform division by means of the arithmetical complement we have the following

RULE.

To the logarithm of the dividend add the arithmetical complement of the logarithm of the divisor : the sum, after subtracting 10, will be the logarithm of the quotient.

EXAMPLES.

1. Divide 327.5 by 22.07.

log 327.5	.	.	2.515211
log 22.07	ar. comp.		8.656198
Quotient	.	.	<u>1.171409</u>

2. Divide 0.7438 by 12.9476.

log 0.7438	.	.	1.871456
log 12.9476	ar. comp.		8.887811
Quotient	.	.	<u>2.759267</u>

In this example, the sum of the characteristics is 8, from which, taking 10, the remainder is $\bar{2}$.

3. Divide 37.149 by 523.76

log 37.149	.	.	1.569947
log 523.76	ar. comp.		7.280867
Quotient	.	.	<u>2.850814</u>

CHAPTER II.

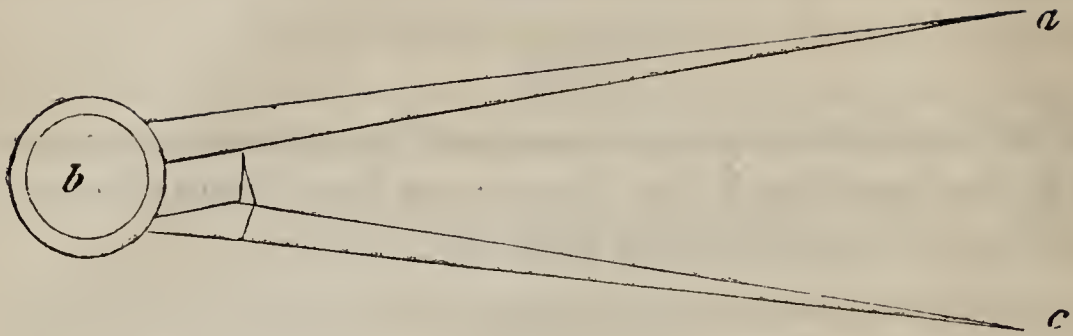
Description of the Instruments used for Delineating or Drawing Lines and Angles on paper. Construction of Problems.

18. Drawings, or delineations on paper, are the copies of things which they are intended to represent.

In order that these copies may be exact, their different parts must bear the same proportion to each other that exists between the corresponding parts of the things themselves.

To enable us to delineate lines and angles correctly, upon paper, certain instruments are necessary ; these we will now describe.

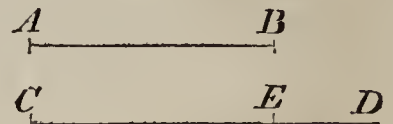
DIVIDERS.



19. The dividers is the most simple and useful of the instruments used for drawing. It consists of two legs ba , bc , which may be easily turned around a joint at b .

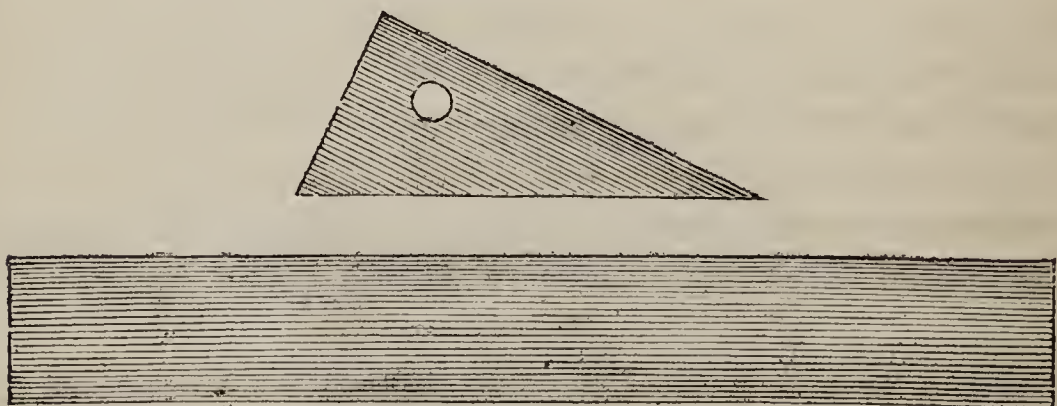
One of the principal uses of this instrument is to lay off on a line, a distance equal to a given line.

For example, to lay off on CD a distance equal to AB .



For this purpose, place the forefinger on the joint of the dividers, and set one foot at A : then extend, with the thumb and other fingers, the other leg of the dividers, until its foot reaches the point B . Then raise the dividers, place one foot at C , and mark with the other the distance CE : this will evidently be equal to AB .

RULER AND TRIANGLE.



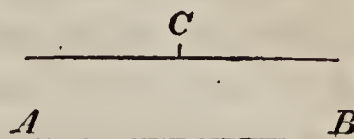
20. A Ruler of a convenient size, is about twenty inches in length, two inches wide, and a fifth of an inch in thickness. It should be made of a hard material, perfectly straight and smooth.

The hypotenuse of the right-angled triangle, which is used in connexion with it, should be about ten inches in

length, and it is most convenient to have one of the sides considerably longer than the other. We can solve, with the ruler and triangle, the two following problems.

I. *To draw through a given point a line which shall be parallel to a given line.*

Let C be the given point, and AB the given line.

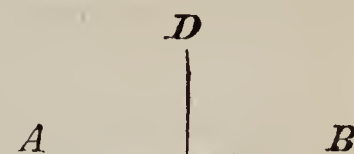


Place the hypotenuse of the triangle against the edge of the ruler, and then place the ruler and triangle on the paper, so that one of the sides of the triangle shall coincide exactly with AB : the triangle being below the line.

Then placing the thumb and fingers of the left hand firmly on the ruler, slide the triangle with the other hand along the ruler until the side which coincided with AB reaches the point C . Leaving the thumb of the left hand on the ruler, extend the fingers upon the triangle and hold it firmly, and with the right hand, mark with a pen or pencil, a line through C : this line will be parallel to AB .

II. *To draw through a given point a line which shall be perpendicular to a given line.*

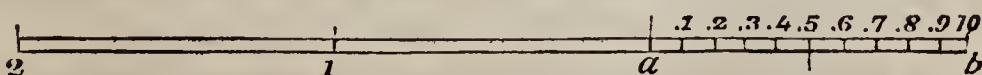
Let AB be the given line, and D the given point.



Place the hypotenuse of the triangle against the edge of the ruler, as before.

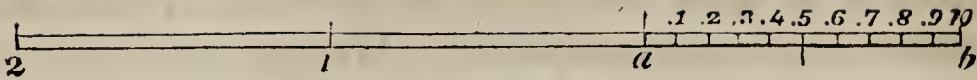
Then place the ruler and triangle so that one of the sides of the triangle shall coincide exactly with the line AB . Then slide the triangle along the ruler until the other side reaches the point D : draw through D a right line, and it will be perpendicular to AB .

SCALE OF EQUAL PARTS.



21. A scale of equal parts is formed by dividing a line of a given length into equal portions.

If, for example, the line ab of a given length, say one inch, be divided into any number of equal parts, as 10, the scale thus formed, is called a scale of ten parts to the inch. The line

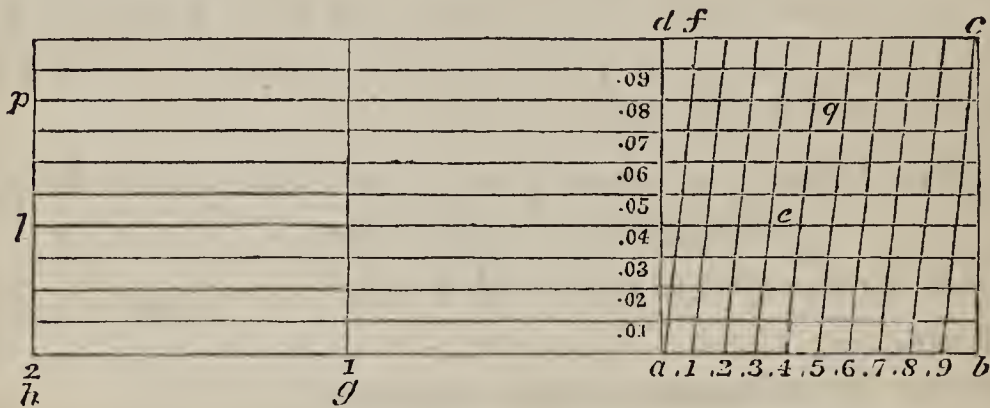


ab , which is divided, is called the *unit of the scale*. This unit is laid off several times on the left of the divided line, and the points marked, 1, 2, 3, &c.

The unit of scales of equal parts, is, in general, either an inch, or an exact part of an inch. If, for example, ab the unit of the scale, were half an inch, the scale would be one of 10 parts to half an inch, or of 20 parts to the inch.

If it were required to take from the scale a line equal to two inches and six-tenths, place one foot of the dividers at 2 on the left, and extend the other to .6, which marks the sixth of the small divisions: the dividers will then embrace the required distance.

DIAGONAL SCALE OF EQUAL PARTS.



22. This scale is thus constructed. Take ab for the unit of the scale, which may be one inch, $\frac{1}{2}$, $\frac{1}{4}$ or $\frac{3}{4}$ of an inch, in length. On ab describe the square $abcd$. Divide the sides ab and dc each into ten equal parts. Draw af and the other nine parallels as in the figure.

Produce ba to the left, and lay off the unit of the scale any convenient number of times, and mark the point 1, 2, 3, &c. Then, divide the line ad into ten equal parts, and through the points of division draw parallels to ab as in the figure.

Now, the small divisions of the line ab are each one-tenth (.1) of ab ; they are therefore .1 of ad , or .1 of ag or gh .

If we consider the triangle adf , the base df is one-tenth of ad the unit of the scale. Since the distance from a to the first horizontal line above ab , is one-tenth of the distance ad , it follows that the distance measured on that line between ad

and af is one-tenth of df : but since one-tenth of a tenth is a hundredth, it follows that this distance is one hundredth (.01) of the unit of the scale. A like distance measured on the second line will be two hundredths (.02) of the unit of the scale; on the third, .03; on the fourth, .04, &c.

If it were required to take, in the dividers, the unit of the scale, and any number of tenths, place one foot of the dividers at 1, and extend the other to that figure between a and b which designates the tenths. If two or more units are required, the dividers must be placed on a point of division farther to the left.

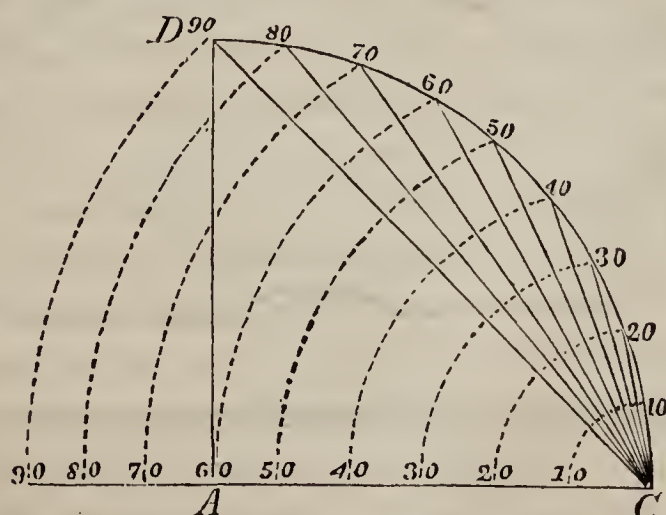
When units, tenths, and hundredths, are required, place one foot of the dividers where the vertical line through the point which designates the units, intersects the line which designates the hundredths: then, extend the dividers to that line between ad and bc which designates the tenths: the distance so determined will be the one required.

For example, to take off the distance 2.34, we place one foot of the dividers at l , and extend the other to e : and to take off the distance 2.58, we place one foot of the dividers at p and extend the other to q .

REMARK I. If a line is so long that the whole of it cannot be taken from the scale, it must be divided, and the parts of it taken from the scale in succession.

REMARK II. If a line be given upon the paper, its length can be found by taking it in the dividers and applying it to the scale.

SCALE OF CHORDS.



23. If, with any radius, as AC , we describe the quadrant CD , and then divide it into 90 equal parts, each part is called a degree.

Through C , and each point of division, let a chord be drawn, and let the lengths of these chords be accurately laid off on a scale: such a scale is called a *scale of chords*. In the figure, the chords are drawn for every ten degrees.

The scale of chords being once constructed, the radius of the circle from which the chords were obtained, is known; for, the chord marked 60 is always equal to the radius of the circle. A scale of chords is generally laid down on the scales which belong to cases of mathematical instruments, and is marked CHO.

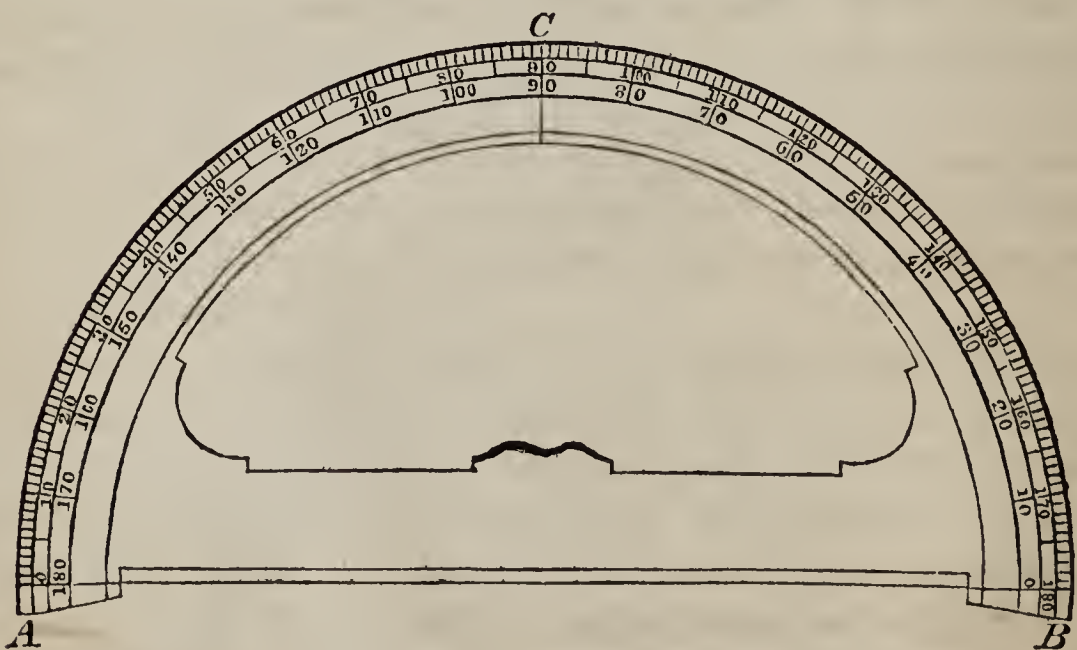
To lay off, at a given point of a line, with the scale of chords, an angle equal to a given angle.

Let AB be the line, and A the given point.

Take from the scale the chord of 60 degrees, and with this radius and the point A as a centre, describe the arc BC . Then take from the scale the chord of the given angle, say 30 degrees, and with this line as a radius, and B as a centre, describe an arc cutting BC in C . Through A and C draw the line AC , and BAC will be the required angle.



SEMICIRCULAR PROTRACTOR.



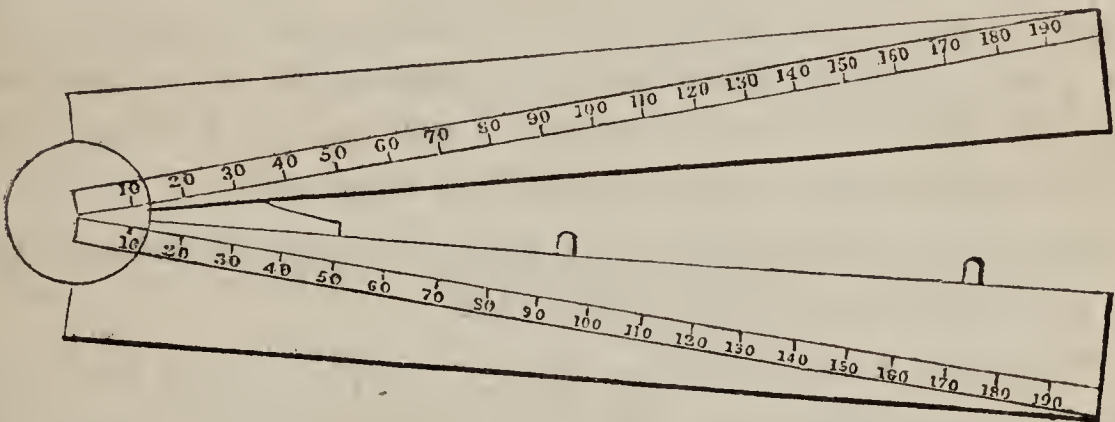
24. This instrument is used to lay down, or protract angles. It may also be used to measure angles included between lines already drawn upon paper.

It consists of a brass semicircle ABC divided to half degrees. The degrees are numbered from 0 to 180, both ways; that is, from A to B and from B to A . The divisions, in the figure, are only made to degrees. There is a small notch at the middle of the diameter AB , which indicates the centre of the protractor.

To lay off an angle with a Protractor.

Place the diameter AB on the line, so that the centre shall fall on the angular point. Then count the degrees contained in the given angle from A towards B , or from B towards A and mark the extremity of the arc with a pin. Remove the protractor, and draw a line through the point so marked and the angular point: this line will make with the given line the required angle.

SECTORAL SCALE OF EQUAL PARTS.



25. The sector is an instrument generally made of ivory or brass. It consists of two arms, or sides, which open by turning round a joint at their common extremity.

There are several scales laid down on the sector: those, however, which are chiefly used in drawing lines and angles, are, the scale of chords already described, and the scale of equal parts now to be explained.

On each arm of the sector, there is a diagonal line that passes through the point about which the arms turn: these diagonal lines are divided into equal parts.

On the sectors which belong to the cases of English instruments, the diagonal lines are designated by the letter L , and numbered from the centre of the sector, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, to the two extremities. On the sectors which belong

to cases of French instruments, they are designated, "Les parties egales," and numbered, 10, 20, 30, 40, &c. to 200. On the English sectors there are 20 equal divisions between either two of the lines numbered 1, 2, 3, &c., so that, there are 200 equal parts on the scale.

The advantage of the sectoral scale of equal parts, is this—

When it is proposed to draw a line upon paper, on such a scale that any number of parts of the line, 40 for example, shall be represented by one inch on the paper, or by any part of an inch, take the inch, or part of the inch from the scale of inches on the sector: then, placing one foot of the dividers at 40 on one arm of the sector, open the sector until the other foot reaches to the corresponding number on the other arm: then lay the sector on the table without varying the angle.

Now, if we regard the lines on the sector as the sides of a triangle, of which the line 40 measured across, is the base, it is plain, that if any other line be likewise measured across the angle of the sector, the bases of the triangles, so formed, will be proportional to their sides. Therefore, if we extend the dividers from 50 to 50, this distance will represent a line of 50, to the given scale: and similarly for other lines.

Let it now be required to lay down a line of sixty-seven feet, to a scale of twenty feet to the inch.

Take one inch from the scale of inches: then place one foot of the dividers at the twentieth division, and open the sector until the dividers will just reach the twentieth division on the other arm: the sector is then set to the proper angle; after which the required distance to be laid down on the paper, is found, by extending the dividers from the sixty-seventh division on one arm, to the sixty-seventh division on the other.

GUNTERS' SCALE.

26. This is a scale of two feet in length, on the faces of which a variety of scales are marked. The face on which the divisions of inches are made, contains, however, all the scales necessary for laying down lines and angles. These are, the scale of equal parts, the diagonal scale of equal parts, and the scale of chords, all of which have been described.

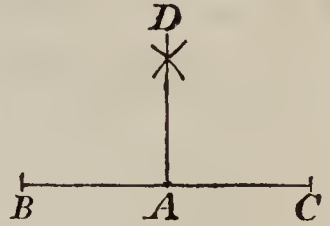
SOLUTION OF PROBLEMS REQUIRING THE USE OF THE INSTRUMENTS THAT HAVE BEEN DESCRIBED.

PROBLEM I.

At a given point in a given straight line, to erect a perpendicular to the line.

27. Let A be the given point, and BC the given line.

From A lay off any two distances AB and AC equal to each other. Then, from the points B and C , as centres, with a radius greater than BA , describe two arcs intersecting each other in D : draw AD , and it will be the perpendicular required.

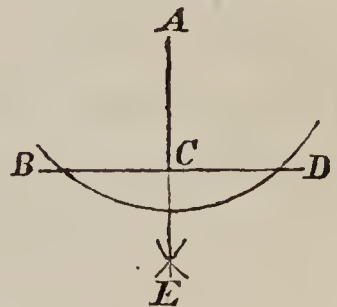


PROBLEM II.

From a given point without a straight line, to let fall a perpendicular on the line.

28. Let A be the given point and BD the given line.

From the point A as a centre, with a radius sufficiently great, describe an arc cutting the line BD in the two points B and D : then mark a point E , equally distant from the points B and D , and draw AE : AE will be the perpendicular required.

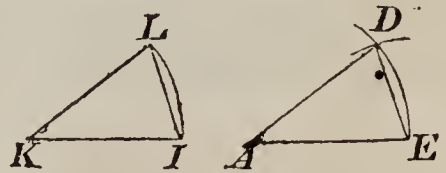


PROBLEM III.

At a point, in a given line, to make an angle equal to a given angle.

29. Let A be the given point, AE the given line, and IKL the given angle.

From the vertex K , as a centre, with any radius, describe the arc IL , terminating in the two sides of the angle. From the point A as a centre, with a distance AE equal to KI , describe the arc ED ; then take the chord LI , with which, from the point E as a centre, describe an arc cutting the indefinite arc DE , in D ; draw AD , and the angle EAD will be equal to the given angle K .

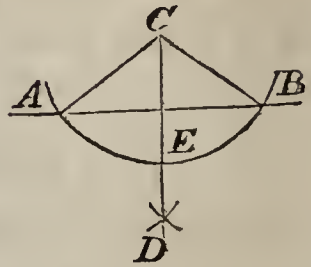


PROBLEM IV.

To divide a given angle, or a given arc, into two equal parts.

30. Let C be the given angle, and AEB the arc which measures it.

From the points A and B as centres, describe with the same radius two arcs cutting each other in D : through D and the centre C draw CD : the angle ACE will be equal to the angle ECB , and the arc AE to the arc EB .

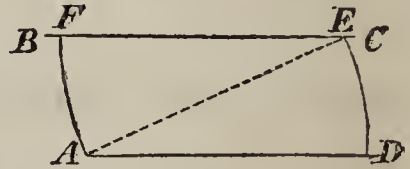


PROBLEM V.

Through a given point to draw a parallel to a given line.

31. Let A be the given point, and BC the given line.

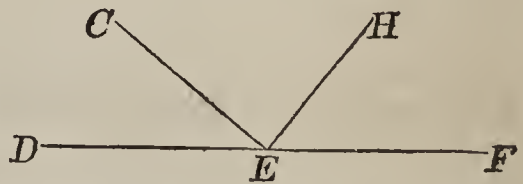
From A as a centre, with a radius greater than the shortest distance from A to BC , describe the indefinite arc ED : from the point E as a centre, with the same radius, describe the arc AF ; make $ED = AF$, and draw AD : then will AD be the parallel required.



PROBLEM VI.

Two angles of a triangle being given, to find the third.

32. Draw the indefinite line DEF . At the point E , make the angle DEC equal to one of the given angles, and the angle CEH equal to the other: the remaining angle HEF will be the third angle required.



PROBLEM VII.

To lay down, on paper, a line of a given length, so that any number of its parts shall correspond to the unit of the scale.

33. Suppose that the given line were 75 feet in length, and it were required to draw it on paper, on a scale of 25 feet to the inch.

The length of the line 75 feet, being divided by 25, will give 3, the number of inches which will represent the line on paper

Therefore, draw the indefinite line AB , on which lay off a



distance AC equal to 3 inches: AC will represent the given line of 75 feet drawn to the required scale.

REMARK I. This problem explains the manner of laying down a line upon paper, in such a manner that a given number of parts shall correspond to the unit of the scale, whether that unit be an inch or any part of an inch.

When the length of the line to be laid down is given, and it has been determined how many parts of it are to be represented on the paper by a distance equal to the unit of the scale, we find the length which is to be taken from the scale by the following

RULE.

Divide the length of the line by the number of parts which is to be represented by the unit of the scale: the quotient will show the number of parts which is to be taken from the scale.

EXAMPLES.

1. If a line of 640 feet in length is to be laid down on paper, on a scale of 40 feet to the inch; what length must be taken from the scale?

$$40)640(16 \text{ inches.}$$

2. If a line of 357 feet is to be laid down on a scale of 68 feet to the unit of the scale, (which we will suppose half an inch), how many parts are to be taken?

$$\text{Ans. } \left\{ \begin{array}{l} 5.25, \text{ parts, or} \\ 2.625 \text{ inches.} \end{array} \right.$$

REMARK II. When the length of a line is given on the paper, and it is required to find the true length of the line which it represents, take the line in the dividers and apply it to the scale, and note the number of units, and parts of an

unit to which it is equal. Then multiply this number by the number of parts which the unit of the scale represents, and the product will be the length of the line.

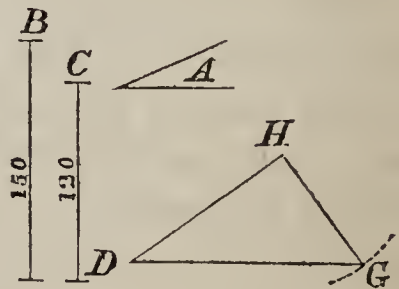
For example, suppose the length of a line drawn on the paper was found to be 3.56 inches, the scale being 40 feet to the inch : then,

$$3.55 \times 40 = 142 \text{ feet, the length of the line.}$$

PROBLEM VIII.

Having given two sides and the included angle of a triangle, to describe the triangle.

34. Let the line $B=150$ feet, and $C=120$ feet, be the given sides ; and $A=30$ degrees, the given angle : to describe the triangle on a scale of 200 feet to the inch.

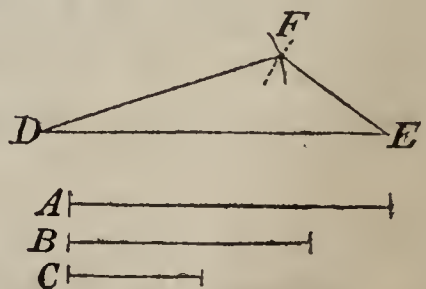


Draw the indefinite line DG , and at the point D , make the angle GDH equal to 30 degrees ; then lay off DG equal to 150, equal to three quarters of an inch, and DH equal to 120, equal to six tenths of an inch, and draw GH : DGH will be the required triangle.

PROBLEM IX.

The three sides of a triangle being given, to describe the triangle.

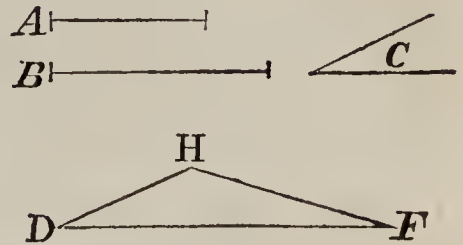
35. Let A , B and C , be the sides. Draw DE equal to the side A . From the point D as a centre, with a radius equal to the second side B , describe an arc : from E as a centre, with a radius equal to the third side C , describe another arc intersecting the former in F ; draw DF and EF , and DEF will be the triangle required.



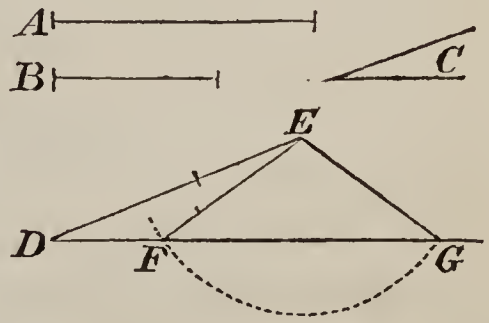
PROBLEM X.

Having given two sides of a triangle and an angle opposite one of them, to describe the triangle.

36. Let A and B be the given sides, and C the given angle which we will suppose is opposite the side B . Draw the indefinite line DF and make the angle FDH equal to the angle C : take $DH=A$, from the point H , as a centre, with a radius equal to the other given side B , describe an arc cutting DF in F ; draw HF : then will DHF be the required triangle.



If the angle C is acute, and the side B less than A , then the arc described from the centre E with the radius $EF = B$ will cut the side DF in two points, F and G , lying on the same side of D : hence there will be two triangles, DEF , and DEG , either of which will satisfy all the conditions of the problem.

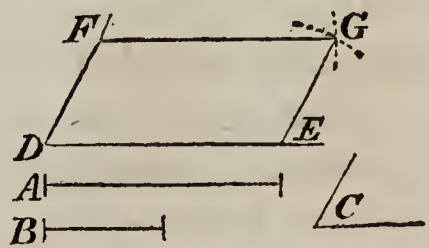


PROBLEM XI.

The adjacent sides of a parallelogram, with the angle which they contain, being given, to describe the parallelogram.

37. Let A and B be the given sides, and C the given angle.

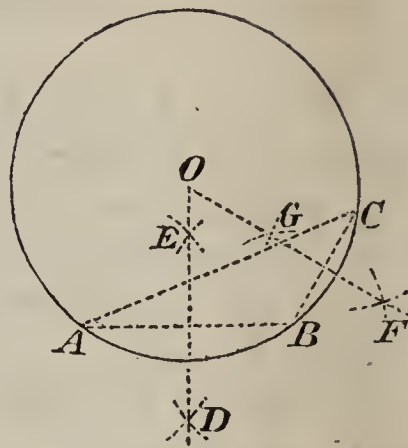
Draw the line $DE=A$; at the point D , make the angle $EDF=C$; take $DF=B$: describe two arcs, the one from F , as a centre, with a radius $FG=DE$, the other from E , as a centre, with a radius $EG=DF$; through the point G , where these arcs intersect each other, draw FG , EG ; $DEGF$ will be the parallelogram required.



PROBLEM XII.

To find the centre of a given circle or arc.

38. Take three points, A , B , C , any where in the circumference, or in the arc: draw AB , BC ; bisect these two lines by the perpendiculars, DE , FG : the point O where these perpendiculars meet will be the centre sought.



The same construction serves for making a circumference pass through three given points A , B , C , and also for describing a circumference, about a given triangle.

CHAPTER III.

Plane Trigonometry.

39. In every plane triangle there are six parts: three sides and three angles. These parts are so related to each other, that if a certain number of them are known or given, the remaining ones can be determined.

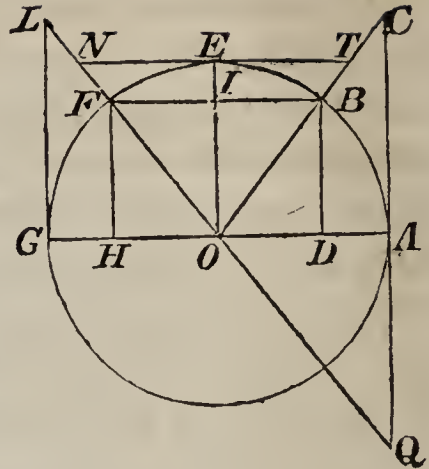
40. *Plane Trigonometry* explains the methods of finding, by calculation, the unknown parts of a triangle when a sufficient number of the six parts is given.

It has already been shown, in the problems, that triangles may be constructed when three parts are known. But these constructions, which are called *graphic methods*, though perfectly correct in theory, would give only a moderate approximation in practice, on account of the imperfection of the instruments required in constructing them.

Trigonometrical methods, on the contrary, being independent of mechanical operations, give solutions with the utmost accuracy.

41. For the purposes of trigonometrical calculations, the circumference of the circle is divided into 360 equal parts, called degrees; each degree into 60 equal parts, called minutes; and each minute into 60 equal parts, called seconds.

$\sin AB$ for BD
 $\cos AB$ for OD
 $\tan AB$ for AC
 $\sec AB$ for OC .



49. If ABE be equal to a quadrant, or 90° , then EB will be the complement of AB . Let the lines ET and IB be drawn perpendicular to OE . Then,

ET , the tangent of EB , is called the cotangent of AB ;
 IB , the sine of EB , is equal to the cosine of AB ;
 OT , the secant of EB , is called the cosecant of AB .

In general, if A is any arc or angle, we have,

$$\begin{aligned} \cos A &= \sin (90^\circ - A) \\ \cot A &= \tan (90^\circ - A) \\ \operatorname{cosec} A &= \sec (90^\circ - A) \end{aligned}$$

50. If we take an arc $ABEF$, greater than 90° , its sine will be FH ; OH will be its cosine; AQ its tangent, and OQ its secant. But FH is the sine of the arc GF , which is the supplement of AF , and OH is its cosine: hence, *the sine of an arc is equal to the sine of its supplement; and the cosine of an arc is equal to the cosine of its supplement.**

Furthermore, AQ is the tangent of the arc AF , and OQ is its secant: GL is the tangent, and OL the secant, of the supplemental arc GF . But since AQ is equal to GL , and OQ to OL , it follows that, *the tangent of an arc is equal to the tangent of its supplement; and the secant of an arc is equal to the secant of its supplement.**

Let us suppose, that in a circle of a given radius, the lengths of the sine, cosine, tangent, and cotangent, have been calculated for every minute or second of the quadrant, and arranged in a table; such a table is called a table of sines and tangents. If the radius of the circle is 1, the table is called a table of natural sines. A table of natural sines, therefore, shows the

* These relations are between the *values* of the trigonometrical lines; the algebraic signs, which they have in the different quadrants, are not considered.

values of the sines, cosines, tangents and cotangents of all the arcs of a quadrant, divided to minutes or seconds.

If the sines, cosines, tangents and secants are known for arcs less than 90° , those for arcs which are greater can be found from them. For if an arc is less than 90° , its supplement will be greater than 90° , and the values of these lines are the same for an arc and its supplement. Thus, if we know the sine of 20° , we also know the sine of its supplement 160° ; for the two are equal to each other.

TABLE OF LOGARITHMIC SINES.

51. In this table are arranged the logarithms of the numerical values of the sines, cosines, tangents and cotangents of all the arcs of a quadrant, calculated to a radius of 10,000,000,000. The logarithm of this radius is 10. In the first and last horizontal lines of each page, are written the degrees whose sines, cosines, &c. are expressed on the page. The vertical columns on the left and right, are columns of minutes.

CASE I.

To find, in the table, the logarithmic sine, cosine, tangent, or cotangent of any given arc or angle.

52. If the angle is less than 45° , look for the degrees in the first horizontal line of the different pages: then descend along the column of minutes, on the left of the page, till you reach the number showing the minutes: then pass along the horizontal line till you come into the column designated, sine, cosine, tangent, or cotangent, as the case may be: the number so indicated is the logarithm sought. Thus, on page 37, for $19^\circ 55'$ we find,

sin $19^\circ 55'$	.	.	9.532312
cos $19^\circ 55'$	.	.	9.973215
tan $19^\circ 55'$	.	.	9.559097
cot $19^\circ 55'$	.	.	10.440903

53. If the angle is greater than 45° , search for the degrees along the bottom line of the different pages: then, ascend along the column of minutes on the right hand side of the page, till you reach the number expressing the minutes: then pass along the horizontal line into the columns designated

tang, cot, sine, or cosine, as the case may be ; the number so pointed out is the logarithm required.

54. The column designated sine, at the top of the page, is designated cosine at the bottom ; the one designated tang, by cotang, and the one designated cotang, by tang.

The angle found by taking the degrees at the top of the page and the minutes from the first vertical column on the left, is the complement of the angle found by taking the corresponding degrees at the bottom of the page, and the minutes traced up in the right hand column to the same horizontal line. Therefore, sine, at the top of the page, should correspond with cosine, at the bottom ; cosine with sine, tang with cotang, and cotang with tang, as in the tables (Art. 49).

If the angle is greater than 90° , we have only to subtract it from 180° , and take the sine, cosine, tangent or cotangent of the remainder.

The column of the table next to the column of sines, and on the right of it, is designated by the letter *D*. This column is calculated in the following manner.

Opening the table at any page, as 42, the sine of 24° is found to be 9.609313 ; that of $24^{\circ} 01'$, 9.609597 : their difference is 284 ; this being divided by 60, the number of seconds in a minute, gives 4.73, which is entered in the column *D*, omitting the decimal point.

Now, supposing the increase of the logarithmic sine to be proportional to the increase of the arc, and it is nearly so for $60''$, it follows, that 473 (the last two places being regarded as decimals), is the increase of the sine for $1''$. Similarly, if the arc were $24^{\circ} 20'$ the increase of the sine for $1''$, would be 465, the last two places being decimals.

The same remarks are equally applicable in respect of the column *D*, after the column cosine, and of the column *D*, between the tangents and cotangents. The column *D*, between the columns tangents and cotangents, answers to both of these columns.

Now, if it were required to find the logarithmic sine of an arc expressed in degrees, minutes, and seconds, we have only to find the degrees and minutes as before ; then, multiply the corresponding tabular number by the seconds, cut off two places to the right hand for decimals, and then add the product to the number first found, for the sine of the given arc.

Thus, if we wish the sine of $40^{\circ} 26' 28''$.

The sine $40^{\circ} 26'$	9.811952
Tabular difference . 247	
Number of seconds . 28	
Product . . <u>69.16</u> to be added	69.16
Gives for the sine of $40^{\circ} 26' 28''$	<u>9.812021.</u>

The decimal figures at the right are generally omitted in the last result ; but when they exceed five-tenths, the figure on the left of the decimal point is increased by 1 ; this gives the result to the nearest unit.

The tangent of an arc, in which there are seconds, is found in a manner entirely similar. In regard to the cosine and cotangent, it must be remembered, that they increase while the arcs decrease, and decrease as the arcs are increased ; consequently, the proportional numbers found for the seconds, must be subtracted, not added.

EXAMPLES.

1. To find the cosine of $3^{\circ} 40' 40''$

The cosine of $3^{\circ} 40'$	9.999110
Tabular difference . 13	
Number of seconds . 40	
Product . . <u>5.20</u> to be subtracted	5.20
Gives for the cosine of $3^{\circ} 40' 40''$	<u>9.999105</u>

2. Find the tangent of $37^{\circ} 28' 31''$

Ans. 9.884592.

3. Find the cotangent of $87^{\circ} 57' 59''$

Ans. 8.550356.

CASE II.

To find the degrees, minutes and seconds, answering to any given logarithmic sine, cosine, tangent or cotangent.

56. Search in the table, and in the proper column, until the number is found : the degrees will be shown either at the top or bottom of the page, and the minutes in the side columns, either at the left or right.

But, if the number cannot be exactly found in the table, take from the table the degrees and minutes answering to the nearest less logarithm, the logarithm itself, and also the corresponding tabular difference. Subtract the logarithm taken

from the table from the given logarithm, annex two ciphers to the remainder, and then divide the remainder by the tabular difference: the quotient will be seconds, and is to be connected with the degrees and minutes before found; to be added for the sine and tangent, and subtracted for the cosine and cotangent.

EXAMPLES.

1. Find the arc answering to the sine	9.880054
Sine $49^{\circ} 20'$, next less in the table	9.879963
Tabular difference . . .	<u>181)9100(50''</u>

Hence, the arc $49^{\circ} 20' 50''$ corresponds to the given sine 9.880054.

2. Find the arc whose cotangent is .	10.008688
cot $44^{\circ} 26'$, next less in the table . .	10.008591
Tabular difference . . .	<u>421)9700(23''</u>

Hence, $44^{\circ} 26' - 23'' = 44^{\circ} 25' 37''$ is the arc answering to the given cotangent 10.008688.

3. Find the arc answering to tangent 9.979110
Ans. $43^{\circ} 37' 21''$.

4. Find the arc answering to cosine 9.944599
Ans. $28^{\circ} 19' 45''$.

We shall now demonstrate the principal theorems of Plane Trigonometry.

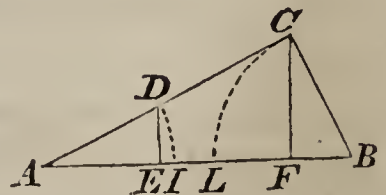
THEOREM I.

The sides of a plane triangle are proportional to the sines of their opposite angles.

57. Let ABC be a triangle; then will
 $CB : CA :: \sin A : \sin B$.

For, with A as a centre, and AD equal to the less side BC , as a radius, describe the arc DI : and with B as a centre and the equal radius BC , describe the arc CL : now DE is the sine of the angle A , and CF is the sine of B , to the same radius AD or BC . But by similar triangles,

$$AD : DE :: AC : CF.$$



But AD being equal to BC , we have

$$BC : \sin A :: AC : \sin B, \text{ or}$$

$$BC : AC :: \sin A : \sin B.$$

By comparing the sides AB, AC , in a similar manner, we should find, $AB : AC :: \sin C : \sin B$.

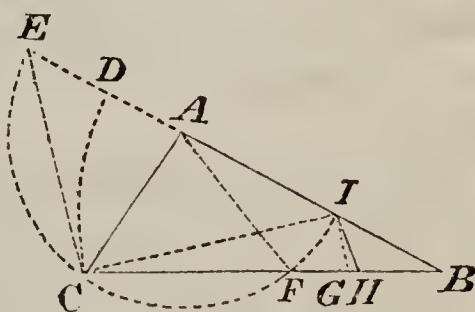
THEOREM II.

In any triangle, the sum of the two sides containing either angle, is to their difference, as the tangent of half the sum of the two other angles, to the tangent of half their difference.

58. Let ACB be a triangle: then will

$$AB + AC : AB - AC :: \tan \frac{1}{2}(C + B) : \tan \frac{1}{2}(C - B).$$

With A as a centre, and a radius AC the less of the two given sides, let the semicircle $IFCE$ be described, meeting AB in I , and BA produced, in E . Then, BE will be the sum of the sides, and BI their difference. Draw CI and AF .



Since CAE is an outward angle of the triangle ACB , it is equal to the sum of the inward angles C and B (Bk. I, Prop. XXV, Cor. 6). But the angle CIE being at the circumference, is half the angle CAE at the centre (Bk. III, Prop. XVIII); that is, half the sum of the angles C and B , or equal to $\frac{1}{2}(C + B)$.

The angle $AFC = ACB$, is also equal to $ABC + BAF$; therefore, $BAF = ACB - ABC$.

But, $ICF = \frac{1}{2}(BAF) = \frac{1}{2}(ACB - ABC)$, or $\frac{1}{2}(C - B)$.

With I and C as centres, and the common radius IC , let the arcs CD and IG be described, and draw the lines CE and IH perpendicular to IC . The perpendicular CE will pass through E , the extremity of the diameter IE , since the right angle ICE must be inscribed in a semicircle.

But CE is the tangent of $CIE = \frac{1}{2}(C + B)$; and IH is the tangent of $ICB = \frac{1}{2}(C - B)$, to the common radius CI .

But since the lines CE and IH are parallel, the triangles BHI and BCE are similar, and give the proportion,

$$BE : BI :: CE : IH, \text{ or}$$

by placing for BE and BI , CE and IH , their values, we have

$$AB + AC : AB - AC :: \tan \frac{1}{2}(C + B) : \tan \frac{1}{2}(C - B).$$

THEOREM III.

In any plane triangle, if a line be drawn from the vertical angle perpendicular to the base, dividing it into two segments : then, the whole base, or sum of the segments, is to the sum of the other two sides, as the difference of those sides to the difference of the segments.

59. Let BAC be a triangle, and AD perpendicular to the base ; then will

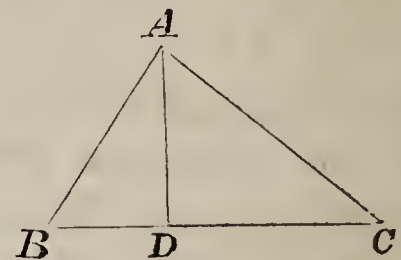
$$BC : CA + AB :: CA - AB : CD - DB$$

For, $AB^2 = BD^2 + AD^2$

(Bk. IV, Prop. XI) ;

and $AC^2 = DC^2 + AD^2$

by subtraction $AC^2 - AB^2 = CD^2 - BD^2$.



But since the difference of the squares of two lines is equal to the rectangle contained by their sum and difference (Bk. IV, Prop. X), we have,

$$AC^2 - AB^2 = (AC + AB). (AC - AB)$$

and $CD^2 - DB^2 = (CD + DB). (CD - DB)$

therefore, $(CD + DB). (CD - DB) = (AC + AB). (AC - AB)$

hence, $CD + DB : AC + AB :: AC - AB : CD - DB$.

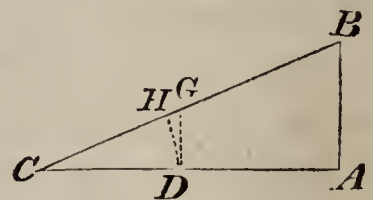
THEOREM IV.

In any right-angled plane triangle, radius is to the tangent of either of the acute angles, as the side adjacent to the side opposite.

60. Let CAB be the proposed triangle, and denote the radius by R : then will

$$R : \tan C : AC : AB.$$

For, with any radius as CD describe the arc DH , and draw the tangent DG .



From the similar triangles CDG and CAB we shall have,

$$CD : DG :: CA : AB ; \text{ hence,}$$

$$R : \tan C :: CA : AB.$$

By describing an arc with B as a centre, we could show in the same manner that,

$$R : \tan B :: AB : AC.$$

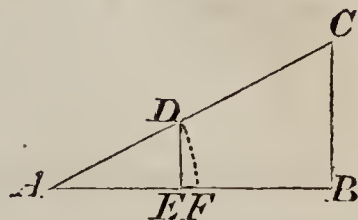
THEOREM V.

In every right-angled plane triangle, radius is to the cosine of either of the acute angles, as the hypotenuse to the side adjacent.

61. Let ABC be a triangle, right angled at B then will

$$R : \cos A : AC : AB.$$

For, from the point A as a centre, and any radius as AD , describe the arc DF , which will measure the angle A , and draw DE perpendicular to AB : then will AE be the cosine of A .



The triangles ADE and ACB , being similar, we have

$$AD : AE :: AC : AB : \text{that is,}$$

$$R : \cos A :: AC : AB.$$

62. REMARK. The relations between the sides and angles of plane triangles, demonstrated in these five theorems, are sufficient to solve all the cases of Plane Trigonometry. Of the six parts which make up a plane triangle, at least three must be given, and one of these a side, before the others can be determined.

If the three angles are given, it is plain, that an indefinite number of similar triangles may be constructed, the angles of which shall be respectively equal to the angles that are given, and therefore, the sides could not be determined.

Assuming, with this restriction, any three parts of a triangle as given, one of the three following cases will always be presented.

- I. When two angles and a side are given.
- II. When two sides and an opposite angle are given.
- III. When two sides and the included angle are given.
- IV. When the three sides are given.

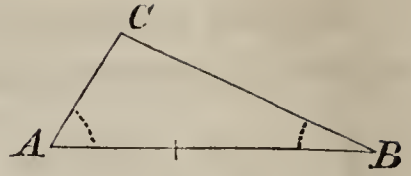
CASE I.

When two angles and a side are given.

63. Add the given angles together and subtract their sum from 180 degrees. The remaining parts of the triangle can then be found by Theorem I.

EXAMPLES.

1. In a plane triangle ABC , there are given the angle $A=58^{\circ} 07'$, the angle $B=22^{\circ} 37'$, and the side $AB=408$ yards. Required the other parts.



INSTRUMENTALLY.

Draw an indefinite straight line AB , and from the scale of equal parts lay off AB equal to 408. Then at A lay off an angle equal to $58^{\circ} 07'$, and at B an angle equal to $22^{\circ} 37'$, and draw the lines AC and BC : then will ABC be the triangle required.

The angle C may be measured either with the protractor or the scale of chords (Arts. 23 and 24), and will be found equal to $99^{\circ} 16'$. The sides AC and BC may be measured by referring them to the scale of equal parts (Art. 22). We shall find $AC=158.9$ and $BC=251$ yards.

BY LOGARITHMS.

To the angle	. .	$A=58^{\circ} 07'$	
Add the angle	. .	$B=22^{\circ} 37'$	
		Their sum	. . $=80^{\circ} 44'$
taken from	. .	$180^{\circ} 00'$	
leaves C	. .	$99^{\circ} 16'$	which, exceeding 90° ,
we use its supplement		$80^{\circ} 44'$	

To find the side BC .

As $\sin C$	. .	$99^{\circ} 16'$	. .	ar. comp.	. .	0.005705
: $\sin A$	. .	$58^{\circ} 07'$	. .	. .	. .	9.928972
:: AB	. .	408	. .	. .	. .	2.610660
: BC	. .	351.024		(after rejecting 10)	. .	2.545337

REMARK. The logarithm of the fourth term of a proportion is obtained by adding the logarithm of the second term to that of the third, and subtracting from their sum the logarithm of the first term. But to subtract the first term is the same as to add its arithmetical complement and reject 10 from the sum (Art. 17): hence, the arithmetical complement of the first term added to the logarithms of the second and third terms, will give the logarithm of the fourth term.

To find side AC .

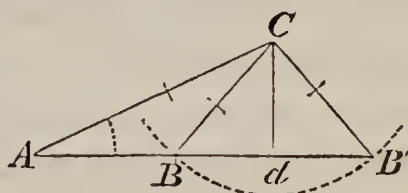
As $\sin C$	. $99^\circ 16'$	ar. comp.	. . .	0.005705
: $\sin B$	. $22^\circ 37'$	. . .	. . .	9.584968
: : AB	. 408	. . .	. . .	2.610660
: AC	. 158.976	. . .	. . .	2.201333

2. In a triangle ABC , there are given $A=38^\circ 25'$, $B=57^\circ 42'$, and $AB=400$: required the remaining parts.
Ans. $C=83^\circ 53'$, $BC=249.974$, $AC=340.04$.

CASE II.

When two sides and an opposite angle are given

64. In a plane triangle ABC , there are given $AC=216$, $CB=117$, the angle $A=22^\circ 37'$, to find the other parts.



INSTRUMENTALLY.

Draw an indefinite right line ABB' : from any point as A , draw AC making $BAC=22^\circ 37'$, and make $AC=216$. With C as a centre, and a radius equal to 117, the other given side, describe the arc $B'B$; draw $B'C$ and BC : then will either of the triangles ABC or $AB'C$, answer all the conditions of the question.

BY LOGARITHMS.

To find the angle B .

As BC	. 117	. ar. comp.	. . .	7.931814
: AC	. 216	. . .	. . .	2.334454
: : $\sin A$	. $22^\circ 37'$	. . .	. . .	9.584968
: $\sin B'$	$45^\circ 13' 55''$, or ABC	$134^\circ 46' 05''$		9.851236

The ambiguity in this, and similar examples, arises in consequence of the first proportion being true for either of the angles ABC , or $AB'C$, which are supplements of each other, and therefore have the same sine (Art. 43). As long as the two triangles exist, the ambiguity will continue. But if the side CB , opposite the given angle, is greater than AC , the arc BB' will cut the line ABB' , on the same side of the point A , in but one

point, and then there will be only one triangle answering the conditions.

If the side CB is equal to the perpendicular Cd , the arc BB' will be tangent to ABB' , and in this case also there will be but one triangle. When CB is less than the perpendicular Cd , the arc BB' will not intersect the base ABB' , and in that case, no triangle can be formed, or it will be impossible to fulfil the conditions of the problem.

2. Given two sides of a triangle 50 and 40 respectively, and the angle opposite the latter equal to 32° : required the remaining parts of the triangle.

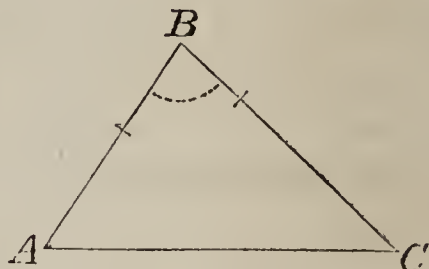
Ans. If the angle opposite the side 50 is acute, it is equal to $41^\circ 28' 59''$; the third angle is then equal to $106^\circ 31' 01''$, and the third side to 72.368. If the angle opposite the side 50 is obtuse, it is equal to $138^\circ 31' 01''$, the third angle to $9^\circ 28' 59''$, and the remaining side to 12.436.

CASE III.

When the two sides and their included angle are given.

65. Let ABC be a triangle; AB , BC , the given sides, and B the given angle.

Since B is known, we can find the sum of the two other angles: for



$$A + C = 180^\circ - B \quad \text{and} \\ \frac{1}{2}(A + C) = \frac{1}{2}(180^\circ - B)$$

We next find half the difference of the angles A and C by Theorem II. Viz.

$BC + BA : BC - BA :: \tan \frac{1}{2}(A + C) : \tan \frac{1}{2}(A - C)$.
in which we consider BC greater than BA , and therefore A is greater than C ; since the greater angle must be opposite the greater side.

Having found half the difference of A and C , by adding it to the half sum $\frac{1}{2}(A + C)$, we obtain the greater angle, and by subtracting it from half the sum, we obtain the less. That is

$$\frac{1}{2}(A + C) + \frac{1}{2}(A - C) = A, \quad \text{and} \\ \frac{1}{2}(A + C) - \frac{1}{2}(A - C) = C.$$

Having found the angles A and C , the third side AC may be found by the proportion.

$$\sin A : \sin B :: BC : AC.$$

EXAMPLES.

1. In the triangle ABC , let $BC=540$, $AB=450$, and the included angle $B=80^\circ$: required the remaining parts.

INSTRUMENTALLY.

Draw an indefinite right line BC and from any point, as B , lay off a distance $BC=540$. At B make the angle $CBA=80^\circ$: draw BA and make the distance $BA=450$; draw AC ; then will ABC be the required triangle.

BY LOGARITHMS.

$$BC+BA=540+450=990; \text{ and } BC-BA=540-450=90.$$

$$A+C=180^\circ-B=180^\circ-80^\circ=100^\circ, \text{ and therefore,}$$

$$\frac{1}{2}(A+C)=\frac{1}{2}(100^\circ)=50^\circ$$

To find $\frac{1}{2}(A-C)$.

As $BC+BA$	. 990	. ar. comp.	. 7.004365
: $BC-BA$	. 90	. . . .	. 1.954243
:: $\tan \frac{1}{2}(A+C)$	. 50° 10.076187
: $\tan \frac{1}{2}(A-C)$	. $6^\circ 11'$	. . . .	. 9.034795

Hence, $50^\circ+6^\circ 11'=56^\circ 11'=A$; and $50^\circ-6^\circ 11'=43^\circ 49'=C$.

To find the third side AC .

As $\sin C$	. $43^\circ 49'$	. ar. comp.	. 0.159672
: $\sin B$	. 80° 9.993351
:: AB	. 450	. . . .	. 2.653213
: AC	. 640.082	. . . .	. 2.806236

2. Given two sides of a plane triangle, 1686 and 960, and their included angle $128^\circ 04'$: required the other parts.

Ans. Angles, $33^\circ 34' 39''$; $18^\circ 21' 21''$; side 2400.

CASE IV.

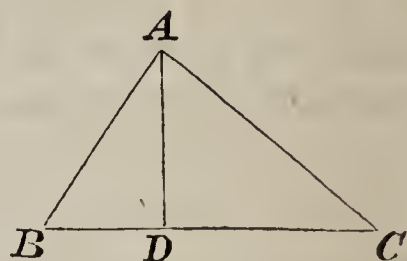
Having given the three sides of a plane triangle, to find the angles.

66. Let fall a perpendicular from the angle opposite the

greater side, dividing the given triangle into two right-angled triangles: then find the difference of the segments of the base by Theorem III. Half this difference being added to half the base, gives the greater segment; and, being subtracted from half the base, gives the less segment. Then, since, the greater segment belongs to the right-angled triangle having the greatest hypotenuse, we have the sides and right angle of two right-angled triangles, to find the acute angles.

EXAMPLES.

1. The sides of a plane triangle being given; viz: $BC=40$, $AC=34$ and $AB=25$: required the angles.



INSTRUMENTALLY.

With the three given lines as sides construct a triangle as in Problem IX. Then measure the angles of the triangle, either with the protractor or scale of chords.

BY LOGARITHMS.

$$\text{As } BC : AC + AB :: AC - AB : CD - BD$$

$$\text{That is, } 40 : 59 :: 9 : \frac{59 \times 9}{40} = 13.275$$

$$\text{Then, } \frac{40 + 13.275}{2} = 26.6375 = CD$$

$$\text{And } \frac{40 - 13.275}{2} = 13.3625 = BD.$$

In the triangle DAC , to find the angle DAC .

As	AC	.	34	.	.	ar. comp.	.	8.468521
:	DC	.	26.6375	.	.	.	.	1.425493
::	$\sin D$	.	90°	10.000000
:	$\sin DAC$	.	$51^\circ 34' 40''$	.	.	.	.	<u>9.894014</u>

In the triangle BAD , to find the angle BAD .

As	AB	. .	25	. .	ar. comp.	. . .	8.602060
:	BD	:	13.3625	.	.	.	1.125887
::	$\sin D$	.	90°	.	.	.	10.000000
:	$\sin BAD$	.	$32^\circ 18' 35''$	.	.	.	<u>9.727947</u>

Hence $90^\circ - DAC = 90^\circ - 51^\circ 34' 40'' = 38^\circ 25' 20'' = C$

and $90^\circ - BAD = 90^\circ - 32^\circ 18' 35'' = 57^\circ 41' 25'' = B$

and $BAD + DAC = 51^\circ 34' 40'' + 32^\circ 18' 35'' = 83^\circ 53' 15'' = A$.

2. In a triangle, in which the sides are 4, 5 and 6, what are the angles. ?

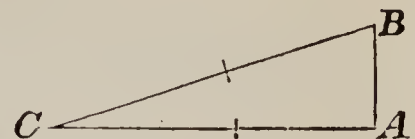
Ans. $41^\circ 24' 35''$; $55^\circ 46' 16''$; and $82^\circ 49' 09''$.

SOLUTION OF RIGHT-ANGLED TRIANGLES.

67. The unknown parts of a right-angled triangle may be found by either of the four last cases: or, if two of the sides are given, by means of the property that the square of the hypotenuse is equal to the sum of the squares of the other two sides. Or the parts may be found by Theorem V.

EXAMPLES.

1. In a right-angled triangle BAC , there are given the hypotenuse $BC = 250$, and the base $AC = 240$: required the other parts.



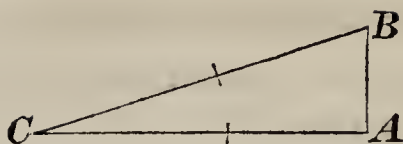
To find the angle B .

As	BC	. .	250	. .	ar. comp.	. . .	7.602060
:	AC	:	240	.	.	.	2.380211
::	$\sin A$	.	90°	.	.	.	10.000000
:	$\sin B$	.	$73^\circ 44' 23''$	.	.	.	<u>9.982271</u>

But $C = 90^\circ - B = 90^\circ - 73^\circ 44' 23'' = 16^\circ 15' 37''$:

Or C might be found from the proportion.

As	CB	. .	250	. .	ar. comp.	. . .	7.602060
:	AC	:	240	.	.	.	9.380211
::	R	.	.	.	.	.	10.000000
:	$\cos C$	.	$16^\circ 15' 37''$	.	.	.	<u>9.982271</u>



To find side AB by Theorem IV.

As $\sin A$	.	90°	ar. comp.	.	.	0.000000
: $\tan C$	.	$16^\circ 15' 37''$	.	.	.	9.464889
:: AC	.	240	.	.	.	<u>2.380211</u>
: AB	.	70.0003	.	.	.	<u>1.845100</u>

2. In a right-angled triangle BAC , there are given $AC=384$, and $B=53^\circ 08'$: required the remaining parts.

Ans. $AB=287.96$; $BC=479.979$; $C=36^\circ 52'$.

ELEMENTS OF SURVEYING.

CHAPTER I.

Definitions and Introductory Remarks.

68. Surveying, in its most extensive signification, comprises all the operations necessary for finding.

1st. The area or content of any portion of the surface of the earth ;

2d. The lengths and directions of the bounding lines ;
and

3d. The accurate delineation of the whole on paper.

69. The earth being spherical, its surface is curved, and every line traced on its surface is also curved.

If large portions of the surface are to be measured, such as states and territories, the curvature must be taken into account ; and very material errors will arise if it be neglected. When the curvature is considered, the method of measurement and computation is called *Geodesic Surveying*.

The radius of the earth, however, being large, the curvature of its surface is small, and when the measurement is limited to small portions of the surface, the error becomes insensible, if we consider the surface a plane. This method of measurement and computation, is called *Plane Surveying*, and is the only kind that will be treated of in these Elements.

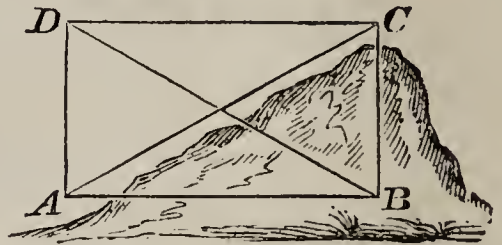
70. If at any point of the surface of the earth, a plane be drawn perpendicular to the radius passing through this point, such plane is tangent to the surface, and is called a *horizontal plane*. All planes parallel to such a plane, are also called *horizontal planes*.

71. A plane which is perpendicular to a horizontal plane is called a *vertical plane*.

72. All lines of a horizontal plane, and all lines which are parallel to it, are called *horizontal lines*.

73. Lines which are perpendicular to a horizontal plane, are called *vertical lines*; and all lines which are inclined to it, are called *oblique lines*.

Thus, AB and DC are horizontal lines; BC and AD are vertical lines; and AC and BD are oblique lines.



74. The horizontal distance between two points, is the horizontal line intercepted between the two vertical lines passing through those points. Thus, DC or AB is the horizontal distance between the two points A and C , or the points B and D .

75. A *horizontal angle* is one whose sides are horizontal; its plane is also horizontal.

A horizontal angle may also be defined to be, *the angle included between two vertical planes passing through the angular point, and the two objects which subtend the angle*.

76. A vertical angle is one, the plane of whose sides is vertical.

77. An angle of *elevation*, is a vertical angle having one of its sides horizontal, and the inclined side above the horizontal side.

Thus, in the last figure, BAC is the angle of elevation from A to C .

78. An angle of *depression*, is a vertical angle having one of its sides horizontal, and the inclined side under the horizontal side. Thus, DCA is the angle of depression from C to A .

79. An *oblique angle* is one, the plane of whose sides is oblique to the horizontal plane.

80. All lines, which can be the object of measurement, must belong to one of the classes above named, viz.:

- 1st. Horizontal lines:
- 2d. Vertical lines:
- 3d. Oblique lines.

All the angles may also be divided into three classes, viz.:

- 1st. Horizontal angles:

2d. Vertical angles ; which may be again divided into angles of elevation and angles of depression : and

3d. Oblique angles.

CHAPTER II.

Of the measurement and calculation of Lines and Angles.

81. It has been shown (Art. 62), that at least one side and two of the other parts of a plane triangle must be given or known, before the remaining parts can be found by calculation.

When, therefore, distances are to be found, by trigonometrical calculations, two things are necessary.

1st. To measure certain lines on the ground ; and also, as many angles as may be necessary to render at least three parts of every triangle known : and

2d. To calculate, by trigonometry, the other sides and angles that may be required. Our attention, then, is directed,

1st. To the measurement of lines ;

2d. To the measurement of angles ; and

3d. To the calculations for the unknown and required parts.

82. Any tape, rod, or chain, on which equal parts are marked, may be used as a measure ; and one of the equal parts into which the measure is divided, is called the *unit* of the measure. The unit of a measure may be a foot, a yard, a rod, or any other ascertained distance.

83. The measure in general use, is a chain of four rods or sixty-six feet in length ; it is called Gunter's chain, from the name of the inventor. This chain is composed of 100 links. Every tenth link from either end, is marked by a small attached brass plate, which is notched, to designate its number from the end. The division of the chain into 100 equal parts, is a very convenient one, since the divisions or links, are decimals of the whole chain, and in the calculations may be treated as such.

TABLE.

1 chain = 4 rods = 66 feet = 792 inches = 100 links.

Hence, 1 link is equal to 7.92 inches.

80 chains = 320 rods = 1 mile.

40 chains = $\frac{1}{2}$ mile.

20 chains = $\frac{1}{4}$ mile.

84. Besides the chain, there are wanted for measuring, ten marking pins, which should be of iron, about ten inches in length and an eighth of an inch in thickness. These pins should be strung upon an iron ring, and this ring should be attached to a belt, to be passed over the right shoulder, suspending the pins at the left side. Two staves are also required. They should be about six feet in length, and have a spike in the lower end to aid in holding them firmly, and a horizontal strip of iron to prevent the chain from slipping off; these staves are to be passed through the rings at the ends of the chain.

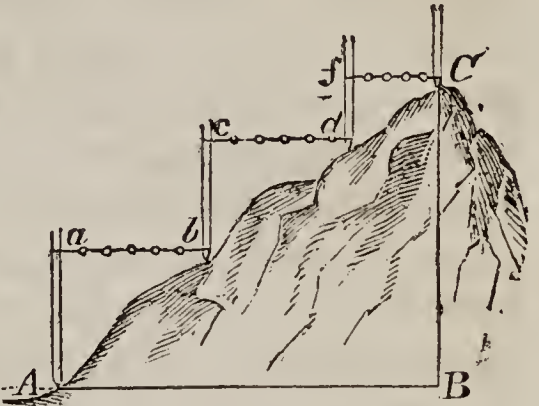
TO MEASURE A HORIZONTAL LINE.

85. At the point where the measurement is to be begun, place in a vertical position, a signal staff, having a small flag attached to its upper extremity; and place another at the point where the measurement is to be terminated. These two points are generally called *stations*.

Having passed the staves through the rings of the chain, let the ten marking pins and one end of the chain be taken by the person who is to go forward, and who is called the leader, and let him plant the staff as nearly as possible in the direction of the stations. Then, taking the staff in his right hand, let him stand off at arm's length, so that the person at the other end of the chain can align it exactly with the stations: when the alignment is made, let the chain be stretched and a marking pin placed; then measure a second chain in the same manner, and so on, until all the marking pins shall have been placed. When the marking pins are exhausted, a note should be made, that ten chains have been measured; after which, the marking pins are to be returned to the leader, and the measurement continued as before, until the whole distance is passed over.

Great care must be taken to keep the chain horizontal, and if the acclivity or declivity of the ground be too great to admit of measuring a whole chain at a time, a part of a chain only should be measured: the sum of all the horizontal lines so measured, is evidently the horizontal distance between the stations.

For example, in measuring the horizontal distance between *A* and *C*, we first place a staff at *A* and another at *b*, in the direction towards *C*. Then slide up the chain on the staff at *A* until it becomes horizontal, and note the distance *ab*. Then remove the



staves and place them at *b* and *d*: make the chain horizontal, and note the distance *cd*. Measure in the same manner the line *fc*; and the sum of the horizontal lines *ab*, *cd* and *fc*, will be equal to *AB*, the horizontal distance between *A* and *C*.

86. We come now to the measurement of angles, and for this purpose several instruments are used. The one, however, which affords the most accurate results, and which indeed can alone be relied on for nice or extensive operations, is called a Theodolite. This instrument only will be described at present; others will be subsequently explained.

OF THE THEODOLITE.

Pl. 1. The theodolite is an instrument used to measure horizontal and vertical angles. It is usually placed on a tripod *ABC*, which enters by means of a screw the lower horizontal plate *DE*, and becomes firmly attached to the body of the instrument. Through the horizontal plate *DE*, four small hollow cylinders are inserted, which receive four screws with milled heads, that work against a second horizontal plate, *FG*. The upper side of the plate *DE* terminates in a curved surface, which encompasses a ball, that is nearly a semi-sphere, with the plane of its base horizontal. This ball, which is hollow, is firmly connected with the smaller base of a hollow conic frustrum, that passes through the curved part

of the plate *DE*, and screws firmly into the curved part of the second horizontal plate *FG*.

A hollow conic spindle passes through the middle of the ball, and the hollow frustrum with which it is connected. To this spindle, a third horizontal and circular plate *HI*, called *the limb of the instrument*, is permanently attached. Within this spindle, and concentric with it, there is a second spindle, called the inner, or solid spindle. To this latter, is united a thin circular plate, called the *vernier plate*, which rests on the limb of the instrument, and supports the upper frame-work. The two spindles terminate at the base of the spherical ball, where a small screw enters the inner one, and presses a washer against the other, and the base of the ball. On the upper surface of the plate *FG*, rests a clamp which goes round the outer spindle, and which being compressed by the clamp-screw *K*, is made fast to it. This clamp is thus connected with the plate *FG*. A small cylinder *a*, is fastened to the plate *FG*: through this cylinder a thumb-screw *L* passes, and works into a small cylinder *b*, connected with the clamp. The cylinders *b* and *a*, admit of a motion round their axes, to relieve the screw *L* of the pressure which would otherwise be occasioned by working it.

Directly above the clamp, is the lower telescope *MN*. This telescope is connected with a hollow cylinder, which is worked freely round the outer spindle, by the thumb-screw *P* having a pinion working into a concealed cog-wheel, that is permanently fastened to the limb of the instrument. By means of a clamp-screw *Q*, the telescope is made fast to the limb, when it will have a common motion with the limb and outer spindle.

The circular edge of the limb is chamfered, and is generally made of silver, and on this circle the graduation for horizontal angles is made. In the instrument described, the circle is cut into degrees and half degrees; the degrees are numbered from 0 to 360.

On the circular edge of the vernier plate, is a small space of silver, called a *vernier*; this space is divided into 30 equal parts, and numbered from the line marked 0 to the left.

There are two levels attached to the vernier plate, at right angles to each other, by small adjusting screws; one of them is seen in the figure. The vernier plate turns freely around

with the inner spindle. It is made fast to the limb of the instrument by the clamp-screw *S*; after which the smaller motions are made by the tangent-screw *T*.

There is a compass on the vernier plate, that is concentric with it, the use of which will be explained under the head compass.

The frame-work which supports the horizontal axis of the vertical semicircle *UV* and the upper telescope, with its attached level, rests on the vernier plate, to which it is made fast by three adjusting screws, placed at the angular points of an equilateral triangle. The vertical semicircle *UV*, is called the *vertical limb*; its motions are governed by the thumb-screw *Z*, which has a pinion, that works with the teeth of the vertical limb. On the face of the vertical limb, opposite the thumb-screw *Z*, the limb is divided into degrees and half degrees: the degrees are numbered both ways from the line marked 0. There is a small plate resting against the graduated face of the vertical limb, called the vernier; it is divided into 30 equal parts, and the middle line is designated by 0.

On the other face of the vertical limb, are two ranges of divisions, commencing at the 0 point, and extending each way 45° . The one shows the vertical distance of any object to which the upper telescope is directed, above or below the place of the instrument, in 100th parts of the horizontal distance: the other, the difference between the hypotenusal and base lines: the hypotenuse being supposed to be divided into one hundred equal parts: therefore, by mere inspection, we can ascertain the number of links, which must be subtracted from every chain of an oblique line, to reduce it to a true horizontal distance.

The supports of the upper telescope are called the wyes, and designated *Y*'s. Two loops, turning on hinges, pass over the telescope, and are made fast by the pins *c* and *d*; these loops confine the telescope in the *Y*'s. By withdrawing the pins, and turning the loops on their hinges, the telescope may be removed for the purpose of being reversed in position; and in both situations, the telescope can be revolved in the *Y*'s about its axis.

In the telescopes attached to the theodolite, are two principal lenses, one at each end. The one at the end where

the eye is placed, is called the eyeglass, the other the object glass.

In order that the axis of the telescope may be directed to an object with precision, two spider's lines, or small hairs, are fixed at right angles to each other, and placed within the barrel of the telescope, and at the focus of the eyeglass. The vertical hair is moved by two small horizontal screws, one of which, f , is seen in the figure; and the horizontal hair, by two vertical screws, g and h .

Before using the theodolite, it must be properly adjusted. The adjustment consists in bringing the different parts to their proper places.

The line of *collimation*, is the axis of the telescope. With this axis, the line drawn through the centre of the eyeglass, and the intersection of the spider's lines, ought to coincide.

FIRST ADJUSTMENT. The first adjustment regards the line of collimation: it is, *to fix the intersection of the spider's lines in the axis of the telescope.*

Having screwed the tripod to the instrument, extend the legs, and place them firmly. Then loosen the clamp-screw S of the vernier plate, and direct the telescope to a small, well-defined, and distant object. By means of a small pin i , on the under side of the telescope, slide the eyeglass till the spider's lines are seen distinctly; then with the thumb-screw X , which forces out and draws in, the object glass, adjust this glass to its proper focus, when the object, as well as the spider's lines, will be distinctly seen: after which, by the tangent-screw T and the thumb-screw Z , bring the intersection of the spider's lines exactly upon a well-defined point of the object.

Having done this, revolve the telescope in the Y 's, half round, when the attached level mn , will come to the upper side. See, in this position, if the horizontal hair appears above or below the point, and in either case, loosen one, and tighten the other, of the two screws that work the horizontal hair, till the horizontal hair has been carried over half the space between its last position and the observed point. Carry the telescope back to its place; direct again the intersection of the spider's lines, to the point, and repeat the operation till the horizontal hair neither ascends nor descends, while the tele-

scope is revolved. A similar process will arrange the vertical hair, and the line of collimation is then adjusted.

SECOND ADJUSTMENT.—*To make the axis of the attached level of the upper telescope, parallel to the line of collimation.*

Turn the vernier plate, till the telescope comes directly over two of the levelling screws, between the plates *DE* and *FG*. Turn these screws contrary ways, keeping them firm against the plate *FG*, till the bubble of the level *mn*, stands at the middle of the tube. Then, open the loops, and reverse the telescope. If the bubble still stands in the middle of the tube, the axis of the tube is horizontal; but if not, it is inclined, the bubble being at the elevated end. In that case, by means of the small vertical screws *m* and *n*, at the ends of the level, raise the depressed end, or depress the elevated one, half the inclination; and then, with the levelling screws, bring the level into a horizontal position. Reverse the telescope in the *Y*'s, and make the same correction again; and so on, until the bubble stands in the middle of the tube, in both positions of the telescope: the axis of the level is then horizontal. Let the telescope be now revolved in the *Y*'s. If the bubble continue in the middle of the tube, the axis of the level is not only horizontal, but also parallel to the line of collimation. If, however, the bubble recede from its centre, the axis of the level is inclined to the line of collimation, and must be made parallel to it by means of two small screws, (one of which is seen at *p*,) which work horizontally. By loosening one of them, and tightening the other, the level is soon brought parallel to the line of collimation, and then, if the telescope be revolved in the *Y*'s, the bubble will continue in the middle of the tube.

It is difficult to make the first part of this adjustment, while the axis of the level is considerably inclined to the line of collimation; for, if the level were truly horizontal in one position of the telescope, when the telescope is reversed, the bubble would not stand in the middle of the tube, except in one position of the level. This suggests the necessity of making the first part of the adjustment with tolerable accuracy; then, having made the second with care, let the first be again examined, and proceed thus till the adjustment is completed.

THIRD ADJUSTMENT.—*To make the limb of the instrument horizontal, or, to make the common axis of the limb and vernier plate truly vertical.*

This adjustment is effected, partly by the levelling screws, and partly by the thumb-screw *Z*. Turn the vernier plate, until the upper telescope comes directly over two of the levelling screws, then turn them contrary ways, till the upper telescope is horizontal; after which, turn the vernier plate 180° , and if the bubble of the level remains in the middle of the tube, one line of the limb is horizontal. But if the bubble recede from the centre of the level, raise the lower, or depress the upper end, one-half by the levelling screws, the other by the thumb-screw *Z*, till it is brought into a horizontal position. Turn the vernier plate again 180° , and if the level be not then horizontal, make it so, by dividing the error as before, and repeat the operation until the line of the limb is truly horizontal. Then turn the vernier plate 90° , and level as before. The limb ought now to be truly horizontal; but lest the first horizontal line may have been changed, in obtaining the second, it is well to bring the telescope and level two or three times over the levelling screws, until an entire revolution can be made without displacing the bubble from the middle of the tube. As this can only be the case when the level revolves around a vertical line, it follows that the limb will then be horizontal, and the axis of the instrument vertical.

This adjustment being completed, the levels of the vernier plate are readily made parallel with it, by means of the small screws at their extremities. The three levels being then horizontal, and perpendicular in direction to the axis of the theodolite, the bubbles will retain the middle places in the tubes, during an entire revolution of the vernier plate, or of the limb and vernier plate together.

But the levels of the vernier plate may be made parallel with the limb, and the limb made truly horizontal, without the aid of the upper level.

Let the upper telescope be placed directly over two of the levelling screws. One of the levels of the vernier plate will then be parallel to the line of these two screws, and the other level will be at right angles to this line, or parallel to the line of the other two levelling screws. In this situation, let the

levels be made horizontal, by means of the levelling screws. Then turn the vernier plate 180° , and if they both continue horizontal, the limb is truly level. But if both, or either of them, be changed from a horizontal position, let the error be divided between the level and the limb; and repeat the operation until the levels will continue horizontal during an entire revolution: the limb is then horizontal, and the axis of the instrument truly vertical.

FOURTH ADJUSTMENT.—*To make the axis of the vertical limb truly horizontal, or perpendicular to the axis of the instrument.*

Bring the intersection of the spider's lines of the upper telescope upon a plumb line, or any well-defined vertical object, and move the telescope with the thumb-screw *Z*: if the intersection of the spider's lines continue on the vertical line, the axis is horizontal.

Or, the adjustment may be effected thus: Direct the intersection of the spider's lines to a well-defined point that is considerably elevated: then turn the vertical limb, until the axis of the telescope rests on some other well-defined point, upon or near the ground: reverse the telescope, and turn the vernier plate 180° ; now, if in elevating and depressing the telescope, the line of collimation passes through the two points before noted, the axis is horizontal. If it be found, by either of the above methods, that the axis is not horizontal, it must be made so by the screws which fasten the frame-work to the vernier plate.

There are two important lines of the theodolite, the positions of which are determined with great care by the maker, and fixed permanently. First, the axis of the instrument is placed exactly at right angles with the limb and vernier plate; and unless it have this position, the vernier plate will not revolve at right angles to the axis, as explained in the third adjustment. Secondly, the line of collimation of the upper telescope, is fixed at right angles to the horizontal axis of the vertical limb. We can ascertain whether these last lines are truly at right angles, by directing the intersection of the spider's lines to a well-defined point; then removing the caps which confine the horizontal axis in its supports, and reversing the axis: if the intersection of the spider's lines can be made to

cover exactly the same point, without moving the vernier plate, the line of collimation is at right angles to the axis.

If the theodolite be so constructed that either of the *Y*'s admits of being moved laterally, so as to vary the angle between the horizontal axis and the line of collimation, these lines may be adjusted at right angles to each other, if they have not been so placed by the maker.

The lower telescope being used merely as a guard, requires no adjustment, although it is better to make the axis, about which its vertical motions are performed, horizontal, or perpendicular to the axis of the instrument; and this is easily effected by means of the two small screws *k* and *l*, which work into the slide *A'*, that is connected with the horizontal axis.

The theodolite being properly adjusted, the particular uses of its several parts, and the manner of measuring angles, are now to be explained.

There are two verniers on the vernier plate, and the points of them marked 0, are at the opposite extremities of a diameter; which diameter is the intersection of a vertical plane passed through the line of collimation, with the vernier plate. It is important to ascertain the exact arc intercepted on the limb, between its 0 point, (this being the point from which the degrees are numbered), and this diameter, for any position which it may assume. The limb being divided to half degrees, if we had only the line marked 0 on the vernier, to guide us, the place of the extremity of the diameter could only be ascertained with certainty to half degrees, as there would be no means of determining its exact position, when it falls between the lines of division on the limb. But the vernier affords results much more accurate. As most instruments for the measurement of angles have verniers, it will perhaps be best to explain their use generally.

First.—Count carefully the number of spaces into which the vernier is divided: this number is one less than the number of lines which limit them.

Secondly.—Turn the vernier till the line at one extremity coincides with a line of the graduated limb, when the line at the other extremity will also coincide with a line of the graduated limb; for the sum of the spaces on the vernier is

always exactly equal to a given number of spaces on the limb; then count the number of spaces on the limb which the vernier covers.

Thirdly.—Examine the limb of the instrument, and ascertain into what parts of a degree it is divided, and express one of those equal parts in minutes.

Let x represent the value of one of the equal spaces of the vernier, and n their number; then nx will be equal to the space covered by the vernier. Let a represent the smallest equal space into which the limb is divided, and m the number of such spaces covered by the vernier; then ma will be equal to the space on the limb covered by the vernier, which is also equal to nx .

The equation $nx=ma$ is called the *equation of the instrument*. In this equation,

$$x = \frac{ma}{n};$$

m , a , and n , being known, x can be found, as also the difference between a and x , which we shall show presently, to be the smallest *certain count* of the instrument.

In the theodolite, $m=29$, $a=30'$ and $n=30$ hence;

$$x = \frac{29 \times 30'}{30} = 29';$$

$$\text{and } a - x = 30' - 29' = 1',$$

the excess of a space on the limb over a space on the vernier.

Fig. 2. Let AB be a portion of the limb of the instrument, and CED the vernier in one of its positions, its 0 point coinciding with the line marked 10 on the limb. Now, since each space of the vernier is less by $1'$ than each space of the limb, the first line on the left of 0, will be $1'$ to the right of the first line on the left of the 10 on the limb; and if the vernier plate be moved $1'$ towards the left, these lines will coincide, and the second line from 0 will then be $1'$ to the right of the second line from 10; if the vernier be moved another minute, these last lines will coincide. The vernier would then show $10^0 2'$.

If the vernier plate be turned still farther, till the third, fourth, fifth, &c. lines coincide, it is plain, that the 0 point of the vernier will have passed the line 10 on the limb, by as many minutes as there are lines of the vernier which shall have coincided with lines of the limb. When the last line

of the vernier coincides with a line of the limb, the vernier will have been moved $30'$, or half a degree; and the 0 point will at the same time coincide with a line of the limb, and show $10^{\circ} 30'$.

The general rule for reading the angle for any position of the vernier may now be stated.

When the 0 line of the vernier coincides with a line of the limb, the arc is easily read from the limb; but when it falls between two lines, note the degrees and half degrees up to the line on the right; then pass along the vernier till a line is found coinciding with a line of the limb: the *number* of this line from the 0 point, indicates the minutes which are to be added to the degrees and half degrees, for the entire angle.

To measure a horizontal angle with the theodolite.

Place the axis of the instrument directly over the point at which the angle is to be measured. This is effected by means of a plumb, suspended from the plate which forms the upper end of the tripod.

Having made the limb truly level, place the 0 of the vernier at 0 or 360° of the limb, and fasten the clamp-screw *S* of the vernier plate. Then, facing in the direction between the lines which subtend the angle to be measured, turn the limb with the outer spindle, until the telescope points to the object on the left, very nearly. Clamp the limb with the clamp-screw *K*, and by means of the tangent screws *L* and *Z*, bring the intersection of the spider's lines to coincide exactly with the object.

Having loosened the clamp-screw *Q* of the lower telescope *MN*, direct it with the thumb-screw *P* to the same object at which the upper telescope is directed; then tighten the clamp-screw *Q*. This being done, loosen the clamp-screw *S* of the vernier plate, and direct the telescope to the other object: the arc passed over by the 0 point of the vernier, is the measure of the angle sought.

The lower telescope having been made fast to the limb, will indicate any change of its position, should any have taken place; and, as the accuracy of the measurements depends on the fixedness of the limb, the lower telescope ought to be often examined, and if its position has been altered, the limb must be brought back to its place by the tangent-screw *L*.

It is not necessary to place the 0 point of the vernier at the 0 point of the limb, previously to commencing the measurement of the angle, but convenient merely; for, whatever be the position of this point on the limb, it is evident that the arc which it passes over is the true measure of the horizontal angle. If, therefore, its place be carefully noted for the first direction, and also for the second, the difference of these two readings will be the true angle, unless the vernier shall have passed the 0 point of the limb, in which case the greater reading must be subtracted from 360° , and the remainder added to the less.

To measure a vertical angle.

In Fig. 3, *AB* represents a view of the vertical limb opposite the thumb-screw *Z*, and *ED* is the vernier. The 0 point of this vernier is at the middle division line, and fifteen spaces lie on each side of it. The relation which exists between the spaces on the limb and those of the vernier, is the same as that between the divisions of the horizontal limb and its vernier, and the degrees and half degrees are read in the same manner: the angles of elevation being read from the 0 of the limb towards the right, and those of depression in the contrary direction. For the minutes, we pass along the vernier in the direction in which the degrees are counted, and if we reach the extreme line, which is the fifteenth, without finding a coincidence, we must then pass to the other extremity of the vernier, and look along towards the 0 point till two lines are found to coincide: the number of the line on the vernier will show the minutes. The lines of the vernier are numbered both ways from the 0 point, and marked 5, 10, 15, to one extremity, and correspondingly from the other extremity 15, 20 and 25, to the 0 point again. The upper range shows the minutes for angles of elevation, and the lower range for those of depression. The vernier in Fig. 3 stands at $2^\circ 15'$ of depression. Had the 15th line at the left, passed the short line with which it now coincides, we should pass to the line 15, on the lower range to the right, and then count towards the 0 to the left.

The first thing to be done, is to ascertain the point of the vertical limb at which the 0 point of the vernier stands, when the line of collimation of the upper telescope, together with

its attached level, is truly horizontal. This is called the true 0 of the limb.

If the instrument be accurately constructed, and the parts have not been disarranged, this point is the 0 point of the limb. This, however, is easily ascertained by turning the limb till the 0's correspond, and then examining if the upper level be truly horizontal. If not, direct the telescope to a distant and elevated object, and read the degrees on the vertical limb. Turn the vernier plate 180° , reverse the telescope, direct it a second time to the same point, and read the arc on the vertical limb. The half difference of these two readings, counted from the 0 point of the limb, in the direction of the greater arc read, gives the true 0 point of the vertical limb; that is, the point at which the 0 of the vernier stands when the line of collimation is horizontal.

Suppose for example, that we had directed the telescope to a point and found the 0 of the vernier to stand at 10° of elevation. If we now reverse the telescope, it ought to incline at an equal angle of depression. If then we turn the whole 180° , and then raise the depressed end of the telescope with the thumb-screw *Z*, until it is directed to the same point as before, the 0 ought to stand at 10° . If it shows a less arc, the true 0 is between the 0 of the limb and the first arc read; if a greater, it is on the other side, and the difference divided by two will indicate the exact 0 point. The half difference thus found is called the *correction*. When the true 0 falls between the marked 0 and the eyeglass, the correction is to be subtracted from the arc read, for angles of elevation, and added, for angles of depression; and the reverse when it falls on the other side. The eyeglass is supposed to be over the thumb-screw *Z*, as in the plate.

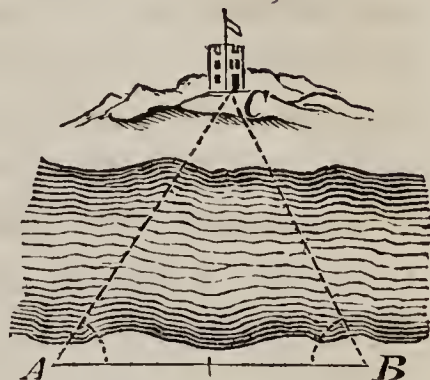
These preparatory steps being taken, let the axis of the telescope be directed to any point either above or below the plane of the limb, and read the arc indicated by the 0 of the vernier. To the arc so read apply the proper correction, if any, and the result will be the true angle of elevation or depression.

87. Having explained the preliminary principles, it only remains to apply them to the measurement of **Heights and Distances**.

PROBLEM I.

To determine the horizontal distance to a point which is inaccessible by reason of an intervening river.

88. Let C be the point. Measure along the bank of the river a horizontal base line AB , and select the stations A and B , in such a manner that each can be seen from the other, and the point C from both of them. Then measure the horizontal angles CAB and CBA .



Let us suppose that we have found $AB=600$ yards, $CAB=57^\circ 35'$ and $CBA=64^\circ 51'$.

The angle $C=180^\circ - (A+B)=57^\circ 34'$.

To find the distance BC .

As	sin C	.	$57^\circ 34'$	.	ar. comp.	.	.	0.073649
:	sin A	.	$57^\circ 35'$	.	.	.	.	9.926431
::	AB	.	600	.	.	.	.	2.778151
:	BC	.	600.11 yards.	.	.	.	.	<u>2.778231</u>

To find the distance AC .

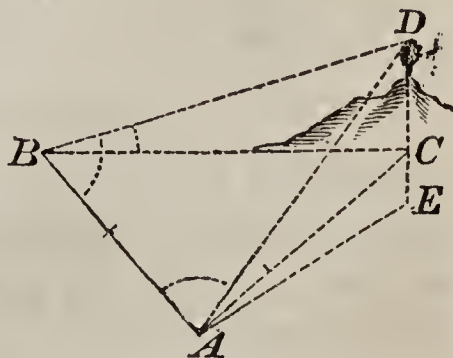
As	sin C	.	$57^\circ 34'$	.	ar. comp.	.	.	0.073649
:	sin B	.	$64^\circ 51'$	.	.	.	.	9.956744
::	AB	.	600	.	.	.	.	2.778151
:	AC	.	643.94 yards	.	.	.	.	<u>2.808544</u>

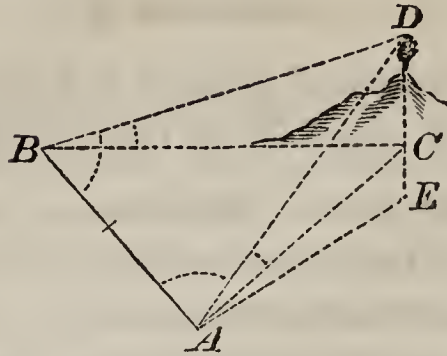
PROBLEM II.

To determine the altitude of an inaccessible object above a given horizontal plane.

FIRST METHOD.

89. Suppose D to be the inaccessible object, and BC the horizontal plane from which the altitude is to be estimated: then, if we suppose DC to be a vertical line, it will represent the required distance.





Measure any horizontal base line, as BA ; and at the extremities B and A , measure the horizontal angles CBA and CAB . Measure also, the angle of elevation DBC .

Then in the triangle CBA there will be known, two angles and the side AB ; the side BC can therefore be determined. Having found BC , we shall have, in the right-angled triangle DBC , the base BC and the angle at the base, to find the perpendicular DC , which measures the altitude of the point D above the horizontal plane BC .

Let us suppose that we have found

$BA=780$ yards, the horizontal angle $CBA=41^{\circ} 24'$, the horizontal angle $CAB=96^{\circ} 28'$, and the angle of elevation $DBC=10^{\circ} 43'$.

In the triangle BAC , to find the horizontal distance BC .

The angle $BCA=180^{\circ} - (41^{\circ} 24' + 96^{\circ} 28') = 42^{\circ} 08' = C$.

As	$\sin C$	. . .	$42^{\circ} 08'$	ar. comp.	. . .	0.173369
:	$\sin A$	. . .	$96^{\circ} 28'$	. . .	. . .	9.997228
::	AB	. . .	780	. . .	. . .	2.892095
:	BC	. . .	1155.29	. . .	. . .	<u>3.062692</u>

In the right-angled triangle DBC , to find DC .

As	R	. . .		ar. comp.	. . .	0.000000
:	$\tan DBC$	. . .	$10^{\circ} 43'$	. . .	. . .	9.277043
::	BC	. . .	1155.29	. . .	. . .	3.062692
:	DC	. . .	218.64	. . .	. . .	<u>2.339735</u>

REMARK I. It might, at first, appear that the solution which we have given, requires that the points B and A should be in the same horizontal plane, but it is entirely independent of such a supposition.

For, the horizontal distance, which is represented by BA , is the same, whether the station A is on the same level with B , above it, or below it (Art. 74). The horizontal angles CAB and CBA are also the same, so long as the point C is in the vertical line DC (Art. 75). Therefore, if the horizontal line through A should cut the vertical line DC , at any point as E , above or below C , AB would still be the horizontal distance between B and A , and AE which is equal to AC , would be the horizontal distance between A and C .

If at A , we measure the angle of elevation of the point D , we shall know in the right angled DAE , the base AE , and the angle at the base; from which the perpendicular DE can be determined.

Let us suppose that we had measured the angle of elevation DAE , and found it equal to $20^{\circ} 15'$.

First: In the triangle BAC , to find AC or its equal AE .

As $\sin C$	. . .	$42^{\circ} 08'$	ar. comp.	. . .	0.173369
:	$\sin B$	. . .	. . .	. . .	9.820406
::	AB	. . .	. . .	. . .	2.892095
:	AC	. . .	. . .	. . .	<u>2.885870</u>

In the right-angled triangle DAE , to find DE .

As R	. . .		ar. comp.	. . .	0.000000
:	$\tan A$	. . .	. . .	. . .	9.566932
::	AE	. . .	. . .	. . .	2.885870
:	DE	. . .	. . .	. . .	<u>2.452802</u>

Now, since DC is less than DE , it follows that the station B is above the station A . That is,

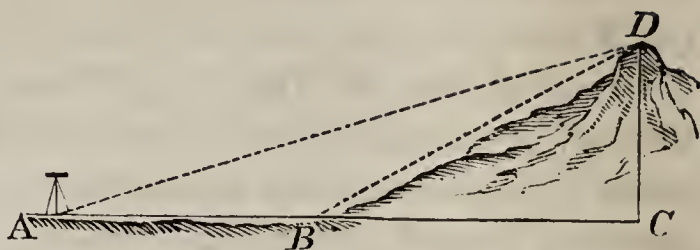
$$DE - DC = 283.66 - 218.64 = 65.02 = EC,$$

which expresses the vertical distance that the station B is above the station A .

REMARK II. It should be remembered, that the vertical distance which is obtained by the calculation, is estimated from a horizontal line passing through the eye at the time of observation. Hence, the height of the instrument is to be added, in order to obtain the true result.

SECOND METHOD.

90. When the nature of the ground will admit of it, measure a base line AB in the direction of the object D . To do this, it will be well to place the theodolite at A , and range the chain staves by means of the upper telescope. Having measured the base, measure with the instrument the angles of elevation at A and B .



Then, since the outward angle DBC is equal to the sum of the angles A and ADB , it follows, that the angle ADB is equal to the difference of the angles of elevation at A and B . Hence, we can find all the parts of the triangle ADB . Having found DB , and knowing the angle DBC , we can find the altitude DC .

This method supposes that the stations A and B are on the same horizontal plane; and therefore can only be used when the line AB is nearly horizontal.

Let us suppose that we have measured the base line, and the two angles of elevation, and

$$\text{found } \begin{cases} AB = 975 \text{ yards} \\ A = 15^\circ 36' \\ DBC = 27^\circ 29'; \end{cases}$$

required the altitude DC .

$$\text{First: } ADB = DBC - A = 27^\circ 29' - 15^\circ 36' = 11^\circ 53'.$$

In the triangle ADB , to find BD .

As	$\sin D$	$11^\circ 53'$	ar. comp.		0.686302
:	$\sin A$	$15^\circ 36'$			9.429623
::	AB	975			2.989005
:	DB	1273.3			<u>3.104930</u>

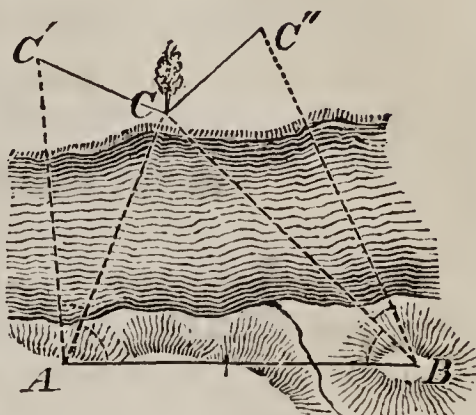
In the triangle DBC , to find DC .

As	R		ar. comp.		0.000000
:	$\sin B$	$27^\circ 29'$			9.664163
::	DB	1273.3			3.104930
:	DC	587.61			<u>2.769093</u>

PROBLEM III.

To determine the perpendicular distance of an object below a given horizontal plane.

91. Suppose C to be directly over the given object, and A the point through which the horizontal plane is supposed to pass.



Measure a horizontal base line AB , and at the stations A and B conceive the two horizontal lines AC , BC , to be drawn. The oblique lines from A and B to the object will be the hypotenuses of two right-angled triangles, of which AC , BC , are the bases. The perpendiculars of these triangles will be the distances from the horizontal lines AC , BC , to the object. If we turn the triangles about their bases AC , BC , until they become horizontal, the object, in the first case, will fall at C' , and in the second at C'' .

Measure the horizontal angles CAB , CBA , and also the angles of depression $C'AC$, $C''BC$.

Let us suppose that we have

$$\text{found } \begin{cases} AB = 672 \text{ yards} \\ \angle BAC = 72^\circ 29' \\ \angle ABC = 39^\circ 20' \\ \angle C'AC = 27^\circ 49' \\ \angle C''BC = 19^\circ 10' \end{cases}$$

First: In the triangle ABC , the horizontal angle $ACB = 180^\circ - (A + B) = 180^\circ - 111^\circ 49' = 68^\circ 11'$.

To find the horizontal distance AC .

As	sin C	. 68° 11'	. ar. comp.	. .	0.032275
:	sin B	. 39° 20'	. . . .	. .	9.801973
::	AB	. 672	. . . .	. .	2.827369
:	AC	. 458.79	. . . .	. .	2.661617

To find the horizontal distance BC .

As	sin C	. 68° 11'	. ar. comp.	. .	0.032275
:	sin A	. 72° 29'	. . . .	. .	9.979380
::	AB	. 672	. . . .	. .	2.827369
:	BC	. 690.28	. . . .	. .	2.839024

In the triangle CAC' , to find CC' .

As	R	.	.	ar. comp.	.	0.000000
:	$\tan C'AC$	.	$27^{\circ} 49'$	.	.	9.722315
::	AC	.	458.79	.	.	<u>2.661617</u>
:	CC'	.	242.06	.	.	<u>2.383932</u>

In the triangle CBC'' , to find CC'' .

As	R	.	.	ar. comp.	.	0.000000
:	$\tan C''BC$	.	$19^{\circ} 10'$	.	.	9.541061
::	BC	.	690.28	.	.	<u>2.839024</u>
:	CC''	.	239.93	.	.	<u>2.380085</u>

Hence also, $CC' - CC'' = 242.06 - 239.93 = 2.13$ yards; which is the height of the station A above station B .

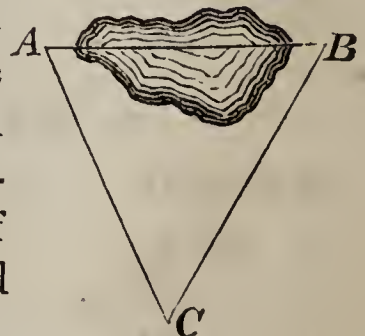
REMARK. In measuring a base line, if great accuracy is required, the theodolite should be placed at one extremity, and the telescope directed to the other, and the alignment of the staves made by means of the intersection of the spider's lines. If the highest degree of accuracy is necessary, the base line should be measured with rods, which admit of being adjusted to a horizontal position by means of a spirit level.

APPLICATIONS.

1. Wanting to know the distance between two inaccessible objects, which lie in a direct line from the bottom of a tower of 120 feet in height, the angles of depression are measured, and are found to be, of the nearest 57° , of the most remote $25^{\circ} 30'$; required the distance between them.

Ans. 173.656 feet.

2. In order to find the distance between two trees A and B , which could not be directly measured because of a pool which occupied the intermediate space, the distances of a third point C from each of them were measured, and also the included angle ACB : it was found that



$$\begin{aligned} CB &= 672 \text{ yards} \\ CA &= 588 \text{ yards} \\ \angle ACB &= 55^\circ 40'; \end{aligned}$$

required the distance AB :

Ans. 592.967 yards.

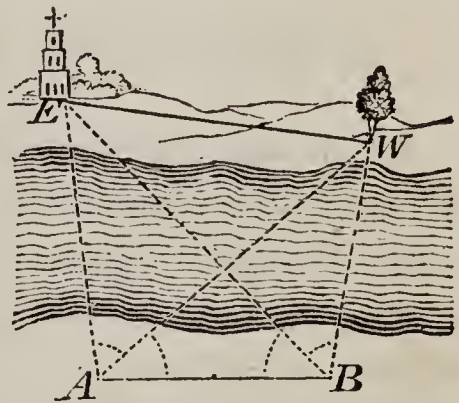
3. Being on a horizontal plane, and wanting to ascertain the height of a tower, standing on the top of an inaccessible hill, there were measured, the angle of elevation of the top of the hill 40° , and of the top of the tower 51° ; then measuring in a direct line 180 feet farther from the hill, the angle of elevation of the top of the tower was $33^\circ 45'$; required the height of the tower.

Ans. 83.998 feet.

4. Wanting to know the horizontal distance between two inaccessible objects E and W , the following measurements were made,

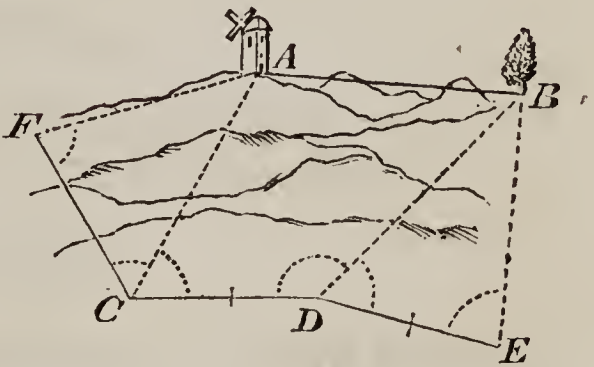
$$\text{viz. } \begin{cases} AB = 536 \text{ yards} \\ \angle BAW = 40^\circ 16' \\ \angle WAE = 57^\circ 40' \\ \angle ABE = 42^\circ 22' \\ \angle EBW = 71^\circ 07' \end{cases}$$

required the distance EW .



Ans. 939.527 yards.

5. Wanting to know the horizontal distance between two inaccessible objects A and B , and not finding any station from which both of them could be seen, two points C and D , were chosen, at a distance from each



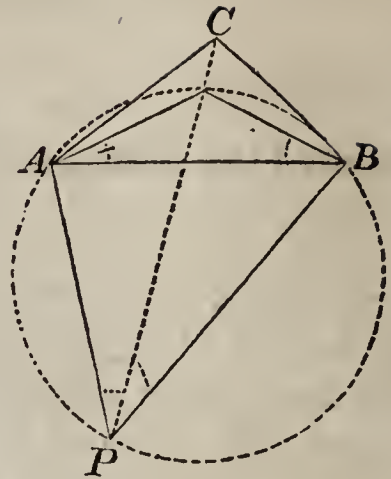
other, equal to 200 yards; from the former of these points A could be seen, and from the latter B , and at each of the points C and D a staff was set up. From C a distance CF was measured, not in the direction DC , equal to 200 yards, and from D a distance DE equal to 200 yards, and the following angles taken,

$$\text{viz. } \begin{cases} \angle AFC = 83^\circ 00' & \angle BDE = 54^\circ 30' \\ \angle ACD = 53^\circ 30' & \angle BDC = 156^\circ 25' \\ \angle ACF = 54^\circ 31' & \angle BED = 88^\circ 30' \end{cases}$$

Ans. $AB = 345.467$ yards.

6. From a station P there can be seen three objects A , B and C , whose distances from each other are known: viz. $AB=800$, $AC=600$, and $BC=400$ yards. Now, there are measured the horizontal angles

$APC=33^{\circ} 45'$ and $BPC=22^{\circ} 30'$: it is required to find the three distances PA , PC , and PB .



$$\text{Ans. } \begin{cases} PA=710.193 \text{ yards.} \\ PC=1042.522 \\ PB=934.291 \end{cases}$$

OF MEASUREMENTS WITH THE TAPE OR CHAIN ONLY.

92. It often happens that instruments for the measurement of angles cannot be easily obtained; we must then rely entirely on the tape or chain.

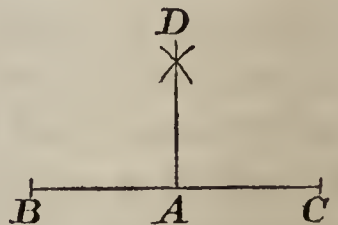
We now propose to explain the best methods of determining distances, without the aid of instruments for the measurement of horizontal or vertical angles.

PROBLEM I.

To trace, on the ground, the direction of a right line, that shall be perpendicular at a given point, to a given right line.

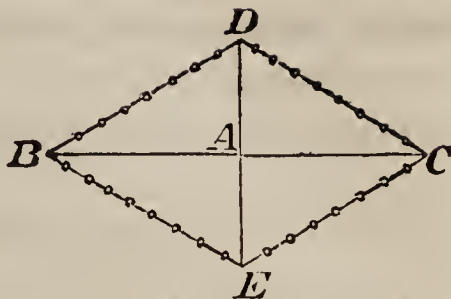
FIRST METHOD.

93. Let BC be the given right line, and A the given point. Measure from A , on the line BC , two equal distances AB , AC , one on each side of the point A . Take a portion of the chain or tape, greater than AB , and place one extremity at B , and with the other trace the arc of a circle on the ground. Then remove the end which was at B , to C , and trace a second arc intersecting the former at D . The straight line drawn through D and A will be perpendicular to BC at A .



SECOND METHOD.

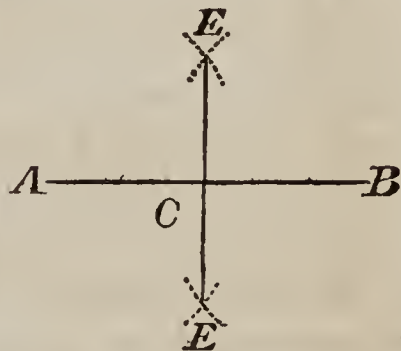
94. Having made $AB=AC$, take any portion of the tape or chain, considerably greater than the distance between B and C . Mark the middle point of it, and fasten its two extremities, the one at B and the other at



C . Then, taking the chain by the middle point, stretch it tightly on either side of BC , and place a staff at D or E : then will DAE be the perpendicular required.

THIRD METHOD.

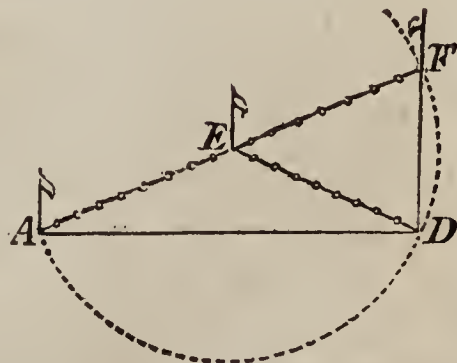
95. Let AB be the given line, and C the point at which the perpendicular is to be drawn. From the point C measure a distance CA equal to 8. With C as a centre, and a radius equal to 6, describe an arc on either side of AB : then, with A as a centre, and a radius equal to 10, describe a second arc intersecting the one before described at E : then draw the line EC , and it will be perpendicular to AB at C .



REMARK. Any three lines, having the ratio of 6, 8 and 10, form a right-angled triangle, of which the side corresponding to 10 is the hypotenuse.

FOURTH METHOD.

96. Let AD be the given right line, and D the point at which the perpendicular is to be drawn. Take any distance on the tape or chain, and place one extremity at D , and fasten the other at some point as E , between the two lines which are to form the right angle. Place a staff at E .



Then, having stationed a person at D , remove the extremity of the chain and carry it round until it ranges on the line DA at A . Place a staff at A : then remove the end of the

chain at A , and carry it round until it falls on the line AE at F . Then place a staff at F , and ADF will be a right angle, being an angle in a semi-circle.

97. There is a very simple instrument, used exclusively in laying off right angles on the ground, which is called the

SURVEYING CROSS.

Pl. 2. Fig. 1. This instrument consists of two bars, AB and CD , permanently fixed at right angles to each other, and firmly attached at E to a pointed staff, which serves as a support. Four sights are screwed firmly to the bars, by means of the screws a , b , c , and d .

As the only use of this instrument is to lay off right angles, it is of the first importance that the lines of sight be truly at right angles. To ascertain if they are so, let the bar AB be turned until its sights mark some distinct object; then look through the other sights and place a staff on the line which they indicate: let the cross be then turned until the sights of the bar AB come to the same line: if the other sights are directed to the first object, the lines of sight are exactly at right angles.

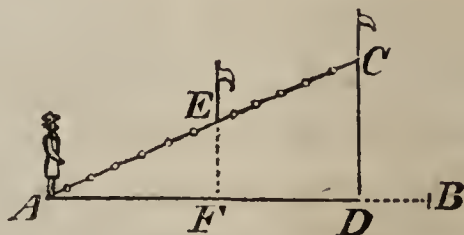
The sights being at right angles, if one of them be turned in the direction of a given line, the other will mark the direction of a line perpendicular to it, at the point where the instrument is placed.

PROBLEM II.

From a given point without a straight line, to let fall a perpendicular on the line.

98. Let C be the given point, and AB the given line.

From C measure a line, as CA , to any point of the line AB . From A , measure on AB any distance as AF , and at F erect FE perpendicular to AB .



Having stationed a person at A , measure along the perpendicular FE until the forward staff is aligned on the line AC : then measure the distance AE . Now, by similar triangles, we have

$$AE : AF :: AC : AD$$

in which all the terms are known except AD , which may, therefore, be considered as found. The distance AD being laid off from A , the point D , at which the perpendicular CD meets AB , becomes known. If we wish the length of the perpendicular, we use the proportion

$$AE : EF :: AC : CD,$$

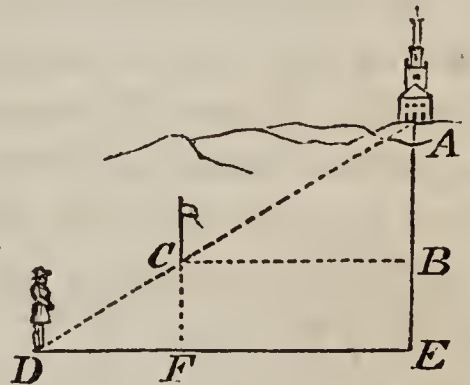
in which all the terms are known, excepting CD : therefore, CD is determined.

PROBLEM III.

To determine the horizontal distance from a given point to an inaccessible object.

99. Let A be an inaccessible object, and E the point from which the distance is to be measured.

At E lay off the right angle AED , and measure in the direction ED , any convenient distance to D , and place a staff at D . Then measure from E , directly towards the object



A , a distance EB of a convenient length, and at B lay off a line BC perpendicular to EA . Measure along the line BC , until a person at D shall range the forward staff on the line DA . Now, DF is known, being equal to the difference between the two measured lines DE and CB . Hence, by similar triangles,

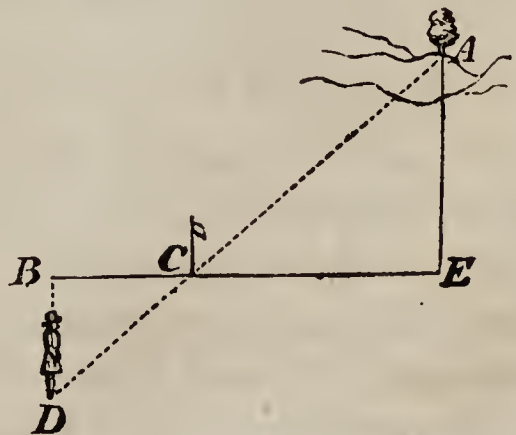
$$DF : FC :: DE : EA,$$

in which proportion all the terms are known, except the fourth, which may, therefore, be regarded as found: hence, EA is determined.

SECOND METHOD.

100. At the point E lay off EB perpendicular to the line EA , and measure along it any convenient distance, as EB .

At B lay off the right angle EBD , and measure any distance in the direction BD . Let a person at D align a staff on DA ,



while a second person at B aligns it on BE : the staff will thus be fixed at C . Then measure the distance BC .

The two triangles BCD and CAE being similar, we have,

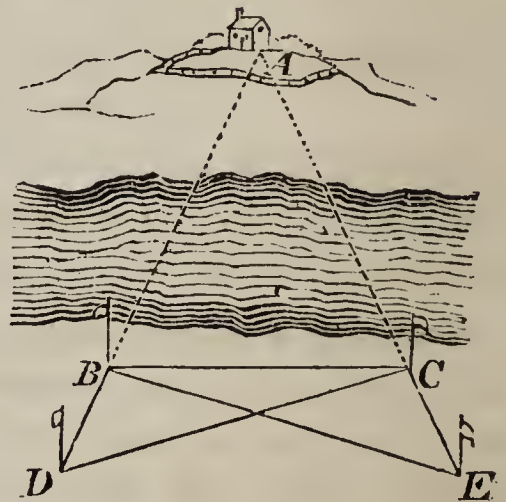
$$BC : BD :: CE : EA,$$

in which all the terms are known, except the fourth, which may, therefore, be regarded as found.

THIRD METHOD.

101. Let B be the given point, and A the inaccessible object, it is required to find BA .

Measure any horizontal base line, as BC . Then, having placed staves at B and C , measure any convenient distances BD and CE , such that the points D, B and A , shall be in the same right line, as also, the points E, C and A ; then measure the diagonal lines DC and EB .



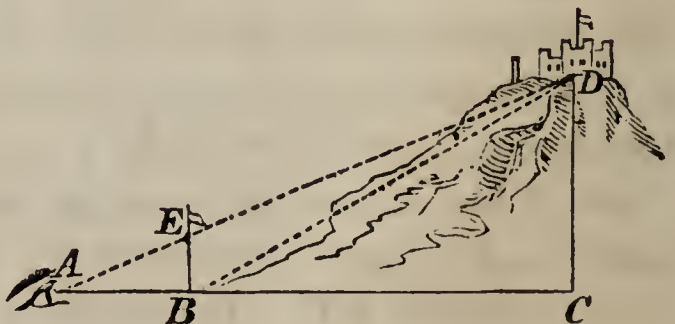
Now, in the triangle BEC , the three sides are known, therefore, the angle ECB can be found. In the triangle CDB , the three sides are also known, therefore the angle CBD can be determined. These angles being respectively subtracted from 180° , the two angles ACB and ABC become known; and hence, in the triangle ABC , we have two angles and the included side, to find the side BA .

PROBLEM IV.

To find the altitude of an object, when the distance to the vertical line passing through the top of it is known.

102. Let CD be the altitude required, and AC the known distance.

From A , measure on the line AC , any convenient distance AB , and place a



staff vertically at B . Then placing the eye at A , sight to

the object D , and let the point, at which the line AD cuts the staff BE , be marked. Measure the distance BE on the staff; then say,

$$\text{As } AB : BE :: AC : CD,$$

then, CD becomes known.

If the line AC cannot be measured, on account of intervening objects, it may be determined by calculation, as in the last problem, and then, having found the horizontal distance, the vertical line is readily determined, as before.

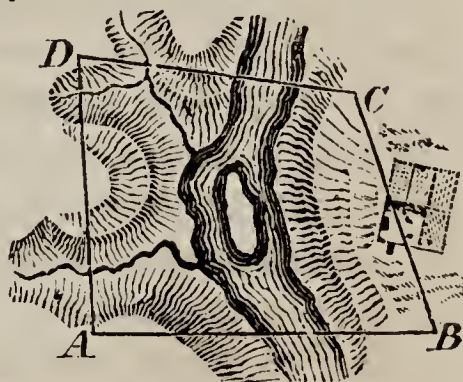
CHAPTER III.

Of the area or content of ground.—Of laying out and dividing land.

103. We come next to the determination of the area or content of ground.

The surface of the ground being, in general, broken and uneven, it is impossible, without great trouble and expense, to ascertain its exact area or content. To avoid this inconvenience, it has been agreed to refer every surface to a horizontal plane: that is, to regard all its bounding lines as horizontal, and its area as measured by that portion of the horizontal plane which the boundary lines enclose.

For example, if $ABCD$ were a piece of ground having an uneven surface, we should refer the whole to a horizontal plane, and take for the measure of the area that part of the plane which is included between the bounding lines AB, BC, CD, DA .



In estimating land in this manner, the sum of the areas of all the parts into which a tract may be divided, is equal to the area estimating it as an entire piece: but this would not be the case if the areas of the parts had reference to the actual surface, and the area of the whole were calculated from its bounding lines.

104. The *unit* of a quantity is one of the equal parts of which the quantity is composed (*Arith. In. VI*). Thus, a line of three feet in length is made up of three single feet, and of this line, 1 foot is the unit. The unit of a line may be 1 foot, 1 yard, 1 rod, 1 chain, or any other known distance.

If, on the unit of length, a square be described, it will form the unit for computing areas.

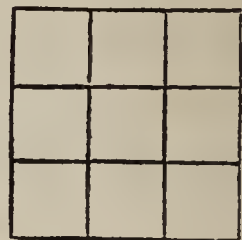
Thus, is 1 square foot,

1 foot.



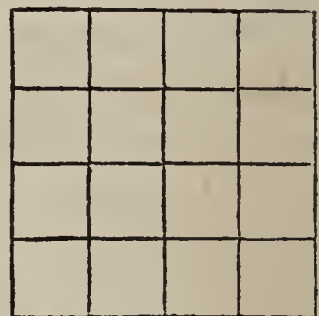
1 square yard, or 9 square feet, .

1 yard=3 feet.



1 square chain, or 16 square rods. .

1 chain=4 rods.



Thus it is seen that there are two kinds of quantity to be considered, viz. lines, and areas or surfaces; and each kind has its own unit of measure.

When, therefore, the linear measures of ground are feet, yards, rods, or chains, the superficial measures will be square feet, square yards, square rods, or square chains; and the number expressing the area will be nothing else than the number of times which the unit of superficial measure is contained in the land measured.

It has been already observed (Art. 83), that Gunter's chain of four rods, or 66 feet in length, and which is divided into 100 links, is the chain in general use among surveyors. We shall, therefore, take the length of this chain for the unit of linear measure.

105. An *acre* is a surface equal in extent to 10 square chains; that is, equal to a rectangle of which one side is ten chains, and the other side one chain.

One-quarter of an acre, is called a *rood*.

Since the chain is 4 rods in length, 1 square chain contains 16 square rods; and therefore, an acre, which is 10 square chains, contains 160 square rods, and a rood contains 40 square rods. The square rods are called *perches*.

106. Land is generally computed in acres, roods, and perches, which are respectively designated by the letters *A. R. P.*

When the linear dimensions of a survey are chains or links, the area will be expressed in square chains or square links, and it is necessary to form a rule for reducing this area to acres, roods, and perches. For this purpose, let us form the following

TABLE.

1 square chain = 10000 square links.

1 acre = 10 square chains = 100000 square links.

1 acre = 4 roods = 160 perches.

1 square mile = 6400 square chains = 640 acres.

Now, when the linear dimensions are links, the area will be expressed in square links, and may be reduced to acres by dividing by 100000, the number of square links in an acre: that is, by pointing off five decimal places from the right hand.

If the decimal part be then multiplied by 4, and five places of decimals pointed off from the right hand, the figures to the left will express the roods.

If the decimal part of this result be now multiplied by 40, and five places for decimals pointed off, as before, the figures to the left will express the perches.

If one of the dimensions be in links, and the other in chains, the chains may be reduced to links by annexing two ciphers: or, the multiplication may be made without annexing the ciphers, and the product reduced to acres and decimals of an acre, by pointing off three decimal places at the right hand.

When both the dimensions are in chains, the product is reduced to acres by dividing by 10, or pointing off one decimal place.

From which we conclude ; that,

1st. *If links be multiplied by links, the product is reduced to acres by pointing off five decimal places from the right hand.*

2d. *If chains be multiplied by links, the product is reduced to acres by pointing off three decimal places from the right hand.*

3d. *If chains be multiplied by chains, the product is reduced to acres by pointing off one decimal place from the right hand.*

107. Since there are 16.5 feet in a rod, a square rod is equal to $16.5 \times 16.5 = 272.25$ square feet.

If the last number be multiplied by 160, we shall have

$$272.25 \times 160 = 43560 = \text{the square feet in an acre.}$$

Since there are 9 square feet in a square yard, if the last number be divided by 9, we obtain

$$4840 = \text{the number of square yards in an acre.}$$

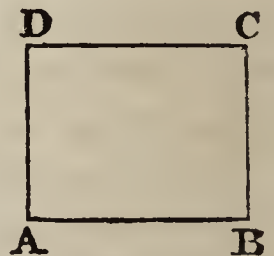
PROBLEM I.

108. To find the area of a square or rectangular piece of ground.

Multiply the two sides together, and the product will express the area (Geom. Bk. IV, Prop. IV).

1. To find the area of the rectangular field $ABCD$.

Measure the two sides AB , BC : let us suppose that we have found $AB = 14$ chains 27 links, and $BC = 9$ chains 75 links. Then,



$$AB = 1427 \text{ links,}$$

$$BC = 975 \text{ links,}$$

$$AB \times BC = 1391325 \text{ square links,}$$

$$= 13.91325 \text{ acres.}$$

$$\begin{array}{r} 4 \\ \hline 3.65300 \text{ rods,} \end{array}$$

$$\begin{array}{r} 40 \\ \hline 26.12000 \text{ perches.} \end{array}$$

Ans. 13A 3R 26P.

2. What is the area of a square field, of which the sides are each 33 ch 8 l?

Ans. 109A 1R 29P.

3. What is the content of a rectangular field, of which the longest side is 49 ch 27 l, and the shorter 38 ch 7 l?

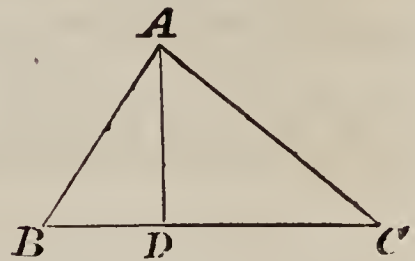
Ans. 187*A* 2*R* 11*P*.

PROBLEM II.

109. To find the content of a piece of land in the form of a triangle.

FIRST METHOD.

Measure either side of the triangle as BC, and from the opposite angle A let fall a perpendicular AD, and measure this perpendicular; then, multiply the base and perpendicular together, and divide the product by 2, the result will express the area of the triangle. Or, the area is equal to the base multiplied by half the perpendicular, or to the perpendicular multiplied by half the base (Geom. Bk. IV, Prop. II).



1. What is the content of a triangle whose base is 25 ch 1 l, and perpendicular 18 ch 14 l?

Ans. 22*A* 2*R* 29*P*.

2. What is the content of a triangle whose base is 15.48 chains, and altitude 9.67 chains?

Ans. 7*A* 1*R* 38*P*.

SECOND METHOD.

Measure two sides and their included angle. Then, add together the logarithms of the two sides and the logarithmic sine of their included angle; from this sum subtract the logarithm of the radius, which is 10, and the remainder will be the logarithm of double the area of the triangle. Find, from the table, the number answering to this logarithm, and divide it by 2; the quotient will be the required area (Geom. Mens. Prob. II).

1. In a triangle *ABC*, suppose that we have found *AB* = 57.65 ch, *AC* = 125.81 ch, and the included angle *CAB* = 57° 25': required the area.

Let the required area be designated by Q : then

$$\log 2Q = \begin{cases} +\log AB & 57.65 & . & . & 1.760799 \\ +\log AC & 125.81 & . & . & 2.099715 \\ +\log \sin A & 57^\circ 25' & . & . & 9.925626 \\ -\log R & . & . & . & 10 \\ \hline 2Q & . & . & . & 6111.4 & . & . & . & \underline{\underline{3.786140}} \end{cases}$$

And . Q . . . 3055.7 square chains.

Ans. 305A 2R 11P.

REMARK. In this example, the links are treated as decimal parts of the chain; the result, therefore, is in square chains and decimal parts of a square chain.

2. What is the area of a triangle whose sides are 30 and 40 chains, and their included angle $28^\circ 57'$?

Ans. 29A 0R 7P.

THIRD METHOD.

Measure the three sides of the triangle. Then, add them together and take half their sum. From this half sum subtract each side separately. Then, multiply the half sum and the three remainders together, and extract the square root of the product: the result will be the area (Geom. Mens. Prob. II).

Or, after having obtained the three remainders, add together the logarithm of the half sum and the logarithms of the respective remainders, and divide their sum by 2: the quotient will be the logarithm of the area.

1. Find the area of a triangular piece of ground whose sides are 20, 30, and 40 chains.

FIRST METHOD.

$$\begin{array}{r} 20 \qquad \qquad 45 \qquad \qquad 45 \qquad \qquad 45 \\ 30 \qquad \qquad -20 \qquad \qquad -30 \qquad \qquad -40 \\ \hline 40 \qquad \qquad \underline{25} \text{ 1st rem.} \qquad \underline{15} \text{ 2d rem.} \qquad \underline{5} \text{ 3d rem.} \\ 2 \overline{)90} \end{array}$$

45 = half sum. Then,

$$45 \times 25 \times 15 \times 5 = 84375 : \text{ and } \sqrt{84375} = 290.4737 = \text{the area.}$$

Ans. 29A 0R 8P.

2. What is the area of a triangle whose sides are 2569, 4900, and 5035 links?

two triangles, in both of which all the sides will be known. Then, find the areas of the triangles separately, and their sum will be the area of the quadrilateral.

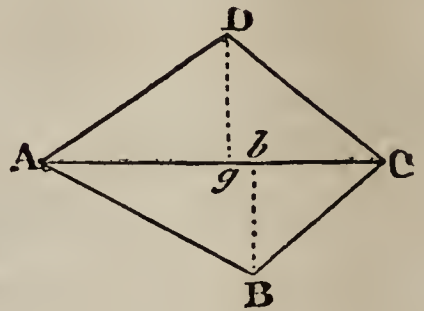
1. Suppose that we have measured the sides and diagonal AC , of the quadrilateral $ABCD$, and found

$$AB=40.05 \text{ ch, } CD=29.87 \text{ ch,}$$

$$BC=26.27 \text{ ch, } AD=37.07 \text{ ch,}$$

and $AC=55 \text{ ch}$:

required the area of the quadrilateral.



Ans. 101A 1R 15P.

REMARK. Instead of measuring the four sides of the quadrilateral, we may let fall the perpendiculars Bb , Dg , on the diagonal AC . The area of the triangle may then be determined by measuring these perpendiculars and the diagonal AC . The perpendiculars are $Dg=18.95 \text{ ch}$, and $Bb=17.92 \text{ ch}$.

PROBLEM V.

112. To find the content of a field having any number of sides.

Measure the sides of the field and also the diagonals : the three sides of each of the triangles into which the field will be thus divided will then be known, and the areas of the triangles may then be calculated by the preceding rules. Or, measure the diagonals, and from the angular points of the field draw perpendiculars to the diagonals and measure their lengths : the base and perpendicular of each of the triangles will then be known.

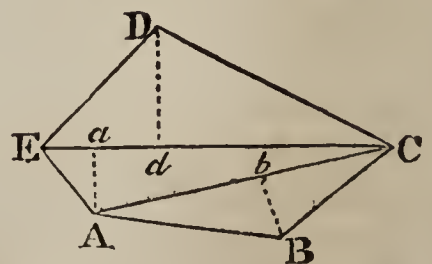
1. Let it be required to determine the content of the field $ABCDE$, having five sides.

Let us suppose that we have measured the diagonals and perpendiculars, and found

$$AC=36.21 \text{ ch, } EC=39.11 \text{ ch,}$$

$$Bb=4.08 \text{ ch, } Dd=7.26 \text{ ch, } Aa=$$

4.19 ch ; also $Ea=4.00 \text{ ch, } Ed=13.60 \text{ ch, } Ab=20.30 \text{ ch}$: required the area of the field.



Area of triangle $ABC = 73.8684$	square chains
area of " $CDE = 141.9693$	" "
area of " $ACE = 81.7399$	" "
area of $ABCDE = \underline{297.5776}$	" "

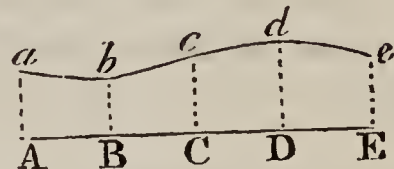
Ans. 29A 3R 12P.

PROBLEM VI.

113. To find the content of a long and irregular figure, bounded on one side by a straight line.

Suppose the ground, of which the content is required, to be of the form $ABEeda$, bounded on one side by the right line AE , and on the other by the curve $edca$.

At A and E , the extremities of the right line AE , erect the two perpendiculars Aa , Ee , and on each of them measure the breadth of the land. Then



divide the base into any convenient number of equal parts and measure the breadth of the land at each point of division.

Add together the intermediate breadths and half the sum of the two extreme ones: then multiply this sum by one of the equal parts of the base line, and the product will be the required area very nearly (Mens. Prob. VI).

1. The breadths of an irregular figure, at five equidistant places, being 8.20 ch, 7.40 ch, 9.20 ch, 10.20 ch, and 8.60 chains, and the whole length 40 chains, required the area.

8.20	4)40	
8.60	10	one of the equal parts.
2)16.80		
8.40	mean of the extremes	35.20 sum
7.40		10
9.20	area	<u>352.00</u> square ch.
10.20		
<u>35.20</u>	sum	

Ans. 35A 2R.

2. The length of an irregular piece of land being 21 ch, and the breadths, at six equidistant points, being 4.35 ch,

5.15 ch, 3.55 ch, 4.12 ch, 5.02 ch, and 6.10 chains : required the area.

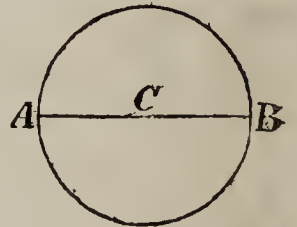
Ans. 9*A* 2*R* 30*P*.

REMARK. If it is not convenient to erect the perpendiculars at equal distances from each other, the areas of the trapezoids, into which the whole figure is divided, must be computed separately : their sum will be the required area.

PROBLEM VII.

114. To find the area of a piece of ground in the form of a circle.

Measure the radius AC : then multiply the square of the radius by 3.1416 (Mens. Prob. X).



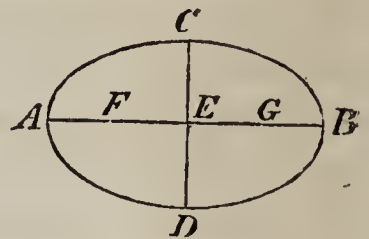
1. To find the area of a circular piece of land, of which the diameter is 25 ch.

Ans. 49*A* 0*R* 14*P*.

PROBLEM VIII.

115. To find the content of a piece of ground in the form of an ellipsis.

Measure the semi-axes AE , CE . Then multiply them together, and their product by 3.1416.



1. To find the area of an elliptical piece of ground, of which the transverse axis is 16.08 ch, and the conjugate axis 9.72 ch.

Ans. 12*A* 1*R* 4*P*.

REMARK I. The following is the manner of tracing an ellipse on the ground, when the two axes are known.

From C , one of the extremities of the conjugate axis as a centre, and AE half the transverse axis as a radius, describe the arc of a circle cutting AB in the two points F and G : these points are called the *foci* of the ellipse.

Then, take a tape, the length of which is equal to AB , and fasten the two ends, one at the focus F , the other at the focus G . Place a pin against the tape and move it around, keeping the tape tightly stretched: the extremity of the pin will trace the curve of the ellipse.

REMARK II. In determining the content of ground, in the examples which have been given, the linear dimensions have been taken in chains and decimals of a chain.

If the linear dimensions were taken in terms of any other unit, they may be readily reduced to chains. For, a chain is equal to 4 rods, equal to 22 yards, equal to 66 feet. Hence,

1st. *Rods may be reduced to chains and the decimal of a chain, by dividing by 4.*

2d. *Yards may be reduced to chains and the decimal of a chain, by dividing by 22.*

3d. *Feet may be reduced to chains and the decimal of a chain, by dividing by 66.*

REMARK III. If it is thought best to calculate the area, without reducing the linear dimensions to chains, the result can be reduced to acres.

1st. *By dividing it by 160 when it is in square rods (Art. 107).*

2d. *By dividing it by 4840 when it is in square yards (Art. 107).*

3d. *By dividing it by 43560 when it is in square feet (Art. 107).*

OF LAYING OUT AND DIVIDING LAND.

116. The surveyor is often required to lay off a given quantity of land, in such a way that its bounding lines shall form a particular figure, viz., a square, a rectangle, a triangle, &c. He is also often called upon to divide given pieces of land into parts containing given areas, or bearing certain relations with each other.

The manner of making such divisions must always depend on a judicious application of the principles of geometry to the particular case.

If, for example, it were required to lay out an acre of ground in a square form, it would first be necessary to find, by calculation, the side of such a square, and then to trace, on the ground, four equal lines at right angles to each other.

PROBLEM I.

117. To lay out a given quantity of land in a square form.

Reduce the given area to square chains, or square rods: then extract the square root, and the result will be the side of the required square. This square being described on the ground, will be the figure required.

1. To trace a square which shall contain 15A 0R 12P.

First, . 15 A = 60 R = 2400 P

Add 12 P; hence,

15 A 0 R 12 P = 2412 P; the square root of

which is 49.11.

Therefore, if a square be traced on the ground, of which the side is 49.11 rods, it will be the required figure.

2. To trace a square which shall contain 176A 1R 24P.

First, . 176 A = 1760 square chains,

1 R = 2.5 " "

24 P = 1.5 " " ; hence,

176 A 1 R 24 P = 1764 square chains: the square root of which is 42. Hence, if a square be traced on the ground, of which the side is 42 ch, it will be the required figure.

PROBLEM II.

118. To lay out a given quantity of land in a rectangular form, having one of its sides given.

Divide the given area, reduced to square chains or square rods, by the given side of the required rectangle, and the quotient will be the other side. Then trace the rectangle on the ground.

1. To lay off 240 acres in a rectangular form, one of the sides being given, and equal to 80 rods.

First, 240 A = 2400 square chains = 38400 square rods.

Then, 80)38400(480 rods; which is the required side of the rectangle.

119. A great number of similar problems might be proposed. The solution of them does not, however, properly belong to surveying. The laying out of the ground, and the tracing of lines, after the figure and area have been determined, are the only parts which appertain to a practical treatise. The manner of tracing lines having been already explained, it seems unnecessary to add the numerous examples often given under this head of the subject.

CHAPTER IV.

Of the Surveying Compass.—Of Surveying with the Compass.— Of the Plane-Table.

120. Before considering the principles involved in the method of surveying now to be explained, it will be necessary to describe the instrument principally used in the field, and which is called

THE CIRCUMFERENTER, OR SURVEYOR'S COMPASS.

Pl. 2, Fig. 2. This instrument consists of a compass-box *DCE*, a magnetic needle, a brass plate *AB*, from twelve to fourteen inches long, two plain sights, *AF* and *BG*, one of which is more fully shown in Fig. 3; and a stand, which is sometimes a tripod, and sometimes a single staff pointed with iron at the lower end, so that it may be placed firmly in the ground.

The open sights, *AF* and *BG*, are placed at right angles to the plate *AB*, and fastened to it firmly by the screws *a* and *b*. In each sight there is a large and small aperture or slit; the larger aperture being above the smaller in one of the sights, and below it in the other. A hair or thread of silk is drawn vertically through the middle of the large aperture, as shown in Fig. 3.

The compass-box *DCE* is circular, and generally about six inches in diameter. At the centre is a small pin, on which the magnetic needle is poised. This needle, if allowed

to turn freely around the point of support, will settle to a state of rest: the direction which it then indicates, is called the *magnetic meridian*.

In the interior of the compass-box, there is a graduated circle divided to degrees, and sometimes to half degrees: the degrees are numbered from the extremities of the diameter NS , both ways to 90° .

The length of the magnetic needle is a little less than the diameter of the graduated circle, so that the needle can move freely around its centre, within the circle, and its positions be noted on the graduated arc.

The compass-box is turned about its centre, without moving the plate AB , by means of the milled screw L : it is fastened to the plate AB , by the screw P .

In using the compass, it is important to ascertain the exact angle which may be included between the magnetic meridian and the direction that may be given to the line drawn through the eye and the sights AF and BG .

To effect this, a small arc HI is described on the bar AB , having its centre at the centre of the compass-box. This arc is divided to degrees, and sometimes to the parts of a degree. A vernier is also used, which is permanently attached to the compass-box.

When the 0 point of this vernier coincides with the 0 point of the graduated arc HI , the line of the compass-box marked NS , has the same horizontal direction as the line along which the sights are directed.

Now, supposing the 0 of the vernier to coincide with the 0 of the arc HI , if the end of the needle does not stand at one of the lines of division of the graduated circle, let the whole degrees be read. Then, turn the compass-box by means of the screw L , until the needle points exactly to the line which marked the whole degrees: the space passed over by the 0 of the vernier, shows the minutes that are to be added.

OF SURVEYING WITH THE COMPASS.

121. The line about which the earth revolves is called its *axis*; and the two points in which the axis meets the surface of the earth are called the *poles*.

122. A meridian is a line traced on the surface of the earth, which would, if sufficiently produced in both directions, pass through the poles. Hence, all the meridian lines intersect each other at the two poles.

The poles, however, are so distant from each other, that no sensible error will arise in supposing the meridians to be parallel; and since, in all the surveys made with the compass, the surface of the ground is regarded as a horizontal plane, the meridians are represented by horizontal and parallel lines.

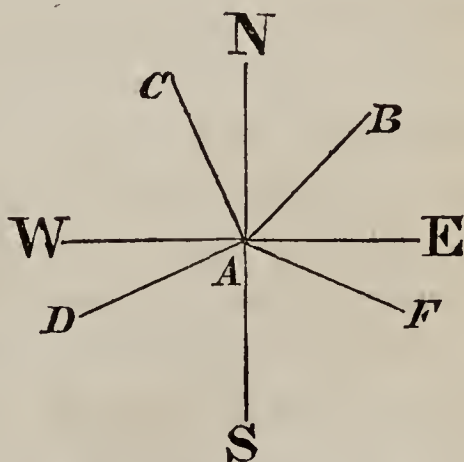
123. When the compass is placed on its stand, and the needle is allowed to settle to a state of rest, the direction it assumes has been named the *magnetic meridian*. Although this line is different from the true meridian, yet in the surveys made with the compass, we shall take for the meridian that line which is determined by the direction of the magnetic needle.

124. If the right hand be turned towards the point where the sun rises, the direction pointed by the farthest end of the needle is called *north*; the direction shown by the nearest end is called *south*, and the line thus indicated is called a north and south line, as well as a meridian.

125. A line perpendicular to the meridian is called an *east* and *west* line: the east point being on the right hand, and the west on the left.

126. A line traced or measured on the ground, is called a *course*; and the angle which this line makes with the meridian passing through the point of beginning, is called the *bearing*.

Thus, if we start from the point *A*, and measure in the direction *AB*, the line *AB* is the course, and the angle *NAB* is the bearing.

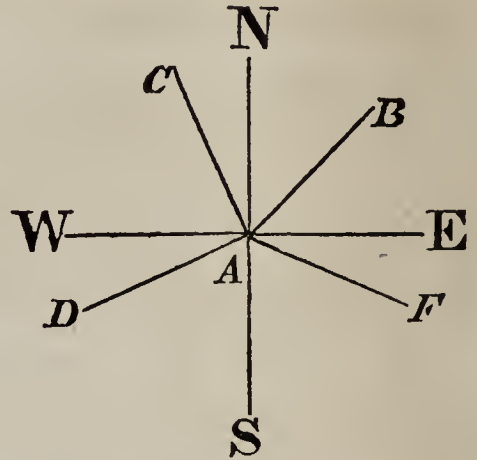


When the course, like *AB*, falls between the north and east points, the bearing is read, north 46° east, and is written, N 46° E.

When the course, like AC , falls between the north and west points, the bearing is read, north 30° west, and is written, N 30° W.

When the course, like AF , falls between the south and east points, the bearing is read, south 70° east, and is written, S 70° E.

When the course, like AD , falls between the south and west points, the bearing is read, south 70° west, and is written, S 70° W.

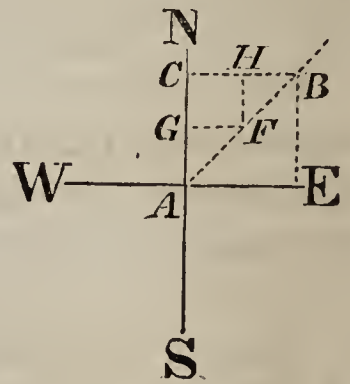


A course which runs due north, or due south, is designated by the letter N or S: and one which runs due east, or due west, by the letter E or W.

127. If, after having passed over a course, the bearing be taken to the back station, this bearing is called the *back sight*, or *reverse bearing*.

128. The perpendicular distance between the east and west lines, drawn through the extremities of a course, is called the *northing* or *southing*, according as the course is run towards the north or south. This distance is also called the *difference of latitude*, or simply the latitude, because it shows the distance which one of the points is north or south of the other.

Thus, in running the course from A to B , AC is the difference of latitude, north.



129. The perpendicular distance between the meridians passing through the extremities of a course, is called the *departure* of that course, and is east or west, according as the course lies on the east or west side of the meridian passing through the point of beginning.

Thus, in running the course AB , CB is the departure, east.

130. It will be found convenient, in explaining the rules for surveying with the compass, to attribute to the latitudes and departures the algebraic signs, $+$ and $-$; which are read plus and minus.

We shall, therefore, consider every northing as affected

with the sign $+$, and every southing as affected with the sign $-$. We shall also consider every easting as affected with the sign $+$, and every westing as affected with the sign $-$.

131. The meridian distance of a point is the perpendicular let fall on the meridian, from which the distance is estimated. This meridian is called the *assumed meridian*. Thus, if the distance be estimated from NS , BC will be the meridian distance of the point B .

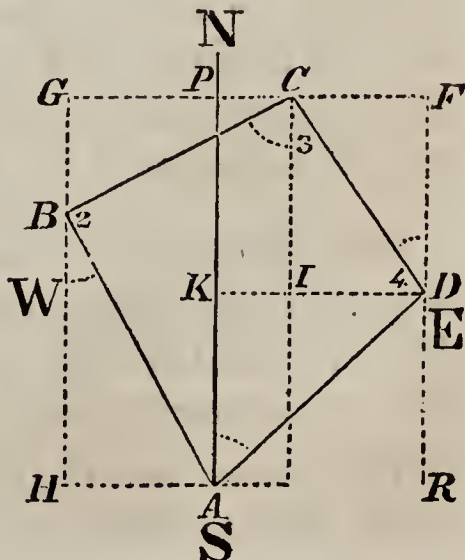
132. The meridian distance of a line, is the distance of the middle point of that line from an assumed meridian: and is east or west, according as this point lies on the east or west side of the assumed meridian. Thus, FG drawn through the middle point of AB , is the meridian distance of the line AB .

The sign $+$ will always be given to the meridian distance of a point or line, when it lies on the east of the assumed meridian, and the sign $-$, when it lies on the west.

133. When a piece of ground is to be surveyed, we begin at some prominent corner of the field, and go entirely around the land, measuring the lengths of the bounding lines with the chain, and taking their bearings with the compass. It is not material whether the ground be kept on the right hand or on the left, and all the rules deduced for one of the cases, are equally applicable to the other. To preserve, however, an uniformity in the language of the rules, we shall suppose the land to be always kept on the right hand of the surveyor.

Let $ABCD$ be a piece of ground to be surveyed, A the point where the work is to be begun, and NS a meridian.

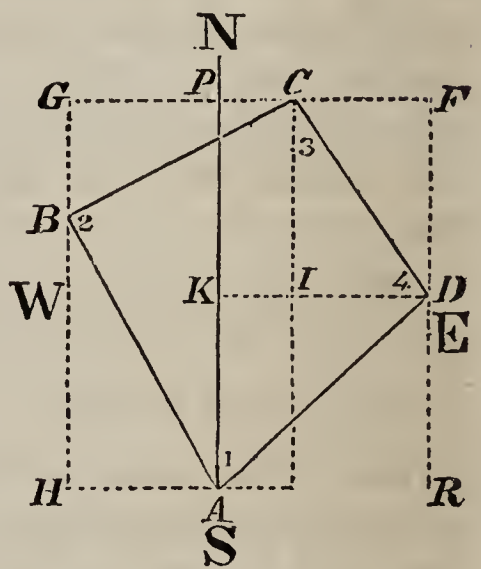
On a sheet of paper, rule three columns, as in next page, and head them stations, bearings, distances.



FIELD NOTES.

Stations.	Bearings.	Distances.
1	N $31\frac{1}{2}^{\circ}$ W	10.
2	N $62\frac{3}{4}^{\circ}$ E	9.25
3	S 36° E	7.60
4	S $45\frac{1}{2}^{\circ}$ W	10.40

Place the compass at A and take the bearing to B , which is PAB : suppose this angle has been found to be $31\frac{1}{2}^{\circ}$. The bearing from A to B is then N $31\frac{1}{2}^{\circ}$ W. Enter this bearing in the field notes opposite station 1. Then measure the distance from A to B , which we will suppose to be 10 ch, and insert that distance opposite station 1, in the column of distances.



We next take the bearing from B to C , N $62\frac{3}{4}^{\circ}$ E, and then measure the distance $BC=9$ ch 25 l, both of which we insert in the notes opposite station 2.

At station C we take the bearing to D , S 36° E, and then measure the distance $CD=7$ ch 60 l, and place them in the notes opposite station 3.

At D we take the bearing to A , S $45\frac{1}{2}^{\circ}$ W, and then measure the distance $DA=10$ ch 40 l. We have thus made all the measurements on the field which are necessary to determine the content of the ground.

134. REMARK I. The reverse bearing, or back sight, from B to A , is the angle ABH ; and since the meridians NS and HG are parallel, this angle is equal to the bearing NAB . The reverse bearing is, therefore, S $31\frac{1}{2}^{\circ}$ E.

The reverse bearing from C , is S $63\frac{3}{4}^{\circ}$ W: that is, it is the angle $ICB=GBC$.

And generally, a reverse bearing, or back sight, is always equal to the forward bearing, and differs from it in both of the letters by which it is designated.

135. REMARK II. In taking the bearings with the compass, there are two sources of error. 1st. The inaccuracy of the observations: 2d. Local attractions, or the derangement which the needle experiences when brought into the vicinity of iron-ore beds, or any ferruginous substances.

To guard against these sources of error, the reverse bearing should be taken at every station: if this and the forward bearing are of the same value, the work is probably right; but if they differ considerably, they should both be taken again.

136. REMARK III. In passing over the course AB , the northing is found to be HB , and the departure, which is west, is represented by AH . Of the course BC , the northing is expressed by BG , and the departure, which is east, by GC . Of the course CD , the southing is expressed by CI , and the departure, which is east, by CF . Of the course DA , the southing is expressed by KA , and the departure, which is west, by DK . It is seen from the figure, that the sum of the northings is equal to $HB + BG = HG$; and that the sum of the southings is equal to $CI + KA = PA = HG$: hence, *the sum of the northings is equal to the sum of the southings.*

If we consider the departures, it is apparent that the sum of the eastings is equal to $GC + CF = GF$; and that the sum of the westings is equal to $AH + DK = GF$: hence also, *the sum of the eastings is equal to the sum of the westings.* We therefore conclude, that when any survey is correctly made, *the sum of the northings will be equal to the sum of the southings, and the sum of the eastings to the sum of the westings.*

It would indeed appear plain, even without a rigorous demonstration, that after having gone entirely round a piece of land, the distance passed over in the direction due north, must be equal to that passed over in the direction due south; and the distance passed over in the direction due east, equal to that passed over in the direction due west.

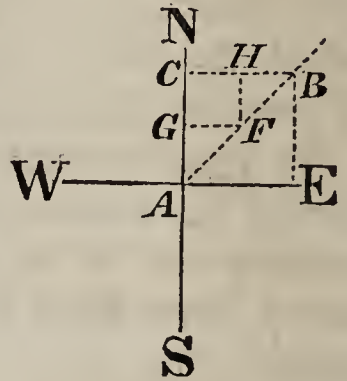
Having now explained the necessary operations on the field, we shall proceed to show the manner of computing the content of the ground. We shall first explain

THE TRAVERSE TABLE.

137. This table shows the difference of latitude, and the departure, corresponding to any bearing, and for courses less than 100.

Let AB denote any course, NS the meridian, and NAB the bearing of AB . Then will AC be the difference of latitude, and BC the departure.

It is evident that the course, the difference of latitude, and the departure, are respectively, the hypotenuse, the base, and the perpendicular of a right-angled triangle, of which the bearing is the angle at the base.



If there be two bearings, which are complements of each other, or of which the sum is 90° , the difference of latitude corresponding to the one, will be the departure of the other, and reciprocally. For, if BC were a meridian, CBA which is the complement of CAB , would be the bearing of BA ; CB would be the difference of latitude, and CA would be the departure.

In the traverse table, the figures at the top and bottom of each page, show the bearings to degrees and parts of a degree; and the columns on the left and right, the distances to which the latitudes and departures correspond.

If the bearing is less than 45° , the angle will be found at the top of the page; if greater, at the bottom. Then, if the distance is less than 50, it will be found in the column "distance," on the left hand page; if greater than 50, in the corresponding column of the right hand page. The table is calculated only to quarter degrees, for the bearings cannot be relied on to smaller parts of a degree.

The latitudes or departures of courses of different lengths, but which have the same bearing, will be proportional to the lengths of the courses. Thus, in the last figure, the latitudes AG , AC , or the departures GF , CB , are to each other as the courses AF , AB .

Therefore, when the distance is greater than 100, it may be divided by any number which will give an exact quotient, less than 100: then the latitude and departure being

found and multiplied by the divisor, the products will be the latitude and departure of the whole course. It is also plain, that the latitude or departure of two or more courses, having the same bearing, is equal to the sum of the latitudes or departures of the courses taken separately.

Hence, if we have any number greater than 100, as 614, we have only to regard the last figure as a cipher, and recollect that, $610 \div 10 = 61$; and also, that the latitude and departure of 610, are ten times greater, respectively, than the latitude and departure of 61: that is, equal to the latitude and departure of 61 multiplied by 10, or with the decimal point removed one place to the right.

1. To find the latitude and departure for the bearing $29\frac{1}{2}^\circ$, and the course 614.

Latitude for 610 . . . 530.90	Departure for 610 . . . 300.40
Latitude for <u>4</u> . . . 3.48	Departure for <u>4</u> . . . 1.97
Latitude for 614 . . . <u>534.38</u>	Departure for 614 . . . <u>302.37</u>

In this example, the latitude and departure answering to the bearing $29\frac{1}{2}^\circ$, and to the distance 61, are first taken from the table, and the decimal point removed one place to the right: this gives the latitude and departure for the distance 610; the latitude and departure answering to the same bearing and the distance 4, are then taken from the table and added.

2. To find the latitude and departure for the bearing $62\frac{1}{2}^\circ$, and the course 7855 chains.

Latitude for 7800 . . . 3602.00	Departure for 7800 . . . 6919.00
Latitude for <u>55</u> . . . 25.40	Departure for <u>55</u> . . . 48.79
Latitude for 7855 . . . <u>3627.40</u>	Departure for 7855 . . . <u>6967.79</u>

REMARK. When the distances are expressed in whole numbers and decimals, the manner of finding the latitudes and departures is still the same, except in pointing off the places for decimals: but this is not difficult, when it is remembered that the column of distances in the table, may be regarded as decimals, by removing the decimal point to the left in the other columns.

3. To find the latitude and departure for the bearing $47\frac{3}{4}^{\circ}$, and the course 37.57.

Latitude for 37.00 . . . 24.88	Departure for 37.00 . . . 27.39
Latitude for <u>57</u> . . . <u>38</u>	Departure for <u>57</u> . . . <u>42</u>
Latitude for <u>37.57</u> . . . <u>25.26</u>	Departure for <u>37.57</u> . . . <u>27.81</u>

Of Balancing the work.

138. The use of the traverse table being explained, we can proceed to compute the area of the ground.

The field notes having been completed, rule a new table, as below, with four additional columns, two for latitude, and two for departure.

Then find, from the traverse table, the latitude and departure of each course, and enter them in the proper columns opposite the station.

Then add up the column of northings, and also the column of southings: the two sums should be equal to each other. If they are not, subtract the less from the greater, and the remainder is called the *error in latitude*. This error takes the name of that column which is the least. For example, if the sum of the northings is less than the sum of the southings, the error is called, *error in northing*: but if the sum of the southings is less than the sum of the northings, the error is called, *error in southing*. We find the error for each particular course by the following proportion:

As the sum of the courses
Is to the error of latitude,
So is each particular course
To its correction.

The error of each course, thus found, may be entered in a separate column; after which, add it to the latitude of the course, when the error and latitude are of the *same name*, but subtract it, when they are of *different names*. This will make the sum of the northings equal to the sum of the southings, and is called *balancing* the work. The northings and southings, thus corrected, are entered in columns on the right, under the head, *balanced*. Having done this, balance the eastings and westings in the very same manner. The difference between their sums, is called the *error in departure*.

For an example, we will resume the same example that has already been considered.

Sta.	Bearings.	Distances.	LATITUDE.		DEPARTURE.		Cor. Lat.	Cor. Dep.	BALANCED.				
			N. +	S. -	E. +	W. -			N. +	S. -	E. +	W. -	
1	N 31½° W	10.	8.53			5.22	+0.18	+0.02	8.71				5.24
2	N 62¾° E	9.25	4.23		8.22		+0.17	-0.01	4.40			8.21	
3	S 36° E	7.60		6.15	4.47		-0.14	-00.1			6.01	4.46	
4	S 45½° W	10.40		7.29		7.41	-0.19	+0.02			7.10		7.43
Sum of courses, 37.25			12.76	13.44	12.69	12.63			13.11	13.11	12.67	12.67	

Error in Northing, . . . 0.68 | 0.06 Error in Westing.

As 37.25 : 0.68 :: 10 : 0.18 error in lat. of 1st course.

As 37.25 : 0.68 :: 9.25 : 0.17 error in lat. of 2d course.

As 37.25 : 0.68 :: 7.60 : 0.14* error in lat. of 3d course.

As 37.25 : 0.68 :: 10.40 : 0.19 error in lat. of 4th course.

As 37.25 : 0.06 :: 10 : 0.02* error in dep. of 1st course.

As 37.25 : 0.06 :: 9.25 : 0.01 error in dep. of 2d course.

As 37.25 : 0.06 :: 7.60 : 0.01 error in dep. of 3d course.

As 37.25 : 0.06 :: 10.40 : 0.02 error in dep. of 4th course.

139. REMARK I. In finding the error in latitude or departure, for a particular course, the last figure is sometimes doubtful ; in which case it is best to mark it, as in the third proportion for error in latitude, and the first for error in departure ; and then, if the figures taken do not balance the work, let each be increased or diminished by 1.

140. REMARK II. It has already been observed (Art. 136), that if the measurements on the field are correctly made, the sums of the northings and southings will be equal to each other, as also those of the eastings and westings. It is the opinion of some surveyors, that when the error in latitude or departure exceeds one link for every five chains of the courses, the field notes ought not to be relied on. This, perhaps, is a higher degree of accuracy than can be attained. The error, however, should always be made considerably less than one link to a chain.

Of the double meridian distances of the courses.

141. After the work has been balanced, the next thing to be done is to calculate the double meridian distance of each course.

For this purpose, a meridian line is assumed, lying either wholly without the land, or passing through any point within it. It is, however, most convenient to take that meridian which passes through the most easterly or westerly station of the survey; and these two stations are readily determined by inspecting the field notes.

Having chosen the meridian, let the station through which it passes, be called the *principal station*, and the course which begins at this point, *the first course*. Care, however, must be taken, not to confound this with the course which begins at station 1, and which is the first course that is entered in the field notes.

It has already been remarked (Art. 132), that all departures in the direction east, are considered as *plus*, and all departures in the direction west, as *minus*: then, through whatever station of the survey the assumed meridian be taken, we shall have for the calculation of the double meridian distances, the following

RULE.

I. *The double meridian distance of the first course is equal to its departure.*

II. *The double meridian distance of the next course is equal to the double meridian distance of the first course, plus its departure, plus the departure of the second course.*

III. *The double meridian distance of the third course is equal to the double meridian distance of the second, plus its departure, plus the departure of the third course.*

IV. *And, the double meridian distance of any course is equal to the double meridian distance of the preceding course, plus its departure, plus the departure of the course itself.*

REMARK. It should be recollected that *plus* is here used in its algebraic sense, and that when double the meridian distance of a course and the departure which is to be added to it, are of different names, that is, one east and the other west, they will have contrary algebraic signs; hence, their algebraic sum will be expressed by their difference, with the sign of the greater prefixed to it.

In this table there is but a single column for the difference of latitude, and a single column for the departures. The + sign shows when the difference of latitude is north, and the - sign, when it is south. The + sign also shows when the departure is east, and the - sign, when it is west.

Stations.	Bearings.	Distances.	Dif. Lat.	Dep.	D. M. D.
1	N 31 $\frac{1}{2}$ ° W	10.	+8.71	-5.24	+17.91 - 7.43 - 5.24 +5.24
2*	N 62 $\frac{3}{4}$ ° E	9.25	+4.40	+8.21	8.21
3	S 36° E	7.60	-6.01	+4.46	+8.21 +8.21 +4.46 +20.88
4	S 45 $\frac{1}{2}$ ° W	10.40	-7.10	-7.43	+20.88 + 4.46 - 7.43 +17.91

We see, from inspecting the notes, that 2 is the most westerly, and 4 the most easterly station. Either of them may, therefore, be taken for the principal station. Let us assume 2 for the principal station, and distinguish it by a star, thus*.

Having done so, we enter the departure 8.21 in the column of double meridian distances, which gives the double meridian distance of the first course. The double meridian distances of the other courses are calculated according to the rule; and as the last, opposite to station 1, is equal to the departure of the course, the work is known to be right.

Of the Area.

143. Having calculated the double meridian distance of each course, the next and last operation for finding the content of the ground, is explained in the following

RULE.

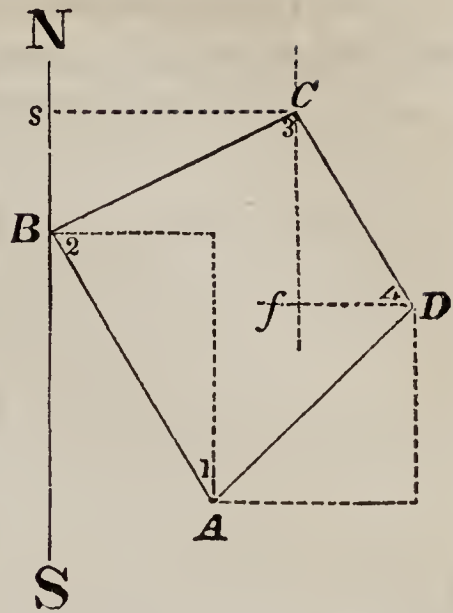
I. *Multiply the double meridian distance of each course by its northing or southing, observing that like signs in the multiplicand and multiplier give plus in the product, and that unlike signs give minus in the product.*

II. *Place all the products which have a plus sign in one column, and all the products which have a minus sign in another.*

III. *Add up each of the columns separately and take their difference: this difference will be double the area of the land.*

144. It only remains to make a plot of the ground.

For this purpose, draw any line, as *NS*, to represent the meridian passing through the principal station, on which take any point, as *B*, to represent that station.



FIRST METHOD OF PLOTTING.

Having fixed upon the scale on which the plot is to be made, lay off from *B* on the meridian, a distance *Bs* equal to the difference of latitude of the first course, and at *s* erect a perpendicular to the meridian, and make it equal to the departure of the first course: then draw *BC*, which will be the first course.

Through *C* draw a meridian, and make *Cf* equal to the difference of latitude of the second course, and through *f* draw a perpendicular *fD*, and make it equal to the departure of the second course: draw *CD*, and it will be the second course.

Lay down, in the same manner, the courses *DA* and *AB*, and the entire plot will be completed.

SECOND METHOD OF PLOTTING.

The work may be plotted in another manner, thus. At the principal station *B*, lay off an angle equal to the bearing from *B* to *C*, which will give the direction of *BC*. Then, from the scale of equal parts, make *BC* equal to the first course: this will give the station *C*.

Through *C* draw a meridian, and lay off an angle equal to the bearing from *C* to *D*, and then lay off the course *CD*. Do the same for the bearing at *D* and the course *DA*; also, for the bearing at *A* and the course *AB*, and a complete plot of the ground will thus be obtained. If the work is all right, the last line *AB* will exactly close the figure. This plot is made on a scale of 40 chains to an inch.

2. It is required to determine the content and plot of a piece of land, of which the following are the field notes, viz.

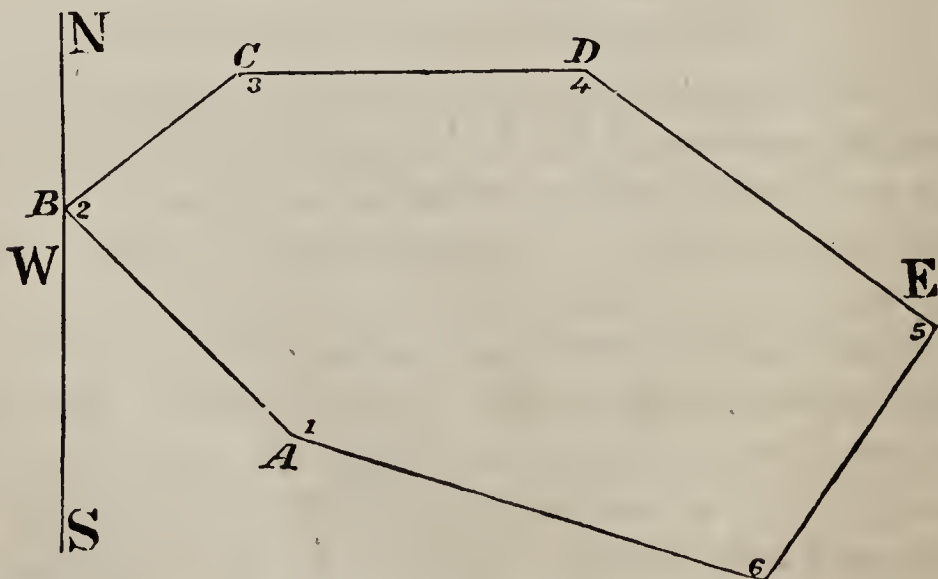
Stations.	Bearings.	Distances.
1	N 46½° W	20 ch.
2	N 51¾° W	13.80
3	E	21.25
4	S 56° E	27.60
5	S 33¼° W	18.80
6	N 74½° W	30.95

CALCULATION.

Sta- tions	Bearings.	Dist.	Dif.		Lat.		Dep.		BALANCED.		D.M.D. +	AREA. +	AREA. -
			N +	S -	E +	W -	Lat.	Dep.					
1	N 46½° W	20 ch	13.77				14.51	+13.88	-14.56	14.56	202.0928		
2*	N 51¾° E	13.80	8.54		10.84			+8.61	+10.81	10.81	93.0741		
3	E	21.25			21.25			...	+21.20	42.82	...		
4	S 56° E	27.60		15.44		22.88		-15.29	+22.82	86.84		1327.7836	
5	S 33¼° W	18.80		15.72			10.31	-15.63	-10.36	99.30		1552.0590	
6	N 74½° W	30.95	8.27				29.83	+8.43	-29.91	59.03	497.6229		

Sum of courses . . 132.40 | 30.58 | 31.16 | 54.97 | 54.65 792.7898 | 2879.8426
30.58 | 54.65 792.7898
 Error in Northing . . . 0.58 | 0.32 Error in Westing 2) 2087.0528
Ans. 104A 1R 16P 1043.5264

Plot of the above example.



REMARK. When a bearing is due east or west, the error in latitude is nothing, and the course must be subtracted from

the sum of the courses, before balancing the columns of latitude. In the last example, the 3d bearing is due east, and the first term of the several proportions for error in latitude, was $132.40 - 21.25 = 111.15$.

In like manner, if a bearing is due north or south, the error in departure is nothing; and the sum of the courses must be diminished by this course, before balancing the columns of departure.

3. Required the content and plot of a piece of land, of which the following are the field notes.

Stations.	Bearings.	Distances.
1	S 34° W	3.95 ch.
2	S	4.60
3	S $36\frac{1}{2}^{\circ}$ E	8.14
4	N $59\frac{1}{2}^{\circ}$ E	3.72
5	N 25° E	6.24
6	N 16° W	3.50
7	N 65° W	8.20

Ans. 10A 0R 5P.

4. Required the content and plot of a piece of land, from the following field notes.

Stations.	Bearings.	Distances.
1	S 40° W	70 rods
2	N 45° W	89
3	N 36° E	125
4	N	54
5	S 81° E	186
6	S 8° W	137
7	W	130

Ans. 207A 3R 33P

5. Required the content and plot of a piece of land, from the following field notes.

Stations.	Bearings.	Distances.
1	S $40\frac{1}{2}^{\circ}$ E	31.80 ch.
2	N 54° E	2.08
3	N $29\frac{1}{4}^{\circ}$ E	2.21
4	N $28\frac{3}{4}^{\circ}$ E	35.35
5	N 57° W	21.10
6	S 47° W	31.30

Ans. 92A 3R 32P.

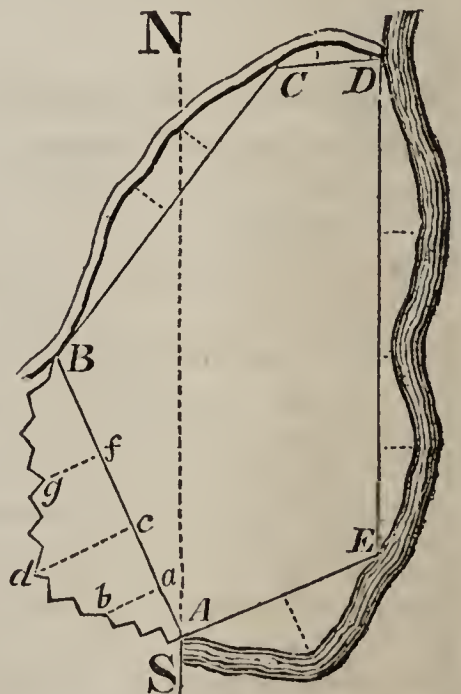
PROBLEM.

To determine the content and boundary of a piece of land, by means of offsets from the principal lines.

145. An offset is a line drawn perpendicular to a course, and may lie either on the right or left of it.

146. Let *ABCDE* be a piece of ground to be surveyed. Let us suppose it to be bounded on the west and north by a fence and road, and on the east and south by a creek or river.

Place stations at the principal points, as *A, B, C, D* and *E*. Take, with the compass, the bearings from *A* to *B*, from *B* to *C*, from *C* to *D*, from *D* to *E*, and from *E* to *A*; and measure the distances *AB, BC, CD, DE*, and *EA*.



At convenient points of the course *AB*, as *a, c* and *f*, make the offsets *ab, cd, fg*. Then, having measured these lines, as also the distances *Aa, ac, cf* and *fB*, enough will be known to determine the area which lies without the station

line AB . The points b , d , and g , of the fence which runs from A to B , are also determined.

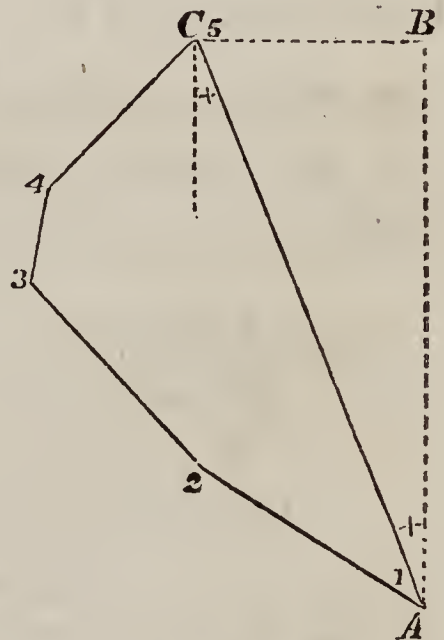
Erect, in a similar manner, offsets to the other courses, and determine the areas which lie without the station lines. These several areas being added to the area within the station lines, will give the entire area of the ground.

If the offsets fall within the station lines, the corresponding area must be subtracted from the area which is bounded by the station lines.

PROBLEM.

To determine the bearing and distance from one point to another, when the points are so situated that one cannot be seen from the other.

147. Let AB be a meridian, and A and C the two points. From either of them, as A , measure a course $A2$, of a convenient length in the direction towards C , and take the bearing with the compass. At 2, take the bearing of a second course, and measure the distance to 3. At 3, take a third bearing and measure to 4. At 4, take the bearing to C , and measure the distance from 4 to C .



Then, the difference between the sum of the northings and the sum of the southings will be represented by AB , and the difference between the sum of the eastings and the sum of the westings by BC . The base AB , and the perpendicular BC of the right-angled triangle ABC , are then known. The angle at the base, BAC , is the bearing from A to C ; or the equal alternate angle at C is the bearing from C to A , and the hypotenuse AC is the distance.

Having measured the bearings and courses on the field, form a table, and find the base and perpendicular of the right-angled triangle, in numbers.

Stations.	Bearings.	Distances.	N.	S.	E.	W.
1	N 61° W	40 ch.	19.39			34.98
2	N 42° W	41.	30.47			27.43
3	N 12° E	16.10	15.75		3.35	
4	N 47° E	32.50	22.16		23.77	
			<i>AB</i> =87.77		27.12	62.41
					27.12	
					<i>CB</i> =35.29 ch.	

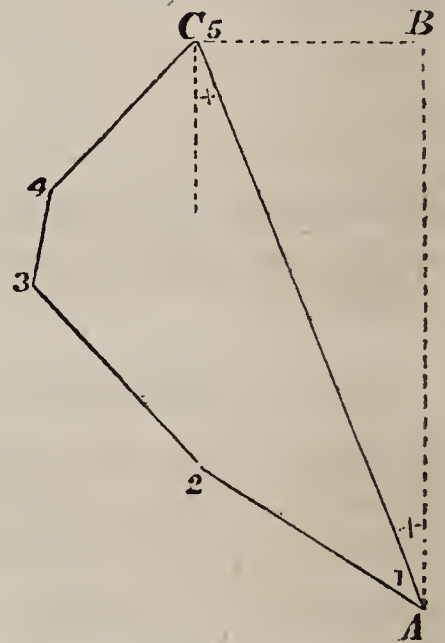
REMARK. Had any of the courses run south, *AB* would have been equal to the sum of the northings, minus the sum of the southings.

To find the angle *BAC*, or the bearing from *A* to *C*.

As radius : tan *A* :: *AB* : *BC*,

or *AB* : *BC* :: *R* : tan *A* :

that is,



As <i>AB</i> 87.77	.	ar. comp.	.	8.056654
: <i>BC</i> 35.29	.	.	.	1.547652
:: <i>R</i>	.	.	.	10.
: tan <i>A</i> 21° 54' 12''.	.	.	.	<u>9.604306</u>

To find the distance *AC*.

As sin <i>A</i> 21° 54' 12''	ar. comp.	.	0.428242
: <i>R</i>	.	.	10.
:: <i>BC</i> 35.29	.	.	1.547652
: <i>AC</i> 94.6	.	.	<u>1.975894</u>

Hence, the bearing and distance are both found.

Of supplying omissions in the field notes.

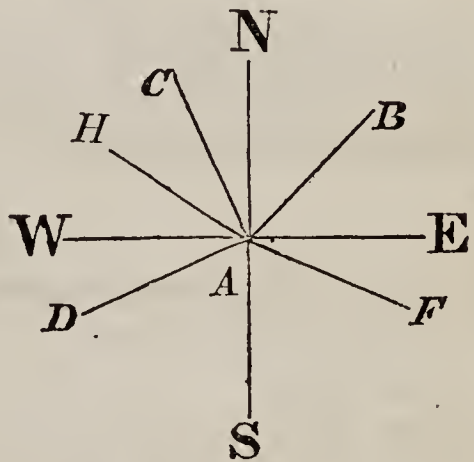
148. The last problem affords an easy method of finding the bearing and length of one of the courses of a survey, when the bearings and lengths of all the others are known. It may be necessary to use this method when there are obstacles which prevent the measuring of a course, or when the

bearing cannot be taken. Indeed, any *two omissions* may always be supplied by calculation. It is far better, however, if possible, to take all the notes on the field. For, when any of them are supplied by calculation, there are no tests by which the accuracy of the work can be ascertained, and all the errors of the notes affect also the parts which are supplied.

To determine the angle included between any two courses, when their bearings are known.

149. Let NS be a meridian passing through A.

Let AB, AC, AD and AH be four courses running from A. We readily deduce the following



RULES.

AC is N 26° W
 AH is N 65° W
 $\underline{CAH = 39^\circ}$

} When the meridional letters are alike, and those of departure also alike, *the difference of the bearings will be the angle between the courses.*

AB is N 46° E
 AC is N 26° W
 $\underline{CAB = 72^\circ}$

} When the meridional letters are alike, and those of departure unlike, *the sum of the bearings will be the angle between the courses.*

AC is N 26° W
 AD is S 66° W
 $\underline{CAD = 180^\circ - 92^\circ = 88^\circ}$

} When the meridional letters are unlike, and those of departure alike, *the angle between the courses will be equal to 180° minus the sum of the bearings.*

AC is N 26° W
 AF is S 66° E
 $\underline{CAF = 180^\circ - 40^\circ = 140^\circ}$

} When the meridional letters are unlike, and those of departure also unlike, *the angle between the courses will be equal to the difference of the bearings taken from 180°.*

REMARK. The above rules are determined, under the supposition that the two courses are both run from the angular point. Hence, if it be required to apply the rules to two courses run in the ordinary way, as we go around the field,

the bearing of one of them must be reversed before the calculation for the angle is made.

1. The bearings of two courses, from the same point, are $N\ 37^\circ\ E$, and $S\ 85^\circ\ W$: what is the angle included between them ?

Ans. 132° .

2. The bearings of two adjacent courses, in going round a piece of land, are $N\ 39^\circ\ W$, and $S\ 48^\circ\ W$: what is the angle included between them ?

Ans. 87° .

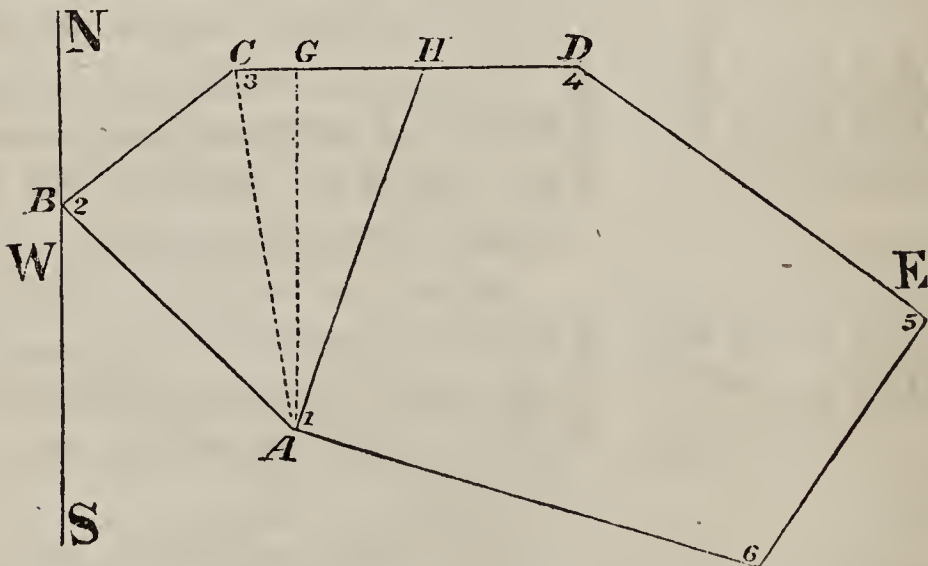
3. The bearings of two adjacent courses, in going round a piece of land, are $S\ 85^\circ\ W$, and $N\ 69^\circ\ W$: what is the angle included between them ?

Ans. 154° .

PROBLEM.

To run a line from a given point in the boundary of a piece of land, so as to cut off on either side of it a given portion of the field.

150. Make a complete survey of the field, by the rules already given. Let us take, as an example, the field whose area is computed at page 106. That field contains $104A\ 1R\ 16P$, and the following is a plot of it.



Let it now be required to run a line from station A , in such a manner as to cut off on the left any part of the field ; say,

$26A\ 2R\ 31P$.

It is seen, by examining the field, that the division line will probably terminate on the course CD . Therefore, draw a line from A to C , which we will call the first closing line.

The bearings and lengths of the courses AB , BC , are always known ; and in the present example are found in the

table on page 106 : hence, the bearing and distance from *C* to *A*, can be calculated by the last problem : they are in this example,

Bear. S 9° 28' E : Course 22.8 ch.

Having calculated the bearing and length of the closing line, find, by the general method, the area which it cuts off : that area, in the present case, is

13*A* 3*R* 3*P*.

It is now evident that the division line must fall on the right of the closing line *AC*, and must cut off an area *ACH*, equal to the difference between that already cut off, and the given area : that is, an area equal

26*A* 2*R* 31*P* given area.
 13*A* 3*R* 3*P* area already cut off.

to . . . 12*A* 3*R* 28*P*.

Since the bearing of the next course *CD*, and the bearing of the closing line *AC* are known, the angle *ACD* which they form with each other, can be calculated, and is in this example 80° 32°. Hence, knowing the hypotenuse *AC*, and the angle *ACG* at the base, the length *AG* of the perpendicular let fall on the course *CD*, can be found, and is 22.49 chains.

Since the area of a triangle is equal to its base multiplied by half its altitude, it follows, that the base is equal to the area divided by half the altitude. Therefore, if the area

12*A* 3*R* 28*P*

be reduced to square chains, and divided by 11.24½ chains, which is half the perpendicular *AG*, the quotient, which is 11.58 chains, will be the base *CH*. Hence, if we lay off from *C*, on *CD*, a distance *CH*, equal to 11.5 chains, and then run the line *AH*, it will cut off from the land the required area.

REMARK I. If the part cut off by the first closing line, should exceed the given area, the division line will fall on the left of *AC*.

REMARK II. If the difference between the given area and the first area cut off, divided by half the perpendicular *AG*, gives a quotient larger than the course *CD* ; then, draw a

line from A to D , and consider it as the first closing line, and let fall a perpendicular on DE .

REMARK III. When the point from which the division line is to be drawn, falls between the extremities of a course, dividing the course into two parts, consider one of the parts as an entire course, and the other as forming a new course, having the same bearing. The manner of making the calculation will then be the same as before.

Method of Surveying the Public Lands.

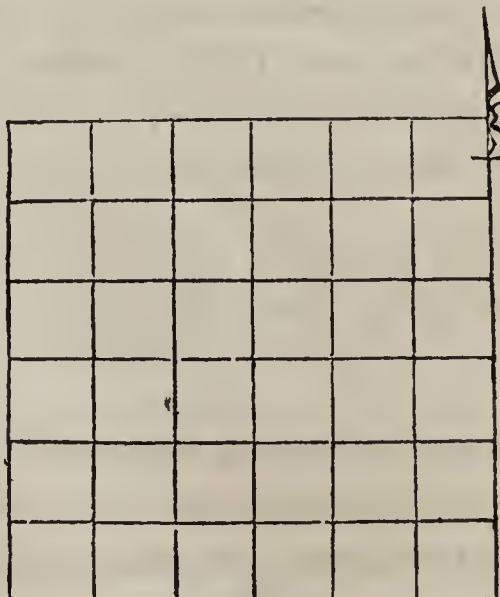
151. In the year 1802, the following method of surveying the public lands, was adopted by Colonel Jared Mansfield, then surveyor-general of the North-Western Territory.

152. The country to be surveyed is first divided by parallel meridians, six miles distant from each other; and then again, by a system of east and west lines, also six miles from each other. The whole country is thus divided into equal squares, which are called *townships*. Hence, each township is a square, six miles on a side, and contains 36 square miles.

The townships which lie along the same meridian, are called a *range*, and are numbered, to distinguish them from each other.

Each township is divided into equal squares, by meridians one mile apart, and by east and west lines at the same distance from each other. Hence, each township is divided into 36 square miles, each one of which is called a *section*. The sections of a township are numbered from 1 to 36, and each contains 640 acres.

The diagram exhibits the 36 sections of a township.



To describe a section accurately, we say, section number 5, in township number 4, in range 3d, west of a known meridian, the one, for example, drawn through the mouth of the Great Miami river. This description fixes precisely the place of the section. Go to the 3d range of townships, west of the known meridian, find township number 4 in this range, and lastly, section number 5 of that township. The corners of the sections should be marked by permanent corner-posts, or by lines blazed on trees.

The sections are divided into half sections, quarter sections, and even into eighths of sections. The following table shows the content of a township, and its subdivisions.

1 township = 36 sections = 23040 acres.

1 section = 640 acres.

$\frac{1}{2}$ section = 320 acres.

$\frac{1}{4}$ section = 160 acres.

$\frac{1}{8}$ section = 80 acres.

The principal meridians, and the principal east and west lines, have been established by astronomical observation, and the lines of subdivision run with the compass.

VARIATION OF THE NEEDLE.

153. The line indicated by the magnetic needle, when allowed to move freely about the point of support, and settle to a state of rest, has been called the magnetic meridian. This, in general, is a different line from the true meridian, which always passes through the poles of the earth, when sufficiently produced in both directions.

154. The angle which the magnetic meridian makes with the true meridian, at any place on the surface of the earth, is called the *variation of the needle* at that place, and is east or west, according as the north end of the needle lies on the east or west side of the true meridian.

155. The variation is different at different places, and even at the same place it does not remain constant for any length of time. The variation is ascertained by comparing the magnetic, with the true meridian.

156. The best practical method of determining the true meridian of a place, is by observing the north star. If this star were precisely at the point in which the axis of the earth,

produced, pierces the heavens, then, the intersection of the vertical plane passing through it and the place, with the surface of the earth, would be the true meridian. But, the star being at a distance from the pole, equal to $1^{\circ} 34'$ nearly, it performs a revolution about the pole in a circle, the polar distance of which is $1^{\circ} 34'$: the time of revolution is 23 h. and 56 min.

To the eye of an observer, this star is continually in motion, and is due north but twice in 23 h. 56 min.; and is then said to be on the meridian. Now, when it departs from the meridian, it apparently moves east or west, for 5 h. and 59 min., and then returns to the meridian again. When at its greatest distance from the meridian, east or west, it is said to be at its greatest *eastern* or *western* elongation.

The following tables show the times of its greatest eastern and western elongations.

EASTERN ELONGATIONS.

Days	April	May	June	July	August	Sept.
	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.
1	18 18	16 26	14 24	12 20	10 16	8 20
7	17 56	16 03	14 00	11 55	9 53	7 58
13	17 34	15 40	13 35	11 31	9 30	7 36
19	17 12	15 17	13 10	11 07	9 08	7 15
25	16 49	14 53	12 45	10 43	8 45	6 53

WESTERN ELONGATIONS.

Days	Oct.	Nov.	Dec.	Jan.	Feb.	March
	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.
1	18 18	16 22	14 19	12 02	9 50	8 01
7	17 56	15 59	13 53	11 36	9 26	7 38
13	17 34	15 35	13 27	11 10	9 02	7 16
19	17 12	15 10	13 00	10 44	8 39	6 54
25	16 49	14 45	12 34	10 18	8 16	6 33

The eastern elongations are put down from the first of April to the first of October; and the western, from the first of October to the first of April; the time is computed from 12 at noon. The western elongations in the first case, and the eastern in the second, occurring in the daytime, cannot

be used. Some of those put down are also invisible, occurring in the evening, before it is dark, or after daylight in the morning. In such case, if it be necessary to determine the meridian at that particular season of the year, let 5 h. and 59 min. be added to, or subtracted from, the time of greatest eastern or western elongation, and the observation be made at night, when the star is on the meridian.

The following table exhibits the angle which the meridian plane makes with the vertical plane passing through the pole-star, when at its greatest eastern or western elongation: such angle is called the *azimuth*. The mean angle only is put down, being calculated for the first of July of each year.

AZIMUTH TABLE.

Years	Lat. 32° Azimuth	Lat. 34° Azimuth	Lat. 36° Azimuth	Lat. 38° Azimuth	Lat. 40° Azimuth	Lat. 42° Azimuth	Lat. 44° Azimuth
1836	1° 50'	1° 52½'	1° 56'	1° 58½'	2° 2½'	2° 6'	2° 10½'
1837	1° 50½'	1° 52½'	1° 55½'	1° 58½'	2° 2'	2° 5½'	2° 10'
1838	1° 50'	1° 52½'	1° 55'	1° 58'	2° 1½'	2° 5'	2° 9½'
1839	1° 49½'	1° 52'	1° 54½'	1° 57½'	2° 1'	2° 4½'	2° 9'
1840	1° 49'	1° 51½'	1° 54'	1° 57½'	2° 0½'	2° 4'	2° 8½'
1841	1° 48½'	1° 51'	1° 53½'	1° 57½'	2° 0'	2° 3½'	2° 8'
1842	1° 48'	1° 50½'	1° 53'	1° 56½'	1° 59½'	2° 3'	2° 7½'
1843	1° 47½'	1° 50'	1° 52½'	1° 56'	1° 59'	2° 2½'	2° 7'
1844	1° 47'	1° 49½'	1° 52'	1° 55½'	1° 58½'	2° 2'	2° 6½'
1845	1° 46½'	1° 49'	1° 51½'	1° 55'	1° 58'	2° 1½'	2° 6'
1846	1° 46'	1° 48½'	1° 51'	1° 54½'	1° 57½'	2° 1'	2° 5½'

The use of the above tables, in finding the true meridian, will soon appear.

To find the true meridian with the theodolite.

157. Take a board, of about one foot square, paste white paper upon it, and perforate it through the centre; the diameter of the hole being somewhat larger than the diameter of the telescope of the theodolite. Let this board be so fixed

to a vertical staff, as to slide up and down freely : and let a small piece of board, about three inches square, be nailed to the lower edge of it, for the purpose of holding a candle.

About twenty-five minutes before the time of the greatest eastern or western elongation of the pole-star, as shown by the tables of elongations, let the theodolite be placed at a convenient point and levelled. Let the board be placed about one foot in front of the theodolite, a lamp or candle placed on the shelf at its lower edge ; and let the board be slipped up or down, until the pole-star can be seen through the hole. The light reflected from the paper will show the cross hairs in the telescope of the theodolite.

Then, let the vertical spider's line be brought exactly upon the pole-star, and, if it is an eastern elongation that is to be observed, and the star has not yet reached the most easterly point, it will move from the line towards the east, and the reverse when the elongation is west.

At the time the star attains its greatest elongation, it will appear to coincide with the vertical spider's line for some time, and then leave it, in the direction contrary to its former motion.

As the star moves towards the point of greatest elongation, the telescope must be continually directed to it, by means of the tangent-screw of the vernier plate ; and when the star has attained its greatest elongation, great care should be taken that the instrument be not afterwards moved.

Now, if it be not convenient to leave the instrument in its place until daylight, let a staff, with a candle or small lamp upon its upper extremity, be arranged at thirty or forty yards from the theodolite, and in the same vertical plane with the axis of the telescope. This is easily effected, by revolving the vertical limb about its horizontal axis without moving the vernier plate, and aligning the staff to coincide with the vertical hair. Then mark the point directly under the theodolite ; the line passing through this point and the staff, makes an angle with the true meridian equal to the azimuth of the pole-star.

From the table of azimuths, take the azimuth corresponding to the year and nearest latitude. If the observed elongation were east, the true meridian lies on the west of the line which has been found, and makes with it an angle equal to

the azimuth. If the elongation were west, the true meridian lies on the east of the line : and, in either case, laying off the azimuth angle with the theodolite, gives the true meridian.

To find the true meridian with the compass.

158. 1. Drive two posts firmly into the ground, in a line nearly east and west ; the uppermost ends, when driven firmly, being about three feet above the surface, and the posts about four feet apart : then lay a plank, or piece of timber three or four inches in width, and smooth on the upper side, upon the posts, and let it be pinned or nailed, to hold it firmly.

2. Prepare a piece of board four or five inches square, and smooth on the under side. Let one of the compass-sights be placed at right angles to the upper surface of the board, and let a nail be driven through the board, so that it can be tacked to the timber resting on the posts.

3. At about twelve feet from the stakes, and in the direction of the pole-star, let a plumb be suspended from the top of an inclined stake or pole. The top of the pole should be of such a height that the pole-star will appear about six inches below it ; and the plumb should be swung in a vessel of water to prevent it from vibrating.

This being done, about twenty minutes before the time of elongation, place the board, to which the compass-sight is fastened, on the horizontal plank, and slide it east or west, until the aperture of the compass-sight, the plumb line, and the star, are brought into the same range. Then if the star depart from the plumb-line, move the compass-sight, east or west, along the timber, as the case may be, until the star shall attain its greatest elongation, when it will continue behind the plumb-line for several minutes ; and will then recede from it in the direction contrary to its motion before it became stationary. Let the compass-sight be now fastened to the horizontal plank. During this observation it will be necessary to have the plumb-line lighted : this may be done by an assistant holding a candle near it.

Let now a staff, with a candle or lamp upon it, be placed at a distance of thirty or forty yards from the plumb-line, and in the same direction with it and the compass-sight. The line so determined, makes, with the true meridian, an angle

equal to the azimuth of the pole-star; and, from this line, the variation of the needle is readily determined, even without tracing the true meridian on the ground.

Place the compass upon this line, turn the sights in the direction of it, and note the angle shown by the needle. Now, if the elongation, at the time of observation, were west, and the north end of the needle on the west side of the line, the azimuth, plus the angle shown by the needle, is the true variation. But should the north end of the needle be found on the east side of the line, the elongation being west, the difference between the azimuth and the angle would show the variation: and the reverse when the elongation is east.

1. Elongation west, azimuth	. . .	2° 04'
North end of the needle on the west, angle		4° 06'
	Variation	<u>6° 10'</u> west.
2. Elongation west, azimuth	. . .	1° 59'
North end of the needle on the east, angle		4° 50'
	Variation	<u>2° 51'</u> east.
3. Elongation east, azimuth	. . .	2° 05'
North end of the needle on the west, angle		8° 30'
	Variation	<u>6° 25'</u> west.
4. Elongation east, azimuth	. . .	1° 57'
North end of the needle on the east, angle		8° 40'
	Variation	<u>10° 37'</u> east.

REMARK I. The variation at West Point, in September, 1835, was 6° 32' west.

REMARK II. The variation of the needle should always be noted on every survey made with the compass, and then if the land be surveyed at a future time, the old lines can always be re-run.

159. It has been found by observation, that heat and cold sensibly affect the magnetic needle, and that the same needle will, at the same place, indicate different lines at different hours of the day.

If the magnetic meridian be observed early in the morning, and again at different hours of the day, it will be found that the needle will continue to recede from the meridian as the day advances, until about the time of the highest tempera-

ture, when it will begin to return, and at evening will make the same line as in the morning. This change is called the *diurnal variation*, and varies, during the summer season, from one-fourth to one-fifth of a degree.

OF THE PLAIN-TABLE.

160. Pl. 3, Fig. 1. The plain-table consists of two parts ; a rectangular board *CDBA*, and a tripod *EHG*, to which it is firmly secured.

Directly under the rectangular board are four milled screws which pass through sockets inserted in a horizontal brass plate : these screws are worked against a second horizontal plate, for the purpose of levelling the table ; the table having a ball and socket motion, similar to the limb of the theodolite.

For the purpose of levelling the table, a small detached spirit-level is used. This level being placed over the centre, and also over two of the levelling screws, the screws are turned contrary ways until the level is horizontal ; after which, it is placed over the other two screws, and made horizontal in the same manner.

Between the upper horizontal plate and the table, there is a clamp-screw, similar to the clamp-screw of the theodolite, which being loosened, the table can be turned freely about its axis. There is, also, a small tangent-screw, by which the smaller motions of the table are regulated, after the clamp-screw is made fast. Neither of these screws can be seen in the figure.

The upper side of the table is bordered by four brass plates, about one inch in width, and the centre of the table is marked by a small pin, *F*. About this centre, and tangent to the sides of the table, conceive a circle to be described. Suppose the circumference of the circle to be divided into degrees and parts of a degree, and radii to be drawn through the centre and the points of division. The points in which these radii intersect the outer edge of the brass border, are marked by lines on the brass plates, and the degrees are numbered in the direction from left to right, from the point *L* to the point *I*, 180° , and from the point *I* to the point *L*, 180° . In some plain-tables, however, they are numbered from 0 to 360° .

There are, generally, diagonal scales of equal parts cut on

the plates *DLC* and *AIB*, the use of which will be explained hereafter.

Near the two other edges of the table, two small grooves are made, into which the plates of brass *DB* and *CA* are fitted, and these plates are drawn to their places by means of milled screws which pass through the table from the under side, and screw firmly into the plates. The heads of two of the screws, *Q* and *S*, are seen in the figure, as also one of the plates and its two screws in Fig. 3. The object of these plates is to confine a sheet of paper on the table. By loosening the screws, and pressing them upwards, the plates are raised above the surface of the table; the edges of the paper can then be placed under them: then, by turning the screws back again, the plates are drawn down and the paper held tightly. Fig. 1 represents the table with the paper partly put upon it: one edge of the paper has been placed under the plate *DB*, and the screws *S* and *Q*, tightened. The paper, before being put on, should be moistened, in order to expand it; and then, after it has been dried, it will fit closely to the table.

A ruler, *AB* (Fig. 2), with open vertical sights, is used with the plain-table. This ruler has a fiducial edge, which is in the same vertical plane with the hairs of the sights. A ruler with a telescope, and a vertical limb, similar to the vertical limb of the theodolite, is sometimes used with the plain-table. A compass, also, is often attached to the table, to show the bearings of the lines.

The plain-table is used for two distinct objects.

1st. For the measurement of horizontal angles.

2dly. For the determination of the shorter lines of a survey, both in extent and position.

To measure a horizontal angle.

161. Place, by means of a plumb, the centre of the table directly over the angular point: then level the table; after which, place the fiducial edge of the ruler against the small pin at the centre: direct the sights to one of the objects, and note the degrees on the brass plate; then turn the ruler and sights to the other object, and note the degrees as before. If the ruler has not passed over the 0 point, the difference of the readings is the angle sought; but, if it has, the larger

taken from 180° , and the remainder added to the smaller, gives the required angle.

Of the determination of lines in extent and position.

162. Having placed a paper on the table, examine the objects and lines which are to be determined, and measure a base line in such a direction, if possible, that all the objects can be seen from its extremities. Then place the plain-table with its centre, nearly, though not accurately, over one extremity of the base; make it truly horizontal, and turn it until the larger part of the paper lies on the same side of the base with the objects.

Then, tighten the clamp-screw, and mark with a pin the point of the paper directly over the station, which point is determined most accurately by suspending a plumb from the lower side of the table. Press the pin firmly on this point, bring the fiducial edge of the ruler against it, and sight to the other extremity of the base line, and mark with the pin or pencil, the direction of the line on the paper. Sight in like manner to every other object, and draw on the paper the corresponding lines, numbering them from the base line, 1, 2, 3, 4, &c.

Then, with a pair of dividers, take from the scale a certain number of equal parts to represent the base, and lay off the distance on the base line from the place of the pin. Take up the table, carry it to the other extremity of the base, and place the point of the paper corresponding to that extremity, directly over it. Place the fiducial edge of the ruler on the base line, and turn the table, by means of the tangent-screw, until the sights are directed to the first station. If, however, in bringing the table to this position, the corresponding point of the paper has been moved from over the extremity of the base line, move the legs of the tripod until it is brought back to its place. Let the table be then levelled, after which, place the ruler again on the base line, and bring the table to its proper position by the tangent-screw, and continue the adjustment until the extremity of the base line on the paper is directly over the station, and in the same vertical plane with the base line on the ground. Then direct the sights to all the objects sighted to from the other station, and mark the lines 1, 2, 3, 4, &c. from the base line, as before. The inter-

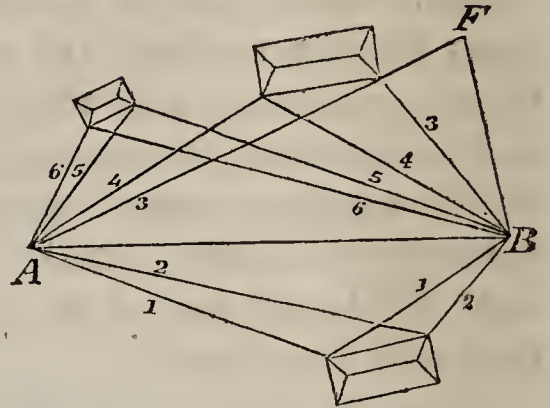
sections of the corresponding lines 1,1, 2,2, 3,3, 4,4, &c., determine, on the paper, the positions of the several objects; and a reference of these lines to the scale of equal parts, determines the true distances.

163. Let it be required, for example, to determine, by means of the plain-table, the relative position of several houses.

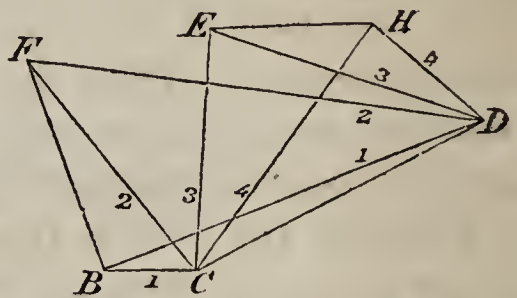
Measure the base line AB , which we will suppose equal to 300 yards. Place the plain-table at A , and sight to the corners of the houses, and mark the lines 1, 2, 3, 4, &c.

Then remove the table to B , and sight to the same corners as before, and draw the lines as in the figure. The points at which they intersect the corresponding lines before drawn, determine the corners of the houses. The front lines of the houses may then be drawn on the paper. Draw lines at right angles to the front lines, and on them lay off the depths of the houses, with the same scale as that used for the base line.

To find the length of any line drawn on the paper, as the line 1, drawn through A , for example, place the dividers at A and extend them to the other extremity of the line, and then apply the line to the scale. The length of the line 1 is equal to 198 yards.



164. In this example, we determine from the base line CD , the positions of the points B , F , E , and H .



Of changing the Paper.

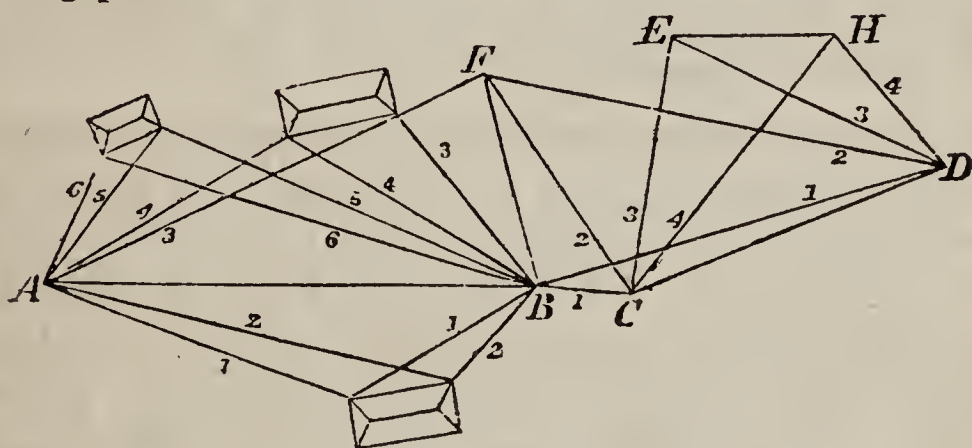
165. When one paper is filled, and there is yet more work to be done, let the paper be removed, and a second paper put on the table; after which, the table may be used as before.

Now, in order that the two papers may be put together and form one entire plan, it is necessary that two points determined on the first paper, be also determined on the second; and then, by placing the lines joining these points upon each other, all the lines on the two papers will have the same

relative position as the corresponding lines on the ground; and the same for as many papers as it may be necessary to use. If different scales are used, the corresponding points will not join, and then the work must be reduced to the same scale, before the papers can be put together.

In the first example, the position of the point *F* was determined, in order to unite the first paper with the second.

In the second example, we sighted from *C* and *D*, the extremities of the base line, to the points *B* and *F*; we thus determined the line *BF* on the second paper. Placing the line *BF* of the one paper on *BF* of the other, we have the following plan.



In this plan, all the points and lines are accurately laid down. Any number of papers may be joined in the same manner.

The plain-table is used to great advantage when only a plot of the ground is wanted. It ought not to be used for the determination of long lines, nor can it be relied on in determining extended areas.

CHAPTER V.

Of Levelling.

166. If all the points of the earth's surface were equidistant from the centre, it would be perfectly even, and present to the eye an unbroken level.

Intersected, however, as it is, by valleys and ridges of mountains, it becomes an important problem to ascertain the *difference* between the distances of given points from the centre of the earth; such difference is called the *difference*

of level ; and a line, all the points of which are equally distant from the centre, is called *the line of true level*.*

167. One point is said to be *above* another, when it is farther from the centre of the earth ; and *below* it, when it is nearer.

168. Let C (Pl. 4, Fig. 1), represent the centre of the earth. A a point of its surface, and AEF the line of true level. If, at the point A , a tangent line ABD be drawn to the surface, such line is called *the line of apparent level*.

169. Now, if an instrument were placed at A , and brought into a horizontal position so as to indicate a horizontal line, this line would be tangent to the earth at A , and would be the line ABD of apparent level.

170. When, therefore, we have ascertained the direction of a tangent, or horizontal line, we have found the line of apparent level only ; the line of true level is yet to be determined.

If at the points E and F , vertical staves be placed, the line of apparent level passing through A will cut them at B and D , while the line of true level cuts them at E and F . Therefore, BE and DF are, respectively, the differences between the apparent levels of the points E and F , as determined by the horizontal line passing through A , and the true levels of those points.

But $AB^2 = BE (BE + 2EC)$, and $AD^2 = DF (DF + 2FC)$ (Geom. Bk. IV, Prop. XXX). In the common operations of levelling, the arcs AE , AF , are small ; and since the difference between small arcs and their tangents is very inconsiderable, the arcs AE , AF may be substituted for the tangents AB , AD . And since the external parts of the secants BE and DF are very small in comparison with the diameter of the earth, they may be neglected without sensible error : the expressions above will then become,

$$AE^2 = BE \times 2EC, \text{ and } AF^2 = DF \times 2FC,$$

$$\text{or, } BE = \frac{AE^2}{2EC} ; \text{ and } DF = \frac{AF^2}{2FC} ;$$

and since the diameter of the earth is constant, BE and DF are proportional to AE^2 and AF^2 .

* The spheroidal form of the earth is not considered, as it affects the results too inconsiderably to be regarded in the common operations of levelling.

But BE and DF are respectively the differences between the true levels of the points E and F , and their apparent levels, as determined from the point A : hence, the difference between the apparent and true level of any point, is equal to the square of the distance of that point from the place where the apparent level was made, divided by the diameter of the earth ; or, the diameter being constant, the rise of the apparent above the true level, is proportional to the square of the distance.

171. The mean diameter of the earth being about 7919 miles, if AE be taken equal to 1 mile, then the excess

$$BE = \frac{AE^2}{2AC} \text{ becomes equal to } \frac{1}{7919} = 8.001 \text{ inches.}$$

If the excess FD , for any other distance AF , were required,
 $AE^2 : AF^2 :: BE : FD ;$

and by similar proportions the following table is calculated.

Table showing the differences in inches between the true and apparent level, for distances between 1 and 100 chains.

Chains.	Inches.	Chains.	Inches.	Chains.	Inches.	Chains.	Inches.
1	.001	26	.845	51	3.255	76	7.221
2	.005	27	.911	52	3.380	77	7.412
3	.011	28	.981	53	3.511	78	7.605
4	.020	29	1.051	54	3.645	79	7.802
5	.031	30	1.125	55	3.781	80	8.001
6	.045	31	1.201	56	3.925	81	8.202
7	.061	32	1.280	57	4.061	82	8.406
8	.080	33	1.360	58	4.205	83	8.612
9	.101	34	1.446	59	4.351	84	8.832
10	.125	35	1.531	60	4.500	85	9.042
11	.151	36	1.620	61	4.654	86	9.246
12	.180	37	1.711	62	4.805	87	9.462
13	.211	38	1.805	63	4.968	88	9.681
14	.245	39	1.901	64	5.120	89	9.902
15	.281	40	2.003	65	5.281	90	10.126
16	.320	41	2.101	66	5.443	91	10.351
17	.361	42	2.208	67	5.612	92	10.587
18	.405	43	2.311	68	5.787	93	10.812
19	.451	44	2.420	69	5.955	94	11.046
20	.500	45	2.531	70	6.125	95	11.233
21	.552	46	2.646	71	6.302	96	11.521
22	.605	47	2.761	72	6.480	97	11.763
23	.661	48	2.880	73	6.662	98	12.017
24	.720	49	3.004	74	6.846	99	12.246
25	.781	50	3.125	75	7.032	100	12.502

We cannot proceed farther in the discussion of the principles of levelling, until we have described the instruments which are to be used, and explained the particular objects which they are to answer.

OF THE LEVEL.

172. The level is an instrument used to determine horizontal lines, and the difference of level of any points on the surface of the earth.

The part of the instrument shown in Pl. 4, Fig. 2, rests on a tripod to which it is permanently attached at *Z*. *HH* is a horizontal brass plate, through which four levelling screws with milled heads are passed, and worked against a second horizontal plate *GG*. Two of these screws, *K* and *I*, are seen in the figure. *S* is a clamp-screw, which, being loosened, allows the upper part of the instrument to turn freely around its axis. *Q* is a tangent-screw, by means of which the upper part of the instrument is moved gently, after the clamp-screw *S* has been made fast. *EE* is a horizontal bar, perpendicular to which are the wyes, designated *Y*'s, that support the telescope *LB*. This telescope is confined in the *Y*'s by the loops *r, r*, which are fastened by the pins *p* and *p*. The object-glass *B*, is adjusted to its focus by the screw *X*; the eye-glass *L* slides out and in freely. The screws *f, f*, work the slide which carries the horizontal hair; and two horizontal screws, only one of which, *a*, is seen, work the slide that carries the vertical hair. *CD* is an attached spirit level. The screw *N* elevates and depresses the *Y*, nearest the eye-glass. In some instruments this *Y* is elevated and depressed, by means of two screws at *M* and *R*.

Before using the level, it must be adjusted. The adjustment consists in bringing the different parts to their proper places.

The line of *collimation* is the axis of the telescope. With this axis, the line drawn through the centre of the eye-glass, and the intersection of the spider's lines, within the barrel of the telescope, ought to coincide.

FIRST ADJUSTMENT.* *To fix the intersection of the spider's lines in the axis of the telescope.*

Having screwed the tripod to the instrument, extend the

* This, and some of the following adjustments, are so similar to those of the theodolite, that they would not be repeated, but that some may use the level without wishing to study a more complicated instrument.

legs, and place them firmly. Then loosen the clamp-screw S , and direct the telescope to a small, well-defined, and distant object. Then slide the eye-glass till the spider's lines are seen distinctly; after which, with the screw X , adjust the object-glass to its proper focus, when the object and the spider's lines will be distinctly seen. Note now the precise point covered by the intersection of the spider's lines.

Having done this, revolve the telescope in the Y 's, half round, when the attached level CD will come to the upper side. See if, in this position, the horizontal hair appears above or below the point, and in either case, loosen the one, and tighten the other, of the two screws which work the horizontal hair, until it has been carried over half the space between its last position and the observed point. Carry the telescope back to its place; direct again, by the screws at M and R , the intersection of the spider's lines to the point, and repeat the operation, till the horizontal hair neither ascends nor descends while the telescope is revolved. A similar process will arrange the vertical hair, and the line of collimation is then adjusted.

SECOND ADJUSTMENT. *To make the axis of the attached level CD parallel to the line of collimation.*

Turn the screw N , or the screws M and R , until the bubble of the level DC stands at the middle of the tube. Then open the loops, and reverse the telescope. If the bubble still stands at the middle of the tube, the axis of the level is horizontal; but if not, it is inclined, the bubble being at the elevated end. In such case, raise the depressed, or depress the elevated end, by means of the screw h , half the inclination; and then with the screw N , bring the level to a horizontal position. Reverse the telescope in the Y 's, and make the same correction again; and proceed thus, until the bubble stands in the middle of the tube, in both positions of the telescope; the axis of the level is then horizontal.

Let the telescope be now revolved in the Y 's. If the bubble continue in the middle of the tube, the axis of the level is not only horizontal, but also parallel to the line of collimation. If, however, the bubble recedes from the centre, the axis of the level is inclined to the line of collimation, and

must be made parallel to it, by means of two small screws, which work horizontally ; one of these screws is seen at *q*. By loosening one of them, and tightening the other, the level is soon brought parallel to the line of collimation ; and then, if the telescope be revolved in the *Y*'s, the bubble will continue at the middle point of the tube. It is, however, difficult to make the first part of this adjustment, while the axis of the level is considerably inclined to the line of collimation : for, allowing the level to be truly horizontal in one position of the telescope, after it is reversed, there will be but one corresponding position in which the bubble will stand at the middle of the tube. This suggests the necessity of making the first part of the adjustment with tolerable accuracy ; then, having made the second with care, re-examine the first, and proceed thus till the adjustment is completed.

THIRD ADJUSTMENT. *To make the level CD and the line of collimation perpendicular to the axis of the instrument, or parallel to the horizontal bar EE .*

Loosen the clamp-screw *S*, and turn the bar *EE*, until the level *DC* comes directly over two of the levelling screws. By means of these screws, make the level *CD* truly horizontal. Then, turn the level quite round ; if, during the revolution, it continue horizontal, it must be at right angles to the axis of the instrument about which it has been revolved. But if, after the revolution, the level *CD* be not horizontal, rectify half the error with the screws at *M* and *R*, and half with the levelling screws. Then place the bar *EE* over the other two levelling screws, and make the same examinations and corrections as before ; and proceed thus, until the level can be turned entirely around without displacing the bubble at the centre. When this can be done, it is obvious that the level *DC* and the line of collimation, are at right angles to the axis of the instrument about which they revolve ; and since the axis is carefully adjusted by the maker, at right angles to the bar *EE*, it follows, that the line of collimation, the level *DC*, and the bar *EE*, are parallel to each other.

The level is now adjusted. When used, however, it is best to re-examine it every day or two, as the work will be erroneous unless the adjustments are accurate.

Of Levelling Staves.

173. The levelling staves are used to determine the points at which a given horizontal line intersects lines that are perpendicular to the surface of the earth, and to show the distance of such points of intersection from the ground.

They are thus constructed. AB (Pl. 4, Fig. 3) is a rectangular piece of wood, in the middle of which is a groove $abcd$. Into this groove a slide $lnst$ enters, and is moved freely along the groove. At the upper end of the slide is a rectangular board $fhow$, called a *vane*, six inches, in the direction hi . The vane is divided into four equal parts, by the lines fg , hi : the two rectangles fh , ig , are usually painted black, and the other two, if , hg , white; so that the lines fg and hi may be distinguished with great accuracy. The slide from fg to ln , is of the same length with the body of the staff AB : hence, when the line fg coincides with bc , the lower end of the slide ln , will coincide with ad . The pins p and q , which work in grooves, and are largest at the ends p and q , are pressed in to hold the slide in any position at which it may be placed. The length of the staff is generally six feet, and it is usually divided into eighths or tenths of an inch. The slide is divided in the same way. The longer lines show the feet, the shorter, the inches. *The object to be attained by these divisions, is, to ascertain the distance of the line fg from the ground.*

When the line fg is brought to the top of the staff, to coincide with bc , the lower line wio of the vane, coincides with the line marked 6, on the left of the staff: which shows, the staff standing upright, that the line fg is six feet above the ground. From the line marked 6, to the lower end of the staff, is, indeed, but 5 feet 9 inches; but the line fg is three inches above the line wio , so that fg is six feet from the ground.

If, from the last position, the slide be run up until the line wio coincides with the division marked 1, on the left of the staff, the line fg will be six feet and one inch from the ground: if, till it coincides with bc , it will be six feet and three inches, the inches being marked on the staff. If the slide be still run up, until 7 on the slide coincides with bc , the line fg will be seven feet from the ground. In the figure, the line fg is

seven feet from the bottom of the staff. The count above 6 feet 3 inches is always made on the slide. The manner of counting off, for the parts of an inch, is too plain to require particular explanation.

Having run down the slide till the upper line h , of the vane, coincides with bc , place bB on the ground, and the staff vertical. It is now plain, that the line fg is three inches above the ground. These three inches are marked on the right of the staff. If the slide be run up till the lower line h coincides with 1, on the right of the staff, the line fg will be one foot from the ground, and similarly, until six feet be shown at the other end of the staff.

The feet are marked 1, 2, 3, &c., from the upper end, and are reversed in the present position of the staff; but are upright when the staff is placed for use. In the last position of the staff, the count is made at the *lower line of the vane*.

174. There is a method of testing the adjustments of the level, which ought not to be neglected, since all the results depend on the accuracy of the instrument. The method is this:

The level being adjusted, place it at any convenient point, as G (Fig. 4). At equal distances of about 100 yards, on either side, and in the same line with the level, place the levelling staves CE , BF . Make the level horizontal with the levelling screws. Then, turn it towards either staff, as BF , and run the vane up or down, as required, until the intersection of the hairs strikes the centre: then make the slide fast, and note carefully the height of the vane. Turn the level half round, and do the same in respect of the staff CE . Let the telescope be now reversed in the Y 's. Sight again to the staff BF , and note the exact height of the vane. Let the telescope be now turned half round, and the same be done for the staff CE . If the two heights last observed, are equal to those first noted, each to each, the line of collimation will be perpendicular to the axis of the instrument, and if the bubble has, at the same time, preserved its place at the middle point of the tube, the instrument is truly adjusted.

For, had the line of collimation been inclined to the axis of the level, it would, in the first instance, have taken the direction AF or Ad ; and when turned half round, it would have taken the direction Ab or AE . The telescope being

reversed in the *Y*'s, and again directed to the staff *BF*, the line of collimation would take the direction *Ad* or *AF*, and when turned to the staff *CE*, it would take the direction *AE* or *Ab* : and the two distances *BF*, *Bd*, or *Cb*, *CE*, can only be equal to each other when the line of collimation falls on the horizontal line *gf*.

175. Having described the instruments used in levelling, we will explain the practical operations on the field.

When it is proposed to find the difference of level of any two objects, or stations, all levels made in the direction of the station at which the work is begun, are, for the sake of distinction merely, called *back-sights*; and levels taken in the direction of the other station, *fore-sights*.

Before going on the field with the level, rule three columns, as below, and head them, stations, back-sights, fore-sights.

Stations.	Back-Sights.	Fore-Sights.
1	10	3
2	11-6	0
3	6-8	4-9
4	3-9	8-3
Sums	31-11 16-00	16-0
Dif. of level . . .	<u>15-11</u>	

PROBLEM.

176. To find the difference of level between any two points, as *A* and *G* (Pl. 4, Fig. 5).

The level being adjusted, place it at any point as *B*, as nearly in the line joining *A* and *G* as may be convenient. Place a levelling staff at *A*, and another at *N*, a point lying as near as may be in the direction of *G*. Make the level horizontal, by means of the levelling screws; turn the telescope to the staff at *A*, and direct the person at the staff to slide up the vane until the horizontal line *ab* cuts its centre; then note the distance *Ab* (equal to 10 feet in the present example), and enter it in the column of back-sights, opposite station 1. Sight also to the staff at *N*, and enter the distance

$\mathcal{N}a$, equal to 3 feet, in the column of fore-sights, opposite station 1.

Take up the level, and place it at some other convenient station, as C , and remove the staff at \mathcal{A} , to \mathcal{M} . Having levelled the instrument, sight to the staff at \mathcal{N} , and enter the distance $\mathcal{N}d$, 11 feet 6 inches, in the column of back-sights, opposite station 2: sight also to the staff at \mathcal{M} , and enter the distance $\mathcal{M}f$, equal 0, in the column of fore-sights, opposite station 2.

Let the level be now removed to any other station, as D , and the staff at \mathcal{N} , to some other point, as P . Let the distance $\mathcal{M}g$, equal to 6 feet 8 inches, be entered in the column of back-sights, opposite station 3, and the distance P_h , equal to 4 feet 9 inches, in the column of fore-sights. Let the instrument be now placed at E , and the distance P_m , equal to 3 feet 9 inches, and G_n , equal to 8 feet 3 inches, be entered opposite station 4, in their proper columns.

By adding up the columns, we find, that the sum of the back-sights is equal to 31 feet 11 inches, and the sum of the fore-sights, 16 feet; the difference, 15 feet and 11 inches, is the difference of level of the points \mathcal{A} and G .

DEMONSTRATION.

Let the back-sights be called plus, and the fore-sights, minus.

Then, having let fall the perpendiculars $\mathcal{N}F$, $\mathcal{M}H$, PI , and GL , on the horizontal line $\mathcal{A}L$, it remains to be proved, that the difference of level,

$$GL = \mathcal{A}b + \mathcal{N}d + \mathcal{M}g + P_m - \mathcal{N}a - 0 - hP - nG.$$

$$\text{Now, } \mathcal{A}b + \mathcal{N}d - \mathcal{N}a = \mathcal{A}b + ad = Fd;$$

$$\text{Therefore, } GL = Fd + \mathcal{M}g + P_m - hP - nG.$$

$$\text{But } Fd + \mathcal{M}g = Hg, \text{ and } +P_m - hP = -hm,$$

$$\text{Therefore, } GL = Hg - hm - nG = hI - (hm + nG) = GL.$$

As the same may be shown in every example, we conclude that, *the difference between the sum of the fore-sights and the sum of the back-sights is, in all cases, equal to the difference of level.*

It is also evident that, when the sum of the back-sights exceeds the sum of the fore-sights, the last station is more elevated than the first; and, conversely, if the sum of the

back-sights is less than the sum of the fore-sights, the second station is lower than the first.

177. In this example, we have not regarded the difference between the true and apparent level. If it be necessary to ascertain the result with extreme accuracy, this difference must be considered; and then, the horizontal distances between the level, at each of its positions, and the staves, must be measured, and the apparent levels diminished by the differences of level; which differences can be found from the table.

The following is such an Example.

Stat.	Back-sts.	Distances.	Fore-st.	Distances.	Cor. back-sights.	Cor. fore-sts.
1	9-8	20 ch.	1-6	32 ch.	9-7.500	1-4.720
2	8-7	25 ch.	2-4	28 ch.	8-6.219	2-3.019
3	5-2	18 ch.	3-1	16 ch.	5-1.595	3-0.680
4	10-3	29 ch.	1-9	87 ch.	10-1.949	0-11.538
5	11-0	45 ch.	2-5	72 ch.	10-9.469	1-10.520
					44-2.732	9-6.477

In this example, the first column shows the stations; the second, the back-sights; the third, the distances from the level in each of its positions to the back staff; the fourth, the fore-sights; the fifth, the distances from the level to the forward staff; the sixth and seventh, are the columns of back and fore sights, corrected by the difference of level. The corrections are thus made:—The difference of level in the table corresponding to 20 chains, is 5 tenths of an inch, which being subtracted from 9 feet 8 inches, leaves 9 feet 7.5 inches for the corrected back-sight; this is entered opposite station 1 in the sixth column. The difference of level corresponding to 32 chains, is 1.280 inches, which being subtracted from the apparent level, 1 foot 6 inches, leaves 1 foot 4.720 inches for the true fore-sight from station 1. The other corrections are made in the same manner.

The sum of the back-sights being 44 feet 2.732 inches, and the sum of the fore-sights 9 feet 6.477 inches, it follows,

that the difference, 34 feet 8.255 inches, is the true difference of level.

178. In finding the true from the apparent level, we have not regarded the effect caused by refraction on the apparent elevation of objects, as well because the refraction is different in different states of the atmosphere, as because the corrections are inconsiderable in themselves.

179. The small errors that would arise from regarding the apparent as the true level, may be avoided *by placing the levelling staves at equal distances from the level*. In such case, it is plain, 1st, that equal corrections must be made in the fore and back sights; and, 2dly, that when the fore and back sights are diminished equally, the result, which is always the difference of their sums, will not be affected.

This method should always be followed, if practicable, as it avoids the trouble of making corrections for the difference of true and apparent level.

The differences between the true and apparent level, being very inconsiderable for short distances, if only ordinary accuracy be required, it will be unnecessary to make measurements at all. Care, however, ought to be taken, in placing the levelling staves, to have them as nearly at equal distances from the level as can be determined by the eye; and if the distances are unequal, let the next distances also be made unequal; that is, if the back-sight was the longest in the first case, let it be made proportionably shorter in the second, and the reverse.

CHAPTER VI.

Of the methods of showing the contour and accidents of ground.

180. Besides the surveys that are made to determine the area of land and the relative positions of objects, it is frequently necessary to make minute and careful examinations for the purpose of ascertaining the form and accidents of the ground, and to make such a plan as will distinguish the

swelling hill from the sunken valley, and the course of the rivulet from the unbroken plain.

181. This branch of surveying is called Topography. In surveys made with a view to the location of extensive works, the determination of the slopes and irregularities of the ground is of the first importance: indeed, the examinations would otherwise be useless.

182. The manner of ascertaining these irregularities is, to intersect the surface of the ground by a system of horizontal planes at equal distances from each other; the curves determined by these secant planes, being lines of the surface, will indicate its form at the places of section, and, as the curves are more or less numerous, the form of the surface will be more or less accurately ascertained.

If such a system of curves be determined, and then projected or let fall on a horizontal plane, it is obvious that the curves on such plane will be nearer together or farther apart, as the ascent of the hill is steep or gentle.

If, therefore, such intersections be made, and the curves so determined be accurately delineated on paper, the map will present such a representation of the ground as will show its form, its inequalities, and its striking characteristics.

183. The subject divides itself, naturally, into two parts.

First, To make the necessary examinations and measurements on the field.

And, 2dly, to make the delineations on paper.

For the former of these objects, the theodolite is the best instrument; the common level, however, will answer all the purposes, though it is less convenient.

Before going on the field, it is necessary to provide a number of wooden stakes, about two feet in length, with heads. These stakes are used to designate particular points, and are to be driven to the surface of the ground. A nail should then be driven into the head of each of them, to mark its centre.

184. We shall, perhaps, be best understood, by giving an example or two, and then adding such general remarks as will extend the particular cases to all others that can occur.

Let *A* (Pl. 4, Fig. 6), be the summit of a hill, the contour of

which it is required to represent. At A , let a stake be driven, and let the axis of the theodolite, or level, be placed directly over the nail which marks its centre. From A , measure any line down the hill, as AB , using the telescope of the theodolite or level to arrange all its points in the same vertical plane. Great care must be taken to keep the measuring chain horizontal, for it is the *horizontal distances* that are required. At different points of this line, as a, b, c, d , &c., let stakes be driven, and let the horizontal distances Aa, ab, bc , and cd , be carefully measured. In placing the stakes, reference must be had to the abruptness of the declivity, and the accuracy with which the surface is to be delineated: their differences of level ought not to exceed once and a half, or twice, the distance between the horizontal planes of section.

Having placed stakes, and measured all the distances along the line AB , run another line down the hill, as AC , placing stakes at the points e, f, g , and h , and measuring the horizontal distances Ae, ef, fg , and gh . Run also the line AD , placing stakes at i, l, m , and n , and measuring the horizontal distances Ai, il, lm , and mn .

Each line, AB, AC, AD , running down the hill from A , may be regarded as the intersection of the hill by a vertical plane; and these secant planes are to be continued over all the ground which is to be surveyed. If the work is done with a theodolite, or with a level having a compass, the angles DAB and BAC , contained by the vertical secant planes, can be measured; if it is done with a level, having no needle, let any of the distances ae, bf, ai, bl , &c. be measured with the chain, and there will then be known the three sides of the triangles Aae, Abf, Aai, Abl , &c.

Let now, the difference of level of the several points marked in each of the lines AB, AD, AC , be determined.

In the present example the results of the measurements and levelling, are—

Line AB .

Distances.		Difference of Level.
$Aa = 40$ feet		A above a 12 feet
$ab = 50$ “		a above b 8 “
$bc = 30$ “		b above c 9 “
$cd = 46$ “		c above d 11 “

Line *AC*.

Distances.		Difference of Level.
<i>Ae</i> = 28 feet		<i>A</i> above <i>e</i> 11 feet
<i>ef</i> = 45 "		<i>e</i> above <i>f</i> 9 "
<i>fg</i> = 55 "		<i>f</i> above <i>g</i> 12 "
<i>gh</i> = 49 "		<i>g</i> above <i>h</i> 14 "

Line *AD*.

Distances.		Difference of Level.
<i>Ai</i> = 25 feet		<i>A</i> above <i>i</i> 9 feet
<i>il</i> = 55 "		<i>i</i> above <i>l</i> 13 "
<i>lm</i> = 38 "		<i>l</i> above <i>m</i> 7 "
<i>mn</i> = 48 "		<i>m</i> above <i>n</i> 14 "

Angle *CAB* = 25°, Angle *DAB* = 30°.

These data are sufficient, not only to find the intersections of horizontal planes with the surface of the hill, but also for delineating such curves of section on paper.

Having drawn on the paper the line *AB*, lay off the angle *BAC* = 25°, and the angle *BAD* = 30°. Then, from a convenient scale of equal parts, lay off the distances *Aa*, *ab*, *bc*, *cd*, *Ae*, *ef*, *fg*, *gh*, *Ai*, *il*, *lm*, and *mn*.

Let it be required that the horizontal planes be at a distance of eight feet from each other. Since *A* is the highest point of the hill, and the difference of level of the points *A* and *a*, is 12 feet, the first plane, reckoning downwards, will intersect the line traced on the ground from *A* to *B*, between *A* and *a*. Regarding the descent as uniform, which we may do for small distances without sensible error, we have this proportion; as the difference of level of the points *A* and *a*, is to the horizontal distance *Aa*, so is 8 feet, to the horizontal distance from *A* to where the first horizontal plane will cut the line from *A* to *B*. This distance being thus found, and laid off from *A* to *o*, gives *o*, a point of the curve in which the first plane intersects the ground. The points at which it cuts the line from *A* to *C*, and the line from *A* to *D*, are determined similarly, and three points in the first curve are thus found.

By the aid of the sector, the graphic operations are greatly facilitated. Let it be borne in mind, that the descent from *A* to *a*, is 12 feet, and that it is required, upon the supposition

of the descent being uniform, to find that part of the distance corresponding to a descent of 8 feet. Take the distance from A to a , in the dividers, and open the arms of the sector until the dividers will reach from 12 on the line of equal parts, on one side, to 12 on the line of equal parts, on the other. Then, without changing the angle, extend the dividers from 8 on one side, to 8 on the other; this will give the proportional distance to be laid off from A to o . Or, if the dividers be extended from 4 to 4, the proportional distance may be laid off from a to o .

If the distances to be taken from the sector fall too near the joint, let multiples of them be used; as for instance, on the French sectors, let the arms be extended until the dividers reach from 120 on the one, to 120 on the other, then 80 or 40 will be the proportional numbers. Other multiples may be used, though it is generally more convenient to multiply by 10.

The second plane is to pass 8 feet below the first, that is, 16 feet below A , or 4 feet below a , a being 12 feet below A . Take the distance ab in the dividers, and extend the sector, so that the dividers will reach from 8 to (the descent from a to b being 8 feet) 8, or from 80 to 80; then, the distance from 4 to 4, or from 40 to 40, being laid off from a to p , gives p , a point of the second curve.

The difference of level between a and b being 8 feet, and the difference of level between a and p being 4 feet, the difference of level between p and b must also be 4 feet: hence, the third plane will pass 4 feet below b , and q , determined as above, is a point of the third curve.

The difference of level between b and c being 9 feet, and consequently between q and c , 5 feet, the fourth plane will pass 3 feet below c , and r is a point of the fourth curve.

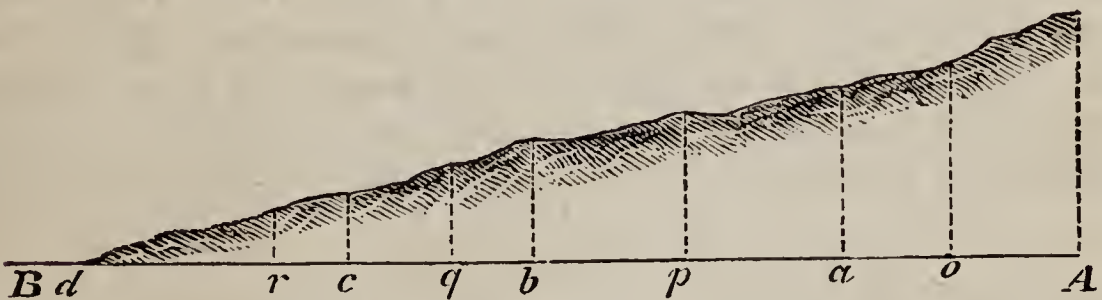
The difference of level between c and d being 11 feet, the difference of level between r and d is 8 feet; so that the fifth plane will pass through d , which is consequently a point of the fifth curve.

The points at which the horizontal planes cut the lines drawn from A to C , and from A to D , are determined in a manner entirely similar. Having thus made as many diverging sections from the point A as may be necessary, and found the points in which they are cut by horizontal planes, the

horizontal curves of section can be described through the several corresponding points. These curves being represented on paper, their curvature shows the form of the surface of the hill in the direction of a horizontal line traced around it; and the distances between them, the abruptness or gentleness of the declivity. The numbers (8), (16), &c. show the vertical distances of the respective planes below the point *A*.

Having drawn the horizontal curves, the next thing to be done is so to shade the drawing that it may represent accurately the surface of the ground. This is done by drawing a system of small broken lines, as in the figure, perpendicular in direction to the horizontal curves already described. In all topographical representations of undulating ground, the lines of shading are drawn perpendicular to the horizontal curves.

185. If it be required to show a profile of the ground, let the vertical plane passing through *A* and *B* be revolved about its intersection with a horizontal plane passing through *d*. Erect perpendiculars at *r*, *c*, *q*, *b*, *p*, *a*, *o*, and *A*, to the line *BA*, and make them equal to the respective distances of these points above the horizontal plane passing through *d*, viz. at *r*, 8 feet, at *c*, 11, at *q*, 16, at *b*, 20, at *p*, 24, at *a*, 28, at *o*, 32, and at *A*, 40; and through the extremities of the perpendiculars so determined, let a curve be traced: this curve will be the curve of the hill from *d* to *A*.



186. This method of finding the form of the surface of a hill, is perhaps the best, when the hill slopes gradually from its summit, and the declivity is sufficiently gentle to measure down it. If the surface were that of an undulating plain, the following method is preferable.

Measure a horizontal line, as *AB* (Pl. 4, Fig. 7), running along one side of the ground to be surveyed. At the extremities *A* and *B*, erect the perpendiculars *AD* and *BC*, and produce them until all the land to be surveyed shall be in-

cluded within the rectangle $ABCD$. On the line AB , measure the horizontal distances AE, EF, FG , and GB ; and on the line DC , the distances DH, HI, IL , and LC , respectively equal to the distances on AB : that is, $DH=AE, HI=EF$, &c. The distances AE, EF , &c. are regulated by the inequalities of the ground, being less if the changes in the surface are considerable, and greater if the changes are nearly uniform. In the present example, they are 100 feet each, which, upon ordinary ground, would render the work tolerably accurate.

Let stakes be driven at $A, E, F, G, B, C, L, I, H$, and D . Measure now the line AD , and place stakes at convenient distances, as a, b, c , and d : place stakes also along the other lines EH, FI, GL , and BC , at suitable points, and measure the respective distances Ef, fg , &c. It is best to use the telescope of the theodolite or level, in order to run the lines and place the stakes truly. In placing the stakes, it should be borne in mind, that the difference of level of either two that follow each other, ought not to be very great; and also, that they ought not to be on the same horizontal plane.

After the stakes are all placed, and the distances measured, let the differences of level of all the points so designated be found. In the present example, the results of the measurements are—

$Aa = 80$	$AE = 100$	$EF = 100$	$FG = 100$	$GB = 100$
$ab = 60$	$Ef = 105$	$Fi = 74$	$Gm = 96$	$Bq = 76$
$bc = 90$	$fg = 85$	$ik = 115$	$mn = 76$	$qs = 85$
$cd = 55$	$gh = 71$	$kl = 60$	$np = 76$	$st = 127$
$dD = 50$	$hH = 74$	$li = 86$	$pL = 87$	$tC = 47$

Of the Levelling.

Line AD .	Line EH .	Line FI .	Line GL .	Line BC .
A above a 5	E below A 3	F below E 2	G below F 1	B below G 2
a " b 6	E above f 9	F above i 3	G above m 2	B above q 3
b " c 7	f " g 3	i " k 5	m " n 1	q " s 2
c below d 2	g " h 1	k " l 2	n " p 2	s " t 3
d above D 4	h below H 3	l below I 3	p below L 4	t below C 5

The heights of the points are here compared with each other, two and two. Before, however, we can conceive clearly their relative heights, we must assume some one point,

and compare all the others with it. Let the point *A* be taken. The height of

<i>A</i> above <i>a</i>	^{Ft.} 5	<i>A</i> above <i>f</i>	^{Ft.} 12	<i>A</i> above <i>k</i>	^{Ft.} 13	<i>A</i> above <i>p</i>	^{Ft.} 11
<i>A</i> " <i>b</i>	11	<i>A</i> " <i>g</i>	15	<i>A</i> " <i>l</i>	15	<i>A</i> " <i>L</i>	7
<i>A</i> " <i>c</i>	18	<i>A</i> " <i>h</i>	16	<i>A</i> " <i>I</i>	12	<i>A</i> " <i>B</i>	8
<i>A</i> " <i>d</i>	16	<i>A</i> " <i>H</i>	13	<i>A</i> " <i>G</i>	6	<i>A</i> " <i>q</i>	11
<i>A</i> " <i>D</i>	20	<i>A</i> " <i>F</i>	5	<i>A</i> " <i>m</i>	8	<i>A</i> " <i>s</i>	13
<i>A</i> " <i>E</i>	3	<i>A</i> " <i>i</i>	8	<i>A</i> " <i>n</i>	9	<i>A</i> " <i>t</i>	16

And of *A* above *C*, 11 feet.

This being done, a mere inspection shows us the highest and lowest points, as also the relative heights of the others, reckoning upwards or downwards. Let them be now written in the order of their heights above the lowest point, which is *D*. The difference of level between *A* and *D* being 20 feet, if the difference of level of each of the points below *A*, be taken from 20 feet, the remainder will be the height above *D*. Arranging them in their order, we have

<i>c</i> above <i>D</i>	^{Ft.} 2	<i>H</i> above <i>D</i>	^{Ft.} 7	<i>p</i> above <i>D</i>	^{Ft.} 9	<i>B</i> above <i>D</i>	^{Ft.} 12
<i>d</i> " <i>D</i>	4	<i>k</i> " <i>D</i>	7	<i>q</i> " <i>D</i>	9	<i>L</i> " <i>D</i>	13
<i>h</i> " <i>D</i>	4	<i>s</i> " <i>D</i>	7	<i>C</i> " <i>D</i>	9	<i>G</i> " <i>D</i>	14
<i>t</i> " <i>D</i>	4	<i>f</i> " <i>D</i>	8	<i>n</i> " <i>D</i>	11	<i>a</i> " <i>D</i>	15
<i>g</i> " <i>D</i>	5	<i>I</i> " <i>D</i>	8	<i>i</i> " <i>D</i>	12	<i>F</i> " <i>D</i>	15
<i>l</i> " <i>D</i>	5	<i>b</i> " <i>D</i>	9	<i>m</i> " <i>D</i>	12	<i>E</i> " <i>D</i>	17

A above *D*, 20 feet.

Let the surface be now intersected by a system of horizontal planes at 3 feet from each other,—the first plane being 3 feet above the point *D*. The point *b* being 9 feet above *D*, and the point *c*, 2 feet, the first plane will intersect the line *AD* between *b* and *c*: let the proportional distance be found, as in the last example, and one point *u*, of the first curve, will be known. The point *H* being 7 feet above *D*, the plane will cut the line *DC* between *H* and *D*, and finding the proportional distance as before, a second point, *v*, of the first curve, is determined. Now, in drawing this curve, it will be borne in mind, that the point *h* is but 4 feet above *D*, and consequently but 1 foot above the first curve, so that the curve must run from *u* towards *h*, and then turn around to the point *v*. The curve is maked (3), which is the number of feet that it is above the lowest point, and similarly for the

other curves of the figure; their number showing their distance in feet above D . Around the point d , there is a small curve, also marked (3). By inspecting the table, it will be seen that d is 4 feet above D , and that the ground descends from d towards D and c : d is therefore a small knoll, the top of which is cut off by the first plane. To show that the ground descends from d , even below the first curve (3), a plane is passed 1 foot below the first plane, or 2 feet above D ; the curve of section is marked (2).

The second of the system of curves, or the one marked (6), must cut the line AD between b and c , the line EH between f and g , the line FI between k and l , and also between l and I ; it also cuts EH again between h and H , and the line DC between H and D .

The third curve, or the one passing 9 feet above D , passes through b , cuts the line EH between E and f , the line FI between i and k ; thence it passes to p , and thence to the line DC , crossing it between I and L . There is also another curve determined by this plane, since it passes through the points C and q , leaving the points t and s below it. This curve runs from C to p , and from p to q , as drawn in the figure.

The fourth curve, marked (12), intersects the line AD between a and b , EH between E and f , FI at i , GL at m , and BC at B . There is also another curve lying around the point L : for the plane cuts GL between p and L , the line DC between C and L , and again between I and L .

The fifth curve, marked (15), cuts AD at a , EH between E and f , and AB at F . The sixth curve, marked (18), cuts AD between A and a , and AB between A and E . The proportional distances in all these cases are found as in the first example.

In looking on the little map that has been made, it is clearly indicated by the curves and shading, that the ground slopes from A to c , thence rises to d , and then slopes to D . It also slopes from A along the line AB ; from E in the directions f and i , from F in the directions i and m , from G in the directions m and B , and from B in the direction Bqs . The ground also slopes from L to p , thence to l and h , and along to curve (2), and the point D : and on the other side to t and s .

187. Thus far, we have said nothing of a *plane of reference*, which is any horizontal plane to which the levels of all the points are referred. In the first example, the plane of reference was assumed through the point *A* (Pl. 4, Fig. 6), and tangent to the surface of the hill: in the second example, it was taken through *D*, the lowest point of the work.

188. After having compared all the levels with any one point, the highest and the lowest points are at once discovered, and the plane of reference may be assumed through either of them. As, however, in comparing the heights of objects, the mind most readily refers the higher to the lower, it is considered preferable to take the plane of reference through the lowest point. We say, for example, that the summit of a hill is 200 feet above a given plain, and not that the plain is 200 feet below the summit of the hill; so we say that a plain is at a given distance above a river, and not that the river is below the plain. This habit of the mind of referring the higher to the lower objects, suggests the propriety of taking the plane of reference through the lowest point, where there is no other circumstance to influence its selection. If, however, there are fixed and permanent objects, to which, as points of comparison, the mind readily refers all others, such as the court-house or church of a village, the market-house of a town, or any public building or monument, it is best to assume the plane of reference through some such point; for, it must be kept in mind, that the ends proposed in the construction of maps, are, to present an accurate view of the ground, its form, its accidents, and the relative position of objects upon it.

189. When the plane of reference is so chosen that the points of the work fall on different sides of it, all the references on one side are called positive, and those on the other, negative. The curves having a negative reference are distinguished by placing the minus sign before the number; thus — ().

190. In topographical surveys, great care should be taken to leave some *permanent marks*, with their levels written on them in a durable manner. For example, if there are any rocks, let one or more of them be smoothed, and the vertical distance from the plane of reference marked thereon: or let

the vertical distance of a point on some prominent building, be ascertained and marked permanently on the building. Such points should also be noted on the map, so that a person, although unacquainted with the ground, could by means of the map, go upon it, and trace out all the points, together with their differences of level.

191. The manner of shading the map, so as to indicate the hills and slopes, consists in drawing the lines of shading perpendicular to the horizontal curves, as already explained.

192. In making topographical surveys, the great point is, to determine the curves which result from the intersection of the surface by horizontal planes.

Besides the methods of diverging and parallel sections, we may assume a point on the surface of a hill, place the level there, and run a line of level round the hill, measuring the angles at every turn or change of direction : such a line will be a horizontal curve. Then, levelling up or down the hill, a distance equal to the vertical distance between the horizontal curves, let a second curve be traced ; and similarly for as many curves as may be necessary.

This method, however, is not as good as the methods before explained.

193. Besides representing the contour of the ground, it is often necessary to make a map which shall indicate the cultivated field, the woodland, the marsh, and the winding river. For this, certain characters, or conventional signs, have been agreed upon, as the representatives of things, and when these are once fixed in the mind, they readily suggest the objects for which they stand. Those which are given in Plates 5 and 6, have been adopted by the Engineer Department, and are used in all plans and maps made by the United States Engineers.

It is very desirable that a uniform method of delineation should be adopted, and none would seem to be of higher authority than that established by the Topographical Beaureau. It is, therefore, recommended, that the conventional signs given in Plates 5 and 6, be carefully studied and closely followed.

CHAPTER VII.

Of Surveying Harbours.

194. There are two objects to be attained in the survey of a harbour.

1st. To survey the shore along high or low water mark, to trace its windings, to note the points and inlets, and to ascertain and fix the places at which rivers and creeks discharge themselves. And,

2dly. To discover the channels, their direction, depth, and width; the position of shoals, the depth of water upon them, the nature of the bottom, and in short, whatever may contribute to easy and safe navigation.

To determine the principal points and trace the shore.

195. Having provided a boat and crew, row once or twice around the harbour, mark the more important and prominent points; at which, let station-staves with flags upon them be erected.

Then, measure a base line, and form a series of triangles, having their angles at the stations already chosen. Let the angles of these triangles be measured with the theodolite, and their sides calculated; after which, the high or low water mark may be traced along the shore with the compass, as hereafter explained.

Let us suppose that Plate 6 is a map of a harbour to be surveyed.

We see, by inspecting it, that the upper end of the lake at *A*, the termination of the harbour at *B*, the rocks at *C*, the point at *D*, the fisheries at *E*, and the two bays at *F* and *G*, are all prominent points. At these points, therefore, let station-flags be placed. Then, measure the distance from *A* to *B*, for a base line, and let the work be begun at *A*.

Remove the staff at *A*, and place, by means of a plumb-line, the axis of the theodolite over the station. Then, having levelled the instrument, bring the 0 of the eyeglass vernier to coincide with the 0 of the limb, and tighten the clamp-screw of the vernier plate. Loosen the lower clamp-screw, and turn

the body of the instrument until the telescope comes nearly on the base line AB : then tighten the clamp-screw K , and by means of the lower tangent-screw L , and the thumb-screw Z , bring the intersection of the spider's lines to coincide with the bottom of the staff at B . Then, direct the lower telescope to the same point, without moving the limb.

Having thus placed the instrument, examine the opposite vernier, and if it stands exactly at 180° , enter the direction from A to B , 00 , as in the field notes below.

But if the reading of the opposite vernier exceeds 180° , enter half the excess for the direction. If the reading is less than 180° , take half of what it falls short, from 360° , and enter the remainder for the direction from A to B .

The two verniers are used to avoid any error which might arise from a defective graduation of the limb, or from an imperfect centring. A false centring, is when the centre of the limb or vernier plate is out of the axis of the instrument, and when this is the case, it is a fruitful source of error.

Both verniers should be read at every observation, and a mean between the readings taken for the true direction.

Having thus placed the instrument, loosen the clamp-screw of the vernier plate, and direct the telescope to station E . Note the degrees, and take a mean between the readings of the two verniers for the minutes, and enter the result opposite direction AE , as in the field notes. Do the same for the station G , and then enter in a column to the right, the angle formed by the lines which join the stations. The angle will either be the difference of the readings, or the difference between 360° and the larger reading, plus the smaller reading.

Station A.

Direction AB	. . 00	
Direction AE	. . $73^\circ 25'$	$BAE = 73^\circ 25'$
Direction AG	. . $138^\circ 35'$	$EAG = 65^\circ 10'$

Having sighted to all the stations which can be seen from A , remove the instrument and replace the station staff.

Take the theodolite to B , the other extremity of the base line. It is now required to place the instrument in such a manner that the horizontal limb shall have the same relative position with the base line AB , as it had at the station A .

For this purpose, after having levelled the instrument, add 180° to the direction from A to B , and place the 0 of the eyeglass vernier at the point so found. Then clamp the vernier plate, after which direct both the telescopes to station A . It is now plain that the line of the limb drawn through 0 and 180° will coincide with the base line AB , the 0 being towards A , as before; hence the theodolite is like placed.

Having clamped the limb, loosen the clamp-screw of the vernier plate, and sight to stations E and C , and enter the directions as below.

Station B.

Direction BA . . .	$180^{\circ} 00'$	
Direction BE . . .	$139^{\circ} 40'$	$ABE = 40^{\circ} 20'$
Direction BC . . .	$57^{\circ} 12'$	$EBC = 82^{\circ} 28'$

Having sighted to all the stations which can be seen from B , replace the station-staff and remove the instrument to station C . To the direction $BC = 57^{\circ} 12'$ add 180° , and the sum is $237^{\circ} 12'$. Having levelled the instrument, place the 0 of the eyeglass vernier at $237^{\circ} 12'$, and then sight to station B . The limb of the theodolite will then have the same relative position as at the stations A and B . Then sight to E and D , and enter the directions as below.

Station C.

Direction CB . . .	$237^{\circ} 12'$	
Direction CE . . .	$180^{\circ} 27'$	$BCE = 56^{\circ} 45'$
Direction CD . . .	$150^{\circ} 27'$	$ECD = 30^{\circ} 00'$

Remove the instrument to E . To the direction $CE = 180^{\circ} 27'$, add 180° , and the sum will be $360^{\circ} 27'$. Then place the 0 of the vernier at $27'$, and direct the telescope to C . Or, the theodolite may be placed at E by adding 180° to the direction AE , as taken from A , or to the direction BE , as taken from B , and then directing the telescope to A or B .

By placing the instrument in a similar manner at every station, the line of the limb passing through 0 and 180° , continues parallel to the base AB , the 0 being constantly in the direction towards A . The instrument is thus placed at all the stations, and the following are the results of the measurements of the angles.

Station E.

Direction <i>EC</i> . . .	$0^{\circ} 27'$	
Direction <i>EB</i> . . .	$319^{\circ} 40'$	$CEB = 40^{\circ} 47'$
Direction <i>EA</i> . . .	$253^{\circ} 25'$	$BEA = 66^{\circ} 15'$
Direction <i>EG</i> . . .	$199^{\circ} 15'$	$AEG = 54^{\circ} 10'$
Direction <i>EF</i> . . .	$164^{\circ} 10'$	$GEF = 35^{\circ} 05'$
Direction <i>ED</i> . . .	$94^{\circ} 10'$	$FED = 70^{\circ} 00'$

Station D.

Direction <i>DC</i> . . .	$330^{\circ} 27'$	
Direction <i>DE</i> . . .	$274^{\circ} 10'$	$CDE = 56^{\circ} 17'$
Direction <i>DF</i> . . .	$225^{\circ} 50'$	$EDF = 48^{\circ} 20'$

Station F.

Direction <i>FD</i> . . .	$45^{\circ} 50'$	
Direction <i>FE</i> . . .	$344^{\circ} 10'$	$DFE = 61^{\circ} 40'$
Direction <i>FG</i> . . .	$247^{\circ} 10'$	$EFG = 97^{\circ} 00'$

Station G.

Direction <i>GF</i> . . .	$67^{\circ} 10'$	
Direction <i>GE</i> . . .	$19^{\circ} 15'$	$FGE = 47^{\circ} 55'$
Direction <i>GA</i> . . .	$318^{\circ} 35'$	$EGA = 61^{\circ} 40'$

The measurements which have been made, enable us to calculate the lengths of the lines joining the several stations. For, commencing with the triangle *AEB*, we know all the angles and the base line *AB*; we can, therefore, find the sides *EB*, *EA*. We shall then know one side and all the angles of the triangle *CEB*, and by pursuing the calculation, the sides of all the triangles can be readily found.

Since the third angle of a triangle can always be found when two of the angles are known, it may seem unnecessary to measure all the angles. But when the three angles are measured and their sum found equal to 180° , the work is proved to be right, and this verification should never be omitted.

It is not probable that the sum of the three measured angles will be exactly equal to 180° . But they ought not to differ much from it. If each of them be measured several

times, and a mean of the measurements be taken, the errors of observation and of the instrument will be much diminished.

196. The method of determining points by a series of consecutive triangles, is called the method by *triangulation*. It may be extended to any number of triangles, and if the three angles of every triangle be measured, and the work carefully verified at each step, there is little danger of error. We have applied the method only in the survey of a harbour, but it may be used with equal advantage in all surveys in which long lines are to be determined, and is, indeed, the only one that can be relied on, where great accuracy is required.

Of the Manner of using the Compass.

197. The compass is often used in connection with the theodolite, and although a rude instrument, may yet be relied on for the shorter lines and smaller parts of a survey. The following is the manner of keeping the field notes.

Divide a paper into two equal parts, by two parallel lines near to each other, and consider each part as a separate leaf or page. Each leaf is divided into three spaces, and the middle one is generally smaller than either of the others, which are equal.

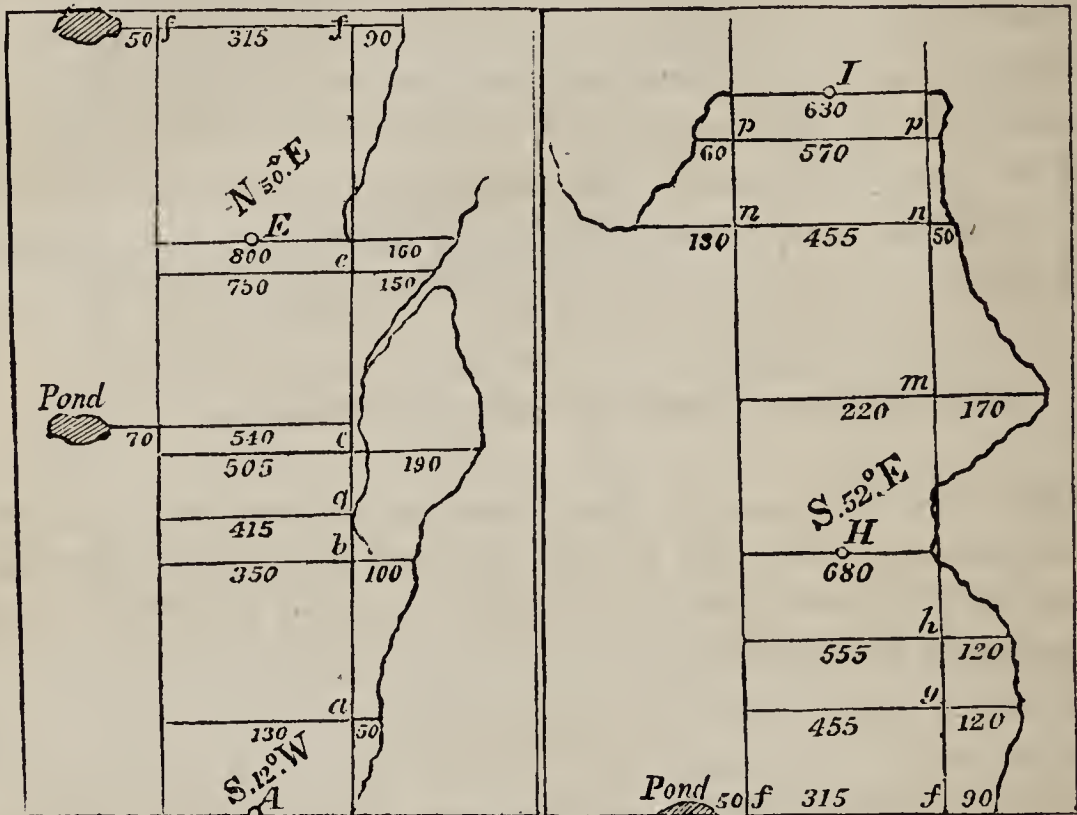
The notes begin at the bottom of the first page, and run up the page to the top. They then commence again at the bottom of the next page, and run up to the top; thence to the bottom of the third page, and thus, for as many pages as the work may require.

When the compass is used in the way we are about to explain, the distances to objects which lie on the right or left of the courses, are determined by means of offsets.

The beginning of every course is designated in the middle column by 0, and the bearing is entered directly above. The other figures of the middle column, express the distances from the beginning of each course to the offsets, and those in the side columns indicate the lengths of the offsets, or the distances to objects on the right or left of the compass lines.

The stations, at which the compass is placed, are designated by 0 in the middle column, and the bearing of each course is entered directly above.

To explain more definitely the manner of using the compass on the field, let us suppose that we have determined, with the theodolite, the prominent parts of the harbour. Place the compass at *A* (Plate 6), and take the bearing of the line *AE*, which S 12° W.



Enter this bearing at *A*. Then measure along the line *AE* any distance, as *Aa* equal to 130 yards, and make an offset to the lake, which we measure and find to be 50 yards. Enter the 130 in the middle column, and as the lake lies on the right (in going from *A* to *E*), we insert the 50 in the right hand column.

We then measure along the line *AE* to *b*, 350 yards from *A*. Here we make a second offset to the lake, and find it to be equal to 100 yards. Having entered the distances in the notes, we measure to *q*, the point where the line *AE* crosses the creek, and we enter the distance from *A*, 415 yards.

At *d*, we lay off an offset on the left, to the pond, 70 yards: at *e*, an offset to the mouth of the creek, 150 yards: and at *E*, where the course terminates, an offset to the lake, of 160 yards. The entire distance from *A* to *E* is 800 yards.

At *E*, we take the bearing to *H*, which is N 50° E. Having measured along this line to *f*, 315 yards, we make an offset to the pond, on the left, of 50 yards, and to the shore, on the right, of 90 yards. Having entered these distances,

we recommence the notes at 315 below, which we suppose to be at the bottom of the second page. Having reached *H*, the extremity of the course, we enter the entire distance from *E*, 680 yards. We next take the bearing to *I*, S 62° E. We then measure the distances to *m*, *n*, *p*, and *I*, and enter them, together with the offsets, as in the notes.

198. It is also well to make, in the columns on the right and left, such sketches of the ground, fields, houses, creeks and rivers, as will afford the means of making an accurate delineation on paper.

199. In making the plan of the harbour, it might be found convenient to use the plain-table in connexion with the theodolite and compass. For example, we might place the plain-table at *G*, and having fixed stations at the principal points of the shore, between *G* and *F*, we would sight to each of them: then remove the table to *F*, and do the same for that station: we should thus determine the points between *F* and *G*, with reference to the line *GF*.

Of Plotting.

200. The lines of the triangles determined with the theodolite, can be plotted in the manner already explained. It would be better, however, to use the instrument which we are about to describe, and which is called

THE CIRCULAR PROTRACTOR.

201. This instrument consists of a brass circular limb (Pl. 2, Fig. 4), of about six inches in diameter, with a moveable index *AB*, having a vernier at one extremity *A*, and a milled screw at the other extremity *B*, with a concealed cog-wheel that works with the cogs of the limb, and thus moves the index *AB* about the centre of the protractor. At the centre of the protractor is a small circular glass plate, on which two lines are cut; the point of their intersection, is the exact centre of the instrument. The limb is generally divided to half degrees; the degrees are numbered from 0 to 360.

At the 0 point, and at the opposite extremity of the diameter passing through that point, are small lines on the inner edge of the limb; the two extremities of the diameter, perpendicular to this latter, are also designated in the same way.

Two angular pieces of brass, each having a small and sharp steel pin at its extremity, are fastened to the index, and revolve freely around the lines ab and cd . The small screws, a , b , c , and d , move them in the directions of the lines ab , cd , for the purpose of bringing the steel pins exactly into the line which passes through the 0 of the index and the centre of the protractor.

To adjust them to their places, place the centre of the protractor over a marked point, and the 0 of the index to the 0 of the limb. Then mark the place of the index by the pins: after which, turn the index 180° , and see if the pins will mark the same points as before. If they do, the index is adjusted; if they do not, correct the error with the screws a , b , c , and d .

To lay off an angle with the Protractor.

202. Let its centre be placed over the angular point, and the diameter passing through 0 and 180° , on the given line. Turn the screw that works the index, until the 0 of the vernier coincides with the division corresponding to the given angle; then let the angular brass pieces be turned down; the points dotted by the steel pins will show the direction of the required line.

If this line does not pass through the angular point, the pins are out of place, and must be adjusted.

First Method of Plotting.

203. Suppose it were required to make the plan of the harbour on a scale of 450 yards to an inch.

Divide the length of the base line AB , which we will suppose equal to 1140 yards, by 450, and the quotient 2.53 will express the length which is to represent the base line on the paper (Art. 33).

Draw an indefinite line AB , to represent the base, and having chosen any point, as A , for the first station, lay off 2.53 inches to B . The other extremity of the base line will thus be determined.

Then, place the circular protractor at A , and lay off the angle BAE , and then the angle EAG . Next, place the protractor at B , and lay off the angles ABE and EBC . The intersection of the lines AE and BE will determine

the station E . Let the protractor be then placed at this point, and all the angles of station E , laid down.

The point G , where EG intersects AG , and the point C , where EC intersects BC , will then be found.

By placing the protractor at C and G , we can determine the points D and F , when the place, on the paper, of all the stations will be known.

To unite the work done with the compass, spread the compass-notes before you, and draw through A a line to represent the meridian. This line makes an angle of 12° with the course AE .

Then, lay off from the scale the distances Aa, Ab, Aq, Ac, Ad, Ae , and at the several points erect perpendiculars to AE . Lay off on these perpendiculars the lengths of the offsets, and the curve traced through the points so determined, will be the margin of the lake.

At E , draw a parallel to the meridian through A , and lay down the course EH , which makes an angle of 50° with the meridian. Then, lay down the several distances to the offsets, and draw the offsets and lay off their lengths. Do the same for the course HI , and all the compass-work will be plotted.

Had there been work done with the plain-table, it could easily be united to that done with the theodolite.

Second Method of Plotting.

204. Place the centre of the protractor near the centre of the paper, and draw a line through the points 0 and 180° . This line will have the same position with the circular protractor that the base line AB had with the limb of the theodolite.

Lay off then from the 0 point an arc equal to the direction from A to E , also an arc equal to the direction AG , and through the centre point, and the points so determined, draw lines. Lay off in succession, in a similar manner, the directions taken at all the stations; and through the centre point, and the points so determined, draw lines, and designate each by the letters of the direction to which it corresponds.

Now, since all the lines drawn on the paper have the same position with the circular protractor, as the corresponding

lines on the ground have with the limb of the theodolite, it follows that each direction will be parallel to its corresponding line upon the ground.

Hence, any line may be drawn parallel to that passing through 0 and 180° , to represent the base line AB . Having drawn such a line, and marked a point for the station A , lay off the length of the base, and the extremity will be the station B .

Through A and B , so determined, draw parallels respectively to the lines corresponding to the directions AE and BE , and the point of intersection will determine station E . Through B and E draw parallels to the lines which correspond to the directions BC , CE , and their point of intersection will determine station C . Through C and E draw lines parallel to the lines corresponding to the directions CE and ED , and the point of intersection will determine D . In a similar manner we may determine the stations F and G .

Of surveying a harbour for the purpose of determining the depth of water, &c.

205. When a harbour is surveyed for the second object, viz., for the purpose of ascertaining the channels, their depth and width, the positions of shoals, and the depth of water thereon, other means must be used, and other examinations made in addition to those already referred to.

Let buoys be anchored on the principal shoals and along the edges of the channel, and using any of the lines already determined as a base, let the angles subtended by lines drawn from its extremities, to the buoys respectively, be measured with the theodolite. Then, there will be known in each triangle the base and angles at the base, from which the distances to the buoys are easily found; and hence, their positions become known.

Having made the soundings, and ascertained the exact depth of the water at each of the buoys, several points of the harbour are established, at which the precise depth of the water is known; and by increasing the number of the buoys, the depth of the water can be found at as many points as may be deemed necessary.

206. If a person with a theodolite, or with any other instrument adapted to the measurement of horizontal angles, be

stationed at each extremity of the base line, it will not be necessary to establish buoys. A boat, provided with an anchor, a sounding line, and a signal flag, has only to throw its anchor, hoist its signal flag, and make the sounding, while the persons at the extremities of the base line measure the angles ;—from these data, the precise place of the boat can be determined.

207. There is also another method of determining the places at which the soundings are made, that admits of great despatch, and which, if the observations be made with care, affords results sufficiently accurate.

Having established, trigonometrically, three points which can be seen from all parts of the harbour, and having provided a sextant, let the sounding be made at any place in the harbour, and at the same time the three angles subtended by lines drawn to the three fixed points, measured with the sextant.

The problem, to find from these data the place of the boat at the time of the sounding, is the same as example 6, page 74.

It is only necessary to measure two of the angles, but it is safest to measure the third also, as it affords a verification of the work.

The great rapidity with which angles can be measured with the sextant, by one skilled in its use, renders this a most expeditious method of sounding and surveying a harbour.

The sextant is not described, nor are its uses explained in these Elements, because its construction combines many philosophical principles, with which the surveyor cannot be supposed conversant.

208. There is yet another method of finding the soundings, which, although not as accurate as those already explained, will, nevertheless, afford results approximating nearly to the truth. It is this :—Let a boat be rowed uniformly across the harbour, from one extremity to the other of any of the lines determined trigonometrically. Let soundings be made continually, and let the precise time of making each be carefully noted. Then, knowing the length of the entire line, the time spent in passing over it, as also the time of making each of the soundings, we can easily find the points of the line at which the several soundings were made ; and hence, the depth of water at those points becomes known. Sound-

ings may thus be made along any number of known lines, and a comparison of the depths found on different lines, at or near their points of intersection, will show with what degree of accuracy the work has been done.

209. If the soundings are made in tide-waters, the time of high tide must be carefully noted, as also the precise time of making the sounding, so that the exact depth at high or low water may be known. It is considered preferable to reduce the soundings to high-water mark, and the number of feet which the tide rises and falls should be noted on the map.

210. Having plotted the work done with the theodolite, as also the outline of the harbour traced with the compass, it remains to delineate the bottom of the harbour; and this is done by means of horizontal curves (Chap. VI), which have already been used to represent broken or undulating ground.

Let the plane of reference be taken through high-water mark, or to coincide with the surface of the water at high tide. The accuracy with which the bottom of the harbour is to be delineated, will guide us in fixing the distance between the horizontal planes of section.

The first horizontal plane should be passed at a distance below the shallowest point that has been sounded, equal to the number of feet fixed upon for the distance between the planes of section; and the curve, in which it intersects the bottom of the harbour determined as in Chapter VI. And similarly, for the other horizontal planes of section.

Having thus delineated the bottom of the harbour, and noted on the map the distance of each intersecting plane below the plane of reference, let such lines be drawn as will indicate the channels, shoals, sunken rocks, and direction of the current.

In the example given in plate 6, soundings have been made in three directions from the sand-bar in the harbour, and also from the rocky shore across to the light-house.

A TABLE

OF

LOGARITHMS OF NUMBERS

FROM 1 TO 10,000.

N.	Log.	N.	Log.	N.	Log.	N.	Log.
1	0.000000	26	1.414973	51	1.707570	76	1.880814
2	0.301030	27	1.431364	52	1.716003	77	1.886491
3	0.477121	28	1.447158	53	1.724276	78	1.892095
4	0.602060	29	1.462398	54	1.732394	79	1.897627
5	0.698970	30	1.477121	55	1.740363	80	1.903090
6	0.778151	31	1.491362	56	1.748188	81	1.908485
7	0.845098	32	1.505150	57	1.755875	82	1.913814
8	0.903090	33	1.518514	58	1.763428	83	1.919078
9	0.954243	34	1.531479	59	1.770852	84	1.924279
10	1.000000	35	1.544068	60	1.778151	85	1.929419
11	1.041393	36	1.556303	61	1.785330	86	1.934498
12	1.079181	37	1.568202	62	1.792392	87	1.939519
13	1.113943	38	1.579784	63	1.799341	88	1.944483
14	1.146128	39	1.591065	64	1.806180	89	1.949390
15	1.176091	40	1.602060	65	1.812913	90	1.954243
16	1.204120	41	1.612784	66	1.819544	91	1.959041
17	1.230449	42	1.623249	67	1.826075	92	1.963788
18	1.255273	43	1.633468	68	1.832509	93	1.968483
19	1.278754	44	1.643453	69	1.838849	94	1.973128
20	1.301030	45	1.653213	70	1.845098	95	1.977724
21	1.322219	46	1.662758	71	1.851258	96	1.982271
22	1.342423	47	1.672098	72	1.857333	97	1.986772
23	1.361728	48	1.681241	73	1.863323	98	1.991226
24	1.380211	49	1.690196	74	1.869232	99	1.995635
25	1.397940	50	1.698970	75	1.875061	100	2.000000

N.B. In the following table, in the last nine columns of each page, where the first or leading figures change from 9's to 0's, points or dots are introduced instead of the 0's through the rest of the line, to catch the eye, and to indicate that from thence the annexed first two figures of the Logarithm in the second column stand in the next lower line.

N.	0	1	2	3	4	5	6	7	8	9	D.
100	000000	0434	0868	1301	1734	2166	2598	3029	3461	3891	432
101	4321	4751	5181	5609	6038	6466	6894	7321	7748	8174	428
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112	9218	9606	9993	.380	.766	1153	1538	1924	2309	2694	386
113	053078	3463	3846	4230	4613	4996	5378	5760	6142	6524	382
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115	060698	1075	1452	1829	2206	2582	2958	3333	3709	4083	376
116	4458	4832	5206	5580	5953	6326	6699	7071	7443	7815	372
117	8186	8557	8928	9298	9668	.38	.407	.776	1145	1514	369
118	071882	2250	2617	2985	3352	3718	4085	4451	4816	5182	366
119	5547	5912	6276	6640	7004	7368	7731	8094	8457	8819	363
120	079181	9543	9904	.266	.626	.987	1347	1707	2067	2426	360
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122	6360	6716	7071	7426	7781	8136	8490	8845	9198	9552	355
123	9905	.258	.611	.963	1315	1667	2018	2370	2721	3071	351
124	093422	3772	4122	4471	4820	5169	5518	5866	6215	6562	349
125	6910	7257	7604	7951	8298	8644	8990	9335	9681	.26	346
126	100371	0715	1059	1403	1747	2091	2434	2777	3119	3462	343
127	3804	4146	4487	4828	5169	5510	5851	6191	6531	6871	340
128	7210	7549	7888	8227	8565	8903	9241	9579	9916	.253	338
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130	113943	4277	4611	4944	5278	5611	5943	6276	6608	6940	333
131	7271	7603	7934	8265	8595	8926	9256	9586	9915	.245	330
132	120574	0903	1231	1560	1888	2216	2544	2871	3198	3525	328
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135	130334	0655	0977	1298	1619	1939	2260	2580	2900	3219	321
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140	146128	6438	6748	7058	7367	7676	7985	8294	8603	8911	309
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147	7317	7613	7908	8203	8497	8792	9086	9380	9674	9968	295
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149	3186	3478	3769	4060	4351	4641	4932	5222	5512	5802	291
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152	181844	2129	2415	2700	2985	3270	3555	3839	4123	4407	285
153	4691	4975	5259	5542	5825	6108	6391	6674	6956	7239	283
154	7521	7803	8084	8366	8647	8928	9209	9490	9771	.51	281
155	190332	0612	0892	1171	1451	1730	2010	2289	2567	2846	279
156	3125	3403	3681	3959	4237	4514	4792	5069	5346	5623	278
157	5899	6176	6453	6729	7005	7281	7556	7832	8107	8382	276
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166	220103	0370	0631	0892	1153	1414	1675	1936	2196	2456	261
167	2716	2976	3236	3496	3755	4015	4274	4533	4792	5051	259
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175	3038	3286	3534	3782	4030	4277	4525	4772	5019	5266	248
176	5513	5759	6006	6252	6499	6745	6991	7237	7482	7728	246
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182	260071	0310	0548	0787	1025	1263	1501	1739	1976	2214	238
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185	7172	7406	7641	7875	8110	8344	8578	8812	9046	9279	234
186	9513	9746	9980	.213	.446	.679	.912	1144	1377	1609	233
187	271842	2074	2306	2538	2770	3001	3233	3464	3696	3927	232
188	4158	4389	4620	4850	5081	5311	5542	5772	6002	6232	230
189	6462	6692	6921	7151	7380	7609	7838	8067	8296	8525	229
190	278754	8982	9211	9439	9667	9895	.123	.351	.578	.806	228
191	281033	1261	1488	1715	1942	2169	2396	2622	2849	3075	227
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193	5557	5782	6007	6232	6456	6681	6905	7130	7354	7578	225
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195	290035	0257	0480	0702	0925	1147	1369	1591	1813	2034	222
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208	8063	8272	8481	8689	8898	9106	9314	9522	9730	9938	208
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218	8456	8656	8855	9054	9253	9451	9650	9849	.47	.246	199
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227	6026	6217	6408	6599	6790	6981	7172	7363	7554	7744	191
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231	3612	3800	3988	4176	4363	4551	4739	4926	5113	5301	188
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234	9216	9401	9587	9772	9958	.143	.328	.513	.698	.883	185
235	371068	1253	1437	1622	1806	1991	2175	2360	2544	2728	184
236	2912	3096	3280	3464	3647	3831	4015	4198	4382	4565	184
237	4748	4932	5115	5298	5481	5664	5846	6029	6212	6394	183
238	6577	6759	6942	7124	7306	7488	7670	7852	8034	8216	182
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249	6199	6374	6548	6722	6896	7071	7245	7419	7592	7766	174
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251	9674	9847	..20	.192	.365	.538	.711	.883	1056	1228	173
252	401401	1573	1745	1917	2089	2261	2433	2605	2777	2949	172
253	3121	3292	3464	3635	3807	3978	4149	4320	4492	4663	171
254	4834	5005	5176	5346	55.7	5688	5858	6029	6199	6370	171
255	6540	6710	6881	7051	7221	7391	7561	7731	7901	8070	170
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259	3300	3467	3635	3803	3970	4137	4305	4472	4639	4806	167
260	414973	5140	5307	5474	5641	5808	5974	6141	6308	6474	167
261	6641	6807	6973	7139	7306	7472	7638	7804	7970	8135	166
262	8301	8467	8633	8798	8964	9129	9295	9460	9625	9791	165
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267	6511	6674	6836	6999	7161	7324	7486	7648	7811	7973	162
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284	3318	3471	3624	3777	3930	4082	4235	4387	4540	4692	153
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292	5383	5532	5680	5829	5977	6126	6274	6423	6571	6719	149
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296	471292	1438	1585	1732	1878	2025	2171	2318	2464	2610	146
297	2756	2903	3049	3195	3341	3487	3633	3779	3925	4071	146
298	4216	4362	4508	4653	4799	4944	5090	5235	5381	5526	146
299	5671	5816	5962	6107	6252	6397	6542	6687	6832	6976	145
300	477121	7266	7411	7555	7700	7844	7989	8133	8278	8422	145
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303	1443	1586	1729	1872	2016	2159	2302	2445	2588	2731	143
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305	4300	4442	4585	4727	4869	5011	5153	5295	5437	5579	142
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307	7138	7280	7421	7563	7704	7845	7986	8127	8269	8410	141
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311	2760	2900	3040	3179	3319	3458	3597	3737	3876	4015	139
312	4155	4294	4433	4572	4711	4850	4989	5128	5267	5406	139
313	5544	5683	5822	5960	6099	6238	6376	6515	6653	6791	139
314	6930	7068	7206	7344	7483	7621	7759	7897	8035	8173	138
315	8311	8448	8586	8724	8862	8999	9137	9275	9412	9550	138
316	9687	9824	9962	..99	.236	.374	.511	.648	.785	.922	137
317	501059	1196	1333	1470	1607	1744	1880	2017	2154	2291	137
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321	6505	6640	6776	6911	7046	7181	7316	7451	7586	7721	135
322	7856	7991	8126	8260	8395	8530	8664	8799	8934	9068	135
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326	3218	3351	3484	3617	3750	3883	4016	4149	4282	4414	133
327	4548	4681	4813	4946	5079	5211	5344	5476	5609	5741	133
328	5874	6006	6139	6271	6403	6535	6668	6800	6932	7064	132
329	7196	7328	7460	7592	7724	7855	7987	8119	8251	8382	132
330	518514	8646	8777	8909	9040	9171	9303	9434	9566	9697	131
331	9828	9959	..90	.221	.353	.484	.615	.745	.876	1007	131
332	521138	1269	1400	1530	1661	1792	1922	2053	2183	2314	131
333	2444	2575	2705	2835	2966	3096	3226	3356	3486	3616	130
334	3746	3876	4006	4136	4266	4396	4526	4656	4785	4915	130
335	5045	5174	5304	5434	5563	5693	5822	5951	6081	6210	129
336	6339	6469	6598	6727	6856	6985	7114	7243	7372	7501	129
337	7630	7759	7888	8016	8145	8274	8402	8531	8660	8788	129
338	8917	9045	9174	9302	9430	9559	9687	9815	9943	..72	128
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358	3883	4004	4126	4247	4368	4489	4610	4731	4852	4973	121
359	5094	5215	5336	5457	5578	5699	5820	5940	6061	6182	121
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361	7507	7627	7748	7868	7988	8108	8228	8349	8469	8589	120
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363	9907	.26	.146	.265	.385	.504	.624	.743	.863	.982	119
364	561101	1221	1340	1459	1578	1698	1817	1936	2055	2174	119
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366	3481	3600	3718	3837	3955	4074	4192	4311	4429	4548	119
367	4666	4784	4903	5021	5139	5257	5376	5494	5612	5730	118
368	5848	5966	6084	6202	6320	6437	6555	6673	6791	6909	118
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370	568202	8319	8436	8554	8671	8788	8905	9023	9140	9257	117
371	9374	9491	9608	9725	9842	9959	.76	.193	.309	.426	117
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373	1709	1825	1942	2058	2174	2291	2407	2523	2639	2755	116
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383	3199	3312	3426	3539	3652	3765	3879	3992	4105	4218	113
384	4331	4444	4557	4670	4783	4896	5009	5122	5235	5348	113
385	5461	5574	5686	5799	5912	6024	6137	6250	6362	6475	113
386	6587	6700	6812	6925	7037	7149	7262	7374	7486	7599	112
387	7711	7823	7935	8047	8160	8272	8384	8496	8608	8720	112
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389	9950	.61	.173	.284	.396	.507	.619	.730	.842	.953	112
390	591065	1176	1287	1399	1510	1621	1732	1843	1955	2066	111
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392	3286	3397	3508	3618	3729	3840	3950	4061	4171	4282	111
393	4393	4503	4614	4724	4834	4945	5055	5165	5276	5386	110
394	5496	5606	5717	5827	5937	6047	6157	6267	6377	6487	110
395	6597	6707	6817	6927	7037	7146	7256	7366	7476	7586	110
396	7695	7805	7914	8024	8134	8243	8353	8462	8572	8681	110
397	8791	8900	9009	9119	9228	9337	9446	9556	9665	9774	109
398	9883	9992	.101	.210	.319	.428	.537	.646	.755	.864	109
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405	7455	7562	7669	7777	7884	7991	8098	8205	8312	8419	107
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410	612784	2890	2996	3102	3207	3313	3419	3525	3630	3736	106
411	3842	3947	4053	4159	4264	4370	4475	4581	4686	4792	106
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414	7000	7105	7210	7315	7420	7525	7629	7734	7839	7943	105
415	8048	8153	8257	8362	8466	8571	8676	8780	8884	8989	105
416	9093	9198	9302	9406	9511	9615	9719	9824	9928	. .32	104
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419	2214	2318	2421	2525	2628	2732	2835	2939	3042	3146	104
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427	630428	0530	0631	0733	0835	0936	1038	1139	1241	1342	102
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431	4477	4578	4679	4779	4880	4981	5081	5182	5283	5383	100
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442	5422	5521	5619	5717	5815	5913	6011	6110	6208	6306	98
443	6404	6502	6600	6698	6796	6894	6992	7089	7187	7285	98
444	7383	7481	7579	7676	7774	7872	7969	8067	8165	8262	98
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446	9335	9432	9530	9627	9724	9821	9919	. .16	.113	.210	97
447	650308	0405	0502	0599	0696	0793	0890	0987	1084	1181	97
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449	2246	2343	2440	2536	2633	2730	2826	2923	3019	3116	97
450	653213	3309	3405	3502	3598	3695	3791	3888	3984	4080	96
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466	8386	8479	8572	8665	8759	8852	8945	9038	9131	9224	93
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470	672098	2190	2283	2375	2467	2560	2652	2744	2836	2929	92
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473	4861	4953	5045	5137	5228	5320	5412	5503	5595	5687	92
474	5778	5870	5962	6053	6145	6236	6328	6419	6511	6602	92
475	6694	6785	6876	6968	7059	7151	7242	7333	7424	7516	91
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477	8518	8609	8700	8791	8882	8973	9064	9155	9246	9337	91
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480	681241	1332	1422	1513	1603	1693	1784	1874	1964	2055	90
481	2145	2235	2326	2416	2506	2596	2686	2777	2867	2957	90
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485	5742	5831	5921	6010	6100	6189	6279	6368	6458	6547	89
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487	7529	7618	7707	7796	7886	7975	8064	8153	8242	8331	89
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489	9309	9398	9486	9575	9664	9753	9841	9930	.19	.167	89
490	690196	0285	0373	0462	0550	0639	0728	0816	0905	0993	89
491	1081	1170	1258	1347	1435	1524	1612	1700	1789	1877	88
492	1965	2053	2142	2230	2318	2406	2494	2583	2671	2759	88
493	2847	2935	3023	3111	3199	3287	3375	3463	3551	3639	88
494	3727	3815	3903	3991	4078	4166	4254	4342	4430	4517	88
495	4605	4693	4781	4868	4956	5044	5131	5219	5307	5394	88
496	5482	5569	5657	5744	5832	5919	6007	6094	6182	6269	87
497	6356	6444	6531	6618	6706	6793	6880	6968	7055	7142	87
498	7229	7317	7404	7491	7578	7665	7752	7839	7926	8014	87
499	8101	8188	8275	8362	8449	8535	8622	8709	8796	8883	87
500	698970	9057	9144	9231	9317	9404	9491	9578	9664	9751	87
501	9838	9924	.11	.98	.184	.271	.358	.444	.531	.617	87
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504	2431	2517	2603	2689	2775	2861	2947	3033	3119	3205	86
505	3291	3377	3463	3549	3635	3721	3807	3895	3979	4065	86
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507	5008	5094	5179	5265	5350	5436	5522	5607	5693	5778	86
508	5864	5949	6035	6120	6206	6291	6376	6462	6547	6632	85
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523	8502	8585	8668	8751	8834	8917	9000	9083	9165	9248	83
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525	720159	0242	0325	0407	0490	0573	0655	0738	0821	0903	83
526	0986	1068	1151	1233	1316	1398	1481	1563	1646	1728	82
527	1811	1893	1975	2058	2140	2222	2305	2387	2469	2552	82
528	2634	2716	2798	2881	2963	3045	3127	3209	3291	3374	82
529	3456	3538	3620	3702	3784	3866	3948	4030	4112	4194	82
530	724276	4358	4440	4522	4604	4685	4767	4849	4931	5013	82
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532	5912	5993	6075	6156	6238	6320	6401	6483	6564	6646	82
533	6727	6809	6890	6972	7053	7134	7216	7297	7379	7460	81
534	7541	7623	7704	7785	7866	7948	8029	8110	8191	8273	81
535	8354	8435	8516	8597	8678	8759	8841	8922	9003	9084	81
536	9165	9246	9327	9408	9489	9570	9651	9732	9813	9893	81
537	9974	.55	.136	.217	.298	.378	.459	.540	.621	.702	81
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539	1589	1669	1750	1830	1911	1991	2072	2152	2233	2313	81
540	732394	2474	2555	2635	2715	2796	2876	2956	3037	3117	80
541	3197	3278	3358	3438	3518	3598	3679	3759	3839	3919	80
542	3999	4079	4160	4240	4320	4400	4480	4560	4640	4720	80
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544	5599	5679	5759	5838	5918	5998	6078	6157	6237	6317	80
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546	7193	7272	7352	7431	7511	7590	7670	7749	7829	7908	79
547	7987	8067	8146	8225	8305	8384	8463	8543	8622	8701	79
548	8781	8860	8939	9018	9097	9177	9256	9335	9414	9493	79
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550	740363	0442	0521	0600	0678	0757	0836	0915	0994	1073	79
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552	1939	2018	2096	2175	2254	2332	2411	2489	2568	2646	79
553	2725	2804	2882	2961	3039	3118	3196	3275	3353	3431	78
554	3510	3588	3667	3745	3823	3902	3980	4058	4136	4215	78
555	4293	4371	4449	4528	4606	4684	4762	4840	4919	4997	78
556	5075	5153	5231	5309	5387	5465	5543	5621	5699	5777	78
557	5855	5933	6011	6089	6167	6245	6323	6401	6479	6556	78
558	6634	6712	6790	6868	6945	7023	7101	7179	7256	7334	78
559	7412	7489	7567	7645	7722	7800	7878	7955	8033	8110	78
560	748188	8266	8343	8421	8498	8576	8653	8731	8808	8885	77
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562	9736	9814	9891	9968	.45	.123	.200	.277	.354	.431	77
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565	2048	2125	2202	2279	2356	2433	2509	2586	2663	2740	77
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570	755875	5951	6027	6103	6180	6256	6332	6408	6484	6560	76
571	6636	6712	6788	6864	6940	7016	7092	7168	7244	7320	76
572	7396	7472	7548	7624	7700	7775	7851	7927	8003	8079	76
573	8155	8230	8306	8382	8458	8533	8609	8685	8761	8836	76
574	8912	8988	9063	9139	9214	9290	9366	9441	9517	9592	76
575	9668	9743	9819	9894	9970	.45	.121	.196	.272	.347	75
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578	1928	2003	2078	2153	2228	2303	2378	2453	2529	2604	75
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627	7268	7337	7406	7475	7545	7614	7683	7752	7821	7890	69
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638	4821	4889	4957	5025	5093	5161	5229	5297	5365	5433	68
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653	4913	4980	5046	5113	5179	5246	5312	5378	5445	5511	66
654	5578	5644	5711	5777	5843	5910	5976	6042	6109	6175	66
655	6241	6308	6374	6440	6506	6573	6639	6705	6771	6838	66
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669	5426	5491	5556	5621	5686	5751	5815	5880	5945	6010	65
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671	6723	6787	6852	6917	6981	7046	7111	7175	7240	7305	65
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704	7573	7634	7696	7758	7819	7881	7943	8004	8066	8128	62
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706	8805	8866	8928	8989	9051	9112	9174	9235	9297	9358	61
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716	4913	4974	5034	5095	5156	5216	5277	5337	5398	5459	61
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733	5104	5163	5222	5282	5341	5400	5459	5519	5578	5637	59
734	5696	5755	5814	5874	5933	5992	6051	6110	6169	6228	59
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744	1573	1631	1690	1748	1806	1865	1923	1981	2040	2098	58
745	2156	2215	2273	2331	2389	2448	2506	2564	2622	2681	58
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755	7947	8004	8062	8119	8177	8234	8292	8349	8407	8464	57
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767	4795	4852	4909	4965	5022	5078	5135	5192	5248	5305	57
768	5361	5418	5474	5531	5587	5644	5700	5757	5813	5870	57
769	5926	5983	6039	6096	6152	6209	6265	6321	6378	6434	56
770	886491	6547	6604	6660	6716	6773	6829	6885	6942	6998	56
771	7054	7111	7167	7223	7280	7336	7392	7449	7505	7561	56
772	7617	7674	7730	7786	7842	7898	7955	8011	8067	8123	56
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774	8741	8797	8853	8909	8965	9021	9077	9134	9190	9246	56
775	9302	9358	9414	9470	9526	9582	9638	9694	9750	9806	56
776	9862	9918	9974	.30	.86	.141	.197	.253	.309	.365	56
777	890421	0477	0533	0589	0645	0700	0756	0812	0868	0924	56
778	0980	1035	1091	1147	1203	1259	1314	1370	1426	1482	56
779	1537	1593	1649	1705	1760	1816	1872	1928	1983	2039	56
780	892095	2150	2206	2262	2317	2373	2429	2484	2540	2595	56
781	2651	2707	2762	2818	2873	2929	2985	3040	3096	3151	56
782	3207	3262	3318	3373	3429	3484	3540	3595	3651	3706	56
783	3762	3817	3873	3928	3984	4039	4094	4150	4205	4261	55
784	4316	4371	4427	4482	4538	4593	4648	4704	4759	4814	55
785	4870	4925	4980	5036	5091	5146	5201	5257	5312	5367	55
786	5423	5478	5533	5588	5644	5699	5754	5809	5864	5920	55
787	5975	6030	6085	6140	6195	6251	6306	6361	6416	6471	55
788	6526	6581	6636	6692	6747	6802	6857	6912	6967	7022	55
789	7077	7132	7187	7242	7297	7352	7407	7462	7517	7572	55
790	897627	7682	7737	7792	7847	7902	7957	8012	8067	8122	55
791	8176	8231	8286	8341	8396	8451	8506	8561	8615	8670	55
792	8725	8780	8835	8890	8944	8999	9054	9109	9164	9218	55
793	9273	9328	9383	9437	9492	9547	9602	9656	9711	9766	55
794	9821	9875	9930	9985	.39	.94	.149	.203	.258	.312	55
795	900367	0422	0476	0531	0586	0640	0695	0749	0804	0859	55
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797	1458	1513	1567	1622	1676	1731	1785	1840	1894	1948	54
798	2003	2057	2112	2166	2221	2275	2329	2384	2438	2492	54
799	2547	2601	2655	2710	2764	2818	2873	2927	2981	3036	54
800	903090	3144	3199	3253	3307	3361	3416	3470	3524	3578	54
801	3633	3687	3741	3795	3849	3904	3958	4012	4066	4120	54
802	4174	4229	4283	4337	4391	4445	4499	4553	4607	4661	54
803	4716	4770	4824	4878	4932	4986	5040	5094	5148	5202	54
804	5256	5310	5364	5418	5472	5526	5580	5634	5688	5742	54
805	5796	5850	5904	5958	6012	6066	6119	6173	6227	6281	54
806	6335	6389	6443	6497	6551	6604	6658	6712	6766	6820	54
807	6874	6927	6981	7035	7089	7143	7196	7250	7304	7358	54
808	7411	7465	7519	7573	7626	7680	7734	7787	7841	7895	54
809	7949	8002	8056	8110	8163	8217	8270	8324	8378	8431	54
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811	9021	9074	9128	9181	9235	9289	9342	9396	9449	9503	54
812	9556	9610	9663	9716	9770	9823	9877	9930	9984	.37	53
813	910091	0144	0197	0251	0304	0358	0411	0464	0518	0571	53
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815	1158	1211	1264	1317	1371	1424	1477	1530	1584	1637	53
816	1690	1743	1797	1850	1903	1956	2009	2063	2116	2169	53
817	2222	2275	2328	2381	2435	2488	2541	2594	2647	2700	53
818	2753	2806	2859	2913	2966	3019	3072	3125	3178	3231	53
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822	4872	4925	4977	5030	5083	5136	5189	5241	5294	5347	53
823	5400	5453	5505	5558	5611	5664	5716	5769	5822	5875	53
824	5927	5980	6033	6085	6138	6191	6243	6296	6349	6401	53
825	6454	6507	6559	6612	6664	6717	6770	6822	6875	6927	53
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828	8030	8083	8135	8188	8240	8293	8345	8397	8450	8502	52
829	8555	8607	8659	8712	8764	8816	8869	8921	8973	9026	52
830	919078	9130	9183	9235	9287	9340	9392	9444	9496	9549	52
831	9601	9653	9706	9758	9810	9862	9914	9967	..19	..71	52
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833	0645	0697	0749	0801	0853	0906	0958	1010	1062	1114	52
834	1166	1218	1270	1322	1374	1426	1478	1530	1582	1634	52
835	1686	1738	1790	1842	1894	1946	1998	2050	2102	2154	52
836	2206	2258	2310	2362	2414	2466	2518	2570	2622	2674	52
837	2725	2777	2829	2881	2933	2985	3037	3089	3140	3192	52
838	3244	3296	3348	3399	3451	3503	3555	3607	3658	3710	52
839	3762	3814	3865	3917	3969	4021	4072	4124	4176	4228	52
840	924279	4331	4383	4434	4486	4538	4589	4641	4693	4744	52
841	4796	4848	4899	4951	5003	5054	5106	5157	5209	5261	52
842	5312	5364	5415	5467	5518	5570	5621	5673	5725	5776	52
843	5828	5879	5931	5982	6034	6085	6137	6188	6240	6291	51
844	6342	6394	6445	6497	6548	6600	6651	6702	6754	6805	51
845	6857	6908	6959	7011	7062	7114	7165	7216	7268	7319	51
846	7370	7422	7473	7524	7576	7627	7678	7730	7781	7832	51
847	7883	7935	7986	8037	8088	8140	8191	8242	8293	8345	51
848	8396	8447	8498	8549	8601	8652	8703	8754	8805	8857	51
849	8908	8959	9010	9061	9112	9163	9215	9266	9317	9368	51
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859	3993	4044	4094	4145	4195	4246	4296	4347	4397	4448	51
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862	5507	5558	5608	5658	5709	5759	5809	5860	5910	5960	50
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883	5961	6010	6059	6108	6157	6207	6256	6305	6354	6403	49
884	6452	6501	6551	6600	6649	6698	6747	6796	6845	6894	49
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886	7434	7483	7532	7581	7630	7679	7728	7777	7826	7875	49
887	7924	7973	8022	8070	8119	8168	8217	8266	8315	8364	49
888	8413	8462	8511	8560	8609	8657	8706	8755	8804	8853	49
889	8902	8951	8999	9048	9097	9146	9195	9244	9292	9341	49
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894	1338	1386	1435	1483	1532	1580	1629	1677	1726	1775	49
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898	3276	3325	3373	3421	3470	3518	3566	3615	3663	3711	48
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916	1895	1943	1990	2038	2085	2132	2180	2227	2275	2322	47
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918	2843	2890	2937	2985	3032	3079	3126	3174	3221	3268	47
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925	6142	6189	6236	6283	6329	6376	6423	6470	6517	6564	47
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929	8016	8062	8109	8156	8203	8249	8296	8343	8390	8436	47
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988	4757	4801	4845	4889	4933	4977	5021	5065	5108	5152	44
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994	7386	7430	7474	7517	7561	7605	7648	7692	7736	7779	44
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998	9131	9174	9218	9261	9305	9348	9392	9435	9479	9522	44
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A TABLE
OF
LOGARITHMIC
SINES AND TANGENTS,
FOR EVERY
DEGREE AND MINUTE
OF THE QUADRANT.

N. B. The minutes in the left-hand column of each page, increasing downwards, belong to the degrees at the top; and those increasing upwards, in the right-hand column, belong to the degrees below.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	M.
0	0.000000		10.000000		0.000000		Infinite.	60
1	6.463726	501717	000000	00	6.463726	501717	13.536274	59
2	764756	293485	000000	00	764756	293483	235244	58
3	940847	208231	000000	00	940847	208231	059153	57
4	7.065786	161517	000000	00	7.065786	161517	12.934214	56
5	162696	131968	000000	00	162696	131969	837504	55
6	241877	111575	9.999999	01	241878	111578	758122	54
7	308824	96653	999999	01	308825	99653	691175	53
8	366816	85254	999999	01	366817	85254	633183	52
9	417968	76263	999999	01	417970	76263	582030	51
10	463725	68988	999998	01	463727	68988	536273	50
11	7.505118	62981	9.999998	01	7.505120	62981	12.494880	49
12	542906	57936	999997	01	542909	57933	457031	48
13	577668	53641	999997	01	577672	53642	422328	47
14	609853	49938	999996	01	609857	49939	390143	46
15	639816	46714	999996	01	639820	46715	360180	45
16	667845	43881	999995	01	667849	43882	332151	44
17	694173	41372	999995	01	694179	41373	305821	43
18	718997	39135	999994	01	719003	39136	280997	42
19	742477	37127	999993	01	742484	37128	257516	41
20	764754	35315	999993	01	764761	35136	235239	40
21	7.785943	33672	9.999992	01	7.785951	33673	12.214049	39
22	806146	32175	999991	01	806155	32176	193845	38
23	825451	30805	999990	01	825460	30806	174540	37
24	843934	29547	999989	02	843944	29549	156056	36
25	861662	28388	999988	02	861674	28390	138326	35
26	878695	27317	999988	02	878708	27318	121292	34
27	895085	26323	999987	02	895099	26325	104901	33
28	910879	25399	999986	02	910894	25401	089106	32
29	926119	24538	999985	02	926134	24540	073866	31
30	940842	23733	999983	02	940858	23735	059142	30
31	7.955082	22980	9.999982	02	7.955100	22981	12.044900	29
32	968870	22273	999981	02	968889	22275	031111	28
33	982233	21608	999980	02	982253	21610	017747	27
34	995198	20981	999979	02	995219	20983	004781	26
35	8.067787	20390	999977	02	8.067809	20392	11.992191	25
36	020021	19831	999976	02	020045	19833	979955	24
37	031919	19302	999975	02	031945	19305	968055	23
38	043501	18801	999973	02	043527	18803	956473	22
39	054781	18325	999972	02	054809	18327	945191	21
40	065776	17872	999971	02	065806	17874	934194	20
41	8.076500	17441	9.999969	02	8.076531	17444	11.923469	19
42	086965	17031	999968	02	086997	17034	913003	18
43	097183	16639	999966	02	097217	16642	902783	17
44	107167	16265	999964	03	107202	16268	892797	16
45	116926	15908	999963	03	116963	15910	883037	15
46	126471	15566	999961	03	126510	15568	873490	14
47	135810	15238	999959	03	135851	15241	864149	13
48	144953	14924	999958	03	144996	14927	855004	12
49	153907	14622	999956	03	153952	14627	846048	11
50	162681	14333	999954	03	162727	14336	837273	10
51	8.171280	14054	9.999952	03	8.171328	14057	11.828672	9
52	179713	13786	999950	03	179763	13790	820237	8
53	187985	13529	999948	03	188036	13532	811964	7
54	196102	13280	999946	03	196156	13284	803844	6
55	204070	13041	999944	03	204126	13044	795874	5
56	211895	12810	999942	04	211953	12814	788047	4
57	219581	12587	999940	04	219641	12590	780359	3
58	227134	12372	999938	04	227195	12376	772805	2
59	234557	12164	999936	04	234621	12168	765379	1
60	241855	11963	999934	04	241921	11967	758079	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	
0	8.241855	11963	9.999934	04	8.241921	11967	11.758079	60
1	249033	11768	999932	04	249102	11772	750898	59
2	256094	11580	999929	04	256165	11584	743835	58
3	263042	11398	999927	04	263115	11402	736885	57
4	269881	11221	999925	04	269956	11225	730044	56
5	276614	11050	999922	04	276691	11054	723309	55
6	283243	10883	999920	04	283323	10887	716677	54
7	289773	10721	999918	04	289856	10726	710144	53
8	296207	10565	999915	04	296292	10570	703708	52
9	302546	10413	999913	04	302634	10418	697366	51
10	308794	10266	999910	04	308884	10270	691116	50
11	8.314954	10122	9.999907	04	8.315046	10126	11.684954	49
12	321027	9982	999905	04	321122	9987	678878	48
13	327016	9847	999902	04	327114	9851	672886	47
14	332924	9714	999899	05	333025	9719	666975	46
15	338753	9586	999897	05	338856	9590	661144	45
16	344504	9460	999894	05	344610	9465	655390	44
17	350181	9338	999891	05	350289	9343	649711	43
18	355783	9219	999888	05	355895	9224	644105	42
19	361315	9103	999885	05	361430	9108	638570	41
20	366777	8990	999882	05	366895	8995	633105	40
21	8.372171	8880	9.999879	05	8.372292	8885	11.627708	39
22	377499	8772	999876	05	377622	8777	622378	38
23	382762	8667	999873	05	382889	8672	617111	37
24	387962	8564	999870	05	388092	8570	611908	36
25	393101	8464	999867	05	393234	8470	606766	35
26	398179	8366	999864	05	398315	8371	601685	34
27	403199	8271	999861	05	403338	8276	596662	33
28	408161	8177	999858	05	408304	8182	591696	32
29	413068	8086	999854	05	413213	8091	586787	31
30	417919	7996	999851	06	418068	8002	581932	30
31	8.422717	7909	9.999848	06	8.422869	7914	11.577131	29
32	427462	7823	999844	06	427618	7830	572382	28
33	432156	7740	999841	06	432315	7745	567685	27
34	436800	7657	999838	06	436962	7663	563038	26
35	441394	7577	999834	06	441560	7583	558440	25
36	445941	7499	999831	06	446110	7505	553890	24
37	450440	7422	999827	06	450613	7428	549387	23
38	454893	7346	999823	06	455070	7352	544930	22
39	459301	7273	999820	06	459481	7279	540519	21
40	463665	7200	999816	06	463849	7206	536151	20
41	8.467985	7129	9.999812	06	8.468172	7135	11.531828	19
42	472263	7060	999809	06	472454	7066	527546	18
43	476498	6991	999805	06	476693	6998	523307	17
44	480693	6924	999801	06	480892	6931	519108	16
45	484848	6859	999797	07	485050	6865	514950	15
46	488963	6794	999793	07	489170	6801	510830	14
47	493040	6731	999790	07	493250	6738	506750	13
48	497078	6669	999786	07	497293	6676	502707	12
49	501080	6608	999782	07	501298	6615	498702	11
50	505045	6548	999778	07	505267	6555	494733	10
51	8.508974	6489	9.999774	07	8.509200	6496	11.490800	9
52	512867	6431	999769	07	513098	6439	486902	8
53	516726	6375	999765	07	516961	6382	483039	7
54	520551	6319	999761	07	520790	6326	479210	6
55	524343	6264	999757	07	524586	6272	475414	5
56	528102	6211	999753	07	528349	6218	471651	4
57	531828	6158	999748	07	532080	6165	467920	3
58	535523	6106	999744	07	535779	6113	464221	2
59	539186	6055	999740	07	539447	6062	460553	1
60	542819	6004	999735	07	543084	6012	456916	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	M.
0	8.542819	6004	9.999735	07	8.543084	6012	11.456916	60
1	546422	5955	999731	07	546691	5962	453309	59
2	549995	5906	999726	07	550268	5914	449732	58
3	553539	5858	999722	08	553817	5866	446183	57
4	557054	5811	999717	08	557336	5819	442664	56
5	560540	5765	999713	08	560828	5773	439172	55
6	563999	5719	999708	08	564291	5727	435709	54
7	567431	5674	999704	08	567727	5682	432273	53
8	570836	5630	999699	08	571137	5638	428863	52
9	574214	5587	999694	08	574520	5595	425480	51
10	577566	5544	999689	08	577877	5552	422123	50
11	8.580892	5502	9.999685	08	8.581208	5510	11.418792	49
12	584193	5460	999680	08	584514	5468	415486	48
13	587469	5419	999675	08	587795	5427	412205	47
14	590721	5379	999670	08	591051	5387	408949	46
15	593948	5339	999665	08	594283	5347	405717	45
16	597152	5300	999660	08	597492	5308	402508	44
17	600332	5261	999655	08	600677	5270	399323	43
18	603489	5223	999650	08	603839	5232	396161	42
19	606623	5186	999645	09	606978	5194	393022	41
20	609734	5149	999640	09	610094	5158	389906	40
21	8.612823	5112	9.999635	09	8.613189	5121	11.386811	39
22	615891	5076	999629	09	616262	5085	383738	38
23	618937	5041	999624	09	619313	5050	380687	37
24	621962	5006	999619	09	622343	5015	377657	36
25	624965	4972	999614	09	625352	4981	374648	35
26	627948	4938	999608	09	628340	4947	371660	34
27	630911	4904	999603	09	631308	4913	368692	33
28	633854	4871	999597	09	634256	4880	365744	32
29	636776	4839	999592	09	637184	4848	362816	31
30	639680	4806	999586	09	640093	4816	359907	30
31	8.642563	4775	9.999581	09	8.642982	4784	11.357018	29
32	645428	4743	999575	09	645853	4753	354147	28
33	648274	4712	999570	09	648704	4722	351296	27
34	651102	4682	999564	09	651537	4691	348463	26
35	653911	4652	999558	10	654352	4661	345648	25
36	656702	4622	999553	10	657149	4631	342851	24
37	659475	4592	999547	10	659928	4602	340072	23
38	662230	4563	999541	10	662689	4573	337311	22
39	664968	4535	999535	10	665433	4544	334567	21
40	667689	4506	999529	10	668160	4526	331840	20
41	8.670393	4479	9.999524	10	8.670870	4488	11.329130	19
42	673080	4451	999518	10	673563	4461	326437	18
43	675751	4424	999512	10	676239	4434	323761	17
44	678405	4397	999506	10	678900	4417	321100	16
45	681043	4370	999500	10	681544	4380	318456	15
46	683665	4344	999493	10	684172	4354	315828	14
47	686272	4318	999487	10	686784	4328	313216	13
48	688863	4292	999481	10	689381	4303	310619	12
49	691438	4267	999475	10	691963	4277	308037	11
50	693998	4242	999469	10	694529	4252	305471	10
51	8.696543	4217	9.999463	11	8.697081	4228	11.302919	9
52	699073	4192	999456	11	699617	4203	300383	8
53	701589	4168	999450	11	702139	4179	297861	7
54	704090	4144	999443	11	704646	4155	295354	6
55	706577	4121	999437	11	707140	4132	292860	5
56	709049	4097	999431	11	709618	4108	290382	4
57	711507	4074	999424	11	712083	4085	287917	3
58	713952	4051	999418	11	714534	4062	285465	2
59	716383	4029	999411	11	716972	4040	283028	1
60	718800	4006	999404	11	719396	4017	280304	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	M.
0	8.718800	4006	9.999404	11	8.719396	4017	11.280604	60
1	721204	3984	999398	11	721806	3995	278194	59
2	723595	3962	999391	11	724204	3974	275796	58
3	725972	3941	999384	11	726588	3952	273412	57
4	728337	3919	999378	11	728959	3930	271041	56
5	730688	3898	999371	11	731317	3909	268683	55
6	733027	3877	999364	12	733663	3889	266337	54
7	735354	3857	999357	12	735996	3868	264004	53
8	737667	3836	999350	12	738317	3848	261683	52
9	739969	3816	999343	12	740626	3827	259374	51
10	742259	3796	999336	12	742922	3807	257078	50
11	8.744536	3776	9.999329	12	8.745207	3787	11.254793	49
12	746802	3756	999322	12	747479	3768	252521	48
13	749055	3737	999315	12	749740	3749	250260	47
14	751297	3717	999308	12	751989	3729	248011	46
15	753528	3698	999301	12	754227	3710	245773	45
16	755747	3679	999294	12	756453	3692	243547	44
17	757955	3661	999286	12	758668	3673	241332	43
18	760151	3642	999279	12	760872	3655	239128	42
19	762337	3624	999272	12	763065	3636	236935	41
20	764511	3606	999265	12	765246	3618	234754	40
21	8.766675	3588	9.999257	12	8.767417	3600	11.232583	39
22	768828	3570	999250	13	769578	3583	230422	38
23	770970	3553	999242	13	771727	3565	228273	37
24	773101	3535	999235	13	773866	3548	226134	36
25	775223	3518	999227	13	775995	3531	224005	35
26	777333	3501	999220	13	778114	3514	221886	34
27	779434	3484	999212	13	780222	3497	219778	33
28	781524	3467	999205	13	782320	3480	217680	32
29	783605	3451	999197	13	784408	3464	215592	31
30	785675	3431	999189	13	786486	3447	213514	30
31	8.787736	3418	9.999181	13	8.788554	3431	11.211446	29
32	789787	3402	999174	13	790613	3414	209387	28
33	791828	3386	999166	13	792662	3399	207338	27
34	793859	3370	999158	13	794701	3383	205299	26
35	795881	3354	999150	13	796731	3368	203269	25
36	797894	3339	999142	13	798752	3352	201248	24
37	799897	3323	999134	13	800763	3337	199237	23
38	801892	3308	999126	13	802765	3322	197235	22
39	803876	3293	999118	13	804758	3307	195242	21
40	805852	3278	999110	13	806742	3292	193258	20
41	8.807819	3263	9.999102	13	8.808717	3278	11.191283	19
42	809777	3249	999094	14	810683	3262	189317	18
43	811726	3234	999086	14	812641	3248	187359	17
44	813667	3219	999077	14	814589	3233	185411	16
45	815599	3205	999069	14	816529	3219	183471	15
46	817522	3191	999061	14	818461	3205	181539	14
47	819436	3177	999053	14	820384	3191	179616	13
48	821343	3163	999044	14	822298	3177	177702	12
49	823240	3149	999036	14	824205	3163	175795	11
50	825130	3135	999027	14	826103	3150	173897	10
51	8.827011	3122	9.999019	14	8.827992	3136	11.172008	9
52	828884	3108	999010	14	829874	3123	170126	8
53	830749	3095	999002	14	831748	3110	168252	7
54	832607	3082	998993	14	833613	3096	166387	6
55	834456	3069	998984	14	835471	3083	164529	5
56	836297	3056	998976	14	837321	3070	162679	4
57	838130	3043	998967	15	839163	3057	160837	3
58	839956	3030	998958	15	840998	3045	159002	2
59	841774	3017	998950	15	842825	3032	157175	1
60	843585	3000	998941	15	844644	3019	155356	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	M.
0	8.843585	3005	9.998941	15	8.844644	3019	11.155356	60
1	845387	2992	998932	15	846455	3007	153545	59
2	847183	2980	998923	15	848260	2995	151740	58
3	848971	2967	998914	15	850057	2982	149943	57
4	850751	2955	998905	15	851846	2970	148154	56
5	852525	2943	998896	15	853628	2958	146372	55
6	854291	2931	998887	15	855403	2946	144597	54
7	856049	2919	998878	15	857171	2935	142829	53
8	857801	2907	998869	15	858932	2923	141068	52
9	859546	2896	998860	15	860686	2911	139314	51
10	861283	2884	998851	15	862433	2900	137567	50
11	8.863014	2873	9.998841	15	8.864173	2888	11.135827	49
12	864738	2861	998832	15	865906	2877	134094	48
13	866455	2850	998823	16	867632	2866	132368	47
14	868165	2839	998813	16	869351	2854	130649	46
15	869868	2828	998804	16	871064	2843	128936	45
16	871565	2817	998795	16	872770	2832	127230	44
17	873255	2806	998785	16	874469	2821	125531	43
18	874938	2795	998776	16	876162	2811	123838	42
19	876615	2786	998766	16	877849	2800	122151	41
20	878285	2773	998757	16	879529	2789	120471	40
21	8.879949	2763	9.998747	16	8.881202	2779	11.118798	39
22	881607	2752	998738	16	882869	2768	117131	38
23	883258	2742	998728	16	884530	2758	115470	37
24	884903	2731	998718	16	886185	2747	113815	36
25	886542	2721	998708	16	887833	2737	112167	35
26	888174	2711	998699	16	889476	2727	110524	34
27	889801	2700	998689	16	891112	2717	108888	33
28	891421	2690	998679	16	892742	2707	107258	32
29	893035	2680	998669	17	894366	2697	105634	31
30	894643	2670	998659	17	895984	2687	104016	30
31	8.896246	2660	9.998649	17	8.897596	2677	11.102404	29
32	897842	2651	998639	17	899203	2667	100797	28
33	899432	2641	998629	17	900803	2658	099197	27
34	901017	2631	998619	17	902398	2648	097602	26
35	902596	2622	998609	17	903987	2638	096013	25
36	904169	2612	998599	17	905570	2629	094430	24
37	905736	2603	998589	17	907147	2620	092853	23
38	907297	2593	998578	17	908719	2610	091281	22
39	908853	2584	998568	17	910285	2601	089715	21
40	910404	2575	998558	17	911846	2592	088154	20
41	8.911949	2566	9.998548	17	8.913401	2583	11.086599	19
42	913488	2556	998537	17	914951	2574	085049	18
43	915022	2547	998527	17	916495	2565	083505	17
44	916550	2538	998516	18	918034	2556	081966	16
45	918073	2529	998506	18	919568	2547	080432	15
46	919591	2520	998495	18	921096	2538	078904	14
47	921103	2512	998485	18	922619	2530	077381	13
48	922610	2503	998474	18	924136	2521	075864	12
49	924112	2494	998464	18	925649	2512	074351	11
50	925609	2486	998453	18	927156	2503	072844	10
51	8.927100	2477	9.998442	18	8.928658	2495	11.071342	9
52	928587	2469	998431	18	930155	2486	069845	8
53	930068	2460	998421	18	931647	2478	068353	7
54	931544	2452	998410	18	933134	2470	066866	6
55	933015	2443	998399	18	934616	2461	065384	5
56	934481	2435	998388	18	936093	2453	063907	4
57	935942	2427	998377	18	937565	2445	062435	3
58	937398	2419	998366	18	939032	2437	060968	2
59	938850	2411	998355	18	940494	2430	059506	1
60	940296	2403	998344	18	941952	2421	058048	0
	Cosine		Sine		Cotang.		Tang.	M.

M	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	M.
0	8.940296	2403	9.998344	19	8.941952	2421	11.058048	60
1	941738	2394	998333	19	943404	2413	056596	59
2	943174	2387	998322	19	944852	2405	055148	58
3	944606	2379	998311	19	946295	2397	053705	57
4	946034	2371	998300	19	947734	2390	052266	56
5	947456	2363	998289	19	949168	2382	050832	55
6	948874	2355	998277	19	950597	2374	049403	54
7	950287	2348	998266	19	952021	2366	047979	53
8	951696	2340	998255	19	953441	2360	046559	52
9	953100	2332	998243	19	954856	2351	045144	51
10	954499	2325	998232	19	956267	2344	043733	50
11	8.955894	2317	9.998220	19	8.957674	2337	11.042326	49
12	957284	2310	998209	19	959075	2329	040925	48
13	958670	2302	998197	19	960473	2323	039527	47
14	960052	2295	998186	19	961866	2314	038134	46
15	961429	2288	998174	19	963255	2307	036745	45
16	962801	2280	998163	19	964639	2300	035361	44
17	964170	2273	998151	19	966019	2293	033981	43
18	965534	2266	998139	20	967394	2286	032606	42
19	966893	2259	998128	20	968766	2279	031234	41
20	968249	2252	998116	20	970133	2271	029867	40
21	8.969600	2244	9.998104	20	8.971496	2265	11.028504	39
22	970947	2238	998092	20	972855	2257	027145	38
23	972289	2231	998080	20	974209	2251	025791	37
24	973628	2224	998068	20	975560	2244	024440	36
25	974962	2217	998056	20	976906	2237	023094	35
26	976293	2210	998044	20	978248	2230	021752	34
27	977619	2203	998032	20	979586	2223	020414	33
28	978941	2197	998020	20	980921	2217	019079	32
29	980259	2190	998008	20	982251	2210	017749	31
30	981573	2183	997996	20	983577	2204	016423	30
31	8.982833	2177	9.997984	20	8.984899	2197	11.015101	29
32	984189	2170	997972	20	986217	2191	013783	28
33	985491	2163	997959	20	987532	2184	012468	27
34	986789	2157	997947	20	988842	2178	011158	26
35	988083	2150	997935	21	990149	2171	009851	25
36	989374	2144	997922	21	991451	2165	008549	24
37	990660	2138	997910	21	992750	2158	007250	23
38	991943	2131	997897	21	994045	2152	005955	22
39	993222	2125	997885	21	995337	2146	004663	21
40	994497	2119	997872	21	996624	2140	003376	20
41	8.995763	2112	9.997860	21	8.997908	2134	11.002092	19
42	997036	2106	997847	21	999188	2127	000812	18
43	998299	2100	997835	21	9.000465	2121	10.999535	17
44	999560	2094	997822	21	001738	2115	998262	16
45	9.000816	2087	997809	21	003007	2109	996993	15
46	002069	2082	997797	21	004272	2103	995728	14
47	003318	2076	997784	21	005534	2097	994466	13
48	004563	2070	997771	21	006792	2091	993208	12
49	005805	2064	997758	21	008047	2085	991953	11
50	007044	2058	997745	21	009298	2080	990702	10
51	9.008278	2052	9.997732	21	9.010546	2074	10.989454	9
52	009510	2046	997719	21	011790	2068	988210	8
53	010737	2040	997706	21	013031	2062	986969	7
54	011962	2034	997693	22	014268	2056	985732	6
55	013182	2029	997680	22	015502	2051	984498	5
56	014400	2023	997667	22	016732	2045	983268	4
57	015613	2017	997654	22	017959	2040	982041	3
58	016824	2012	997641	22	019183	2033	980817	2
59	018031	2006	997628	22	020403	2028	979597	1
60	019235	2000	997614	22	021620	2023	978380	0
	Cosine		Sine		Cotang.		Tang.	M.

M	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	M.
0	9.019235	2000	9.997614	22	9.021620	2023	10.978380	60
1	020435	1995	997601	22	022834	2017	977166	59
2	021632	1989	997588	22	024044	2011	975956	58
3	022825	1984	997574	22	025251	2006	974749	57
4	024016	1978	997561	22	026455	2000	973545	56
5	025203	1973	997547	22	027655	1995	972345	55
6	026386	1967	997534	23	028852	1990	971148	54
7	027567	1962	997520	23	030046	1985	969954	53
8	028744	1957	997507	23	031237	1979	968763	52
9	029918	1951	997493	23	032425	1974	967575	51
10	031089	1947	997480	23	033609	1969	966391	50
11	9.032257	1941	9.997466	23	9.034791	1964	10.965209	49
12	033421	1936	997452	23	035969	1958	964031	48
13	034582	1930	997439	23	037144	1953	962856	47
14	035741	1925	997425	23	038316	1948	961684	46
15	036896	1920	997411	23	039485	1943	960515	45
16	038048	1915	997397	23	040651	1938	959349	44
17	039197	1910	997383	23	041813	1933	958187	43
18	040342	1905	997369	23	042973	1928	957027	42
19	041485	1899	997355	23	044130	1923	955870	41
20	042625	1894	997341	23	045284	1918	954716	40
21	9.043762	1889	9.997327	24	9.046434	1913	10.953566	39
22	044895	1884	997313	24	047582	1908	952418	38
23	046026	1879	997299	24	048727	1903	951273	37
24	047154	1875	997285	24	049869	1898	950131	36
25	048279	1870	997271	24	051008	1893	948992	35
26	049400	1865	997257	24	052144	1889	947856	34
27	050519	1860	997242	24	053277	1884	946723	33
28	051635	1855	997228	24	054407	1879	945593	32
29	052749	1850	997214	24	055535	1874	944465	31
30	053859	1845	997199	24	056659	1870	943341	30
31	054966	1841	9.997185	24	9.057781	1865	10.942219	29
32	056071	1836	997170	24	058900	1869	941100	28
33	057172	1831	997156	24	060016	1855	939984	27
34	058271	1827	997141	24	061130	1851	938870	26
35	059367	1822	997127	24	062240	1846	937760	25
36	060460	1817	997112	24	063348	1842	936652	24
37	061551	1813	997098	24	064453	1837	935547	23
38	062639	1808	997083	25	065556	1833	934444	22
39	063724	1804	997068	25	066655	1828	933345	21
40	064806	1799	997053	25	067752	1824	932248	20
41	9.065885	1794	9.997039	25	9.068846	1819	10.931154	19
42	066962	1790	997024	25	069938	1815	930062	18
43	068036	1786	997009	25	071027	1810	928973	17
44	069107	1781	996994	25	072113	1806	927887	16
45	070176	1777	996979	25	073197	1802	926803	15
46	071242	1772	996964	25	074278	1797	925722	14
47	072306	1768	996949	25	075356	1793	924644	13
48	073366	1763	996934	25	076432	1789	923568	12
49	074424	1759	996919	25	077505	1784	922495	11
50	075480	1755	996904	25	078576	1780	921424	10
51	9.076533	1750	9.996889	25	9.079644	1776	10.920356	9
52	077583	1746	996874	25	080710	1772	919290	8
53	078631	1742	996858	25	081773	1767	918227	7
54	079676	1738	996843	25	082833	1763	917167	6
55	080719	1733	996828	25	083891	1759	916109	5
56	081759	1729	996812	26	084947	1755	915053	4
57	082797	1725	996797	26	086000	1751	914000	3
58	083832	1721	996782	26	087050	1747	912950	2
59	084864	1717	996766	26	088098	1743	911902	1
60	085894	1713	996751	26	089144	1738	910856	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	M.
0	9.085894	1713	9.996751	26	9.089144	1738	10.910856	60
1	086922	1709	996735	26	090187	1734	909813	59
2	087947	1704	996720	26	091228	1730	908772	58
3	088970	1700	996704	26	092266	1727	907734	57
4	089990	1696	996688	26	093302	1722	906698	56
5	091008	1692	996673	26	094336	1719	905664	55
6	092024	1688	996657	26	095367	1715	904633	54
7	093037	1684	996641	26	096395	1711	903605	53
8	094047	1680	996625	26	097422	1707	902578	52
9	095056	1676	996610	26	098446	1703	901554	51
10	096062	1673	996594	26	099468	1699	900532	50
11	9.097065	1668	9.996578	27	9.100487	1695	10.899513	49
12	098066	1665	996562	27	101504	1691	898496	48
13	099065	1661	996546	27	102519	1687	897481	47
14	100062	1657	996530	27	103532	1684	896468	46
15	101056	1653	996514	27	104542	1680	895458	45
16	102048	1649	996498	27	105550	1676	894450	44
17	103037	1645	996482	27	106556	1672	893444	43
18	104025	1641	996465	27	107559	1669	892441	42
19	105010	1638	996449	27	108560	1665	891440	41
20	105992	1634	996433	27	109559	1661	890441	40
21	9.106973	1630	9.996417	27	9.110556	1658	10.889444	39
22	107951	1627	996400	27	111551	1654	888449	38
23	108927	1623	996384	27	112543	1650	887457	37
24	109901	1619	996368	27	113533	1646	886467	36
25	110873	1616	996351	27	114521	1643	885479	35
26	111842	1612	996335	27	115507	1639	884493	34
27	112809	1608	996318	27	116491	1636	883509	33
28	113774	1605	996302	28	117472	1632	882528	32
29	114737	1601	996285	28	118452	1629	881548	31
30	115698	1597	996269	28	119429	1625	880571	30
31	9.116656	1594	9.996252	28	9.120404	1622	10.879596	29
32	117613	1590	996235	28	121377	1618	878623	28
33	118567	1587	996219	28	122348	1615	877652	27
34	119519	1583	996202	28	123317	1611	876683	26
35	120469	1580	996185	28	124284	1607	875716	25
36	121417	1576	996168	28	125249	1604	874751	24
37	122362	1573	996151	28	126211	1601	873789	23
38	123306	1569	996134	28	127172	1597	872828	22
39	124248	1566	996117	28	128130	1594	871870	21
40	125187	1562	996100	28	129087	1591	870913	20
41	9.126125	1559	9.996083	29	9.130041	1587	10.869959	19
42	127060	1556	996066	29	130994	1584	869006	18
43	127993	1552	996049	29	131944	1581	868056	17
44	128925	1549	996032	29	132893	1577	867107	16
45	129854	1545	996015	29	133839	1574	866161	15
46	130781	1542	995998	29	134784	1571	865216	14
47	131706	1539	995980	29	135726	1567	864274	13
48	132630	1535	995963	29	136667	1564	863333	12
49	133551	1532	995946	29	137605	1561	862395	11
50	134470	1529	995928	29	138542	1558	861458	10
51	9.135387	1525	9.995911	29	9.139476	1555	10.860524	9
52	136303	1522	995894	29	140409	1551	859591	8
53	137216	1519	995876	29	141340	1548	858660	7
54	138128	1516	995859	29	142269	1545	857731	6
55	139037	1512	995841	29	143196	1542	856804	5
56	139944	1509	995823	29	144121	1539	855879	4
57	140850	1506	995806	29	145044	1535	854956	3
58	141754	1503	995788	29	145966	1532	854034	2
59	142655	1500	995771	29	146885	1529	853115	1
60	143555	1496	995753	29	147803	1526	852197	0
	Cosine		Sine		Cotang.		Tang.	M.

82 Degrees.

B

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	
0	9.143555	1496	9.995753	30	9.147803	1526	10.852197	60
1	144453	1493	995735	30	148718	1523	851282	59
2	145349	1490	995717	30	149632	1520	850368	58
3	146243	1487	995699	30	150544	1517	849456	57
4	147136	1484	995681	30	151454	1514	848546	56
5	148026	1481	995664	30	152363	1511	847637	55
6	148915	1478	995646	30	153269	1508	846731	54
7	149802	1475	995628	30	154174	1505	845826	53
8	150686	1472	995610	30	155077	1502	844923	52
9	151569	1469	995591	30	155978	1499	844022	21
10	152451	1466	995573	30	156877	1496	843123	50
11	9.153330	1463	9.995555	30	9.157775	1493	10.842225	49
12	154208	1460	995537	30	158671	1490	841329	48
13	155083	1457	995519	30	159565	1487	840435	47
14	155957	1454	995501	31	160457	1484	839543	46
15	156830	1451	995482	31	161347	1481	838653	45
16	157700	1448	995464	31	162236	1479	837764	44
17	158569	1445	995446	31	163123	1476	836877	43
18	159435	1442	995427	31	164008	1473	835992	42
19	160301	1439	995409	31	164892	1470	835108	41
20	161164	1436	995390	31	165774	1467	834226	40
21	9.162025	1433	9.995372	31	9.166654	1464	10.833346	39
22	162885	1430	995353	31	167532	1461	832468	38
23	163743	1427	995334	31	168409	1458	831591	37
24	164600	1424	995316	31	169284	1455	830716	36
25	165454	1422	995297	31	170157	1453	829843	35
26	166307	1419	995278	31	171029	1450	828971	34
27	167159	1416	995260	31	171899	1447	828101	33
28	168008	1413	995241	32	172767	1444	827233	32
29	168856	1410	995222	32	173634	1442	826366	31
30	169702	1407	995203	32	174499	1439	825501	30
31	9.170547	1405	9.995184	32	9.175362	1436	10.824638	29
32	171389	1402	995165	32	176224	1433	823776	28
33	172230	1399	995146	32	177084	1431	822916	27
34	173070	1396	995127	32	177942	1428	822058	26
35	173908	1394	995108	32	178799	1425	821201	25
36	174744	1391	995089	32	179655	1423	820345	24
37	175578	1388	995070	32	180508	1420	819492	23
38	176411	1386	995051	32	181360	1417	818640	22
39	177242	1383	995032	32	182211	1415	817789	21
40	178072	1380	995013	32	183059	1412	816941	20
41	9.178900	1377	9.994993	32	9.183907	1409	10.816093	19
42	179726	1374	994974	32	184752	1407	815248	18
43	180551	1372	994955	32	185597	1404	814403	17
44	181374	1369	994935	32	186439	1402	813561	16
45	182196	1366	994916	33	187280	1399	812720	15
46	183016	1364	994896	33	188120	1396	811880	14
47	183834	1361	994877	33	188958	1393	811042	13
48	184651	1359	994857	33	189794	1391	810206	12
49	185466	1356	994838	33	190629	1389	809371	11
50	186280	1353	994818	33	191462	1386	808538	10
51	9.187092	1351	9.994798	33	9.192294	1384	10.807706	9
52	187903	1348	994779	33	193124	1381	806876	8
53	188712	1346	994759	33	193953	1379	806047	7
54	189519	1343	994739	33	194780	1376	805220	6
55	190325	1341	994719	33	195606	1374	804394	5
56	191130	1338	994700	33	196430	1371	803570	4
57	191933	1336	994680	33	197253	1369	802747	3
58	192734	1333	994660	33	198074	1366	801926	2
59	193534	1330	994640	33	198894	1364	801106	1
60	194332	1328	994620	33	199713	1361	800287	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	M.
0	9.194332	1328	9.994620	33	9.199713	1361	10.800287	60
1	195129	1326	994600	33	200529	1359	799471	59
2	195925	1323	994580	33	201345	1356	798655	58
3	196719	1321	994560	34	202159	1354	797841	57
4	197511	1318	994540	34	202971	1352	797029	56
5	198302	1316	994519	34	203782	1349	796218	55
6	199091	1313	994499	34	204592	1347	795408	54
7	199879	1311	994479	34	205400	1345	794600	53
8	200666	1308	994459	34	206207	1342	793793	52
9	201451	1306	994438	34	207013	1340	792987	51
10	202234	1304	994418	34	207817	1338	792183	50
11	9.203917	1301	9.994397	34	9.208619	1335	10.791381	49
12	203797	1299	994377	34	209420	1333	790580	48
13	204577	1296	994357	34	210220	1331	789780	47
14	205354	1294	994336	34	211018	1328	788982	46
15	206131	1292	994316	34	211815	1326	788185	45
16	206906	1289	994295	34	212611	1324	787389	44
17	207679	1287	994274	35	213405	1321	786595	43
18	208452	1285	994254	35	214198	1319	785802	42
19	209222	1282	994233	35	214989	1317	785011	41
20	209992	1280	994212	35	215780	1315	784220	40
21	9.210760	1278	9.994191	35	9.216568	1312	10.783432	39
22	211526	1275	994171	35	217356	1310	782644	38
23	212291	1273	994150	35	218142	1308	781858	37
24	213055	1271	994129	35	218926	1305	781074	36
25	213818	1268	994108	35	219710	1303	780290	35
26	214579	1266	994087	35	220492	1301	779508	34
27	215338	1264	994066	35	221272	1299	778728	33
28	216097	1261	994045	35	222052	1297	777948	32
29	216854	1259	994024	35	222830	1294	777170	31
30	217609	1257	994003	35	223606	1292	776394	30
31	9.218363	1255	9.993981	35	9.224382	1290	10.775618	29
32	219116	1253	993960	35	225156	1288	774844	28
33	219868	1250	993939	35	225929	1286	774071	27
34	220618	1248	993918	35	226700	1284	773300	26
35	221367	1246	993896	36	227471	1281	772529	25
36	222115	1244	993875	36	228239	1279	771761	24
37	222861	1242	993854	36	229007	1277	770993	23
38	223606	1239	993832	36	229773	1275	770227	22
39	224349	1237	993811	36	230539	1273	769461	21
40	225092	1235	993789	36	231302	1271	768698	20
41	9.225833	1233	9.993768	36	9.232065	1269	10.767935	19
42	226573	1231	993746	36	232826	1267	767174	18
43	227311	1228	993725	36	233586	1265	766414	17
44	228048	1226	993703	36	234345	1262	765655	16
45	228784	1224	993681	36	235103	1260	764897	15
46	229518	1222	993660	36	235859	1258	764141	14
47	230252	1220	993638	36	236614	1256	763386	13
48	230984	1218	993616	36	237368	1254	762632	12
49	231714	1216	993594	37	238120	1252	761880	11
50	232444	1214	993572	37	238872	1250	761128	10
51	9.233172	1212	9.993550	37	9.239622	1248	10.760378	9
52	233899	1209	993528	37	240371	1246	759629	8
53	234625	1207	993506	37	241118	1244	758882	7
54	235349	1205	993484	37	241865	1242	758135	6
55	236073	1203	993462	37	242610	1240	757390	5
56	236795	1201	993440	37	243354	1238	756646	4
57	237515	1199	993418	37	244097	1236	755903	3
58	238235	1197	993396	37	244839	1234	755161	2
59	238953	1195	993374	37	245579	1232	754421	1
60	239670	1193	993351	37	246319	1230	753681	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	M.
0	9.239670	1193	9.993351	37	9.246319	1230	10.753681	60
1	240386	1191	993329	37	247057	1228	752943	59
2	241101	1189	993307	37	247794	1226	752206	58
3	241814	1187	993285	37	248530	1224	751470	57
4	242526	1185	993262	37	249264	1222	750736	56
5	243237	1183	993240	37	249998	1220	750002	55
6	243947	1181	993217	38	250730	1218	749270	54
7	244656	1179	993195	38	251461	1217	748539	53
8	245363	1177	993172	38	252191	1215	747809	52
9	246069	1175	993149	38	252920	1213	747080	51
10	246775	1173	993127	38	253648	1211	746352	50
11	9.247478	1171	9.993104	38	9.254374	1209	10.745626	49
12	248181	1169	993081	38	255100	1207	744900	48
13	248883	1167	993059	38	255824	1205	744176	47
14	249583	1165	993036	38	256547	1203	743453	46
15	250282	1163	993013	38	257269	1201	742731	45
16	250980	1161	992990	38	257990	1200	742010	44
17	251677	1159	992967	38	258710	1198	741290	43
18	252373	1158	992944	38	259429	1196	740571	42
19	253067	1156	992921	38	260146	1194	739854	41
20	253761	1154	992898	38	260863	1192	739137	40
21	9.254453	1152	9.992875	38	9.261578	1190	10.738422	39
22	255144	1150	992852	38	262292	1189	737708	38
23	255834	1148	992829	39	263005	1187	736995	37
24	256523	1146	992806	39	263717	1185	736283	36
25	257211	1144	992783	39	264428	1183	735572	35
26	257898	1142	992759	39	265138	1181	734862	34
27	258583	1141	992736	39	265847	1179	734153	33
28	259268	1139	992713	39	266555	1178	733445	32
29	259951	1137	992690	39	267261	1176	732739	31
30	260633	1135	992666	39	267967	1174	732033	30
31	9.261314	1133	9.992643	39	9.268671	1172	10.731329	29
32	261994	1131	992619	39	269375	1170	730625	28
33	262673	1130	992596	39	270077	1169	729923	27
34	263351	1128	992572	39	270779	1167	729221	26
35	264027	1126	992549	39	271479	1165	728521	25
36	264703	1124	992525	39	272178	1164	727822	24
37	265377	1122	992501	39	272876	1162	727124	23
38	266051	1120	992478	40	273573	1160	726427	22
39	266723	1119	992454	40	274269	1158	725731	21
40	267395	1117	992430	40	274964	1157	725036	20
41	9.268065	1115	9.992406	40	9.275658	1155	10.724342	19
42	268734	1113	992382	40	276351	1153	723649	18
43	269402	1111	992359	40	277043	1151	722957	17
44	270069	1110	992335	40	277734	1150	722266	16
45	270735	1108	992311	40	278424	1148	721576	15
46	271400	1106	992287	40	279113	1147	720887	14
47	272064	1105	992263	40	279801	1145	720199	13
48	272726	1103	992239	40	280488	1143	719512	12
49	273388	1101	992214	40	281174	1141	718826	11
50	274049	1099	992190	40	281858	1140	718142	10
51	9.274708	1098	9.992166	40	9.282542	1138	10.717458	9
52	275367	1096	992142	40	283225	1136	716775	8
53	276024	1094	992117	41	283907	1135	716093	7
54	276681	1092	992093	41	284588	1133	715412	6
55	277337	1091	992069	41	285268	1131	714732	5
56	277991	1089	992044	41	285947	1130	714053	4
57	278644	1087	992020	41	286624	1128	713376	3
58	279297	1086	991996	41	287301	1126	712699	2
59	279948	1084	991971	41	287977	1125	712023	1
60	280599	1082	991947	41	288652	1123	711348	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	
0	9.280599	1082	9.991947	41	9.288652	1123	10.711348	60
1	281248	1081	991922	41	289326	1122	710674	59
2	281897	1079	991897	41	289999	1120	710001	58
3	282544	1077	991873	41	290671	1118	709329	57
4	283190	1076	991848	41	291342	1117	708658	56
5	283836	1074	991823	41	292013	1115	707987	55
6	284480	1072	991799	41	292682	1114	707318	54
7	285124	1071	991774	42	293350	1112	706650	53
8	285766	1069	991749	42	294017	1111	705983	52
9	286408	1067	991724	42	294684	1109	705316	51
10	287048	1066	991699	42	295349	1107	704651	50
11	9.287687	1064	9.991674	42	9.296013	1106	10.703987	49
12	288326	1063	991649	42	296677	1104	703323	48
13	288964	1061	991624	42	297339	1103	702661	47
14	289600	1059	991599	42	298001	1101	701999	46
15	290236	1058	991574	42	298662	1100	701338	45
16	290870	1056	991549	42	299322	1098	700678	44
17	291504	1054	991524	42	299980	1096	700020	43
18	292137	1053	991498	42	300638	1095	699362	42
19	292768	1051	991473	42	301295	1093	698705	41
20	293399	1050	991448	42	301951	1092	698049	40
21	9.294029	1048	9.991422	42	9.302607	1090	10.697393	39
22	294658	1046	991397	42	303261	1089	696739	38
23	295286	1045	991372	43	303914	1087	696086	37
24	295913	1043	991346	43	304567	1086	695433	36
25	296539	1042	991321	43	305218	1084	694782	35
26	297164	1040	991295	43	305869	1083	694131	34
27	297788	1039	991270	43	306519	1081	693481	33
28	298412	1037	991244	43	307168	1080	692832	32
29	299034	1036	991218	43	307815	1078	692185	31
30	299655	1034	991193	43	308463	1077	691537	30
31	9.300276	1032	9.991167	43	9.309109	1075	10.690891	29
32	300895	1031	991141	43	309754	1074	690246	28
33	301514	1029	991115	43	310398	1073	689602	27
34	302132	1028	991090	43	311042	1071	688958	26
35	302748	1026	991064	43	311685	1070	688315	25
36	303364	1025	991038	43	312327	1068	687673	24
37	303979	1023	991012	43	312967	1067	687033	23
38	304593	1022	990986	43	313608	1065	686392	22
39	305207	1020	990960	43	314247	1064	685753	21
40	305819	1019	990934	44	314885	1062	685115	20
41	9.306430	1017	9.990908	44	9.315523	1061	10.684477	19
42	307041	1016	990882	44	316159	1060	683841	18
43	307650	1014	990855	44	316795	1058	683205	17
44	308259	1013	990829	44	317430	1057	682570	16
45	308867	1011	990803	44	318064	1055	681936	15
46	309474	1010	990777	44	318697	1054	681303	14
47	310080	1008	990750	44	319329	1053	680671	13
48	310685	1007	990724	44	319961	1051	680039	12
49	311289	1005	990697	44	320592	1050	679408	11
50	311893	1004	990671	44	321222	1048	678778	10
51	9.312495	1003	9.990644	44	9.321851	1047	10.678149	9
52	313097	1001	990618	44	322479	1045	677521	8
53	313698	1000	990591	44	323106	1044	676894	7
54	314297	998	990565	44	323733	1043	676267	6
55	314897	997	990538	44	324358	1041	675642	5
56	315495	996	990511	45	324983	1040	675017	4
57	316092	994	990485	45	325607	1039	674393	3
58	316689	993	990458	45	326231	1037	673769	2
59	317284	991	990431	45	326853	1036	673147	1
60	317879	990	990404	45	327475	1035	672525	0
	Cosine		Sine		Cotang.		Tang.	

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	M.
0	9.317879	990	9.990404	45	9.327474	1035	10.672526	60
1	318473	988	990378	45	328095	1033	671905	59
2	319066	987	990351	45	328715	1032	671285	58
3	319658	986	990324	45	329334	1030	670666	57
4	320249	984	990297	45	329953	1029	670047	56
5	320840	983	990270	45	330570	1028	669430	55
6	321430	982	990243	45	331187	1026	668813	54
7	322019	980	990215	45	331803	1025	668197	53
8	322607	979	990188	45	332418	1024	667582	52
9	323194	977	990161	45	333033	1023	666967	51
10	323780	976	990134	45	333646	1021	666354	50
11	9.324366	975	9.990107	46	9.334259	1020	10.665741	49
12	324950	973	990079	46	334871	1019	665129	48
13	325534	972	990052	46	335482	1017	664518	47
14	326117	970	990025	46	336093	1016	663907	46
15	326700	969	989997	46	336702	1015	663298	45
16	327281	968	989970	46	337311	1013	662689	44
17	327862	966	989942	46	337919	1012	662081	43
18	328442	965	989915	46	338527	1011	661473	42
19	329021	964	989887	46	339133	1010	660867	41
20	329599	962	989860	46	339739	1008	660261	40
21	9.330176	961	9.989832	46	9.340344	1007	10.659656	39
22	330753	960	989804	46	340948	1006	659052	38
23	331329	958	989777	46	341552	1004	658448	37
24	331903	957	989749	47	342155	1003	657845	36
25	332478	956	989721	47	342757	1002	657243	35
26	333051	954	989693	47	343358	1000	656642	34
27	333624	953	989665	47	343958	999	656042	33
28	334195	952	989637	47	344558	998	655442	32
29	334766	950	989609	47	345157	997	654843	31
30	335337	949	989582	47	345755	996	654245	30
31	9.335906	948	9.989553	47	9.346353	994	10.653647	29
32	336475	946	989525	47	346949	993	653051	28
33	337043	945	989497	47	347545	992	652455	27
34	337610	944	989469	47	348141	991	651859	26
35	338176	943	989441	47	348735	990	651265	25
36	338742	941	989413	47	349329	988	650671	24
37	339306	940	989384	47	349922	987	650078	23
38	339871	939	989356	47	350514	986	649486	22
39	340434	937	989328	47	351106	985	648894	21
40	340996	936	989300	47	351697	983	648303	20
41	9.341558	935	9.989271	47	9.352287	982	10.647713	19
42	342119	934	989243	47	352876	981	647124	18
43	342679	932	989214	47	353465	980	646535	17
44	343239	931	989186	47	354053	979	645947	16
45	343797	930	989157	47	354640	977	645360	15
46	344355	929	989128	48	355227	976	644773	14
47	344912	927	989100	48	355813	975	644187	13
48	345469	926	989071	48	356398	974	643602	12
49	346024	925	989042	48	356982	973	643018	11
50	346579	924	989014	48	357566	971	642434	10
51	9.347134	922	9.988985	48	9.358149	970	10.641851	9
52	347687	921	988956	48	358731	969	641269	8
53	348240	920	988927	48	359313	968	640687	7
54	348792	919	988898	48	359893	967	640107	6
55	349343	917	988869	48	360474	966	639526	5
56	349893	916	988840	48	361053	965	638947	4
57	350443	915	988811	49	361632	963	638368	3
58	350992	914	988782	49	362210	962	637790	2
59	351540	913	988753	49	362787	961	637213	1
60	352088	911	988724	49	363364	960	636636	0
	Cosine		Sine		Cotang.		Tang	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	M.
0	9.352088	911	9.988724	49	9.363364	960	10.636636	60
1	352635	910	988695	49	363940	959	636060	59
2	353181	909	988666	49	364515	958	635485	58
3	353726	908	988636	49	365090	957	634910	57
4	354271	907	988607	49	365664	955	634336	56
5	354815	905	988578	49	366237	954	633763	55
6	355358	904	988548	49	366810	953	633190	54
7	355901	903	988519	49	367382	952	632618	53
8	356443	902	988489	49	367953	951	632047	52
9	356984	901	988460	49	368524	950	631476	51
10	357524	899	988430	49	369094	949	630906	50
11	9.358064	898	9.988401	49	9.369663	948	10.630337	49
12	358603	897	988371	49	370232	946	629768	48
13	359141	896	988342	49	370799	945	629201	47
14	359678	895	988312	50	371367	944	628633	46
15	360215	893	988282	50	371933	943	628067	45
16	360752	892	988252	50	372499	942	627501	44
17	361287	891	988223	50	373064	941	626936	43
18	361822	890	988193	50	373629	940	626371	42
19	362356	889	988163	50	374193	939	625807	41
20	362889	888	988133	50	374756	938	625244	40
21	9.363422	887	9.988103	50	9.375319	937	10.624681	39
22	363954	885	988073	50	375881	935	624119	38
23	364485	884	988043	50	376442	934	623558	37
24	365016	883	988013	50	377003	933	622997	36
25	365546	882	987983	50	377563	932	622437	35
26	366075	881	987953	50	378122	931	621878	34
27	366604	880	987922	50	378681	930	621319	33
28	367131	879	987892	50	379239	929	620761	32
29	367659	877	987862	50	379797	928	620203	31
30	368185	876	987832	51	380354	927	619646	30
31	9.368711	875	9.987801	51	9.380910	926	10.619090	29
32	369236	874	987771	51	381466	925	618534	28
33	369761	873	987740	51	382020	924	617980	27
34	370285	872	987710	51	382575	923	617425	26
35	370808	871	987679	51	383129	922	616871	25
36	371330	870	987649	51	383682	921	616318	24
37	371852	869	987618	51	384234	920	615766	23
38	372373	867	987588	51	384786	919	615214	22
39	372894	866	987557	51	385337	918	614663	21
40	373414	865	987526	51	385888	917	614112	20
41	9.373933	864	9.987496	51	9.386438	915	10.613562	19
42	374452	863	987465	51	386987	914	613013	18
43	374970	862	987434	51	387536	913	612464	17
44	375487	861	987403	52	388084	912	611916	16
45	376003	860	987372	52	388631	911	611369	15
46	376519	859	987341	52	389178	910	610822	14
47	377035	858	997310	52	389724	909	610276	13
48	377549	857	987279	52	390270	908	609730	12
49	378063	856	987248	52	390815	907	609185	11
50	378577	854	987217	52	391360	906	608640	10
51	9.379089	853	9.987186	52	9.391903	905	10.608097	9
52	379601	852	987155	52	392447	904	607553	8
53	380113	851	987124	52	392989	903	607011	7
54	380624	850	987092	52	393531	902	606469	6
55	381134	849	987061	52	394073	901	605927	5
56	381643	848	987030	52	394614	900	605386	4
57	382152	847	986998	52	395154	899	604846	3
58	382661	846	986967	52	395694	898	604306	2
59	383168	845	986936	52	396233	897	603767	1
60	383675	844	986904	52	396771	896	603229	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	M.
0	9.383675	844	9.986904	52	9.396771	896	10.603229	60
1	384182	843	986873	53	397309	896	602691	59
2	384687	842	986841	53	397846	895	602154	58
3	385192	841	986809	53	398383	894	601617	57
4	385697	840	986778	53	398919	893	601081	56
5	386201	839	986746	53	399455	892	600545	55
6	386704	838	986714	53	399990	891	600010	54
7	387207	837	986683	53	400524	890	599476	53
8	387709	836	986651	53	401058	889	598942	52
9	388210	835	986619	53	401591	888	598409	51
10	388711	834	986587	53	402124	887	597876	50
11	9.389211	833	9.986555	53	9.402656	886	10.597344	49
12	389711	832	986523	53	403187	885	596813	48
13	390210	831	986491	53	403718	884	596282	47
14	390708	830	986459	53	404249	883	595751	46
15	391206	828	986427	53	404778	882	595222	45
16	391703	827	986395	53	405308	881	594692	44
17	392199	826	986363	54	405836	880	594164	43
18	392695	825	986331	54	406364	879	593636	42
19	393191	824	986299	54	406892	878	593108	41
20	393685	823	986266	54	407419	877	592581	40
21	9.394179	822	9.986234	54	9.407945	876	10.592055	39
22	394673	821	986202	54	408471	875	591529	38
23	395166	820	986169	54	408997	874	591003	37
24	395658	819	986137	54	409521	874	590479	36
25	396150	818	986104	54	410045	873	589955	35
26	396641	817	986072	54	410569	872	589431	34
27	397132	817	986039	54	411092	871	588908	33
28	397621	816	986007	54	411615	870	588385	32
29	398111	815	985974	54	412137	869	587863	31
30	398600	814	985942	54	412658	868	587342	30
31	9.399088	813	9.985909	55	9.413179	867	10.586821	29
32	399575	812	985876	55	413699	866	586301	28
33	400062	811	985843	55	414219	865	585781	27
34	400549	810	985811	55	414738	864	585262	26
35	401035	809	985778	55	415257	864	584743	25
36	401520	808	985745	55	415775	863	584225	24
37	402005	807	985712	55	416293	862	583707	23
38	402489	806	985679	55	416810	861	583190	22
39	402972	805	985646	55	417326	860	582674	21
40	403455	804	985613	55	417842	859	582158	20
41	9.403938	803	9.985580	55	9.418358	858	10.581642	19
42	404420	802	985547	55	418873	857	581127	18
43	404901	801	985514	55	419387	856	580613	17
44	405382	800	985480	55	419901	855	580099	16
45	405862	799	985447	55	420415	855	579585	15
46	406341	798	985414	56	420927	854	579073	14
47	406820	797	985380	56	421440	853	578560	13
48	407299	796	985347	56	421952	852	578048	12
49	407777	795	985314	56	422463	851	577537	11
50	408254	794	985280	56	422974	850	577026	10
51	9.408731	794	9.985247	56	9.423484	849	10.576516	9
52	409207	793	985213	56	423993	848	576007	8
53	409682	792	985180	56	424503	848	575497	7
54	410157	791	985146	56	425011	847	574989	6
55	410632	790	985113	56	425519	846	574481	5
56	411106	789	985079	56	426027	845	573973	4
57	411579	788	985045	56	426534	844	573466	3
58	412052	787	985011	56	427041	843	572959	2
59	412524	786	984978	56	427547	843	572453	1
60	412996	785	984944	56	428052	842	571948	0
	Cosine		Sine		Cotang.		Tang	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	M.
0	9.412996	785	9.984944	57	9.428052	842	10.571948	60
1	413467	784	984910	57	428557	841	571443	59
2	413938	783	984876	57	429062	840	570938	58
3	414408	783	984842	57	429566	839	570434	57
4	414878	782	984808	57	430070	838	569930	56
5	415347	781	984774	57	430573	838	569427	55
6	415815	780	984740	57	431075	837	568925	54
7	416283	779	984706	57	431577	836	568423	53
8	416751	778	984672	57	432079	835	567921	52
9	417217	777	984637	57	432580	834	567420	51
10	417684	776	984603	57	433080	833	566920	50
11	9.418150	775	9.984569	57	9.433580	832	10.566420	49
12	418615	774	984535	57	434080	832	565920	48
13	419079	773	984500	57	434579	831	565421	47
14	419544	773	984466	57	435078	830	564922	46
15	420007	772	984432	58	435576	829	564424	45
16	420470	771	984397	58	436073	828	563927	44
17	420933	770	984363	58	436570	828	563430	43
18	421395	769	984328	58	437067	827	562933	42
19	421857	768	984294	58	437563	826	562437	41
20	422318	767	984259	58	438059	825	561941	40
21	9.422778	767	9.984224	58	9.438554	824	10.561446	39
22	423238	766	984190	58	439048	823	560952	38
23	423697	765	984155	58	439543	823	560457	37
24	424156	764	984120	58	440036	822	559964	36
25	424615	763	984085	58	440529	821	559471	35
26	425073	762	984050	58	441022	820	558978	34
27	425530	761	984015	58	441514	819	558486	33
28	425987	760	983981	58	442006	819	557994	32
29	426443	760	983946	58	442497	818	557503	31
30	426899	759	983911	58	442988	817	557012	30
31	9.427354	758	9.983875	58	9.443479	816	10.556521	29
32	427809	757	983840	59	443968	816	556032	28
33	428263	756	983805	59	444458	815	555542	27
34	428717	755	983770	59	444947	814	555053	26
35	429170	754	983735	59	445435	813	554565	25
36	429623	753	983700	59	445923	812	554077	24
37	430075	752	983664	59	446411	812	553589	23
38	430527	752	983629	59	446898	811	553102	22
39	430978	751	983594	59	447384	810	552616	21
40	431429	750	983558	59	447870	809	552130	20
41	9.431879	749	9.983523	59	9.448356	809	10.551644	19
42	432329	749	983487	59	448841	808	551159	18
43	432778	748	983452	59	449326	807	550674	17
44	433226	747	983416	59	449810	806	550190	16
45	433675	746	983381	59	450294	806	549706	15
46	434122	745	983345	59	450777	805	549223	14
47	434569	744	983309	59	451260	804	548740	13
48	435016	744	983273	60	451743	803	548257	12
49	435462	743	983238	60	452225	802	547775	11
50	435908	742	983202	60	452706	802	547294	10
51	9.436353	741	9.983166	60	9.453187	801	10.546813	9
52	436798	740	983130	60	453668	800	546332	8
53	437242	740	983094	60	454148	799	545852	7
54	437686	739	983058	60	454628	799	545372	6
55	438129	738	983022	60	455107	798	544893	5
56	438572	737	982986	60	455586	797	544414	4
57	439014	736	982950	60	456064	796	543936	3
58	439456	736	982914	60	456542	796	543458	2
59	439897	735	982878	60	457019	795	542981	1
60	440338	734	982842	60	457496	794	542504	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	M.
0	9.440338	734	9.982842	60	9.457496	794	10.542504	60
1	440778	733	982805	60	457973	793	542027	59
2	441218	732	982769	61	458449	793	541551	58
3	441658	731	982733	61	458925	792	541075	57
4	442096	731	982696	61	459400	791	540600	56
5	442535	730	982660	61	459875	790	540125	55
6	442973	729	982624	61	460349	790	539651	54
7	443410	728	982587	61	460823	789	539177	53
8	443847	727	982551	61	461297	788	538703	52
9	444284	727	982514	61	461770	788	538230	51
10	444720	726	982477	61	462242	787	537758	50
11	9.445155	725	9.982441	61	9.462714	786	10.537286	49
12	445590	724	982404	61	463186	785	536814	48
13	446025	723	982367	61	463658	785	536342	47
14	446459	723	982331	61	464129	784	535871	46
15	446893	722	982294	61	464599	783	535401	45
16	447326	721	982257	61	465069	783	534931	44
17	447759	720	982220	62	465539	782	534461	43
18	448191	720	982183	62	466008	781	533992	42
19	448623	719	982146	62	466476	780	533524	41
20	449054	718	982109	62	466945	780	533055	40
21	9.449485	717	9.982072	62	9.467413	779	10.532587	39
22	449915	716	982035	62	467880	778	532120	38
23	450345	716	981998	62	468347	778	531653	37
24	450775	715	981961	62	468814	777	531186	36
25	451204	714	981924	62	469280	776	530720	35
26	451632	713	981886	62	469746	775	530254	34
27	452060	713	981849	62	470211	775	529789	33
28	452488	712	981812	62	470676	774	529324	32
29	452915	711	981774	62	471141	773	528859	31
30	453342	710	981737	62	471605	773	528395	30
31	9.453768	710	9.981699	63	9.472068	772	10.527932	29
32	454194	709	981662	63	472532	771	527468	28
33	454619	708	981625	63	472995	771	527005	27
34	455044	707	981587	63	473457	770	526543	26
35	455469	707	981549	63	473919	769	526081	25
36	455893	706	981512	63	474381	769	525619	24
37	456316	705	981474	63	474842	768	525158	23
38	456739	704	981436	63	475303	767	524697	22
39	457162	704	981399	63	475763	767	524237	21
40	457584	703	981361	63	476223	766	523777	20
41	9.458006	702	9.981323	63	9.476683	765	10.523317	19
42	458427	701	981285	63	477142	765	522858	18
43	458848	701	981247	63	477601	764	522399	17
44	459268	700	981209	63	478059	763	521941	16
45	459688	699	981171	63	478517	763	521483	15
46	460108	698	981133	64	478975	762	521025	14
47	460527	698	981095	64	479432	761	520568	13
48	460946	697	981057	64	479889	761	520111	12
49	461364	696	981019	64	480345	760	519655	11
50	461782	695	980981	64	480801	759	519199	10
51	9.462199	695	9.980942	64	9.481257	759	10.518743	9
52	462616	694	980904	64	481712	758	518288	8
53	463032	693	980866	64	482167	757	517833	7
54	463448	693	980827	64	482621	757	517379	6
55	463864	692	980789	64	483075	756	516925	5
56	464279	691	980750	64	483529	755	516471	4
57	464694	690	980712	64	483982	755	516018	3
58	465108	690	980673	64	484435	754	515565	2
59	465522	689	980635	64	484887	753	515113	1
60	465935	688	980596	64	485339	753	514661	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	M.
0	9.465935	688	9.980596	64	9.485339	755	10.514661	60
1	466348	688	980558	64	485791	752	514209	59
2	466761	687	980519	65	486242	751	513758	58
3	467173	686	980480	65	486693	751	513307	57
4	467585	685	980442	65	487143	750	512857	56
5	467996	685	980403	65	487593	749	512407	55
6	468407	684	980364	65	488043	749	511957	54
7	468817	683	980325	65	488492	748	511508	53
8	469227	683	980286	65	488941	747	511059	52
9	469637	682	980247	65	489390	747	510610	51
10	470046	681	980208	65	489838	746	510162	50
11	9.470455	680	9.980169	65	9.490285	746	10.509714	49
12	470863	680	980130	65	490733	745	509267	48
13	471271	679	980091	65	491180	744	508820	47
14	471679	678	980052	65	491627	744	508373	46
15	472086	678	980012	65	492073	743	507927	45
16	472492	677	979973	65	492519	743	507481	44
17	472898	676	979934	66	492965	742	507035	43
18	473304	676	979895	66	493410	741	506590	42
19	473710	675	979855	66	493854	740	506143	41
20	474115	674	979816	66	494299	740	505701	40
21	9.474519	674	9.979776	66	9.494743	740	10.505257	39
22	474923	673	979737	66	495186	739	504814	38
23	475327	672	979697	66	495630	738	504370	37
24	475730	672	979658	66	496073	737	503927	36
25	476133	671	979618	66	496515	737	503485	35
26	476536	670	979579	66	496957	736	503043	34
27	476938	669	979539	66	497399	736	502601	33
28	477340	669	979499	66	497841	735	502159	32
29	477741	668	979459	66	498282	734	501718	31
30	478142	667	979420	66	498722	734	501278	30
31	9.478542	667	9.979380	66	9.499163	733	10.500837	29
32	478942	666	979340	66	499603	733	500397	28
33	479342	665	979300	67	500042	732	499958	27
34	479741	665	979260	67	500481	731	499519	26
35	480140	664	979220	67	500920	731	499080	25
36	480539	663	979180	67	501359	730	498641	24
37	480937	663	979140	67	501797	730	498203	23
38	481334	662	979100	67	502235	729	497765	22
39	481731	661	979059	67	502672	728	497328	21
40	482128	661	979019	67	503109	728	496891	20
41	9.482525	660	9.978979	67	9.503546	727	10.496454	19
42	482921	659	978939	67	503982	727	496018	18
43	483316	659	978898	67	504418	726	495582	17
44	483712	658	978858	67	504854	725	495146	16
45	484107	657	978817	67	505289	725	494711	15
46	484501	657	978777	67	505724	724	494276	14
47	484895	656	978736	67	506159	724	493841	13
48	485289	655	978696	68	506593	723	493407	12
49	485682	655	978655	68	507027	722	492973	11
50	486075	654	978615	68	507460	722	492540	10
51	9.486467	653	9.978574	68	9.507893	721	10.492107	9
52	486860	653	978533	68	508326	721	491674	8
53	487251	652	978493	68	508759	720	491241	7
54	487643	651	978452	68	509191	719	490809	6
55	488034	651	978411	68	509622	719	490378	5
56	488424	650	978370	68	510054	718	489946	4
57	488814	650	978329	68	510485	718	489515	3
58	489204	649	978288	68	510916	717	489084	2
59	489593	648	978247	68	511346	716	488654	1
60	489982	648	978206	68	511776	716	488224	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	M.
0	9.489982	648	9.978206	68	9.511776	716	10.488224	60
1	490371	648	978165	68	512206	716	487794	59
2	490759	647	978124	68	512635	715	487365	58
3	491147	646	978083	69	513064	714	486936	57
4	491535	646	978042	69	513493	714	486507	56
5	491922	645	978001	69	513921	713	486079	55
6	492308	644	977959	69	514349	713	485651	54
7	492695	644	977918	69	514777	712	485223	53
8	493081	643	977877	69	515204	712	484796	52
9	493466	642	977835	69	515631	711	484369	51
10	493851	642	977794	69	516057	710	483943	50
11	9.494236	641	9.977752	69	9.516484	710	10.483516	49
12	494621	641	977711	69	516910	709	483090	48
13	495005	640	977669	69	517335	709	482665	47
14	495388	639	977628	69	517761	708	482239	46
15	495772	639	977586	69	518185	708	481815	45
16	496154	638	977544	70	518610	707	481390	44
17	496537	637	977503	70	519034	706	480966	43
18	496919	637	977461	70	519458	706	480542	42
19	497301	636	977419	70	519882	705	480118	41
20	497682	636	977377	70	520305	705	479695	40
21	9.498064	635	9.977335	70	9.520728	704	10.479272	39
22	498444	634	977293	70	521151	703	478849	38
23	498825	634	977251	70	521573	703	478427	37
24	499204	633	977209	70	521995	703	478005	36
25	499584	632	977167	70	522417	702	477583	35
26	499963	632	977125	70	522838	702	477162	34
27	500342	631	977083	70	523259	701	476741	33
28	500721	631	977041	70	523680	701	476320	32
29	501099	630	976999	70	524100	700	475900	31
30	501476	629	976957	70	524520	699	475480	30
31	9.501854	629	9.976914	70	9.524939	699	10.475061	29
32	502231	628	976872	71	525359	698	474641	28
33	502607	628	976830	71	525778	698	474222	27
34	502984	627	976787	71	526197	697	473803	26
35	503360	626	976745	71	526615	697	473385	25
36	503735	626	976702	71	527033	696	472967	24
37	504110	625	976660	71	527451	696	472549	23
38	504485	625	976617	71	527868	695	472132	22
39	504860	624	976574	71	528285	695	471715	21
40	505234	623	976532	71	528702	694	471298	20
41	9.505608	623	9.976489	71	9.529119	693	0.470881	19
42	505981	622	976446	71	529535	693	470465	18
43	506354	622	976404	71	529950	693	470050	17
44	506727	621	976361	71	530366	692	469634	16
45	507099	620	976318	71	530781	691	469219	15
46	507471	620	976275	71	531196	691	468804	14
47	507843	619	976232	72	531611	690	468389	13
48	508214	619	976189	72	532025	690	467975	12
49	508585	618	976146	72	532439	689	467561	11
50	508956	618	976103	72	532853	689	467147	10
51	9.509326	617	9.976060	72	9.533266	688	10.466734	9
52	509696	616	976017	72	533679	688	466321	8
53	510065	616	975974	72	534092	687	465908	7
54	510434	615	975930	72	534504	687	465496	6
55	510803	615	975887	72	534916	686	465084	5
56	511172	614	975844	72	535328	686	464672	4
57	511540	613	975800	72	535739	685	464261	3
58	511907	613	975757	72	536150	685	463850	2
59	512275	612	975714	72	536561	684	463439	1
60	512642	612	975670	72	536972	684	463028	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	M.
0	9.512642	612	9.975670	73	9.536972	684	10.463028	60
1	513009	611	975627	73	537382	683	462618	59
2	513375	611	975583	73	537792	683	462208	58
3	513741	610	975539	73	538202	682	461798	57
4	514107	609	975496	73	538611	682	461389	56
5	514472	609	975452	73	539020	681	460980	55
6	514837	608	975408	73	539429	681	460571	54
7	515202	608	975365	73	539837	680	460163	53
8	515566	607	975321	73	540245	680	459755	52
9	515930	607	975277	73	540653	679	459347	51
10	516294	606	975233	73	541061	679	458939	50
11	9.516657	605	9.975189	73	9.541468	678	10.458532	49
12	517020	605	975145	73	541875	678	458125	48
13	517382	604	975101	73	542281	677	457719	47
14	517745	604	975057	73	542688	677	457312	46
15	518107	603	975013	73	543094	676	456906	45
16	518468	603	974969	74	543499	676	456501	44
17	518829	602	974925	74	543905	675	456095	43
18	519190	601	974880	74	544310	675	455690	42
19	519551	601	974836	74	544715	674	455285	41
20	519911	600	974792	74	545119	674	454881	40
21	9.520271	600	9.974748	74	9.545524	673	10.454476	39
22	520631	599	974703	74	545928	673	454072	38
23	520990	599	974659	74	546331	672	453669	37
24	521349	598	974614	74	546735	672	453265	36
25	521707	598	974570	74	547138	671	452862	35
26	522066	597	974525	74	547540	671	452460	34
27	522424	596	974481	74	547943	670	452057	33
28	522781	596	974436	74	548345	670	451655	32
29	523138	595	974391	74	548747	669	451253	31
30	523495	595	974347	75	549149	669	450851	30
31	9.523852	594	9.974302	75	9.549550	668	10.450450	29
32	524208	594	974257	75	549951	668	450049	28
33	524564	593	974212	75	550352	667	449648	27
34	524920	593	974167	75	550752	667	449248	26
35	525275	592	974122	75	551152	666	448848	25
36	525630	591	974077	75	551552	666	448448	24
37	525984	591	974032	75	551952	665	448048	23
38	526339	590	973987	75	552351	665	447649	22
39	526693	590	973942	75	552750	665	447250	21
40	527046	589	973897	75	553149	664	446851	20
41	9.527400	589	9.973852	75	9.553548	664	10.446452	19
42	527753	588	973807	75	553946	663	446054	18
43	528105	588	973761	75	554344	663	445656	17
44	528458	587	973716	76	554741	662	445259	16
45	528810	587	973671	76	555139	662	444861	15
46	529161	586	973625	76	555536	661	444464	14
47	529513	586	973580	76	555933	661	444067	13
48	529864	585	973535	76	556329	660	443671	12
49	530215	585	973489	76	556725	660	443275	11
50	530565	584	973444	76	557121	659	442879	10
51	9.530915	584	9.973398	76	9.557517	659	10.442483	9
52	531265	583	973352	76	557913	659	442087	8
53	531614	582	973307	76	558308	658	441692	7
54	531963	582	973261	76	558702	658	441298	6
55	532312	581	973215	76	559097	657	440903	5
56	532661	581	973169	76	559491	657	440509	4
57	533009	580	973124	76	559885	656	440115	3
58	533357	580	973078	76	560279	656	439721	2
59	533704	579	973032	77	560673	655	439327	1
60	534052	578	972986	77	561066	655	438934	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	
0	9.534052	578	9.972986	77	9.561066	655	10.438934	60
1	534399	577	972940	77	561459	654	438541	59
2	534745	577	972894	77	561851	654	438149	58
3	535092	577	972848	77	562244	653	437756	57
4	535438	576	972802	77	562636	653	437364	56
5	535783	576	972755	77	563028	653	436972	55
6	536129	575	972709	77	563419	652	436581	54
7	536474	574	972663	77	563811	652	436189	53
8	536818	574	972617	77	564202	651	435798	52
9	537163	573	972570	77	564592	651	435408	51
10	537507	573	972524	77	564983	650	435017	50
11	9.537851	572	9.972478	77	9.565373	650	10.434627	49
12	538194	572	972431	78	565763	649	434237	48
13	538538	571	972385	78	566153	649	433847	47
14	538880	571	972338	78	566542	649	433458	46
15	539223	570	972291	78	566932	648	433068	45
16	539565	570	972245	78	567320	648	432680	44
17	539907	569	972198	78	567709	647	432291	43
18	540249	569	972151	78	568098	647	431902	42
19	540590	568	972105	79	568486	646	431514	41
20	540931	568	972058	78	568873	646	431127	40
21	9.541272	567	9.972011	78	9.569261	645	10.430739	39
22	541613	567	971964	78	569648	645	430352	38
23	541953	566	971917	78	570035	645	429965	37
24	542293	566	971870	78	570422	644	429578	36
25	542632	565	971823	78	570809	644	429191	35
26	542971	565	971776	78	571195	643	428805	34
27	543310	564	971729	79	571581	643	428419	33
28	543649	564	971682	79	571967	642	428033	32
29	543987	563	971635	79	572352	642	427648	31
30	544325	563	971588	79	572738	642	427262	30
31	9.544663	562	9.971540	79	9.573123	641	10.426877	29
32	545000	562	971493	79	573507	641	426493	28
33	545338	561	971446	79	573892	640	426108	27
34	545674	561	971398	79	574276	640	425724	26
35	546011	560	971351	79	574660	639	425340	25
36	546347	560	971303	79	575044	639	424956	24
37	546683	559	971256	79	575427	639	424573	23
38	547019	559	971208	79	575810	638	424190	22
39	547354	558	971161	79	576193	638	423807	21
40	547689	558	971113	79	576576	637	423424	20
41	9.548924	557	9.971066	80	9.576958	637	10.423041	19
42	548359	557	971018	80	577341	636	422659	18
43	548693	556	970970	80	577723	636	422277	17
44	549027	556	970922	80	578104	636	421896	16
45	549360	555	970874	80	578486	635	421514	15
46	549693	555	970827	80	578867	635	421133	14
47	550026	554	970779	80	579248	634	420752	13
48	550359	554	970731	80	579629	634	420371	12
49	550692	553	970683	80	580009	634	419991	11
50	551024	553	970635	80	580389	633	419611	10
51	9.551356	552	9.970586	80	9.580769	633	10.419231	9
52	551687	552	970538	80	581149	632	418851	8
53	552018	552	970490	80	581528	632	418472	7
54	552349	551	970442	80	581907	632	418093	6
55	552680	551	970394	80	582286	631	417714	5
56	553010	550	970345	81	582665	631	417335	4
57	553341	550	970297	81	583043	630	416957	3
58	553670	549	970249	81	583422	630	416578	2
59	554000	549	970200	81	583800	629	416200	1
60	554329	548	970152	81	584177	629	415823	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	
0	9.554329	548	9.970152	81	9.584177	629	10.415823	60
1	554658	548	970103	81	584555	629	415445	59
2	554987	547	970055	81	584932	628	415068	58
3	555315	547	970006	81	585309	628	414691	57
4	555643	546	969957	81	585686	627	414314	56
5	555971	546	969909	81	586062	627	413938	55
6	556299	545	969860	81	586439	627	413561	54
7	556626	545	969811	81	586815	626	413185	53
8	556953	544	969762	81	587190	626	412810	52
9	557280	544	969714	81	587566	625	412434	51
10	557606	543	969665	81	587941	625	412059	50
11	9.557932	543	9.969616	82	9.588316	625	10.411684	49
12	558258	543	969567	82	588691	624	411309	48
13	558583	542	969518	82	589066	624	410934	47
14	558909	542	969469	82	589440	623	410560	46
15	559234	541	969420	82	589814	623	410186	45
16	559558	541	969370	82	590188	623	409812	44
17	559883	540	969321	82	590562	622	409438	43
18	560207	540	969272	82	590935	622	409065	42
19	560531	539	969223	82	591308	622	408692	41
20	560855	539	969173	82	591681	621	408319	40
21	9.561178	538	9.969124	82	9.592054	621	10.407946	39
22	561501	538	969075	82	592426	620	407574	38
23	561824	537	969025	82	592798	620	407202	37
24	562146	537	968976	82	593170	619	406829	36
25	562468	536	968926	83	593542	619	406458	35
26	562790	536	968877	83	593914	618	406086	34
27	563112	536	968827	83	594285	618	405715	33
28	563433	535	968777	83	594656	618	405344	32
29	563755	535	968728	83	595027	617	404973	31
30	564075	534	968678	83	595398	617	404602	30
31	9.564396	534	9.968628	83	9.595768	617	10.404232	29
32	564716	533	968578	83	596138	616	403862	28
33	565036	533	968528	83	596508	616	403492	27
34	565356	532	968479	83	596878	616	403122	26
35	565676	532	968429	83	597247	615	402753	25
36	565995	531	968379	83	597616	615	402384	24
37	566314	531	968329	83	597985	615	402015	23
38	566632	531	968278	83	598354	614	401646	22
39	566951	530	968228	84	598722	614	401278	21
40	567269	530	968178	84	599091	613	400909	20
41	9.567587	529	9.968128	84	9.599459	613	10.400541	19
42	567904	529	968078	84	599827	613	400173	18
43	568222	528	968027	84	600194	612	399806	17
44	568539	528	967977	84	600562	612	399438	16
45	568856	528	967927	84	600929	611	399071	15
46	569172	527	967876	84	601296	611	398704	14
47	569488	527	967826	84	601662	611	398338	13
48	569804	526	967775	84	602029	610	397971	12
49	570120	526	967725	84	602395	610	397605	11
50	570435	525	967674	84	602761	610	397239	10
51	9.570751	525	9.967624	84	9.603127	609	10.396873	9
52	571066	524	967573	84	603493	609	396507	8
53	571380	524	967522	85	603858	609	396142	7
54	571695	523	967471	85	604223	608	395777	6
55	572009	523	967421	85	604588	608	395412	5
56	572323	523	967370	85	604953	607	395047	4
57	572636	522	967319	85	605317	607	394683	3
58	572950	522	967268	85	605682	607	394318	2
59	573263	521	967217	85	606046	606	393954	1
60	573575	521	967166	85	606410	606	393590	0

Cosine Sine Cotang. Tang. M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	M.
0	9.573575	521	9.967166	85	9.606410	606	10.393590	60
1	573888	520	967115	85	606773	606	393227	59
2	574200	520	967064	85	607137	605	392863	58
3	574512	519	967013	85	607500	605	392500	57
4	574824	519	966961	85	607863	604	392137	56
5	575136	519	966910	85	608225	604	391775	55
6	575447	518	966859	85	608588	604	391412	54
7	575758	518	966808	85	608950	603	391050	53
8	576069	517	966756	86	609312	603	390688	52
9	576379	517	966705	86	609674	603	390326	51
10	576689	516	966653	85	610036	602	389964	50
11	9.576999	516	9.966602	86	9.610397	602	10.389603	49
12	577309	516	966550	86	610759	602	389241	48
13	577618	515	966499	86	611120	601	388880	47
14	577927	515	966447	86	611480	601	388520	46
15	578236	514	966395	86	611841	601	388159	45
16	578545	514	966344	86	612201	600	387799	44
17	578853	513	966292	86	612561	600	387439	43
18	579162	513	966240	86	612921	600	387079	42
19	579470	513	966188	86	613281	599	386719	41
20	579777	512	966136	86	613641	599	386359	40
21	9.580085	512	9.966085	87	9.614000	598	10.386000	39
22	580392	511	966033	87	614359	598	385641	38
23	580699	511	965981	87	614718	598	385282	37
24	581005	511	965928	87	615077	597	384923	36
25	581312	510	965876	87	615435	597	384565	35
26	581618	510	965824	87	615793	597	384207	34
27	581924	509	965772	87	616151	596	383849	33
28	582229	509	965720	87	616509	596	383491	32
29	582535	509	965668	87	616867	596	383133	31
30	582840	508	965615	87	617224	595	382776	30
31	9.583145	508	9.965563	87	9.617582	595	10.382418	29
32	583449	507	965511	87	617939	595	382061	28
33	583754	507	965458	87	618295	594	381705	27
34	584058	506	965406	87	618652	594	381348	26
35	584361	506	965353	88	619008	594	380992	25
36	584665	506	965301	88	619364	593	380636	24
37	584968	505	965248	88	619721	593	380279	23
38	585272	505	965195	88	620076	593	379924	22
39	585574	504	965143	88	620432	592	379568	21
40	585877	504	965090	88	620787	592	379213	20
41	9.586179	503	9.965037	88	9.621142	592	10.378858	19
42	586482	503	964984	88	621497	591	378503	18
43	586783	503	964931	88	621852	591	378148	17
44	587085	502	964879	88	622207	590	377793	16
45	587386	502	964826	88	622561	590	377439	15
46	587688	501	964773	88	622915	590	377085	14
47	587989	501	964719	88	623269	589	376731	13
48	588289	501	964666	89	623623	589	376377	12
49	588590	500	964613	89	623976	589	376024	11
50	588890	500	964560	89	624330	588	375670	10
51	9.589190	499	9.964507	89	9.624683	588	10.375317	9
52	589489	499	964454	89	625036	588	374964	8
53	589789	499	964400	89	625388	587	374612	7
54	590088	498	964347	89	625741	587	374259	6
55	590387	498	964294	89	626093	587	373907	5
56	590686	497	964240	89	626445	586	373555	4
57	590984	497	964187	89	626797	586	373203	3
58	591282	497	964133	89	627149	586	372851	2
59	591580	496	964080	89	627501	585	372499	1
60	591878	496	964026	89	627852	585	372148	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine	D.	Cosine	D.	Tang	D.	Cotang.	M.
0	9.591878	496	9.964026	89	9.627852	585	10.372148	60
1	592176	495	963972	89	628203	585	371797	59
2	592473	495	963919	89	628554	585	371446	58
3	592770	495	963865	90	628905	584	371095	57
4	593067	494	963811	90	629255	584	370745	56
5	593363	494	963757	90	629606	583	370394	55
6	593659	493	963704	90	629956	583	370044	54
7	593955	493	963650	90	630306	583	369694	53
8	594251	493	963596	90	630656	583	369344	52
9	594547	492	963542	90	631005	582	368995	51
10	594842	492	963488	90	631355	582	368645	50
11	9.595137	491	9.963434	90	9.631704	582	10.368296	49
12	595432	491	963379	90	632053	581	367947	48
13	595727	491	963325	90	632401	581	367599	47
14	596021	490	963271	90	632750	581	367250	46
15	596315	490	963217	90	633098	580	366902	45
16	596609	489	963163	90	633447	580	366553	44
17	596903	489	963108	91	633795	580	366205	43
18	597196	489	963054	91	634143	579	365857	42
19	597490	488	962999	91	634490	579	365510	41
20	597783	488	962945	91	634838	579	365162	40
21	9.598075	487	9.962890	91	9.635185	578	10.364815	39
22	598368	487	962836	91	635532	578	364468	38
23	598660	487	962781	91	635879	578	364121	37
24	598952	486	962727	91	636226	577	363774	36
25	599244	486	962672	91	636572	577	363428	35
26	599536	485	962617	91	636919	577	363081	34
27	599827	485	962562	91	637265	577	362735	33
28	600118	485	962508	91	637611	576	362389	32
29	600409	484	962453	91	637956	576	362044	31
30	600700	484	962398	92	638302	576	361698	30
31	9.600990	484	9.962343	92	9.638647	575	10.361353	29
32	601280	483	962288	92	638992	575	361008	28
33	601570	483	962233	92	639337	575	360663	27
34	601860	482	962178	92	639682	574	360318	26
35	602150	482	962123	92	640027	574	359973	25
36	602439	482	962067	92	640371	574	359629	24
37	602728	481	962012	92	640716	573	359284	23
38	603017	481	961957	92	641060	573	358940	22
39	603305	481	961902	92	641404	573	358596	21
40	603594	480	961846	92	641747	572	358253	20
41	9.603882	480	9.961791	92	9.642091	572	10.357909	19
42	604170	479	961735	92	642434	572	357566	18
43	604457	479	961680	92	642777	572	357223	17
44	604745	479	961624	93	643120	571	356880	16
45	605032	478	961569	93	643463	571	356537	15
46	605319	478	961513	93	643806	571	356194	14
47	605606	478	961458	93	644148	570	355852	13
48	605892	477	961402	93	644490	570	355510	12
49	606179	477	961346	93	644832	570	355168	11
50	606465	476	961290	93	645174	569	354826	10
51	9.606751	476	9.961235	93	9.645516	569	10.354484	9
52	607036	476	961179	93	645857	569	354143	8
53	607322	475	961123	93	646199	569	353801	7
54	607607	475	961067	93	646540	568	353460	6
55	607892	474	961011	93	646881	568	353119	5
56	608177	474	960955	93	647222	568	352778	4
57	608461	474	960899	93	647562	567	352438	3
58	608745	473	960843	94	647903	567	352097	2
59	609029	473	960786	94	648243	567	351757	1
60	609313	473	960730	94	648583	566	351417	0
	Cosine		Sine		Cotang.		Tang.	M

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	M.
0	9.609313	473	9.960730	94	9.648583	566	10.351417	60
1	609597	472	960674	94	648923	566	351077	59
2	609880	472	960618	94	649263	566	350737	58
3	610164	472	960561	94	649602	566	350398	57
4	610447	471	960505	94	649942	565	350058	56
5	610729	471	960448	94	650281	565	349719	55
6	611012	470	960392	94	650620	565	349380	54
7	611294	470	960335	94	650959	564	349041	53
8	611576	470	960279	94	651297	564	348703	52
9	611858	469	960222	94	651636	564	348364	51
10	612140	469	960165	94	651974	563	348026	50
11	9.612421	469	9.960109	95	9.652312	563	10.347688	49
12	612702	468	960052	95	652650	563	347350	48
13	612983	468	959995	95	652988	563	347012	47
14	613264	467	959938	95	653326	562	346674	46
15	613545	467	959882	95	653663	562	346337	45
16	613825	467	959825	95	654000	562	346000	44
17	614105	466	959768	95	654337	561	345663	43
18	614385	466	959711	95	654674	561	345326	42
19	614665	466	959654	95	655011	561	344989	41
20	614944	465	959596	95	655348	561	344652	40
21	9.615223	465	9.959539	95	9.655684	560	10.344316	39
22	615502	465	959482	95	656020	560	343980	38
23	615781	464	959425	95	656356	560	343644	37
24	616060	464	959368	95	656692	559	343308	36
25	616338	464	959310	96	657028	559	342972	35
26	616616	463	959253	96	657364	559	342636	34
27	616894	463	959195	96	657699	559	342301	33
28	617172	462	959138	96	658034	558	341966	32
29	617450	462	959081	96	658369	558	341631	31
30	617727	462	959023	96	658704	558	341296	30
31	9.618004	461	9.958965	96	9.659039	558	10.340961	29
32	618281	461	958908	96	659373	557	340627	28
33	618558	461	958850	96	659708	557	340292	27
34	618834	460	958792	96	660042	557	339958	26
35	619110	460	958734	96	660376	557	339624	25
36	619386	460	958677	96	660710	556	339290	24
37	619662	459	958619	96	661043	556	338957	23
38	619938	459	958561	96	661377	556	338623	22
39	620213	459	958503	97	661710	555	338290	21
40	620488	458	958445	97	662043	555	337957	20
41	9.620763	458	9.958387	97	9.662376	555	10.337624	19
42	621038	457	958329	97	662709	554	337291	18
43	621313	457	958271	97	663042	554	336958	17
44	621587	457	958213	97	663375	554	336625	16
45	621861	456	958154	97	663707	554	336293	15
46	622135	456	958096	97	664039	553	335961	14
47	622409	456	958038	97	664371	553	335629	13
48	622682	455	957979	97	664703	553	335297	12
49	622956	455	957921	97	665035	553	334965	11
50	623229	455	957863	97	665366	552	334634	10
51	9.623502	454	9.957804	97	9.665697	552	10.334303	9
52	623774	454	957746	98	666029	552	333971	8
53	624047	454	957687	98	666360	551	333640	7
54	624319	453	957628	98	666691	551	333309	6
55	624591	453	957570	98	667021	551	332979	5
56	624863	453	957511	98	667352	551	332648	4
57	625135	452	957452	98	667682	550	332318	3
58	625406	452	957393	98	668013	550	331987	2
59	625677	452	957335	98	668343	550	331657	1
60	625948	451	957276	98	668672	550	331328	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	M.
0	9.625948	451	9.957276	98	9.668673	550	10.331327	60
1	626219	451	957217	98	669002	549	330998	59
2	626490	451	957158	98	669332	549	330668	58
3	626760	450	957099	98	669661	549	330339	57
4	627030	450	957040	98	669991	548	330009	56
5	627300	450	956981	98	670320	548	329680	55
6	627570	449	956921	99	670649	548	329351	54
7	627840	449	956862	99	670977	548	329023	53
8	628109	449	956803	99	671306	547	328694	52
9	628378	448	956744	99	671634	547	328366	51
10	628647	448	956684	99	671963	547	328037	50
11	9.628916	447	9.956625	99	9.672291	547	10.327709	49
12	629185	447	956566	99	672619	546	327381	48
13	629453	447	956506	99	672947	546	327053	47
14	629721	446	956447	99	673274	546	326726	46
15	629989	446	956387	99	673602	546	326398	45
16	630257	446	956327	99	673929	545	326071	44
17	630524	446	956268	99	674257	545	325743	43
18	630792	445	956208	100	674584	545	325416	42
19	631059	445	956148	100	674910	544	325090	41
20	631326	445	956089	100	675237	544	324763	40
21	9.631593	444	9.956029	100	9.675564	544	10.324436	39
22	631859	444	955969	100	675890	544	324110	38
23	632125	444	955909	100	676216	543	323784	37
24	632392	443	955849	100	676543	543	323457	36
25	632658	443	955789	100	676869	543	323131	35
26	632923	443	955729	100	677194	543	322806	34
27	633189	442	955669	100	677520	542	322480	33
28	633454	442	955609	100	677846	542	322154	32
29	633719	442	955548	100	678171	542	321829	31
30	633984	441	955488	100	678496	542	321504	30
31	9.634249	441	9.955428	101	9.678821	541	10.321179	29
32	634514	440	955368	101	679146	541	320854	28
33	634778	440	955307	101	679471	541	320529	27
34	635042	440	955247	101	679795	541	320205	26
35	635306	439	955186	101	680120	540	319880	25
36	635570	439	955126	101	680444	540	319556	24
37	635834	439	955065	101	680768	540	319232	23
38	636097	438	955005	101	681092	540	318908	22
39	636360	438	954944	101	681416	539	318584	21
40	636623	438	954883	101	681740	539	318260	20
41	9.636886	437	9.954823	101	9.682063	539	10.317937	19
42	637148	437	954762	101	682387	539	317613	18
43	637411	437	954701	101	682710	538	317290	17
44	637673	437	954640	101	683033	538	316967	16
45	637935	436	954579	101	683356	538	316644	15
46	638197	436	954518	102	683679	538	316321	14
47	638458	436	954457	102	684001	537	315999	13
48	638720	435	954396	102	684324	537	315676	12
49	638981	435	954335	102	684646	537	315354	11
50	639242	435	954274	102	684968	537	315032	10
51	9.639503	434	9.954213	102	9.685290	536	10.314710	9
52	639764	434	954152	102	685612	536	314388	8
53	640024	434	954090	102	685934	536	314066	7
54	640284	433	954029	102	686255	536	313745	6
55	640544	433	953968	102	686577	535	313423	5
56	640804	433	953906	102	686898	535	313102	4
57	641064	432	953845	102	687219	535	312781	3
58	641324	432	953783	102	687540	535	312460	2
59	641584	432	953722	103	687861	534	312139	1
60	641842	431	953660	103	688182	534	311818	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	
0	9.641842	431	9.953660	103	9.688182	534	10.311818	60
1	642101	431	953599	103	688502	534	311498	59
2	642360	431	953537	103	688823	534	311177	58
3	642618	430	953475	103	689143	533	310857	57
4	642877	430	953413	103	689463	533	310537	56
5	643135	430	953352	103	689783	533	310217	55
6	643393	430	953290	103	690103	533	309897	54
7	643650	429	953228	103	690423	533	309577	53
8	643908	429	953166	103	690742	532	309258	52
9	644165	429	953104	103	691062	532	308938	51
10	644423	428	953042	103	691381	532	308619	50
11	9.644680	428	9.952980	104	9.691700	531	10.308300	49
12	644936	428	952918	104	692019	531	307981	48
13	645193	427	952855	104	692338	531	307662	47
14	645450	427	952793	104	692656	531	307344	46
15	645706	427	952731	104	692975	531	307025	45
16	645962	426	952669	104	693293	530	306707	44
17	646218	426	952606	104	693612	530	306388	43
18	646474	426	952544	104	693930	530	306070	42
19	646729	425	952481	104	694248	530	305752	41
20	646984	425	952419	104	694566	529	305434	40
21	9.647240	425	9.952356	104	9.694883	529	10.305117	39
22	647494	424	952294	104	695201	529	304799	38
23	647749	424	952231	104	695518	529	304482	37
24	648004	424	952168	105	695836	529	304164	36
25	648258	424	952106	105	696153	528	303847	35
26	648512	423	952043	105	696470	528	303530	34
27	648766	423	951980	105	696787	528	303213	33
28	649020	423	951917	105	697103	528	302897	32
29	649274	422	951854	105	697420	527	302580	31
30	649527	422	951791	105	697736	527	302264	30
31	9.649781	422	9.951728	105	9.698053	527	10.301947	29
32	650034	422	951665	105	698369	527	301631	28
33	650287	421	951602	105	698685	526	301315	27
34	650539	421	951539	105	699001	526	300999	26
35	650792	421	951476	105	699316	526	300684	25
36	651044	420	951412	105	699632	526	300368	24
37	651297	420	951349	106	699947	526	300053	23
38	651549	420	951286	106	700263	525	299737	22
39	651800	419	951222	106	700578	525	299422	21
40	652052	419	951159	106	700893	525	299107	20
41	9.652304	419	9.951096	106	9.701208	524	10.298792	19
42	652555	418	951032	106	701523	524	298477	18
43	652806	418	950968	106	701837	524	298163	17
44	653057	418	950905	106	702152	524	297848	16
45	653308	418	950841	106	702466	524	297534	15
46	653558	417	950778	106	702780	523	297220	14
47	653808	417	950714	106	703095	523	296905	13
48	654059	417	950650	106	703409	523	296591	12
49	654309	416	950586	106	703723	523	296277	11
50	654558	416	950522	107	704036	522	295964	10
51	9.654808	416	9.950458	107	9.704350	522	10.295650	9
52	655058	416	950394	107	704663	522	295337	8
53	655307	415	950330	107	704977	522	295023	7
54	655556	415	950266	107	705290	522	294710	6
55	655805	415	950202	107	705603	521	294397	5
56	656054	414	950138	107	705916	521	294084	4
57	656302	414	950074	107	706228	521	293772	3
58	656551	414	950010	107	706541	521	293459	2
59	656799	413	949945	107	706854	521	293146	1
60	657047	413	949881	107	707166	520	292834	0
	Cosine		Sine		Cotang.		Tang.	M.

M	Sine	D	Cosine	D.	Tang.	D.	Cotang.	M.
0	9.657047	413	9.949881	107	9.707166	520	10.292834	60
1	657295	413	949816	107	707478	520	292522	59
2	657542	412	949752	107	707790	520	292210	58
3	657790	412	949688	108	708102	520	291898	57
4	658037	412	949623	108	708414	519	291586	56
5	658284	412	949558	108	708726	519	291274	55
6	658531	411	949494	108	709037	519	290963	54
7	658778	411	949429	108	709349	519	290651	53
8	659025	411	949364	108	709660	519	290340	52
9	659271	410	949300	108	709971	518	290029	51
10	659517	410	949235	108	710282	518	289718	50
11	9.659763	410	9.949170	108	9.710593	518	10.289407	49
12	660009	409	949105	108	710904	518	289096	48
13	660255	409	949040	108	711215	518	288785	47
14	660501	409	948975	108	711525	517	288475	46
15	660746	409	948910	108	711836	517	288164	45
16	660991	408	948845	108	712146	517	287854	44
17	661236	408	948780	109	712456	517	287544	43
18	661481	408	948715	109	712766	516	287234	42
19	661726	407	948650	109	713076	516	286924	41
20	661970	407	948584	109	713386	516	286614	40
21	9.662214	407	9.948519	109	9.713696	516	10.286304	39
22	662459	407	948454	109	714005	516	285995	38
23	662703	406	948388	109	714314	515	285686	37
24	662946	406	948323	109	714624	515	285376	36
25	663190	406	948257	109	714933	515	285067	35
26	663433	405	948192	109	715242	515	284758	34
27	663677	405	948126	109	715551	514	284449	33
28	663920	405	948060	109	715860	514	284140	32
29	664163	405	947995	110	716168	514	283832	31
30	664406	404	947929	110	716477	514	283523	30
31	9.664648	404	9.947863	110	9.716785	514	10.283215	29
32	664891	404	947797	110	717093	513	282907	28
33	665133	403	947731	110	717401	513	282599	27
34	665375	403	947665	110	717709	513	282291	26
35	665617	403	947600	110	718017	513	281983	25
36	665859	402	947533	110	718325	513	281675	24
37	666100	402	947467	110	718633	512	281367	23
38	666342	402	947401	110	718940	512	281060	22
39	666583	402	947335	110	719248	512	280752	21
40	666824	401	947269	110	719555	512	280445	20
41	9.667065	401	9.947203	110	9.719862	512	10.280138	19
42	667305	401	947136	111	720169	511	279831	18
43	667546	401	947070	111	720476	511	279524	17
44	667786	400	947004	111	720783	511	279217	16
45	668027	400	946937	111	721089	511	278911	15
46	668267	400	946871	111	721396	511	278604	14
47	668506	399	946804	111	721702	510	278298	13
48	668746	399	946738	111	722009	510	277991	12
49	668986	399	946671	111	722315	510	277685	11
50	669225	399	946604	111	722621	510	277379	10
51	9.669464	398	9.946538	111	9.722927	510	10.277073	9
52	669703	398	946471	111	723232	509	276768	8
53	669942	398	946404	111	723538	509	276462	7
54	670181	397	946337	111	723844	509	276156	6
55	670419	397	946270	112	724149	509	275851	5
56	670658	397	946203	112	724454	509	275546	4
57	670896	397	946136	112	724759	508	275241	3
58	671134	396	946069	112	725065	508	274935	2
59	671372	396	946002	112	725369	508	274631	1
60	671609	396	945935	112	725674	508	274326	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	M.
0	9.671609	396	9.945935	112	9.725674	508	10.274323	60
1	671847	395	945868	112	725979	508	274021	59
2	672084	395	945800	112	726284	507	273716	58
3	672321	395	945733	112	726588	507	273412	57
4	672558	395	945666	112	726892	507	273108	56
5	672795	394	945598	112	727197	507	272803	55
6	673032	394	945531	112	727501	507	272499	54
7	673268	394	945464	113	727805	506	272195	53
8	673505	394	945396	113	728109	506	271891	52
9	673741	393	945328	113	728412	506	271588	51
10	673977	393	945261	113	728716	506	271284	50
11	9.674213	393	9.945193	113	9.729020	506	10.270980	49
12	674448	392	945125	113	729323	505	270677	48
13	674684	392	945058	113	729626	505	270374	47
14	674919	392	944990	113	729929	505	270071	46
15	675155	392	944922	113	730233	505	269767	45
16	675390	391	944854	113	730535	505	269465	44
17	675624	391	944786	113	730838	504	269162	43
18	675859	391	944718	113	731141	504	268859	42
19	676094	391	944650	113	731444	504	268556	41
20	676328	390	944582	114	731746	504	268254	40
21	9.676562	390	9.944514	114	9.732048	504	10.267952	39
22	676796	390	944446	114	732351	503	267649	38
23	677030	390	944377	114	732653	503	267347	37
24	677264	389	944309	114	732955	503	267045	36
25	677498	389	944241	114	733257	503	266743	35
26	677731	389	944172	114	733558	503	266442	34
27	677964	388	944104	114	733860	502	266140	33
28	678197	388	944036	114	734162	502	265838	32
29	678430	388	943967	114	734463	502	265537	31
30	678663	388	943899	114	734764	502	265236	30
31	9.678895	387	9.943830	114	9.735066	502	10.264931	29
32	679128	387	943761	114	735367	502	264633	28
33	679360	387	943693	115	735668	501	264332	27
34	679592	387	943624	115	735969	501	264031	26
35	679824	386	943555	115	736269	501	263731	25
36	680056	386	943486	115	736570	501	263430	24
37	680288	386	943417	115	736871	501	263129	23
38	680519	385	943348	115	737171	500	262829	22
39	680750	385	943279	115	737471	500	262529	21
40	680982	385	943210	115	737771	500	262229	20
41	9.681213	385	9.943141	115	9.738071	500	10.261929	19
42	681443	384	943072	115	738371	500	261629	18
43	681674	384	943003	115	738671	499	261329	17
44	681905	384	942934	115	738971	499	261029	16
45	682135	384	942864	115	739271	499	260729	15
46	682365	383	942795	116	739570	499	260430	14
47	682595	383	942726	116	739870	499	260130	13
48	682825	383	942656	116	740169	499	259831	12
49	683055	383	942587	116	740468	498	259532	11
50	683284	382	942517	116	740767	498	259233	10
51	9.683514	382	9.942448	116	9.741066	498	10.258934	9
52	683743	382	942378	116	741365	498	258635	8
53	683972	382	942308	116	741664	498	258336	7
54	684201	381	942239	116	741962	497	258038	6
55	684430	381	942169	116	742261	497	257739	5
56	684658	381	942099	116	742559	497	257441	4
57	684887	380	942029	116	742858	497	257142	3
58	685115	380	941959	116	743156	497	256844	2
59	685343	380	941889	117	743454	497	256546	1
60	685571	380	941819	117	743752	496	256248	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	
0	9.685571	380	9.941819	117	9.743752	496	10.256248	60
1	685799	379	941749	117	744050	496	255950	59
2	686027	379	941679	117	744348	496	255652	58
3	686254	379	941609	117	744645	496	255355	57
4	686482	379	941539	117	744943	496	255057	56
5	686709	378	941469	117	745240	496	254760	55
6	686936	378	941398	117	745538	495	254462	54
7	687163	378	941328	117	745835	495	254165	53
8	687389	378	941258	117	746132	495	253868	52
9	687616	377	941187	117	746429	495	253571	51
10	687843	377	941117	117	746726	495	253274	50
11	9.688069	377	9.941046	118	9.747023	494	10.252977	49
12	688295	377	940975	118	747319	494	252681	48
13	688521	376	940905	118	747616	494	252384	47
14	688747	376	940834	118	747913	494	252087	46
15	688972	376	940763	118	748209	494	251791	45
16	689198	376	940693	118	748505	493	251495	44
17	689423	375	940622	118	748801	493	251199	43
18	689648	375	940551	118	749097	493	250903	42
19	689873	375	940480	118	749393	493	250607	41
20	690098	375	940409	118	749689	493	250311	40
21	9.690323	374	9.940338	118	9.749985	493	10.250015	39
22	690548	374	940267	118	750281	492	249719	38
23	690772	374	940196	118	750576	492	249424	37
24	690996	374	940125	119	750872	492	249128	36
25	691220	373	940054	119	751167	492	248833	35
26	691444	373	939982	119	751462	492	248538	34
27	691668	373	939911	119	751757	492	248243	33
28	691892	373	939840	119	752052	491	247948	32
29	692115	372	939768	119	752347	491	247653	31
30	692339	372	939697	119	752642	491	247358	30
31	9.692562	372	9.939625	119	9.752937	491	10.247063	29
32	692785	371	939554	119	753231	491	246769	28
33	693008	371	939482	119	753526	491	246474	27
34	693231	371	939410	119	753820	490	246180	26
35	693453	371	939339	119	754115	490	245885	25
36	693676	370	939267	120	754409	490	245591	24
37	693898	370	939195	120	754703	490	245297	23
38	694120	370	939123	120	754997	490	245003	22
39	694342	370	939052	120	755291	490	244709	21
40	694564	369	938980	120	755585	489	244415	20
41	9.694786	369	9.938908	120	9.755878	489	10.244122	19
42	695007	369	938836	120	756172	489	243828	18
43	695229	369	938763	120	756465	489	243535	17
44	695450	368	938691	120	756759	489	243241	16
45	695671	368	938619	120	757052	489	242948	15
46	695892	368	938547	120	757345	488	242655	14
47	696113	368	938475	120	757638	488	242362	13
48	696334	367	938402	121	757931	488	242069	12
49	696554	367	938330	121	758224	488	241776	11
50	696775	367	938258	121	758517	488	241483	10
51	9.696995	367	9.938185	121	9.758810	488	10.241190	9
52	697215	366	938113	121	759102	487	240898	8
53	697435	366	938040	121	759395	487	240605	7
54	697654	366	937967	121	759687	487	240313	6
55	697874	366	937895	121	759979	487	240021	5
56	698094	365	937822	121	760272	487	239728	4
57	698313	365	937749	121	760564	487	239436	3
58	698532	365	937676	121	760856	486	239144	2
59	698751	365	937604	121	761148	486	238852	1
60	698970	364	937531	121	761439	486	238561	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	M.
0	9.698970	364	9.937521	121	9.761439	486	10.238561	60
1	699189	364	937458	122	761731	486	238269	59
2	699407	364	937385	122	762023	486	237977	58
3	699626	364	937312	122	762314	486	237686	57
4	699844	363	937238	122	762606	485	237394	56
5	700062	363	937165	122	762897	485	237103	55
6	700280	363	937092	122	763188	485	236812	54
7	700498	363	937019	122	763479	485	236521	53
8	700716	363	936946	122	763770	485	236230	52
9	700933	362	936872	122	764061	485	235939	51
10	701151	362	936799	122	764352	484	235648	50
11	9.701368	362	9.936725	122	9.764643	484	10.235357	49
12	701585	362	936652	123	764933	484	235067	48
13	701802	361	936578	123	765224	484	234776	47
14	702019	361	936505	123	765514	484	234486	46
15	702236	361	936431	123	765805	484	234195	45
16	702452	361	936357	123	766095	484	233905	44
17	702669	360	936284	123	766385	483	233615	43
18	702885	360	936210	123	766675	483	233325	42
19	703101	360	936136	123	766965	483	233035	41
20	703317	360	936062	123	767255	483	232745	40
21	9.703533	359	9.935988	123	9.767545	483	10.232455	39
22	703749	359	935914	123	767834	483	232166	38
23	703964	359	935840	123	768124	482	231876	37
24	704179	359	935766	124	768413	482	231587	36
25	704395	359	935692	124	768703	482	231297	35
26	704610	358	935618	124	768992	482	231008	34
27	704825	358	935543	124	769281	482	230719	33
28	705040	358	935469	124	769570	482	230430	32
29	705254	358	935395	124	769860	481	230140	31
30	705469	357	935320	124	770148	481	229852	30
31	9.705683	357	9.935246	124	9.770437	481	10.229563	29
32	705898	357	935171	124	770726	481	229274	28
33	706112	357	935097	124	771015	481	228985	27
34	706326	356	935022	124	771303	481	228697	26
35	706539	356	934948	124	771592	481	228408	25
36	706753	356	934873	124	771880	480	228120	24
37	706967	356	934798	125	772168	480	227832	23
38	707180	355	934723	125	772457	480	227543	22
39	707393	355	934649	125	772745	480	227255	21
40	707606	355	934574	125	773033	480	226967	20
41	9.707819	355	9.934499	125	9.773321	480	10.226679	19
42	708032	354	934424	125	773608	479	226392	18
43	708245	354	934349	125	773896	479	226104	17
44	708458	354	934274	125	774184	479	225816	16
45	708670	354	934199	125	774471	479	225529	15
46	708882	353	934123	125	774759	479	225241	14
47	709094	353	934048	125	775046	479	224954	13
48	709306	353	933973	125	775333	479	224667	12
49	709518	353	933898	126	775621	478	224379	11
50	709730	353	933822	126	775908	478	224092	10
51	9.709941	352	9.933747	126	9.776195	478	10.223805	9
52	710153	352	933671	126	776482	478	223518	8
53	710364	352	933596	126	776769	478	223231	7
54	710575	352	933520	126	777055	478	222945	6
55	710786	351	933445	126	777342	478	222658	5
56	710997	351	933369	126	777628	477	222372	4
57	711208	351	933293	126	777915	477	222085	3
58	711419	351	933217	126	778201	477	221799	2
59	711629	350	933141	126	778487	477	221512	1
60	711839	350	933066	126	778774	477	221226	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	M.
0	9 711839	350	9.933066	126	9.778774	477	10.221226	60
1	712050	350	932990	127	779060	477	220940	59
2	712260	350	932914	127	779346	176	220654	58
3	712469	349	932838	127	779632	476	220368	57
4	712679	349	932762	127	779918	476	220082	56
5	712889	349	932685	127	780203	476	219797	55
6	713098	349	932609	127	780489	476	219511	54
7	713308	349	932533	127	780775	476	219225	53
8	713517	348	932457	127	781060	476	218940	52
9	713726	348	932380	127	781346	475	218654	51
10	713935	348	932304	127	781631	475	218369	50
11	9.714144	348	9.932228	127	9.781916	475	10.218084	49
12	714352	347	932151	127	782201	475	217799	48
13	714561	347	932075	128	782486	475	217514	47
14	714769	347	931998	128	782771	475	217229	46
15	714978	347	931921	128	783056	475	216944	45
16	715186	347	931845	128	783341	475	216659	44
17	715394	346	931768	128	783626	474	216374	43
18	715602	346	931691	128	783910	474	216090	42
19	715809	346	931614	128	784195	474	215805	41
20	716017	346	931537	128	784479	474	215521	40
21	9.716224	345	9.931460	128	9.784764	474	10.215236	39
22	716432	345	931383	128	785048	474	214952	38
23	716639	345	931306	128	785332	473	214668	37
24	716846	345	931229	129	785616	473	214384	36
25	717053	345	931152	129	785900	473	214100	35
26	717259	344	931075	129	786184	473	213816	34
27	717466	344	930998	129	786468	473	213532	33
28	717673	344	930921	129	786752	473	213248	32
29	717879	344	930843	129	787036	473	212964	31
30	718085	343	930766	129	787319	472	212681	30
31	9.718291	343	9.930688	129	9.787603	472	10.212397	29
32	718497	343	930611	129	787886	472	212114	28
33	718703	343	930533	129	788170	472	211830	27
34	718909	343	930456	129	788453	472	211547	26
35	719114	342	930378	129	788736	472	211264	25
36	719320	342	930300	130	789019	472	210981	24
37	719525	342	930223	130	789302	471	210698	23
38	719730	342	930145	130	789585	471	210415	22
39	719935	341	930067	130	789868	471	210132	21
40	720140	341	929989	130	790151	471	209849	20
41	9.720345	341	9.929911	130	9.790433	471	10.209567	19
42	720549	341	929833	130	790716	471	209284	18
43	720754	340	929755	130	790999	471	209001	17
44	720958	340	929677	130	791281	471	208719	16
45	721162	340	929599	130	791563	470	208437	15
46	721366	340	929521	130	791846	470	208154	14
47	721570	340	929442	130	792128	470	207872	13
48	721774	339	929364	131	792410	470	207590	12
49	721978	339	929286	131	792692	470	207308	11
50	722181	339	929207	131	792974	470	207026	10
51	9.722385	339	9.929129	131	9.793256	470	10.206744	9
52	722588	339	929050	131	793538	469	206462	8
53	722791	338	928972	131	793819	469	206181	7
54	722994	338	928893	131	794101	469	205899	6
55	723197	338	928815	131	794383	469	205617	5
56	723400	338	928736	131	794664	469	205336	4
57	723603	337	928657	131	794945	469	205055	3
58	723805	337	928578	131	795227	469	204773	2
59	724007	337	928499	131	795508	468	204492	1
60	724210	337	928420	131	795789	468	204211	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	M.
0	9.724210	337	9.928420	132	9.795789	468	10.204211	60
1	724412	337	928342	132	796070	468	203930	59
2	724614	336	928263	132	796351	468	203649	58
3	724816	336	928183	132	796632	468	203368	57
4	725017	335	928104	132	796913	468	203087	56
5	725219	336	928025	132	797194	468	202806	55
6	725420	335	927946	132	797475	468	202525	54
7	725622	335	927867	132	797755	468	202245	53
8	725823	335	927787	132	798036	467	201964	52
9	726024	335	927708	132	798316	467	201684	51
10	726225	335	927629	132	798596	467	201404	50
11	9.726426	334	9.927549	132	9.798877	467	10.201123	49
12	726626	334	927470	133	799157	467	200843	48
13	726827	334	927390	133	799437	467	200563	47
14	727027	334	927310	133	799717	467	200283	46
15	727228	334	927231	133	799997	466	200003	45
16	727428	333	927151	133	800277	466	199723	44
17	727628	333	927071	133	800557	466	199443	43
18	727828	333	926991	133	800836	466	199164	42
19	728027	333	926911	133	801116	466	198884	41
20	728227	333	926831	133	801396	466	198604	40
21	9.728427	332	9.926751	133	9.801675	466	10.198325	39
22	728626	332	926671	133	801955	466	198045	38
23	728825	332	926591	133	802234	465	197766	37
24	729024	332	926511	134	802513	465	197487	36
25	729223	331	926431	134	802792	465	197208	35
26	729422	331	926351	134	803072	465	196928	34
27	729621	331	926270	134	803351	465	196649	33
28	729820	331	926190	134	803630	465	196370	32
29	730018	330	926110	134	803908	465	196092	31
30	730216	330	926029	134	804187	465	195813	30
31	9.730415	330	9.925949	134	9.804466	464	10.195534	29
32	730613	330	925868	134	804745	464	195255	28
33	730811	330	925788	134	805023	464	194977	27
34	731009	329	925707	134	805302	464	194698	26
35	731206	329	925626	134	805580	464	194420	25
36	731404	329	925545	135	805859	464	194141	24
37	731602	329	925465	135	806137	464	193863	23
38	731799	329	925384	135	806415	463	193585	22
39	731996	328	925303	135	806693	463	193307	21
40	732193	328	925222	135	806971	463	193029	20
41	9.732390	328	9.925141	135	9.807249	463	10.192751	19
42	732587	328	925060	135	807527	463	192473	18
43	732784	328	924979	135	807805	463	192195	17
44	732980	327	924897	135	808083	463	191917	16
45	733177	327	924816	135	808361	463	191639	15
46	733373	327	924735	136	808638	462	191362	14
47	733569	327	924654	136	808916	462	191084	13
48	733765	327	924572	136	809193	462	190807	12
49	733961	326	924491	136	809471	462	190529	11
50	734157	326	924409	136	809748	462	190252	10
51	9.734353	326	9.924328	136	9.810025	462	10.189975	9
52	734549	326	924246	136	810302	462	189698	8
53	734744	325	924164	136	810580	462	189420	7
54	734939	325	924083	136	810857	462	189143	6
55	735135	325	924001	136	811134	461	188866	5
56	735330	325	923919	136	811410	461	188590	4
57	735525	325	923837	136	811687	461	188313	3
58	735719	324	923755	137	811964	461	188036	2
59	735914	324	923673	137	812241	461	187759	1
60	736109	324	923591	137	812517	461	187483	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	M.
0	9.736109	324	9.923591	137	9.812517	461	10.187482	60
1	736303	324	923509	137	812794	461	187206	59
2	736498	324	923427	137	813070	461	186930	58
3	736692	323	923345	137	813347	460	186653	57
4	736886	323	923263	137	813623	460	186377	56
5	737080	323	923181	137	813899	460	186101	55
6	737274	323	923098	137	814175	460	185825	54
7	737467	323	923016	137	814452	460	185548	53
8	737661	322	922933	137	814728	460	185272	52
9	737855	322	922851	137	815004	460	184996	51
10	738048	322	922768	138	815279	460	184721	50
11	9.738241	322	9.922686	138	9.815555	459	10.184445	49
12	738434	322	922603	138	815831	459	184169	48
13	738627	321	922520	138	816107	459	183893	47
14	738820	321	922438	138	816382	459	183618	46
15	739013	321	922355	138	816658	459	183342	45
16	739206	321	922272	138	816933	459	183067	44
17	739398	321	922189	138	817209	459	182791	43
18	739590	320	922106	138	817484	459	182516	42
19	739783	320	922023	138	817759	459	182241	41
20	739975	320	921940	138	818035	458	181965	40
21	9.740167	320	9.921857	139	9.818310	458	10.181690	39
22	740359	320	921774	139	818585	458	181415	38
23	740550	319	921691	139	818860	458	181140	37
24	740742	319	921607	139	819135	458	180865	36
25	740934	319	921524	139	819410	458	180590	35
26	741125	319	921441	139	819684	458	180316	34
27	741316	319	921357	139	819959	458	180041	33
28	741508	318	921274	139	820234	458	179766	32
29	741699	318	921190	139	820508	457	179492	31
30	741889	318	921107	139	820783	457	179217	30
31	9.742080	318	9.921023	139	9.821057	457	10.178943	29
32	742271	318	920939	140	821332	457	178668	28
33	742462	317	920856	140	821606	457	178394	27
34	742652	317	920772	140	821880	457	178120	26
35	742842	317	920688	140	822154	457	177846	25
36	743033	317	920604	140	822429	457	177571	24
37	743223	317	920520	140	822703	457	177297	23
38	743413	316	920436	140	822977	456	177023	22
39	743602	316	920352	140	823250	456	176750	21
40	743792	316	920268	140	823524	456	176476	20
41	9.743982	316	9.920184	140	9.823798	456	10.176202	19
42	744171	316	920099	140	824072	456	175928	18
43	744361	315	920015	140	824345	456	175655	17
44	744550	315	919931	141	824619	456	175381	16
45	744739	315	919846	141	824893	456	175107	15
46	744928	315	919762	141	825166	456	174834	14
47	745117	315	919677	141	825439	455	174561	13
48	745306	314	919593	141	825713	455	174287	12
49	745494	314	919508	141	825986	455	174014	11
50	745683	314	919424	141	826259	455	173741	10
51	9.745871	314	9.919339	141	9.826532	455	10.173468	9
52	746059	314	919254	141	826805	455	173195	8
53	746248	313	919169	141	827078	455	172922	7
54	746436	313	919085	141	827351	455	172649	6
55	746624	313	919000	141	827624	455	172376	5
56	746812	313	918915	142	827897	454	172103	4
57	746999	313	918830	142	828170	454	171830	3
58	747187	312	918745	142	828442	454	171558	2
59	747374	312	918659	142	828715	454	171285	1
60	747562	312	918574	142	828987	454	171013	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	M.
0	9.747562	312	9.918574	142	9.828987	454	10.171013	60
1	747749	312	918489	142	829260	454	170740	59
2	747936	312	918404	142	829532	454	170468	58
3	748123	311	918318	142	829805	454	170195	57
4	748310	311	918233	142	830077	454	169923	56
5	748497	311	918147	142	830349	453	169651	55
6	748683	311	918062	142	830621	453	169379	54
7	748870	311	917976	143	830893	453	169107	53
8	749056	310	917891	143	831165	453	168835	52
9	749243	310	917805	143	831437	453	168563	51
10	749429	310	917719	143	831709	453	168291	50
11	9.749615	310	9.917634	143	9.831981	453	10.168019	49
12	749801	310	917548	143	832253	453	167747	48
13	749987	309	917462	143	832525	453	167475	47
14	750172	309	917376	143	832796	453	167204	46
15	750358	309	917290	143	833068	452	166932	45
16	750543	309	917204	143	833339	452	166661	44
17	750729	309	917118	144	833611	452	166389	43
18	750914	308	917032	144	833882	452	166118	42
19	751099	308	916946	144	834154	452	165846	41
20	751284	308	916859	144	834425	452	165575	40
21	9.751469	308	9.916773	144	9.834696	452	10.165304	39
22	751654	308	916687	144	834967	452	165033	38
23	751839	308	916600	144	835238	452	164762	37
24	752023	307	916514	144	835509	452	164491	36
25	752208	307	916427	144	835780	451	164220	35
26	752392	307	916341	144	836051	451	163949	34
27	752576	307	916254	144	836322	451	163678	33
28	752760	307	916167	145	836593	451	163407	32
29	752944	306	916081	145	836864	451	163136	31
30	753128	306	915994	145	837134	451	162866	30
31	9.753312	306	9.915907	145	9.837405	451	10.162595	29
32	753495	306	915820	145	837675	451	162325	28
33	753679	306	915733	145	837946	451	162054	27
34	753862	305	915646	145	838216	451	161784	26
35	754046	305	915559	145	838487	450	161513	25
36	754229	305	915472	145	838757	450	161243	24
37	754412	305	915385	145	839027	450	160973	23
38	754595	305	915297	145	839297	450	160703	22
39	754778	304	915210	145	839568	450	160432	21
40	754960	304	915123	146	839838	450	160162	20
41	9.755143	304	9.915035	146	9.840108	450	10.159892	19
42	755326	304	914948	146	840378	450	159622	18
43	755508	304	914860	146	840647	450	159353	17
44	755690	304	914773	146	840917	449	159083	16
45	755872	303	914685	146	841187	449	158813	15
46	756054	303	914598	146	841457	449	158543	14
47	756236	303	914510	146	841726	449	158274	13
48	756418	303	914422	146	841996	449	158004	12
49	756600	303	914334	146	842266	449	157734	11
50	756782	302	914246	147	842535	449	157465	10
51	9.756963	302	9.914158	147	9.842805	449	10.157195	9
52	757144	302	914070	147	843074	449	156926	8
53	757326	302	913982	147	843343	449	156657	7
54	757507	302	913894	147	843612	449	156388	6
55	757688	301	913806	147	843882	448	156118	5
56	757869	301	913718	147	844151	448	155849	4
57	758050	301	913630	147	844420	448	155580	3
58	758230	301	913541	147	844689	448	155311	2
59	758411	301	913453	147	844958	448	155042	1
60	758591	301	913365	147	845227	448	154773	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	M.
0	9.758591	301	9.913365	147	9.845227	448	10.154773	60
1	758772	300	913276	147	845496	448	154504	59
2	758952	300	913187	148	845764	448	154236	58
3	759132	300	913099	148	846033	448	153967	57
4	759312	300	913010	148	846302	448	153698	56
5	759492	300	912922	148	846570	447	153430	55
6	759672	299	912833	148	846839	447	153161	54
7	759852	299	912744	148	847107	447	152893	53
8	760031	299	912655	148	847376	447	152624	52
9	760211	299	912566	148	847644	447	152356	51
10	760390	299	912477	148	847913	447	152087	50
11	9.760569	298	9.912388	148	9.848181	447	10.151819	49
12	760748	298	912299	149	848449	447	151551	48
13	760927	298	912210	149	848717	447	151283	47
14	761106	298	912121	149	848986	447	151014	46
15	761285	298	912031	149	849254	447	150746	45
16	761464	298	911942	149	849522	447	150478	44
17	761642	297	911853	149	849790	446	150210	43
18	761821	297	911763	149	850058	446	149942	42
19	761999	297	911674	149	850325	446	149675	41
20	762177	297	911584	149	850593	446	149407	40
21	9.762356	297	9.911495	149	9.850861	446	10.149139	39
22	762534	296	911405	149	851129	446	148871	38
23	762712	296	911315	150	851396	446	148604	37
24	762889	296	911226	150	851664	446	148336	36
25	763067	296	911136	150	851931	446	148069	35
26	763245	296	911046	150	852199	446	147801	34
27	763422	296	910956	150	852466	446	147534	33
28	763600	295	910866	150	852733	445	147267	32
29	763777	295	910776	150	853001	445	146999	31
30	763954	295	910686	150	853268	445	146732	30
31	9.764131	295	9.910596	150	9.853535	445	10.146465	29
32	764308	295	910506	150	853802	445	146198	28
33	764485	294	910415	150	854069	445	145931	27
34	764662	294	910325	151	854336	445	145664	26
35	764838	294	910235	151	854603	445	145397	25
36	765015	294	910144	151	854870	445	145130	24
37	765191	294	910054	151	855137	445	144863	23
38	765367	294	909963	151	855404	445	144596	22
39	765544	293	909873	151	855671	444	144329	21
40	765720	293	909782	151	855938	444	144062	20
41	9.765896	293	9.909691	151	9.856204	444	10.143796	19
42	766072	293	909601	151	856471	444	143529	18
43	766247	293	909510	151	856737	444	143263	17
44	766423	293	909419	151	857004	444	142996	16
45	766598	292	909328	152	857270	444	142730	15
46	766774	292	909237	152	857537	444	142463	14
47	766949	292	909146	152	857803	444	142197	13
48	767124	292	909055	152	858069	444	141931	12
49	767300	292	908964	152	858336	444	141664	11
50	767475	291	908873	152	858602	443	141398	10
51	9.767649	291	9.908781	152	9.858868	443	10.141132	9
52	767824	291	908690	152	859134	443	140866	8
53	767999	291	908599	152	859400	443	140600	7
54	768173	291	908507	152	859666	443	140334	6
55	768348	290	908416	153	859932	443	140068	5
56	768522	290	908324	153	860198	443	139802	4
57	768697	290	908233	153	860464	443	139536	3
58	768871	290	908141	153	860730	443	139270	2
59	769045	290	908049	153	860995	443	139005	1
60	769219	290	907958	153	861261	443	138739	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	
0	9.769219	290	9.907958	153	9.861261	443	10.138739	60
1	769393	289	907866	153	861527	443	138473	59
2	769566	289	907774	153	861792	442	138208	58
3	769740	289	907682	153	862058	442	137942	57
4	769913	289	907590	153	862323	442	137677	56
5	770087	289	907498	153	862589	442	137411	55
6	770260	288	907406	153	862854	442	137146	54
7	770433	288	907314	154	863119	442	136881	53
8	770606	288	907222	154	863385	442	136615	52
9	770779	288	907129	154	863650	442	136350	51
10	770952	288	907037	154	863915	442	136085	50
11	9.771125	288	9.906945	154	9.864180	442	10.135820	49
12	771298	287	906852	154	864445	442	135555	48
13	771470	287	906760	154	864710	442	135290	47
14	771643	287	906667	154	864975	441	135025	46
15	771815	287	906575	154	865240	441	134760	45
16	771987	287	906482	154	865505	441	134495	44
17	772159	287	906389	155	865770	441	134230	43
18	772331	286	906296	155	866035	441	133965	42
19	772503	286	906204	155	866300	441	133700	41
20	772675	286	906111	155	866564	441	133436	40
21	9.772847	286	9.906018	155	9.866829	441	10.133171	39
22	773018	286	905925	155	867094	441	132906	38
23	773190	286	905832	155	867358	441	132642	37
24	773361	285	905739	155	867623	441	132377	36
25	773533	285	905645	155	867887	441	132113	35
26	773704	285	905552	155	868152	440	131848	34
27	773875	285	905459	155	868416	440	131584	33
28	774046	285	905366	156	868680	440	131320	32
29	774217	285	905272	156	868945	440	131055	31
30	774388	284	905179	156	869209	440	130791	30
31	9.774558	284	9.905085	156	9.869473	440	10.130527	29
32	774729	284	904992	156	869737	440	130263	28
33	774899	284	904898	156	870001	440	129999	27
34	775070	284	904804	156	870265	440	129735	26
35	775240	284	904711	156	870529	440	129471	25
36	775410	283	904617	156	870793	440	129207	24
37	775580	283	904523	156	871057	440	128943	23
38	775750	283	904429	157	871321	440	128679	22
39	775920	283	904335	157	871585	440	128415	21
40	776090	283	904241	157	871849	439	128151	20
41	9.776259	283	9.904147	157	9.872112	439	10.127888	19
42	776429	282	904053	157	872376	439	127624	18
43	776598	282	903959	157	872640	439	127360	17
44	776768	282	903864	157	872903	439	127097	16
45	776937	282	903770	157	873167	439	126833	15
46	777106	282	903676	157	873430	439	126570	14
47	777275	281	903581	157	873694	439	126306	13
48	777444	281	903487	157	873957	439	126043	12
49	777613	281	903392	158	874220	439	125780	11
50	777781	281	903298	158	874484	439	125516	10
51	9.777950	281	9.903203	158	9.874747	439	10.125253	9
52	778119	281	903108	158	875010	439	124990	8
53	778287	280	903014	158	875273	438	124727	7
54	778455	280	902919	158	875536	438	124464	6
55	778624	280	902824	158	875800	438	124200	5
56	778792	280	902729	158	876063	438	123937	4
57	778960	280	902634	158	876326	438	123674	3
58	779128	280	902539	159	876589	438	123411	2
59	779295	279	902444	159	876851	438	123149	1
60	779463	279	902349	159	877114	438	122886	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	
0	9.779463	279	9.902349	159	9.877114	438	10.122886	60
1	779631	279	902253	159	877377	438	122623	59
2	779798	279	902158	159	877640	438	122360	58
3	779966	279	902063	159	877903	438	122097	57
4	780133	279	901967	159	878165	438	121835	56
5	780300	278	901872	159	878428	438	121572	55
6	780467	278	901776	159	878691	438	121309	54
7	780634	278	901681	159	878953	437	121047	53
8	780801	278	901585	159	879216	437	120784	52
9	780968	278	901490	159	879478	437	120522	51
10	781134	278	901394	160	879741	437	120259	50
11	9.781301	277	9.901298	160	9.880003	437	10.119997	49
12	781468	277	901202	160	880265	437	119735	48
13	781634	277	901106	160	880528	437	119472	47
14	781800	277	901010	160	880790	437	119210	46
15	781966	277	900914	160	881052	437	118948	45
16	782132	277	900818	160	881314	437	118686	44
17	782298	276	900722	160	881576	437	118424	43
18	782464	276	900626	160	881839	437	118161	42
19	782630	276	900529	160	882101	437	117899	41
20	782796	276	900433	161	882363	436	117637	40
21	9.782961	276	9.900337	161	9.882625	436	10.117375	39
22	783127	276	900240	161	882887	436	117113	38
23	783292	275	900144	161	883148	436	116852	37
24	783458	275	900047	161	883410	436	116590	36
25	783623	275	899951	161	883672	436	116328	35
26	783788	275	899854	161	883934	436	116066	34
27	783953	275	899757	161	884196	436	115804	33
28	784118	275	899660	161	884457	436	115543	32
29	784282	274	899564	161	884719	436	115281	31
30	784447	274	899467	162	884980	436	115020	30
31	9.784612	274	9.899370	162	9.885242	436	10.114758	29
32	784776	274	899273	162	885503	436	114497	28
33	784941	274	899176	162	885765	436	114235	27
34	785105	274	899078	162	886026	436	113974	26
35	785269	273	898981	162	886288	436	113712	25
36	785433	273	898884	162	886549	435	113451	24
37	785597	273	898787	162	886810	435	113190	23
38	785761	273	898689	162	887072	435	112928	22
39	785925	273	898592	162	887333	435	112667	21
40	786089	273	898494	163	887594	435	112406	20
41	9.786252	272	9.898397	163	9.887855	435	10.112145	19
42	786416	272	898299	163	888116	435	111884	18
43	786579	272	898202	163	888377	435	111623	17
44	786742	272	898104	163	888639	435	111361	16
45	786906	272	898006	163	888900	435	111100	15
46	787069	272	897908	163	889160	435	110840	14
47	787232	271	897810	163	889421	435	110579	13
48	787395	271	897712	163	889682	435	110318	12
49	787557	271	897614	163	889943	435	110057	11
50	787720	271	897516	163	890204	434	109796	10
51	9.787883	271	9.897418	164	9.890465	434	10.109535	9
52	788045	271	897320	164	890725	434	109275	8
53	788208	271	897222	164	890986	434	109014	7
54	788370	270	897123	164	891247	434	108753	6
55	788532	270	897025	164	891507	434	108493	5
56	788694	270	896926	164	891768	434	108232	4
57	788856	270	896828	164	892028	434	107972	3
58	789018	270	896729	164	892289	434	107711	2
59	789180	270	896631	164	892549	434	107451	1
60	789342	269	896532	164	892810	434	107190	0
	Cosine		Sine		Cotang.		Tang.	

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	M.
0	9.789342	269	9.896532	164	9.892810	434	10.107190	60
1	789504	269	896433	165	893070	434	106930	59
2	789665	269	896335	155	893331	434	106669	58
3	789827	269	896236	165	893591	434	106409	57
4	789988	269	896137	165	893851	434	106149	56
5	790149	269	896038	165	894111	434	105889	55
6	790310	268	895939	165	894371	434	105629	54
7	790471	268	895840	165	894632	433	105368	53
8	790632	268	895741	165	894892	433	105108	52
9	790793	268	895641	165	895152	433	104848	51
10	790954	268	895542	165	895412	433	104588	50
11	9.791115	268	9.895443	166	9.895672	433	10.104328	49
12	791275	267	895343	166	895932	433	104068	48
13	791436	267	895244	166	896192	433	103808	47
14	791596	267	895145	166	896452	433	103548	46
15	791757	267	895045	166	896712	433	103288	45
16	791917	267	894945	166	896971	433	103029	44
17	792077	267	894846	166	897231	433	102769	43
18	792237	266	894746	166	897491	433	102509	42
19	792397	266	894646	166	897751	433	102249	41
20	792557	266	894546	166	898010	433	101990	40
21	9.792716	266	9.894446	167	9.898270	433	10.101730	39
22	792876	266	894346	167	898530	433	101470	38
23	793035	266	894246	167	898789	433	101211	37
24	793195	265	894146	167	899049	432	100951	36
25	793354	265	894046	167	899308	432	100692	35
26	793514	265	893946	167	899568	432	100432	34
27	793673	265	893846	167	899827	432	100173	33
28	793832	265	893745	167	900086	432	999914	32
29	793991	265	893645	167	900346	432	999654	31
30	794150	264	893544	167	900605	432	999395	30
31	9.794308	264	9.893444	168	9.900864	432	10.099136	29
32	794467	264	893343	168	901124	432	998876	28
33	794626	264	893243	168	901383	432	998617	27
34	794784	264	893142	168	901642	432	998358	26
35	794942	264	893041	168	901901	432	998099	25
36	795101	264	892940	168	902160	432	997840	24
37	795259	263	892839	168	902419	432	997581	23
38	795417	263	892739	168	902679	432	997321	22
39	795575	263	892638	168	902938	432	997062	21
40	795733	263	892536	168	903197	431	996803	20
41	9.795891	263	9.892435	169	9.903455	431	10.096545	19
42	796049	263	892334	169	903714	431	996286	18
43	796206	263	892233	169	903973	431	996027	17
44	796364	262	892132	169	904232	431	995768	16
45	796521	262	892030	169	904491	431	995509	15
46	796679	262	891929	169	904750	431	995250	14
47	796836	262	891827	169	905008	431	994992	13
48	796993	262	891726	169	905267	431	994733	12
49	797150	261	891624	169	905526	431	994474	11
50	797307	261	891523	170	905784	431	994216	10
51	9.797464	261	9.891421	170	9.906043	431	10.093957	9
52	797621	261	891319	170	906302	431	993698	8
53	797777	261	891217	170	906560	431	993440	7
54	797934	261	891115	170	906819	431	993181	6
55	798091	261	891013	170	907077	431	992923	5
56	798247	261	890911	170	907336	431	992664	4
57	798403	260	890809	170	907594	431	992406	3
58	798560	260	890707	170	907852	431	992148	2
59	798716	260	890605	170	908111	430	991889	1
60	798872	260	890503	170	908369	430	991631	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine.	D.	Cosine	D.	Tang.	D.	Cotang.	M.
0	9.798872	260	9.890503	170	9.908369	430	10.091631	60
1	799028	260	890400	171	908628	430	091372	59
2	799184	260	890298	171	908886	430	091114	58
3	799339	259	890195	171	909144	430	090856	57
4	799495	259	890093	171	909402	430	090598	56
5	799651	259	889990	171	909660	430	090340	55
6	799806	259	889888	171	909918	430	090082	54
7	799962	259	889785	171	910177	430	089823	53
8	800117	259	889682	171	910435	430	089565	52
9	800272	258	889579	171	910693	430	089307	51
10	800427	258	889477	171	910951	430	089049	50
11	9.800582	258	9.889374	172	9.911209	430	10.088791	49
12	800737	258	889271	172	911467	430	088533	48
13	800892	258	889168	172	911724	430	088276	47
14	801047	258	889064	172	911982	430	088018	46
15	801201	258	888961	172	912240	430	087760	45
16	801356	257	888858	172	912498	430	087502	44
17	801511	257	888755	172	912756	430	087244	43
18	801665	257	888651	172	913014	429	086986	42
19	801819	257	888548	172	913271	429	086729	41
20	801973	257	888444	173	913529	429	086471	40
21	9.802128	257	9.888341	173	9.913787	429	10.086213	39
22	802282	256	888237	173	914044	429	085956	38
23	802436	256	888134	173	914302	429	085698	37
24	802589	256	888030	173	914560	429	085440	36
25	802743	256	887926	173	914817	429	085183	35
26	802897	256	887822	173	915075	429	084925	34
27	803050	256	887718	173	915332	429	084668	33
28	803204	256	887614	173	915590	429	084410	32
29	803357	255	887510	173	915847	429	084153	31
30	803511	255	887406	174	916104	429	083896	30
31	9.803664	255	9.887302	174	9.916362	429	10.083638	29
32	803817	255	887198	174	916619	429	083381	28
33	803970	255	887093	174	916877	429	083123	27
34	804123	255	886989	174	917134	429	082866	26
35	804276	254	886885	174	917391	429	082609	25
36	804428	254	886780	174	917648	429	082352	24
37	804581	254	886676	174	917905	429	082095	23
38	804734	254	886571	174	918163	428	081837	22
39	804886	254	886466	174	918420	428	081580	21
40	805039	254	886362	175	918677	428	081323	20
41	9.805191	254	9.886257	175	9.918934	428	10.081066	19
42	805343	253	886152	175	919191	428	080809	18
43	805495	253	886047	175	919448	428	080552	17
44	805647	253	885942	175	919705	428	080295	16
45	805799	253	885837	175	919962	428	080038	15
46	805951	253	885732	175	920219	428	079781	14
47	806103	253	885627	175	920476	428	079524	13
48	806254	253	885522	175	920733	428	079267	12
49	806406	252	885416	175	920990	428	079010	11
50	806557	252	885311	176	921247	428	078753	10
51	9.806709	252	9.885205	176	9.921503	428	10.078497	9
52	806860	252	885100	176	921760	428	078240	8
53	807011	252	884994	176	922017	428	077983	7
54	807163	252	884889	176	922274	428	077726	6
55	807314	252	884783	176	922530	428	077470	5
56	807465	251	884677	176	922787	428	077213	4
57	807615	251	884572	176	923044	428	076956	3
58	807766	251	884466	176	923300	428	076700	2
59	807917	251	884360	176	923557	427	076443	1
60	808067	251	884254	177	923813	427	076187	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	M.
0	9.808067	251	9.884254	177	9.923813	427	10.076187	60
1	808218	251	884148	177	924070	427	075930	59
2	808368	251	884042	177	924327	427	075673	58
3	808519	250	883936	177	924583	427	075417	57
4	808669	250	883829	177	924840	427	075160	56
5	808819	250	883723	177	925096	427	074904	55
6	808969	250	883617	177	925352	427	074648	54
7	809119	250	883510	177	925609	427	074391	53
8	809269	250	883404	177	925865	427	074135	52
9	809419	249	883297	178	926122	427	073878	51
10	809569	249	883191	178	926378	427	073622	50
11	9.809718	249	9.883084	178	9.926634	427	10.073366	49
12	809868	249	882977	178	926890	427	073110	48
13	810017	249	882871	178	927147	427	072853	47
14	810167	249	882764	178	927403	427	072597	46
15	810316	248	882657	178	927659	427	072341	45
16	810465	248	882550	178	927915	427	072085	44
17	810614	248	882443	178	928171	427	071829	43
18	810763	248	882336	179	928427	427	071573	42
19	810912	248	882229	179	928683	427	071317	41
20	811061	248	882121	179	928940	427	071060	40
21	9.811210	248	9.882014	179	9.929196	427	10.070804	39
22	811358	247	881907	179	929452	427	070548	38
23	811507	247	881799	179	929708	427	070292	37
24	811655	247	881692	179	929964	426	070036	36
25	811804	247	881584	179	930220	426	069780	35
26	811952	247	881477	179	930475	426	069525	34
27	812100	247	881369	179	930731	426	069269	33
28	812248	247	881261	180	930987	426	069013	32
29	812396	246	881153	180	931243	426	068757	31
30	812544	246	881046	180	931499	426	068501	30
31	9.812692	246	9.880938	180	9.931755	426	10.068245	29
32	812840	246	880830	180	932010	426	067990	28
33	812988	246	880722	180	932266	426	067734	27
34	813135	246	880613	180	932522	426	067478	26
35	813283	246	880505	180	932778	426	067222	25
36	813430	245	880397	180	933033	426	066967	24
37	813578	245	880289	181	933289	426	066711	23
38	813725	245	880180	181	933545	426	066455	22
39	813872	245	880072	181	933800	426	066200	21
40	814019	245	879963	181	934056	426	065944	20
41	9.814166	245	9.879855	181	9.934311	426	10.065689	19
42	814313	245	879746	181	934567	426	065433	18
43	814460	244	879637	181	934823	426	065177	17
44	814607	244	879529	181	935078	426	064922	16
45	814753	244	879420	181	935333	426	064667	15
46	814900	244	879311	181	935589	426	064411	14
47	815046	244	879202	182	935844	426	064156	13
48	815193	244	879093	182	936100	426	063900	12
49	815339	244	878984	182	936355	426	063645	11
50	815485	243	878875	182	936610	426	063390	10
51	9.815631	243	9.878766	182	9.936866	425	10.063134	9
52	815778	243	878656	182	937121	425	062879	8
53	815924	243	878547	182	937376	425	062624	7
54	816069	243	878438	182	937632	425	062368	6
55	816215	243	878328	182	937887	425	062113	5
56	816361	243	878219	183	938142	425	061858	4
57	816507	242	878109	183	938398	425	061602	3
58	816652	242	877999	183	938653	425	061347	2
59	816798	242	877890	183	938908	425	061092	1
60	816943	242	877780	183	939163	425	060837	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	M.
0	9.816943	242	9.877780	183	9.939163	425	10.060837	60
1	817088	242	877670	183	939418	425	060582	59
2	817233	242	877560	183	939673	425	060327	58
3	817379	242	877450	183	939928	425	060072	57
4	817524	241	877340	183	940183	425	059817	56
5	817668	241	877230	184	940438	425	059562	55
6	817813	241	877120	184	940694	425	059306	54
7	817958	241	877010	184	940949	425	059051	53
8	818103	241	876899	184	941204	425	058796	52
9	818247	241	876789	184	941458	425	058542	51
10	818392	241	876678	184	941714	425	058286	50
11	9.818536	240	9.876568	184	9.941968	425	10.058032	49
12	818681	240	876457	184	942223	425	057777	48
13	818825	240	876347	184	942478	425	057522	47
14	818969	240	876236	185	942733	425	057267	46
15	819113	240	876125	185	942988	425	057012	45
16	819257	240	876014	185	943243	425	056757	44
17	819401	240	875904	185	943498	425	056502	43
18	819545	239	875793	185	943752	425	056248	42
19	819689	239	875682	185	944007	425	055993	41
20	819832	239	875571	185	944262	425	055738	40
21	9.819976	239	9.875459	185	9.944517	425	10.055483	39
22	820120	239	875348	185	944771	424	055229	38
23	820263	239	875237	185	945026	424	054974	37
24	820406	239	875126	186	945281	424	054719	36
25	820550	238	875014	186	945535	424	054465	35
26	820693	238	874903	186	945790	424	054210	34
27	820836	238	874791	186	946045	424	053955	33
28	820979	238	874680	186	946299	424	053701	32
29	821122	238	874568	186	946554	424	053446	31
30	821265	238	874456	186	946808	424	053192	30
31	9.821407	238	9.874344	186	9.947063	424	10.052937	29
32	821550	238	874232	187	947318	424	052682	28
33	821693	237	874121	187	947572	424	052428	27
34	821835	237	874009	187	947826	424	052174	26
35	821977	237	873896	187	948081	424	051919	25
36	822120	237	873784	187	948336	424	051664	24
37	822262	237	873672	187	948590	424	051410	23
38	822404	237	873560	187	948844	424	051156	22
39	822546	237	873448	187	949099	424	050901	21
40	822688	236	873335	187	949353	424	050647	20
41	9.822830	236	9.873223	187	9.949607	424	10.050393	19
42	822972	236	873110	188	949862	424	050138	18
43	823114	236	872998	188	950116	424	049884	17
44	823255	236	872885	188	950370	424	049630	16
45	823397	236	872772	188	950625	424	049375	15
46	823539	236	872659	188	950879	424	049121	14
47	823680	235	872547	188	951133	424	048867	13
48	823821	235	872434	188	951388	424	048612	12
49	823963	235	872321	188	951642	424	048358	11
50	824104	235	872208	188	951896	424	048104	10
51	9.824245	235	9.872095	189	9.952150	424	10.047850	9
52	824386	235	871981	189	952405	424	047595	8
53	824527	235	871868	189	952659	424	047341	7
54	824668	234	871755	189	952913	424	047087	6
55	824808	234	871641	189	953167	423	046833	5
56	824949	234	871528	189	953421	423	046579	4
57	825090	234	871414	189	953675	423	046325	3
58	825230	234	871301	189	953929	423	046071	2
59	825371	234	871187	189	954183	423	045817	1
60	825511	234	871073	190	954437	423	045563	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	M.
0	9.825511	234	9.871073	190	9.954437	423	10.045563	60
1	825651	233	870960	190	954691	423	045309	59
2	825791	233	870846	190	954945	423	045055	58
3	825931	233	870732	190	955200	423	044800	57
4	826071	233	870618	190	955454	423	044546	56
5	826211	233	870504	190	955707	423	044293	55
6	826351	233	870390	190	955961	423	044039	54
7	826491	233	870276	190	956215	423	043785	53
8	826631	233	870161	190	956469	423	043531	52
9	826770	232	870047	191	956723	423	043277	51
10	826910	232	869933	191	956977	423	043023	50
11	9.827049	232	9.869818	191	9.957231	423	10.042769	49
12	827189	232	869704	191	957485	423	042515	48
13	827328	232	869589	191	957739	423	042261	47
14	827467	232	869474	191	957993	423	042007	46
15	827606	232	869360	191	958246	423	041754	45
16	827745	232	869245	191	958500	423	041500	44
17	827884	231	869130	191	958754	423	041246	43
18	828023	231	869015	192	959008	423	040992	42
19	828162	231	868900	192	959262	423	040738	41
20	828301	231	868785	192	959516	423	040484	40
21	9.828439	231	9.868670	192	9.959769	423	10.040231	39
22	828578	231	868555	192	960023	423	039977	38
23	828716	231	868440	192	960277	423	039723	37
24	828855	230	868324	192	960531	423	039469	36
25	828993	230	868209	192	960784	423	039216	35
26	829131	230	868093	192	961038	423	038962	34
27	829269	230	867978	193	961291	423	038709	33
28	829407	230	867862	193	961545	423	038455	32
29	829545	230	867747	193	961799	423	038201	31
30	829683	230	867631	193	962052	423	037948	30
31	9.829821	229	9.867515	193	9.962306	423	10.037694	29
32	829959	229	867399	193	962560	423	037440	28
33	830097	229	867283	193	962813	423	037187	27
34	830234	229	867167	193	963067	423	036933	26
35	830372	229	867051	193	963320	423	036680	25
36	830509	229	866935	194	963574	423	036426	24
37	830646	229	866819	194	963827	423	036173	23
38	830784	229	866703	194	964081	423	035919	22
39	830921	228	866586	194	964335	423	035665	21
40	831058	228	866470	194	964588	422	035412	20
41	9.831195	228	9.866353	194	9.964842	422	10.035158	19
42	831332	228	866237	194	965095	422	034905	18
43	831469	228	866120	194	965349	422	034651	17
44	831606	228	866004	195	965602	422	034398	16
45	831742	228	865887	195	965855	422	034145	15
46	831879	228	865770	195	966109	422	033891	14
47	832015	227	865653	195	966362	422	033638	13
48	832152	227	865536	195	966616	422	033384	12
49	832288	227	865419	195	966869	422	033131	11
50	832425	227	865302	195	967123	422	032877	10
51	9.832561	227	9.865185	195	9.967376	422	10.032624	9
52	832697	227	865068	195	967629	422	032371	8
53	832833	227	864950	195	967883	422	032117	7
54	832969	226	864833	196	968136	422	031864	6
55	833105	226	864716	196	968389	422	031611	5
56	833241	226	864598	196	968643	422	031357	4
57	833377	226	864481	196	968896	422	031104	3
58	833512	226	864363	196	969149	422	030851	2
59	833648	226	864245	196	969403	422	030597	1
60	833783	226	864127	196	969656	422	030344	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	M.
0	9.833783	226	9.864127	196	9.969656	422	10.030344	60
1	833919	225	864010	196	969909	422	030091	59
2	834054	225	863892	197	970162	422	029838	58
3	834189	225	863774	197	970416	422	029584	57
4	834325	225	863656	197	970669	422	029331	56
5	834460	225	863538	197	970922	422	029078	55
6	834595	225	863419	197	971175	422	028825	54
7	834730	225	863301	197	971429	422	028571	53
8	834865	225	863183	197	971682	422	028318	52
9	834999	224	863064	197	971935	422	028065	51
10	835134	224	862946	198	972188	422	027812	50
11	9.835269	224	9.862827	198	9.972441	422	10.027559	49
12	835403	224	862709	198	972694	422	027306	48
13	835538	224	862590	198	972948	422	027052	47
14	835672	224	862471	198	973201	422	026799	46
15	835807	224	862353	198	973454	422	026546	45
16	835941	224	862234	198	973707	422	026293	44
17	836075	223	862115	198	973960	422	026040	43
18	836209	223	861996	198	974213	422	025787	42
19	836343	223	861877	198	974466	422	025534	41
20	836477	223	861758	199	974719	422	025281	40
21	9.836611	223	9.861638	199	9.974973	422	10.025027	39
22	836745	223	861519	199	975226	422	024774	38
23	836878	223	861400	199	975479	422	024521	37
24	837012	222	861280	199	975732	422	024268	36
25	837146	222	861161	199	975985	422	024015	35
26	837279	222	861041	199	976238	422	023762	34
27	837412	222	860922	199	976491	422	023509	33
28	837546	222	860802	199	976744	422	023256	32
29	837679	222	860682	200	976997	422	023003	31
30	837812	222	860562	200	977250	422	022750	30
31	9.837945	222	9.860442	200	9.977503	422	10.022497	29
32	838078	221	860322	200	977756	422	022244	28
33	838211	221	860202	200	978009	422	021991	27
34	838344	221	860082	200	978262	422	021738	26
35	838477	221	859962	200	978515	422	021485	25
36	838610	221	859842	200	978768	422	021232	24
37	838742	221	859721	201	979021	422	020979	23
38	838875	221	859601	201	979274	422	020726	22
39	839007	221	859480	201	979527	422	020473	21
40	839140	220	859360	201	979780	422	020220	20
41	9.839272	220	9.859239	201	9.980033	422	10.019967	19
42	839404	220	859119	201	980286	422	019714	18
43	839536	220	858998	201	980538	422	019462	17
44	839668	220	858877	201	980791	421	019209	16
45	839800	220	858756	202	981044	421	018956	15
46	839932	220	858635	202	981297	421	018703	14
47	840064	219	858514	202	981550	421	018450	13
48	840196	219	858393	202	981803	421	018197	12
49	840328	219	858272	202	982056	421	017944	11
50	840459	219	858151	202	982309	421	017691	10
51	9.840591	219	9.858029	202	9.982562	421	10.017438	9
52	840722	219	857908	202	982814	421	017186	8
53	840854	219	857786	202	983067	421	016933	7
54	840985	219	857665	203	983320	421	016680	6
55	841116	218	857543	203	983573	421	016427	5
56	841247	218	857422	203	983826	421	016174	4
57	841378	218	857300	203	984079	421	015921	3
58	841509	218	857178	203	984331	421	015669	2
59	841640	218	857056	203	984584	421	015416	1
60	841771	218	856934	203	984837	421	015163	0
	Cosine		Sine		Cotang.		Tang.	M.

M.	Sine	D.	Cosine	D.	Tang.	D.	Cotang.	
0	9.841771	218	9.856934	203	9.984837	421	10.015163	60
1	841902	218	856812	203	985090	421	014910	59
2	842033	218	856690	204	985343	421	014657	58
3	842163	217	856568	204	985596	421	014404	57
4	842294	217	856446	204	985848	421	014152	56
5	842424	217	856323	204	986101	421	013899	55
6	842555	217	856201	204	986354	421	013646	54
7	842685	217	856078	204	986607	421	013393	53
8	842815	217	855956	204	986860	421	013140	52
9	842946	217	855833	204	987112	421	012888	51
10	843076	217	855711	205	987365	421	012635	50
11	9.843206	216	9.855588	205	9.987618	421	10.012382	49
12	843336	216	855465	205	987871	421	012129	48
13	843466	216	855342	205	988123	421	011877	47
14	843595	216	855219	205	988376	421	011624	46
15	843725	216	855096	205	988629	421	011371	45
16	843855	216	854973	205	988882	421	011118	44
17	843984	216	854850	205	989134	421	010866	43
18	844114	215	854727	206	989387	421	010613	42
19	844243	215	854603	206	989640	421	010360	41
20	844372	215	854480	206	989893	421	010107	40
21	9.844502	215	9.854356	206	9.990145	421	10.009855	39
22	844631	215	854233	206	990398	421	009602	38
23	844760	215	854109	206	990651	421	009349	37
24	844889	215	853986	206	990903	421	009097	36
25	845018	215	853862	206	991156	421	008844	35
26	845147	215	853738	206	991409	421	008591	34
27	845276	214	853614	207	991662	421	008338	33
28	845405	214	853490	207	991914	421	008086	32
29	845533	214	853366	207	992167	421	007833	31
30	845662	214	853242	207	992420	421	007580	30
31	9.845790	214	9.853118	207	9.992672	421	10.007328	29
32	845919	214	852994	207	992925	421	007075	28
33	846047	214	852869	207	993178	421	006822	27
34	846175	214	852745	207	993430	421	006570	26
35	846304	214	852620	207	993683	421	006317	25
36	846432	213	852496	208	993936	421	006064	24
37	846560	213	852371	208	994189	421	005811	23
38	846688	213	852247	208	994441	421	005559	22
39	846816	213	852122	208	994694	421	005306	21
40	846944	213	851997	208	994947	421	005053	20
41	9.847071	213	9.851872	208	9.995199	421	10.004801	19
42	847199	213	851747	208	995452	421	004548	18
43	847327	213	851622	208	995705	421	004295	17
44	847454	212	851497	209	995957	421	004043	16
45	847582	212	851372	209	996210	421	003790	15
46	847709	212	851246	209	996463	421	003537	14
47	847836	212	851121	209	996715	421	003285	13
48	847964	212	850996	209	996968	421	003032	12
49	848091	212	850870	209	997221	421	002779	11
50	848218	212	850745	209	997473	421	002527	10
51	9.848345	212	9.850619	209	9.997726	421	10.002274	9
52	848472	211	850493	210	997979	421	002021	8
53	848599	211	850368	210	998231	421	001769	7
54	848726	211	850242	210	998484	421	001516	6
55	848852	211	850116	210	998737	421	001263	5
56	848979	211	849990	210	998989	421	001011	4
57	849106	211	849864	210	999242	421	000758	3
58	849232	211	849738	210	999495	421	000505	2
59	849359	211	849611	210	999748	421	000253	1
60	849485	211	849485	210	10.000000	421	000000	0
	Cosine		Sine		Cotang.		Tang.	M.

A TRAVERSE TABLE,

SHOWING THE DIFFERENCE OF

LATITUDE AND DEPARTURE

FOR DISTANCES BETWEEN 1 AND 100, AND FOR ANGLES
TO QUARTER DEGREES BETWEEN 1° AND 90° .

TRAVERSE TABLE.

Distance.	$\frac{1}{4}$ Deg.		$\frac{1}{2}$ Deg.		$\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	1.00	0.00	1.00	0.01	1.00	0.01	1
2	2.00	0.01	2.00	0.02	2.00	0.03	2
3	3.00	0.01	3.00	0.03	3.00	0.04	3
4	4.00	0.02	4.00	0.03	4.00	0.05	4
5	5.00	0.02	5.00	0.04	5.00	0.07	5
6	6.00	0.03	6.00	0.05	6.00	0.08	6
7	7.00	0.03	7.00	0.06	7.00	0.09	7
8	8.00	0.03	8.00	0.07	8.00	0.10	8
9	9.00	0.04	9.00	0.08	9.00	0.12	9
10	10.00	0.04	10.00	0.09	10.00	0.13	10
11	11.00	0.05	11.00	0.10	11.00	0.14	11
12	12.00	0.05	12.00	0.10	12.00	0.16	12
13	13.00	0.06	13.00	0.11	13.00	0.17	13
14	14.00	0.06	14.00	0.12	14.00	0.18	14
15	15.00	0.07	15.00	0.13	15.00	0.20	15
16	16.00	0.07	16.00	0.14	16.00	0.21	16
17	17.00	0.07	17.00	0.15	17.00	0.22	17
18	18.00	0.08	18.00	0.16	18.00	0.24	18
19	19.00	0.08	19.00	0.17	19.00	0.25	19
20	20.00	0.09	20.00	0.17	20.00	0.26	20
21	21.00	0.09	21.00	0.18	21.00	0.27	21
22	22.00	0.10	22.00	0.19	22.00	0.29	22
23	23.00	0.10	23.00	0.20	23.00	0.30	23
24	24.00	0.10	24.00	0.21	24.00	0.31	24
25	25.00	0.11	25.00	0.22	25.00	0.33	25
26	26.00	0.11	26.00	0.23	26.00	0.34	26
27	27.00	0.12	27.00	0.24	27.00	0.35	27
28	28.00	0.12	28.00	0.24	28.00	0.37	28
29	29.00	0.13	29.00	0.25	29.00	0.38	29
30	30.00	0.13	30.00	0.26	30.00	0.39	30
31	31.00	0.14	31.00	0.27	31.00	0.41	31
32	32.00	0.14	32.00	0.28	32.00	0.42	32
33	33.00	0.14	33.00	0.29	33.00	0.43	33
34	34.00	0.15	34.00	0.30	34.00	0.45	34
35	35.00	0.15	35.00	0.31	35.00	0.46	35
36	36.00	0.16	36.00	0.31	36.00	0.47	36
37	37.00	0.16	37.00	0.32	37.00	0.48	37
38	38.00	0.17	38.00	0.33	38.00	0.50	38
39	39.00	0.17	39.00	0.34	39.00	0.51	39
40	40.00	0.17	40.00	0.35	40.00	0.52	40
41	41.00	0.18	41.00	0.36	41.00	0.54	41
42	42.00	0.18	42.00	0.37	42.00	0.55	42
43	43.00	0.19	43.00	0.38	43.00	0.56	43
44	44.00	0.19	44.00	0.38	44.00	0.58	44
45	45.00	0.20	45.00	0.39	45.00	0.59	45
46	46.00	0.20	46.00	0.40	46.00	0.60	46
47	47.00	0.21	47.00	0.41	47.00	0.62	47
48	48.00	0.21	48.00	0.42	48.00	0.63	48
49	49.00	0.21	49.00	0.43	49.00	0.64	49
50	50.00	0.22	50.00	0.44	50.00	0.65	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	$89\frac{3}{4}$ Deg.		$89\frac{1}{2}$ Deg.		$89\frac{1}{4}$ Deg.		

Distance.	$\frac{1}{4}$ Deg.		$\frac{1}{2}$ Deg.		$\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	51.00	0.22	51.00	0.45	51.00	0.67	51
52	52.00	0.23	52.00	0.45	52.00	0.68	52
53	53.00	0.23	53.00	0.46	53.00	0.69	53
54	54.00	0.24	54.00	0.47	54.00	0.71	54
55	55.00	0.24	55.00	0.48	55.00	0.72	55
56	56.00	0.24	56.00	0.49	56.00	0.73	56
57	57.00	0.25	57.00	0.50	57.00	0.75	57
58	58.00	0.25	58.00	0.51	57.99	0.76	58
59	59.00	0.26	59.00	0.51	58.99	0.77	59
60	60.00	0.26	60.00	0.52	59.99	0.79	60
61	61.00	0.27	61.00	0.53	60.99	0.80	61
62	62.00	0.27	62.00	0.54	61.99	0.81	62
63	63.00	0.27	63.00	0.55	62.99	0.82	63
64	64.00	0.28	64.00	0.56	63.99	0.84	64
65	65.00	0.28	65.00	0.57	64.99	0.85	65
66	66.00	0.29	66.00	0.58	65.99	0.86	66
67	67.00	0.29	67.00	0.58	66.99	0.88	67
68	68.00	0.30	68.00	0.59	67.99	0.89	68
69	69.00	0.30	69.00	0.60	68.99	0.90	69
70	70.00	0.31	70.00	0.61	69.99	0.92	70
71	71.00	0.31	71.00	0.62	70.99	0.93	71
72	72.00	0.31	72.00	0.63	71.99	0.94	72
73	73.00	0.32	73.00	0.64	72.99	0.96	73
74	74.00	0.32	74.00	0.65	73.99	0.97	74
75	75.00	0.33	75.00	0.65	74.99	0.98	75
76	76.00	0.33	76.00	0.66	75.99	0.99	76
77	77.00	0.34	77.00	0.67	76.99	1.01	77
78	78.00	0.34	78.00	0.68	77.99	1.02	78
79	79.00	0.34	79.00	0.69	78.99	1.03	79
80	80.00	0.35	80.00	0.70	79.99	1.05	80
81	81.00	0.35	81.00	0.71	80.99	1.06	81
82	82.00	0.36	82.00	0.72	81.99	1.07	82
83	83.00	0.36	83.00	0.72	82.99	1.09	83
84	84.00	0.37	84.00	0.73	83.99	1.10	84
85	85.00	0.37	85.00	0.74	84.99	1.11	85
86	86.00	0.38	86.00	0.75	85.99	1.13	86
87	87.00	0.38	87.00	0.76	86.99	1.14	87
88	88.00	0.38	88.00	0.77	87.99	1.15	88
89	89.00	0.39	89.00	0.78	88.99	1.16	89
90	90.00	0.39	90.00	0.79	89.99	1.18	90
91	91.00	0.40	91.00	0.79	90.99	1.19	91
92	92.00	0.40	92.00	0.80	91.99	1.20	92
93	93.00	0.41	93.00	0.81	92.99	1.22	93
94	94.00	0.41	94.00	0.82	93.99	1.23	94
95	95.00	0.41	95.00	0.83	94.99	1.24	95
96	96.00	0.42	96.00	0.84	95.99	1.26	96
97	97.00	0.42	97.00	0.85	96.99	1.27	97
98	98.00	0.43	98.00	0.86	97.99	1.28	98
99	99.00	0.43	99.00	0.86	98.99	1.30	99
100	100.00	0.44	100.00	0.87	99.99	1.31	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	$89\frac{1}{4}$ Deg.		$89\frac{1}{2}$ Deg.		$89\frac{3}{4}$ Deg.		

Distance.	1 Deg.		1 $\frac{1}{4}$ Deg.		1 $\frac{1}{2}$ Deg.		1 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	1.00	0.02	1.00	0.02	1.00	0.03	1.00	0.03	1
2	2.00	0.03	2.00	0.04	2.00	0.05	2.00	0.06	2
3	3.00	0.05	3.00	0.07	3.00	0.08	3.00	0.09	3
4	4.00	0.07	4.00	0.09	4.00	0.10	4.00	0.12	4
5	5.00	0.09	5.00	0.11	5.00	0.13	5.00	0.15	5
6	6.00	0.10	6.00	0.13	6.00	0.16	6.00	0.18	6
7	7.00	0.12	7.00	0.15	7.00	0.18	7.00	0.21	7
8	8.00	0.14	8.00	0.17	8.00	0.21	8.00	0.25	8
9	9.00	0.16	9.00	0.20	9.00	0.24	9.00	0.28	9
10	10.00	0.17	10.00	0.22	10.00	0.26	10.00	0.31	10
11	11.00	0.19	11.00	0.24	11.00	0.28	10.99	0.34	11
12	12.00	0.21	12.00	0.26	12.00	0.31	11.99	0.37	12
13	13.00	0.23	13.00	0.28	13.00	0.34	12.99	0.40	13
14	14.00	0.24	14.00	0.31	14.00	0.37	13.99	0.43	14
15	15.00	0.26	15.00	0.33	14.99	0.39	14.99	0.46	15
16	16.00	0.28	16.00	0.35	15.99	0.42	15.99	0.49	16
17	17.00	0.30	17.00	0.37	16.99	0.45	16.99	0.52	17
18	18.00	0.31	18.00	0.39	17.99	0.47	17.99	0.55	18
19	19.00	0.33	19.00	0.41	18.99	0.50	18.99	0.58	19
20	20.00	0.35	20.00	0.44	19.99	0.52	19.99	0.61	20
21	21.00	0.37	21.00	0.46	20.99	0.55	20.99	0.64	21
22	22.00	0.38	21.99	0.48	21.99	0.58	21.99	0.67	22
23	23.00	0.40	22.99	0.50	22.99	0.60	22.99	0.70	23
24	24.00	0.42	23.99	0.52	23.99	0.63	23.99	0.73	24
25	25.00	0.44	24.99	0.55	24.99	0.65	24.99	0.76	25
26	26.00	0.45	25.99	0.57	25.99	0.68	25.99	0.79	26
27	27.00	0.47	26.99	0.59	26.99	0.71	26.99	0.83	27
28	28.00	0.49	27.99	0.61	27.99	0.73	27.99	0.86	28
29	29.00	0.51	28.99	0.63	28.99	0.76	28.99	0.89	29
30	30.00	0.52	29.99	0.65	29.99	0.79	29.99	0.92	30
31	31.00	0.54	30.99	0.68	30.99	0.81	30.99	0.95	31
32	32.00	0.56	31.99	0.70	31.99	0.84	31.99	0.98	32
33	32.99	0.58	32.99	0.72	32.99	0.86	32.98	1.01	33
34	33.99	0.59	33.99	0.74	33.99	0.89	33.98	1.04	34
35	34.99	0.61	34.99	0.76	34.99	0.92	34.98	1.07	35
36	35.99	0.63	35.99	0.79	35.99	0.94	35.98	1.10	36
37	36.99	0.65	36.99	0.81	36.99	0.97	36.98	1.13	37
38	37.99	0.66	37.99	0.83	37.99	0.99	37.98	1.16	38
39	38.99	0.68	38.99	0.85	38.99	1.02	38.98	1.19	39
40	39.99	0.70	39.99	0.87	39.99	1.05	39.98	1.22	40
41	40.99	0.72	40.99	0.89	40.99	1.07	40.98	1.25	41
42	41.99	0.73	41.99	0.92	41.99	1.10	41.98	1.28	42
43	42.99	0.75	42.99	0.94	42.99	1.13	42.98	1.31	43
44	43.99	0.77	43.99	0.96	43.99	1.15	43.98	1.34	44
45	44.99	0.79	44.99	0.98	44.99	1.18	44.98	1.37	45
46	45.99	0.80	45.99	1.00	45.99	1.20	45.98	1.40	46
47	46.99	0.82	46.99	1.03	46.99	1.23	46.98	1.44	47
48	47.99	0.84	47.99	1.05	47.98	1.26	47.98	1.47	48
49	48.99	0.86	48.99	1.07	48.98	1.28	48.98	1.50	49
50	49.99	0.87	49.99	1.09	49.98	1.31	49.98	1.53	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	89 Deg.		88 $\frac{3}{4}$ Deg.		88 $\frac{1}{2}$ Deg.		88 $\frac{1}{4}$ Deg.		

Distance.	1 Deg.		1 $\frac{1}{4}$ Deg.		1 $\frac{1}{2}$ Deg.		1 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	50.99	0.89	50.99	1.11	50.98	1.34	50.98	1.56	51
52	51.99	0.91	51.99	1.13	51.98	1.36	51.98	1.59	52
53	52.99	0.92	52.99	1.16	52.98	1.39	52.98	1.62	53
54	53.99	0.94	53.99	1.18	53.98	1.41	53.97	1.65	54
55	54.99	0.96	54.99	1.20	54.98	1.44	54.97	1.68	55
56	55.99	0.98	55.99	1.22	55.98	1.47	55.97	1.71	56
57	56.99	0.99	56.99	1.24	56.98	1.49	56.97	1.74	57
58	57.99	1.01	57.99	1.27	57.98	1.52	57.97	1.77	58
59	58.99	1.03	58.99	1.29	58.98	1.54	58.97	1.80	59
60	59.99	1.05	59.99	1.31	59.98	1.57	59.97	1.83	60
61	60.99	1.06	60.99	1.33	60.98	1.60	60.97	1.86	61
62	61.99	1.08	61.99	1.35	61.98	1.62	61.97	1.89	62
63	62.99	1.10	62.99	1.37	62.98	1.65	62.97	1.92	63
64	63.99	1.12	63.98	1.40	63.98	1.68	63.97	1.95	64
65	64.99	1.13	64.98	1.42	64.98	1.70	64.97	1.99	65
66	65.99	1.15	65.98	1.44	65.98	1.73	65.97	2.02	66
67	66.99	1.17	66.98	1.46	66.98	1.75	66.97	2.05	67
68	67.99	1.19	67.98	1.48	67.98	1.78	67.97	2.08	68
69	68.99	1.20	68.98	1.51	68.98	1.81	68.97	2.11	69
70	69.99	1.22	69.98	1.53	69.98	1.83	69.97	2.14	70
71	70.99	1.24	70.98	1.55	70.98	1.86	70.97	2.17	71
72	71.99	1.26	71.98	1.57	71.98	1.88	71.97	2.20	72
73	72.99	1.27	72.98	1.59	72.97	1.91	72.97	2.23	73
74	73.99	1.29	73.98	1.61	73.97	1.94	73.97	2.26	74
75	74.99	1.31	74.98	1.64	74.97	1.96	74.97	2.29	75
76	75.99	1.33	75.98	1.66	75.97	1.99	75.96	2.32	76
77	76.99	1.34	76.98	1.68	76.97	2.02	76.96	2.35	77
78	77.99	1.36	77.98	1.70	77.97	2.04	77.96	2.38	78
79	78.99	1.38	78.98	1.72	78.97	2.07	78.96	2.41	79
80	79.99	1.40	79.98	1.75	79.97	2.09	79.96	2.44	80
81	80.99	1.41	80.98	1.77	80.97	2.12	80.96	2.47	81
82	81.99	1.43	81.98	1.79	81.97	2.15	81.96	2.50	82
83	82.99	1.45	82.98	1.81	82.97	2.17	82.96	2.53	83
84	83.99	1.47	83.98	1.83	83.97	2.20	83.96	2.57	84
85	84.99	1.48	84.98	1.85	84.97	2.23	84.96	2.60	85
86	85.99	1.50	85.98	1.88	85.97	2.25	85.96	2.63	86
87	86.99	1.52	86.98	1.90	86.97	2.28	86.96	2.66	87
88	87.99	1.54	87.98	1.92	87.97	2.30	87.96	2.69	88
89	88.99	1.55	88.98	1.94	88.97	2.33	88.96	2.72	89
90	89.99	1.57	89.98	1.96	89.97	2.36	89.96	2.75	90
91	90.99	1.59	90.98	1.99	90.97	2.38	90.96	2.78	91
92	91.99	1.61	91.98	2.01	91.97	2.41	91.96	2.81	92
93	92.99	1.62	92.98	2.03	92.97	2.43	92.96	2.84	93
94	93.99	1.64	93.98	2.05	93.97	2.46	93.96	2.87	94
95	94.99	1.66	94.98	2.07	94.97	2.49	94.96	2.90	95
96	95.99	1.68	95.98	2.09	95.97	2.51	95.96	2.94	96
97	96.99	1.69	96.98	2.12	96.97	2.54	96.95	2.96	97
98	97.99	1.71	97.98	2.14	97.97	2.57	97.95	2.99	98
99	98.98	1.73	98.98	2.16	98.97	2.59	98.95	3.02	99
100	99.98	1.75	99.98	2.18	99.97	2.62	99.95	3.05	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	89 Deg.		88 $\frac{3}{4}$ Deg.		88 $\frac{1}{2}$ Deg.		88 $\frac{1}{4}$ Deg.		

TRAVERSE TABLE.

Distance.	2 Deg.		2 $\frac{1}{4}$ Deg.		2 $\frac{1}{2}$ Deg.		2 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	1.00	0.03	1.00	0.04	1.00	0.04	1.00	0.05	1
2	2.00	0.07	2.00	0.08	2.00	0.09	2.00	0.10	2
3	3.00	0.10	3.00	0.12	3.00	0.13	3.00	0.14	3
4	4.00	0.14	4.00	0.16	4.00	0.17	4.00	0.19	4
5	5.00	0.17	5.00	0.20	5.00	0.22	4.99	0.24	5
6	6.00	0.21	6.00	0.24	5.99	0.26	5.99	0.29	6
7	7.00	0.24	6.99	0.27	6.99	0.31	6.99	0.34	7
8	7.99	0.28	7.99	0.31	7.99	0.35	7.99	0.38	8
9	8.99	0.31	8.99	0.35	8.99	0.39	8.99	0.43	9
10	9.99	0.35	9.99	0.39	9.99	0.44	9.99	0.48	10
11	10.99	0.38	10.99	0.43	10.99	0.48	10.99	0.53	11
12	11.99	0.42	11.99	0.47	11.99	0.52	11.99	0.58	12
13	12.99	0.45	12.99	0.51	12.99	0.57	12.99	0.62	13
14	13.99	0.49	13.99	0.55	13.99	0.61	13.98	0.67	14
15	14.99	0.52	14.99	0.59	14.99	0.65	14.98	0.72	15
16	15.99	0.56	15.99	0.63	15.99	0.70	15.98	0.77	16
17	16.99	0.59	16.99	0.67	16.98	0.74	16.98	0.82	17
18	17.99	0.63	17.99	0.71	17.98	0.79	17.98	0.86	18
19	18.99	0.66	18.99	0.75	18.98	0.83	18.98	0.91	19
20	19.99	0.70	19.98	0.79	19.98	0.87	19.98	0.96	20
21	20.99	0.73	20.98	0.82	20.98	0.92	20.98	1.01	21
22	21.99	0.77	21.98	0.86	21.98	0.96	21.97	1.06	22
23	22.99	0.80	22.98	0.90	22.98	1.00	22.97	1.10	23
24	23.99	0.84	23.98	0.94	23.98	1.05	23.97	1.15	24
25	24.98	0.87	24.98	0.98	24.98	1.09	24.97	1.20	25
26	25.98	0.91	25.98	1.02	25.98	1.13	25.97	1.25	26
27	26.98	0.94	26.98	1.06	26.97	1.18	26.97	1.30	27
28	27.98	0.98	27.98	1.10	27.97	1.22	27.97	1.34	28
29	28.98	1.01	28.98	1.14	28.97	1.26	28.97	1.39	29
30	29.98	1.05	29.98	1.18	29.97	1.31	29.97	1.44	30
31	30.98	1.08	30.98	1.22	30.97	1.35	30.96	1.49	31
32	31.98	1.12	31.98	1.26	31.97	1.40	31.96	1.54	32
33	32.98	1.15	32.97	1.30	32.97	1.44	32.96	1.58	33
34	33.98	1.19	33.97	1.33	33.97	1.48	33.96	1.63	34
35	34.98	1.22	34.97	1.37	34.97	1.53	34.96	1.68	35
36	35.98	1.26	35.97	1.41	35.97	1.57	35.96	1.73	36
37	36.98	1.29	36.97	1.45	36.96	1.61	36.96	1.78	37
38	37.98	1.33	37.97	1.49	37.96	1.66	37.96	1.82	38
39	38.98	1.36	38.97	1.53	38.96	1.70	38.96	1.87	39
40	39.98	1.40	39.97	1.57	39.96	1.75	39.95	1.92	40
41	40.98	1.43	40.97	1.61	40.96	1.77	40.95	1.97	41
42	41.97	1.47	41.97	1.65	41.96	1.83	41.95	2.02	42
43	42.97	1.50	42.97	1.69	42.96	1.88	42.95	2.06	43
44	43.97	1.54	43.97	1.73	43.96	1.92	43.95	2.11	44
45	44.97	1.57	44.97	1.77	44.96	1.96	44.95	2.16	45
46	45.97	1.61	45.96	1.81	45.96	2.01	45.95	2.21	46
47	46.97	1.64	46.96	1.85	46.96	2.05	46.95	2.25	47
48	47.97	1.68	47.96	1.88	47.95	2.09	47.95	2.30	48
49	48.97	1.71	48.96	1.92	48.95	2.14	48.94	2.35	49
50	49.97	1.74	49.96	1.96	49.95	2.18	49.94	2.40	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	88 Deg.		87 $\frac{3}{4}$ Deg.		87 $\frac{1}{2}$ Deg.		87 $\frac{1}{4}$ Deg.		

TRAVERSE TABLE.

Distance.	2 Deg.		2½ Deg.		2½ Deg.		2¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	50.97	1.78	50.96	2.00	50.95	2.22	50.94	2.45	51
52	51.97	1.81	51.96	2.04	51.95	2.27	51.94	2.50	52
53	52.97	1.85	52.96	2.08	52.95	2.31	52.94	2.54	53
54	53.97	1.88	53.96	2.12	53.95	2.36	53.94	2.59	54
55	54.97	1.92	54.96	2.16	54.95	2.40	54.94	2.64	55
56	55.97	1.95	55.96	2.20	55.95	2.44	55.94	2.69	56
57	56.97	1.99	56.96	2.24	56.95	2.49	56.93	2.73	57
58	57.96	2.02	57.96	2.28	57.94	2.53	57.93	2.78	58
59	58.96	2.06	58.95	2.32	58.94	2.57	58.93	2.83	59
60	59.96	2.09	59.95	2.36	59.94	2.62	59.93	2.88	60
61	60.96	2.13	60.95	2.39	60.94	2.66	60.93	2.93	61
62	61.96	2.16	61.95	2.43	61.94	2.70	61.93	2.97	62
63	62.96	2.20	62.95	2.47	62.94	2.75	62.93	3.02	63
64	63.96	2.23	63.95	2.51	63.94	2.79	63.93	3.07	64
65	64.96	2.27	64.95	2.55	64.94	2.84	64.93	3.12	65
66	65.96	2.30	65.95	2.59	65.94	2.88	65.92	3.17	66
67	66.96	2.34	66.95	2.63	66.94	2.92	66.92	3.21	67
68	67.96	2.37	67.95	2.67	67.94	2.97	67.92	3.26	68
69	68.96	2.41	68.95	2.71	68.93	3.01	68.92	3.31	69
70	69.96	2.44	69.95	2.75	69.93	3.05	69.92	3.36	70
71	70.96	2.48	70.95	2.79	70.93	3.10	70.92	3.41	71
72	71.96	2.51	71.94	2.83	71.93	3.14	71.92	3.45	72
73	72.96	2.55	72.94	2.87	72.93	3.18	72.92	3.50	73
74	73.95	2.58	73.94	2.91	73.93	3.23	73.91	3.55	74
75	74.95	2.62	74.94	2.94	74.93	3.27	74.91	3.60	75
76	75.95	2.65	75.94	2.98	75.93	3.31	75.91	3.65	76
77	76.95	2.69	76.94	3.02	76.93	3.36	76.91	3.70	77
78	77.95	2.72	77.94	3.06	77.93	3.40	77.91	3.74	78
79	78.95	2.76	78.94	3.10	78.92	3.45	78.91	3.79	79
80	79.95	2.79	79.94	3.14	79.92	3.49	79.91	3.84	80
81	80.95	2.83	80.94	3.18	80.92	3.53	80.91	3.89	81
82	81.95	2.86	81.94	3.22	81.92	3.58	81.91	3.93	82
83	82.95	2.90	82.94	3.26	82.92	3.62	82.90	3.98	83
84	83.95	2.93	83.94	3.30	83.92	3.66	83.90	4.03	84
85	84.95	2.97	84.93	3.34	84.92	3.71	84.90	4.08	85
86	85.95	3.00	85.93	3.38	85.92	3.75	85.90	4.13	86
87	86.95	3.04	86.93	3.42	86.92	3.79	86.90	4.17	87
88	87.95	3.07	87.93	3.45	87.92	3.84	87.90	4.22	88
89	88.95	3.11	88.93	3.49	88.92	3.88	88.90	4.27	89
90	89.95	3.14	89.93	3.53	89.91	3.93	89.90	4.32	90
91	90.95	3.18	90.93	3.57	90.91	3.97	90.90	4.37	91
92	91.94	3.21	91.93	3.61	91.91	4.01	91.89	4.41	92
93	92.94	3.25	92.93	3.65	92.91	4.06	92.89	4.46	93
94	93.94	3.28	93.93	3.69	93.91	4.10	93.89	4.51	94
95	94.94	3.32	94.93	3.73	94.91	4.14	94.89	4.56	95
96	95.94	3.35	95.93	3.77	95.91	4.19	95.89	4.61	96
97	96.94	3.39	96.93	3.81	96.91	4.23	96.89	4.65	97
98	97.94	3.42	97.92	3.85	97.91	4.27	97.89	4.70	98
99	98.94	3.46	98.92	3.89	98.91	4.32	98.89	4.75	99
100	99.94	3.49	99.92	3.93	99.91	4.36	99.88	4.80	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	88 Deg.		87½ Deg.		87½ Deg.		87¼ Deg.		

Distance.	3 Deg.		3 $\frac{1}{4}$ Deg.		3 $\frac{1}{2}$ Deg.		3 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	1.00	0.05	1.00	0.06	1.00	0.06	1.00	0.06	1
2	2.00	0.10	2.00	0.11	2.00	0.12	2.00	0.13	2
3	3.00	0.16	3.00	0.17	2.99	0.18	2.99	0.20	3
4	3.99	0.21	3.99	0.23	3.99	0.24	3.99	0.26	4
5	4.99	0.26	4.99	0.28	4.99	0.31	4.99	0.33	5
6	5.99	0.31	5.99	0.34	5.99	0.37	5.99	0.39	6
7	6.99	0.37	6.99	0.40	6.99	0.43	6.99	0.46	7
8	7.99	0.42	7.99	0.45	7.99	0.49	7.98	0.52	8
9	8.99	0.47	8.99	0.51	8.98	0.55	8.98	0.59	9
10	9.99	0.52	9.98	0.57	9.98	0.61	9.98	0.65	10
11	10.98	0.58	10.98	0.62	10.98	0.67	10.98	0.72	11
12	11.98	0.63	11.98	0.68	11.98	0.73	11.97	0.78	12
13	12.98	0.68	12.98	0.73	12.98	0.79	12.97	0.85	13
14	13.98	0.73	13.98	0.79	13.97	0.85	13.97	0.92	14
15	14.98	0.79	14.98	0.85	14.97	0.92	14.97	0.98	15
16	15.98	0.84	15.97	0.91	15.97	0.98	15.97	1.05	16
17	16.98	0.89	16.97	0.96	16.97	1.04	16.96	1.11	17
18	17.98	0.94	17.97	1.02	17.97	1.10	17.96	1.18	18
19	18.98	0.99	18.97	1.08	18.96	1.16	18.96	1.24	19
20	19.97	1.05	19.97	1.13	19.96	1.22	19.96	1.31	20
21	20.97	1.10	20.97	1.19	20.96	1.28	20.96	1.37	21
22	21.97	1.15	21.96	1.25	21.96	1.34	21.95	1.44	22
23	22.97	1.20	22.96	1.30	22.96	1.40	22.95	1.50	23
24	23.97	1.26	23.96	1.36	23.96	1.47	23.95	1.57	24
25	24.97	1.31	24.96	1.42	24.95	1.53	24.95	1.64	25
26	25.96	1.36	25.96	1.47	25.95	1.59	25.94	1.70	26
27	26.96	1.41	26.96	1.53	26.95	1.65	26.94	1.77	27
28	27.96	1.47	27.95	1.59	27.95	1.71	27.94	1.83	28
29	28.96	1.52	28.95	1.64	28.95	1.77	28.94	1.90	29
30	29.96	1.57	29.95	1.70	29.94	1.83	29.94	1.96	30
31	30.96	1.62	30.95	1.76	30.94	1.89	30.93	2.03	31
32	31.96	1.67	31.95	1.81	31.94	1.95	31.93	2.09	32
33	32.95	1.73	32.95	1.87	32.94	2.01	32.93	2.16	33
34	33.95	1.78	33.95	1.93	33.94	2.08	33.93	2.22	34
35	34.95	1.83	34.94	1.98	34.93	2.14	34.92	2.29	35
36	35.95	1.88	35.94	2.04	35.93	2.20	35.92	2.35	36
37	36.95	1.94	36.94	2.10	36.93	2.26	36.92	2.42	37
38	37.95	1.99	37.94	2.15	37.93	2.32	37.92	2.49	38
39	38.95	2.04	38.94	2.21	38.93	2.38	38.92	2.55	39
40	39.95	2.09	39.94	2.27	39.93	2.44	39.91	2.62	40
41	40.94	2.15	40.93	2.32	40.92	2.50	40.91	2.68	41
42	41.94	2.20	41.93	2.38	41.92	2.56	41.91	2.75	42
43	42.94	2.25	42.93	2.44	42.92	2.63	42.91	2.81	43
44	43.94	2.30	43.93	2.49	43.92	2.69	43.91	2.88	44
45	44.94	2.36	44.93	2.55	44.92	2.75	44.90	2.94	45
46	45.94	2.41	45.93	2.61	45.91	2.81	45.90	3.01	46
47	46.94	2.46	46.92	2.66	46.91	2.87	46.90	3.07	47
48	47.93	2.51	47.92	2.72	47.91	2.93	47.90	3.14	48
49	48.93	2.56	48.92	2.78	48.91	2.99	48.90	3.20	49
50	49.93	2.62	49.92	2.83	49.91	3.05	49.89	3.27	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	87 Deg.		86 $\frac{3}{4}$ Deg.		86 $\frac{1}{2}$ Deg.		86 $\frac{1}{4}$ Deg.		

Distance.	3 Deg.		3¼ Deg.		3½ Deg.		3¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	50.93	2.67	50.92	2.89	50.90	3.11	50.89	3.34	51
52	51.93	2.72	51.92	2.95	51.90	3.17	51.89	3.40	52
53	52.93	2.77	52.91	3.00	52.90	3.24	52.89	3.47	53
54	53.93	2.83	53.91	3.06	53.90	3.30	53.88	3.53	54
55	54.92	2.88	54.91	3.12	54.90	3.36	54.88	3.60	55
56	55.92	2.93	55.91	3.17	55.90	3.42	55.88	3.66	56
57	56.92	2.98	56.91	3.23	56.89	3.48	56.88	3.73	57
58	57.92	3.04	57.91	3.29	57.89	3.54	57.88	3.79	58
59	58.92	3.09	58.91	3.34	58.89	3.60	58.87	3.86	59
60	59.92	3.14	59.90	3.40	59.89	3.66	59.87	3.92	60
61	60.92	3.19	60.90	3.46	60.89	3.72	60.87	3.99	61
62	61.92	3.24	61.90	3.51	61.88	3.79	61.87	4.05	62
63	62.91	3.30	62.90	3.57	62.88	3.85	62.87	4.12	63
64	63.91	3.35	63.90	3.63	63.88	3.91	63.86	4.19	64
65	64.91	3.40	64.90	3.69	64.88	3.97	64.86	4.25	65
66	65.91	3.45	65.89	3.74	65.88	4.03	65.86	4.32	66
67	66.91	3.51	66.89	3.80	66.88	4.09	66.86	4.38	67
68	67.91	3.56	67.89	3.86	67.87	4.15	67.85	4.45	68
69	68.91	3.61	68.89	3.91	68.87	4.21	68.85	4.51	69
70	69.90	3.66	69.89	3.97	69.87	4.27	69.85	4.58	70
71	70.90	3.72	70.89	4.03	70.87	4.33	70.85	4.64	71
72	71.90	3.77	71.88	4.08	71.87	4.40	71.85	4.71	72
73	72.90	3.82	72.88	4.14	72.86	4.46	72.84	4.77	73
74	73.90	3.87	73.88	4.20	73.86	4.52	73.84	4.84	74
75	74.90	3.93	74.88	4.25	74.86	4.58	74.84	4.91	75
76	75.90	3.98	75.88	4.31	75.86	4.64	75.84	4.97	76
77	76.89	4.03	76.88	4.37	76.86	4.70	76.84	5.04	77
78	77.89	4.08	77.87	4.42	77.85	4.76	77.83	5.10	78
79	78.89	4.13	78.87	4.48	78.85	4.82	78.83	5.17	79
80	79.89	4.19	79.87	4.54	79.85	4.88	79.83	5.23	80
81	80.89	4.24	80.87	4.59	80.85	4.94	80.83	5.30	81
82	81.89	4.29	81.87	4.65	81.85	5.01	81.82	5.36	82
83	82.89	4.34	82.87	4.71	82.85	5.07	82.82	5.43	83
84	83.88	4.40	83.86	4.76	83.84	5.13	83.82	5.49	84
85	84.88	4.45	84.86	4.82	84.84	5.19	84.82	5.56	85
86	85.88	4.50	85.86	4.88	85.84	5.25	85.82	5.62	86
87	86.88	4.55	86.86	4.93	86.84	5.31	86.81	5.69	87
88	87.88	4.61	87.86	4.99	87.84	5.37	87.81	5.76	88
89	88.88	4.66	88.86	5.05	88.83	5.43	88.81	5.82	89
90	89.88	4.71	89.86	5.10	89.83	5.49	89.81	5.89	90
91	90.88	4.76	90.85	5.16	90.83	5.56	90.81	5.95	91
92	91.87	4.81	91.85	5.22	91.83	5.62	91.80	6.02	92
93	92.87	4.87	92.85	5.27	92.83	5.68	92.80	6.08	93
94	93.87	4.92	93.85	5.33	93.82	5.74	93.80	6.15	94
95	94.87	4.97	94.85	5.39	94.82	5.80	94.80	6.21	95
96	95.87	5.02	95.85	5.44	95.82	5.86	95.79	6.28	96
97	96.87	5.08	96.84	5.50	96.82	5.92	96.79	6.34	97
98	97.87	5.13	97.84	5.56	97.82	5.98	97.79	6.41	98
99	98.86	5.18	98.84	5.61	98.82	6.04	98.79	6.47	99
100	99.86	5.23	99.84	5.67	99.81	6.10	99.79	6.54	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	87 Deg.		86¾ Deg.		86½ Deg.		86¼ Deg.		

Distance.	4 Deg.		4 $\frac{1}{4}$ Deg.		4 $\frac{1}{2}$ Deg.		4 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	1.00	0.07	1.00	0.07	1.00	0.08	1.00	0.08	1
2	2.00	0.14	1.99	0.15	1.99	0.16	1.99	0.17	2
3	2.99	0.21	2.99	0.22	2.99	0.24	2.99	0.25	3
4	3.99	0.28	3.99	0.30	3.99	0.31	3.98	0.33	4
5	4.99	0.35	4.99	0.37	4.98	0.39	4.98	0.41	5
6	5.99	0.42	5.98	0.44	5.98	0.47	5.98	0.50	6
7	6.98	0.49	6.98	0.52	6.98	0.55	6.97	0.58	7
8	7.98	0.56	7.98	0.59	7.98	0.63	7.97	0.66	8
9	8.98	0.63	8.98	0.67	8.97	0.71	8.97	0.75	9
10	9.98	0.70	9.97	0.74	9.97	0.78	9.97	0.83	10
11	10.97	0.77	10.97	0.82	10.97	0.86	10.96	0.91	11
12	11.97	0.84	11.97	0.89	11.96	0.94	11.96	0.99	12
13	12.97	0.91	12.96	0.96	12.96	1.02	12.96	1.08	13
14	13.97	0.98	13.96	1.04	13.96	1.10	13.95	1.16	14
15	14.96	1.05	14.96	1.11	14.95	1.18	14.95	1.24	15
16	15.96	1.12	15.96	1.19	15.95	1.26	15.95	1.32	16
17	16.96	1.19	16.95	1.26	16.95	1.33	16.94	1.41	17
18	17.96	1.26	17.95	1.33	17.94	1.41	17.94	1.49	18
19	18.95	1.33	18.95	1.40	18.94	1.49	18.93	1.57	19
20	19.95	1.40	19.95	1.48	19.94	1.57	19.93	1.66	20
21	20.95	1.46	20.94	1.56	20.94	1.65	20.93	1.74	21
22	21.95	1.53	21.94	1.63	21.93	1.73	21.92	1.82	22
23	22.94	1.60	22.94	1.70	22.93	1.80	22.92	1.90	23
24	23.94	1.67	23.93	1.78	23.93	1.88	23.92	1.99	24
25	24.94	1.74	24.93	1.85	24.92	1.96	24.91	2.07	25
26	25.94	1.81	25.93	1.93	25.92	2.04	25.91	2.15	26
27	26.93	1.88	26.93	2.00	26.92	2.12	26.91	2.24	27
28	27.93	1.95	27.92	2.08	27.91	2.20	27.90	2.32	28
29	28.93	2.02	28.92	2.15	28.91	2.28	28.90	2.40	29
30	29.93	2.09	29.92	2.22	29.91	2.35	29.90	2.48	30
31	30.92	2.16	30.91	2.30	30.90	2.43	30.89	2.57	31
32	31.92	2.23	31.91	2.37	31.90	2.51	31.89	2.65	32
33	32.92	2.30	32.91	2.45	32.90	2.59	32.89	2.73	33
34	33.92	2.37	33.91	2.52	33.90	2.67	33.88	2.82	34
35	34.91	2.44	34.90	2.59	34.89	2.75	34.88	2.90	35
36	35.91	2.51	35.90	2.67	35.89	2.82	35.88	2.98	36
37	36.91	2.58	36.90	2.74	36.89	2.90	36.87	3.06	37
38	37.91	2.65	37.90	2.82	37.88	2.98	37.87	3.15	38
39	38.90	2.72	38.89	2.89	38.88	3.06	38.87	3.23	39
40	39.90	2.79	39.89	2.96	39.88	3.14	39.86	3.31	40
41	40.90	2.86	40.89	3.04	40.87	3.22	40.86	3.40	41
42	41.90	2.93	41.88	3.11	41.87	3.30	41.86	3.48	42
43	42.90	3.00	42.88	3.19	42.87	3.37	42.85	3.56	43
44	43.89	3.07	43.88	3.26	43.86	3.45	43.85	3.64	44
45	44.89	3.14	44.88	3.33	44.86	3.53	44.85	3.73	45
46	45.89	3.21	45.87	3.41	45.86	3.61	45.84	3.81	46
47	46.89	3.28	46.87	3.48	46.86	3.69	46.84	3.89	47
48	47.88	3.35	47.87	3.56	47.85	3.77	47.84	3.97	48
49	48.88	3.42	48.87	3.63	48.85	3.84	48.83	4.06	49
50	49.88	3.49	49.86	3.71	49.85	3.92	49.83	4.14	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	86 Deg.		85 $\frac{3}{4}$ Deg.		85 $\frac{1}{2}$ Deg.		85 $\frac{1}{4}$ Deg.		

Distance.	4 Deg.		4 $\frac{1}{4}$ Deg.		4 $\frac{1}{2}$ Deg.		4 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	50.88	3.56	50.86	3.78	50.84	4.00	50.82	4.22	51
52	51.87	3.63	51.86	3.85	51.84	4.08	51.82	4.31	52
53	52.87	3.70	52.85	3.93	52.84	4.16	52.82	4.39	53
54	53.87	3.77	53.85	4.00	53.83	4.24	53.81	4.47	54
55	54.87	3.84	54.85	4.08	54.83	4.32	54.81	4.55	55
56	55.86	3.91	55.85	4.15	55.83	4.39	55.81	4.64	56
57	56.86	3.98	56.84	4.22	56.82	4.47	56.80	4.72	57
58	57.86	4.05	57.84	4.30	57.82	4.55	57.80	4.80	58
59	58.86	4.12	58.84	4.37	58.82	4.63	58.80	4.89	59
60	59.85	4.19	59.84	4.45	59.82	4.71	59.79	4.97	60
61	60.85	4.26	60.83	4.52	60.81	4.79	60.79	5.05	61
62	61.85	4.32	61.83	4.59	61.81	4.86	61.79	5.13	62
63	62.85	4.39	62.83	4.67	62.81	4.94	62.78	5.22	63
64	63.84	4.46	63.82	4.74	63.80	5.02	63.78	5.30	64
65	64.84	4.53	64.82	4.82	64.80	5.10	64.78	5.38	65
66	65.84	4.60	65.82	4.89	65.80	5.18	65.77	5.47	66
67	66.84	4.67	66.82	4.97	66.79	5.26	66.77	5.55	67
68	67.83	4.74	67.81	5.04	67.79	5.34	67.77	5.63	68
69	68.83	4.81	68.81	5.11	68.79	5.41	68.76	5.71	69
70	69.83	4.88	69.81	5.19	69.78	5.49	69.76	5.80	70
71	70.83	4.95	70.80	5.26	70.78	5.57	70.76	5.88	71
72	71.82	5.02	71.80	5.34	71.78	5.65	71.75	5.96	72
73	72.82	5.09	72.80	5.41	72.77	5.73	72.75	6.04	73
74	73.82	5.16	73.80	5.48	73.77	5.81	73.75	6.13	74
75	74.82	5.23	74.79	5.56	74.77	5.88	74.74	6.21	75
76	75.81	5.30	75.79	5.63	75.77	5.96	75.74	6.29	76
77	76.81	5.37	76.79	5.71	76.76	6.04	76.74	6.38	77
78	77.81	5.44	77.79	5.78	77.76	6.12	77.73	6.46	78
79	78.81	5.51	78.78	5.85	78.76	6.20	78.73	6.54	79
80	79.81	5.58	79.78	5.93	79.75	6.28	79.73	6.62	80
81	80.80	5.65	80.78	6.00	80.75	6.36	80.72	6.71	81
82	81.80	5.72	81.78	6.08	81.75	6.43	81.72	6.79	82
83	82.80	5.79	82.77	6.15	82.74	6.51	82.71	6.87	83
84	83.80	5.86	83.77	6.23	83.74	6.59	83.71	6.96	84
85	84.79	5.93	84.77	6.30	84.74	6.67	84.71	7.04	85
86	85.79	6.00	85.76	6.37	85.73	6.75	85.70	7.12	86
87	86.79	6.07	86.76	6.45	86.73	6.83	86.70	7.20	87
88	87.79	6.14	87.76	6.52	87.73	6.90	87.70	7.29	88
89	88.78	6.21	88.76	6.60	88.73	6.98	88.70	7.37	89
90	89.78	6.28	89.75	6.67	89.72	7.06	89.69	7.45	90
91	90.78	6.35	90.75	6.74	90.72	7.14	90.69	7.54	91
92	91.78	6.42	91.75	6.82	91.72	7.22	91.68	7.62	92
93	92.77	6.49	92.74	6.89	92.71	7.30	92.68	7.70	93
94	93.77	6.56	93.74	6.97	93.71	7.38	93.68	7.78	94
95	94.77	6.63	94.74	7.04	94.71	7.45	94.67	7.87	95
96	95.77	6.70	95.74	7.11	95.70	7.53	95.67	7.95	96
97	96.76	6.77	96.73	7.19	96.70	7.61	96.67	8.03	97
98	97.76	6.84	97.73	7.26	97.70	7.69	97.66	8.12	98
99	98.76	6.91	98.73	7.34	98.69	7.77	98.66	8.20	99
100	99.76	6.98	99.73	7.41	99.69	7.85	99.66	8.28	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	86 Deg.		85 $\frac{1}{4}$ Deg.		85 $\frac{1}{2}$ Deg.		85 $\frac{3}{4}$ Deg.		

Distance.	5 Deg.		5¼ Deg.		5½ Deg.		5¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	1.00	0.09	1.00	0.09	1.00	0.10	0.99	0.10	1
2	1.99	0.17	1.99	0.18	1.99	0.19	1.99	0.20	2
3	2.99	0.26	2.99	0.27	2.99	0.29	2.98	0.30	3
4	3.98	0.35	3.98	0.37	3.98	0.38	3.98	0.40	4
5	4.98	0.44	4.98	0.46	4.98	0.48	4.97	0.50	5
6	5.98	0.52	5.97	0.55	5.97	0.58	5.97	0.60	6
7	6.97	0.61	6.97	0.64	6.97	0.67	6.96	0.70	7
8	7.97	0.70	7.97	0.73	7.96	0.76	7.96	0.80	8
9	8.97	0.78	8.96	0.82	8.96	0.86	8.95	0.90	9
10	9.96	0.87	9.96	0.92	9.95	0.96	9.95	1.00	10
11	10.96	0.96	10.95	1.01	10.95	1.05	10.94	1.10	11
12	11.95	1.05	11.95	1.10	11.94	1.15	11.94	1.20	12
13	12.95	1.13	12.95	1.19	12.94	1.25	12.93	1.30	13
14	13.95	1.22	13.94	1.28	13.94	1.34	13.93	1.40	14
15	14.94	1.31	14.94	1.37	14.93	1.44	14.92	1.50	15
16	15.94	1.39	15.93	1.46	15.93	1.53	15.92	1.60	16
17	16.94	1.48	16.93	1.56	16.92	1.63	16.91	1.70	17
18	17.93	1.57	17.92	1.65	17.92	1.73	17.91	1.80	18
19	18.93	1.66	18.92	1.74	18.91	1.82	18.90	1.90	19
20	19.92	1.74	19.92	1.83	19.91	1.92	19.90	2.00	20
21	20.92	1.83	20.91	1.92	20.90	2.01	20.89	2.10	21
22	21.92	1.92	21.91	2.01	21.90	2.11	21.89	2.20	22
23	22.91	2.00	22.90	2.10	22.89	2.20	22.88	2.30	23
24	23.91	2.09	23.90	2.20	23.89	2.30	23.88	2.40	24
25	24.90	2.18	24.90	2.29	24.88	2.40	24.87	2.50	25
26	25.90	2.27	25.89	2.38	25.88	2.49	25.87	2.60	26
27	26.90	2.35	26.89	2.47	26.88	2.59	26.86	2.71	27
28	27.89	2.44	27.88	2.56	27.87	2.68	27.86	2.81	28
29	28.89	2.53	28.88	2.65	28.87	2.78	28.85	2.91	29
30	29.89	2.61	29.87	2.75	29.86	2.88	29.85	3.01	30
31	30.88	2.70	30.87	2.84	30.86	2.97	30.84	3.11	31
32	31.88	2.79	31.87	2.93	31.85	3.07	31.84	3.21	32
33	32.87	2.88	32.86	3.02	32.85	3.16	32.83	3.31	33
34	33.87	2.96	33.86	3.11	33.84	3.26	33.83	3.41	34
35	34.87	3.05	34.85	3.20	34.84	3.35	34.82	3.51	35
36	35.86	3.14	35.85	3.29	35.83	3.45	35.82	3.61	36
37	36.86	3.22	36.84	3.39	36.83	3.55	36.81	3.71	37
38	37.86	3.31	37.84	3.48	37.83	3.64	37.81	3.81	38
39	38.85	3.40	38.84	3.57	38.82	3.74	38.80	3.91	39
40	39.85	3.49	39.83	3.66	39.82	3.83	39.80	4.01	40
41	40.84	3.57	40.83	3.75	40.81	3.93	40.79	4.11	41
42	41.84	3.66	41.82	3.84	41.81	4.03	41.79	4.21	42
43	42.84	3.75	42.82	3.93	42.80	4.12	42.78	4.31	43
44	43.83	3.83	43.82	4.03	43.80	4.22	43.78	4.41	44
45	44.83	3.92	44.81	4.12	44.79	4.31	44.77	4.51	45
46	45.82	4.01	45.81	4.21	45.79	4.41	45.77	4.61	46
47	46.82	4.10	46.80	4.30	46.78	4.50	46.76	4.71	47
48	47.82	4.18	47.80	4.39	47.78	4.60	47.76	4.81	48
49	48.81	4.27	48.79	4.48	48.77	4.70	48.75	4.91	49
50	49.81	4.36	49.79	4.58	49.77	4.79	49.75	5.01	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	85 Deg.		84¾ Deg.		84½ Deg.		84¼ Deg.		

Distance.	5 Deg.		5¼ Deg.		5½ Deg.		5¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	50.81	4.44	50.79	4.67	50.77	4.89	50.74	5.11	51
52	51.80	4.53	51.78	4.76	51.76	4.98	51.74	5.21	52
53	52.80	4.62	52.78	4.85	52.76	5.08	52.73	5.31	53
54	53.79	4.71	53.77	4.94	53.75	5.18	53.73	5.41	54
55	54.79	4.79	54.77	5.03	54.75	5.27	54.72	5.51	55
56	55.79	4.88	55.77	5.12	55.74	5.37	55.72	5.61	56
57	56.78	4.97	56.76	5.22	56.74	5.46	56.71	5.71	57
58	57.78	5.06	57.76	5.31	57.73	5.56	57.71	5.81	58
59	58.78	5.14	58.75	5.40	58.73	5.65	58.70	5.91	59
60	59.77	5.23	59.75	5.49	59.72	5.75	59.70	6.01	60
61	60.77	5.32	60.74	5.58	60.72	5.85	60.69	6.11	61
62	61.76	5.40	61.74	5.67	61.71	5.94	61.69	6.21	62
63	62.76	5.49	62.74	5.76	62.71	6.04	62.68	6.31	63
64	63.76	5.58	63.73	5.86	63.71	6.13	63.68	6.41	64
65	64.75	5.67	64.73	5.95	64.70	6.23	64.67	6.51	65
66	65.75	5.75	65.72	6.04	65.70	6.33	65.67	6.61	66
67	66.75	5.84	66.72	6.13	66.69	6.42	66.66	6.71	67
68	67.74	5.93	67.71	6.22	67.69	6.52	67.66	6.81	68
69	68.74	6.01	68.71	6.31	68.68	6.61	68.65	6.91	69
70	69.73	6.10	69.71	6.41	69.68	6.71	69.65	7.01	70
71	70.73	6.19	70.70	6.50	70.67	6.81	70.64	7.11	71
72	71.73	6.28	71.70	6.59	71.67	6.90	71.64	7.21	72
73	72.72	6.36	72.69	6.68	72.66	7.00	72.63	7.31	73
74	73.72	6.45	73.69	6.77	73.66	7.09	73.63	7.41	74
75	74.71	6.54	74.69	6.86	74.65	7.19	74.62	7.51	75
76	75.71	6.62	75.68	6.95	75.65	7.28	75.62	7.61	76
77	76.71	6.71	76.68	7.05	76.65	7.38	76.61	7.71	77
78	77.70	6.80	77.67	7.14	77.64	7.48	77.61	7.81	78
79	78.70	6.89	78.67	7.23	78.64	7.57	78.60	7.91	79
80	79.70	6.97	79.66	7.32	79.63	7.67	79.60	8.02	80
81	80.69	7.06	80.66	7.41	80.63	7.76	80.59	8.12	81
82	81.69	7.15	81.66	7.50	81.62	7.86	81.59	8.22	82
83	82.68	7.23	82.65	7.59	82.62	7.96	82.58	8.32	83
84	83.68	7.32	83.65	7.69	83.61	8.05	83.58	8.42	84
85	84.68	7.41	84.64	7.78	84.61	8.15	84.57	8.52	85
86	85.67	7.50	85.64	7.87	85.60	8.24	85.57	8.62	86
87	86.67	7.58	86.64	7.96	86.60	8.34	86.56	8.72	87
88	87.67	7.67	87.63	8.05	87.59	8.43	87.56	8.82	88
89	88.66	7.76	88.63	8.14	88.59	8.53	88.55	8.92	89
90	89.66	7.84	89.62	8.24	89.59	8.63	89.55	9.02	90
91	90.65	7.93	90.62	8.33	90.58	8.72	90.54	9.12	91
92	91.65	8.02	91.61	8.42	91.58	8.82	91.54	9.22	92
93	92.65	8.11	92.61	8.51	92.57	8.91	92.53	9.32	93
94	93.64	8.19	93.61	8.60	93.57	9.01	93.53	9.42	94
95	94.64	8.28	94.60	8.69	94.56	9.11	94.52	9.52	95
96	95.63	8.37	95.60	8.78	95.56	9.20	95.52	9.62	96
97	96.63	8.45	96.59	8.88	96.55	9.30	96.51	9.72	97
98	97.63	8.54	97.59	8.97	97.55	9.39	97.51	9.82	98
99	98.62	8.63	98.59	9.06	98.54	9.49	98.50	9.92	99
100	99.62	8.72	99.58	9.15	99.54	9.58	99.50	10.02	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	85 Deg.		84¾ Deg.		84½ Deg.		84¼ Deg.		

Distance.	6 Deg.		6¼ Deg.		6½ Deg.		6¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.99	0.10	0.99	0.11	0.99	0.11	0.99	0.12	1
2	1.99	0.21	1.99	0.22	1.99	0.23	1.99	0.24	2
3	2.98	0.31	2.98	0.33	2.98	0.34	2.98	0.35	3
4	3.98	0.41	3.98	0.44	3.97	0.45	3.97	0.47	4
5	4.97	0.52	4.97	0.54	4.97	0.57	4.97	0.59	5
6	5.97	0.63	5.96	0.65	5.96	0.68	5.96	0.71	6
7	6.96	0.73	6.96	0.76	6.96	0.79	6.95	0.82	7
8	7.96	0.84	7.95	0.87	7.95	0.91	7.94	0.94	8
9	8.95	0.94	8.95	0.98	8.94	1.02	8.94	1.06	9
10	9.95	1.05	9.94	1.09	9.94	1.13	9.93	1.18	10
11	10.94	1.15	10.93	1.20	10.93	1.25	10.92	1.29	11
12	11.93	1.25	11.93	1.31	11.92	1.36	11.92	1.41	12
13	12.93	1.36	12.92	1.42	12.92	1.47	12.91	1.53	13
14	13.92	1.46	13.92	1.52	13.91	1.59	13.90	1.65	14
15	14.92	1.57	14.91	1.63	14.90	1.70	14.90	1.76	15
16	15.91	1.67	15.90	1.74	15.90	1.81	15.89	1.88	16
17	16.91	1.78	16.90	1.85	16.89	1.92	16.88	2.00	17
18	17.90	1.88	17.89	1.96	17.88	2.04	17.88	2.12	18
19	18.90	1.99	18.89	2.07	18.88	2.15	18.87	2.23	19
20	19.89	2.09	19.88	2.18	19.87	2.26	19.86	2.35	20
21	20.88	2.20	20.88	2.29	20.87	2.38	20.85	2.47	21
22	21.88	2.30	21.87	2.40	21.86	2.49	21.85	2.59	22
23	22.87	2.40	22.86	2.50	22.85	2.60	22.84	2.70	23
24	23.87	2.51	23.86	2.61	23.85	2.72	23.83	2.82	24
25	24.86	2.61	24.85	2.72	24.84	2.83	24.83	2.94	25
26	25.86	2.72	25.85	2.83	25.83	2.94	25.82	3.06	26
27	26.85	2.82	26.84	2.94	26.83	3.06	26.81	3.17	27
28	27.85	2.93	27.83	3.05	27.82	3.17	27.81	3.29	28
29	28.84	3.03	28.83	3.16	28.81	3.28	28.80	3.41	29
30	29.84	3.14	29.82	3.27	29.81	3.40	29.79	3.53	30
31	30.83	3.24	30.82	3.37	30.80	3.51	30.79	3.64	31
32	31.82	3.34	31.81	3.48	31.79	3.62	31.78	3.76	32
33	32.82	3.45	32.80	3.59	32.79	3.74	32.77	3.88	33
34	33.81	3.55	33.80	3.70	33.78	3.85	33.76	4.00	34
35	34.81	3.66	34.79	3.81	34.78	3.96	34.76	4.11	35
36	35.80	3.76	35.79	3.92	35.77	4.08	35.75	4.23	36
37	36.80	3.87	36.78	4.03	36.76	4.19	36.75	4.35	37
38	37.79	3.97	37.77	4.14	37.76	4.30	37.74	4.47	38
39	38.79	4.08	38.77	4.25	38.75	4.41	38.73	4.58	39
40	39.78	4.18	39.76	4.35	39.74	4.53	39.72	4.70	40
41	40.78	4.29	40.76	4.46	40.74	4.64	40.72	4.82	41
42	41.77	4.39	41.75	4.57	41.73	4.76	41.71	4.94	42
43	42.76	4.49	42.74	4.68	42.72	4.87	42.70	5.05	43
44	43.76	4.60	43.74	4.79	43.72	4.98	43.70	5.17	44
45	44.75	4.70	44.73	4.90	44.71	5.09	44.69	5.29	45
46	45.75	4.81	45.73	5.01	45.70	5.21	45.68	5.41	46
47	46.74	4.91	46.72	5.12	46.70	5.32	46.67	5.52	47
48	47.74	5.02	47.71	5.23	47.69	5.43	47.67	5.64	48
49	48.73	5.12	48.71	5.34	48.69	5.55	48.66	5.76	49
50	49.73	5.23	49.70	5.44	49.68	5.66	49.65	5.88	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	84 Deg.		83¾ Deg.		83¼ Deg.		83¼ Deg.		

Distance.	6 Deg.		6¼ Deg.		6½ Deg.		6¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	50.72	5.33	50.70	5.55	50.67	5.77	50.65	5.99	51
52	51.72	5.44	51.69	5.66	51.67	5.89	51.64	6.11	52
53	52.71	5.54	52.68	5.77	52.66	6.00	52.63	6.23	53
54	53.70	5.64	53.68	5.88	53.65	6.11	53.63	6.35	54
55	54.70	5.75	54.67	5.99	54.65	6.23	54.62	6.46	55
56	55.69	5.85	55.67	6.10	55.64	6.34	55.61	6.58	56
57	56.69	5.96	56.66	6.21	56.63	6.45	56.60	6.70	57
58	57.68	6.06	57.66	6.31	57.63	6.57	57.60	6.82	58
59	58.68	6.17	58.65	6.42	58.62	6.68	58.59	6.93	59
60	59.67	6.27	59.64	6.53	59.61	6.79	59.58	7.05	60
61	60.67	6.38	60.64	6.64	60.61	6.91	60.58	7.17	61
62	61.66	6.48	61.63	6.75	61.60	7.02	61.57	7.29	62
63	62.65	6.59	62.63	6.86	62.60	7.13	62.56	7.40	63
64	63.65	6.69	63.62	6.97	63.59	7.25	63.56	7.52	64
65	64.64	6.79	64.61	7.08	64.58	7.36	64.55	7.64	65
66	65.64	6.90	65.61	7.19	65.58	7.47	65.54	7.76	66
67	66.63	7.00	66.60	7.29	66.57	7.58	66.54	7.88	67
68	67.63	7.11	67.60	7.40	67.56	7.70	67.53	7.99	68
69	68.62	7.21	68.59	7.51	68.56	7.81	68.52	8.11	69
70	69.62	7.32	69.58	7.62	69.55	7.92	69.51	8.23	70
71	70.61	7.42	70.58	7.73	70.54	8.04	70.51	8.35	71
72	71.61	7.53	71.57	7.84	71.54	8.15	71.50	8.46	72
73	72.60	7.63	72.57	7.95	72.53	8.26	72.49	8.58	73
74	73.59	7.74	73.56	8.06	73.52	8.38	73.49	8.70	74
75	74.59	7.84	74.55	8.17	74.52	8.49	74.48	8.82	75
76	75.58	7.94	75.55	8.27	75.51	8.60	75.47	8.93	76
77	76.58	8.05	76.54	8.38	76.51	8.72	76.47	9.05	77
78	77.57	8.15	77.54	8.49	77.50	8.83	77.46	9.17	78
79	78.57	8.26	78.53	8.60	78.49	8.94	78.45	9.29	79
80	79.56	8.36	79.53	8.71	79.49	9.06	79.45	9.40	80
81	80.56	8.47	80.52	8.82	80.48	9.17	80.44	9.52	81
82	81.55	8.57	81.51	8.93	81.47	9.28	81.43	9.64	82
83	82.55	8.68	82.51	9.04	82.47	9.40	82.42	9.76	83
84	83.54	8.78	83.50	9.14	83.46	9.51	83.42	9.87	84
85	84.53	8.88	84.50	9.25	84.45	9.62	84.41	9.99	85
86	85.53	8.99	85.49	9.36	85.45	9.74	85.40	10.11	86
87	86.52	9.09	86.48	9.47	86.44	9.85	86.40	10.23	87
88	87.52	9.20	87.48	9.58	87.43	9.96	87.39	10.34	88
89	88.51	9.30	88.47	9.69	88.43	10.08	88.38	10.46	89
90	89.51	9.41	89.47	9.80	89.42	10.19	89.38	10.58	90
91	90.50	9.51	90.46	9.91	90.42	10.30	90.37	10.70	91
92	91.50	9.62	91.45	10.02	91.41	10.41	91.36	10.81	92
93	92.49	9.72	92.45	10.12	92.40	10.53	92.36	10.93	93
94	93.49	9.83	93.44	10.23	93.40	10.64	93.35	11.05	94
95	94.48	9.93	94.44	10.34	94.39	10.75	94.34	11.17	95
96	95.47	10.03	95.43	10.45	95.38	10.87	95.33	11.28	96
97	96.47	10.14	96.42	10.56	96.38	10.98	96.33	11.40	97
98	97.46	10.24	97.42	10.67	97.37	11.09	97.32	11.52	98
99	98.46	10.35	98.41	10.78	98.36	11.21	98.31	11.64	99
100	99.45	10.45	99.41	10.89	99.36	11.32	99.31	11.75	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	84 Deg.		83¾ Deg.		83½ Deg.		83¼ Deg.		

Distance.	7 Deg.		7¼ Deg.		7½ Deg.		7¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.99	0.12	0.99	0.13	0.99	0.13	0.99	0.13	1
2	1.99	0.24	1.98	0.25	1.98	0.26	1.98	0.27	2
3	2.98	0.37	2.98	0.38	2.97	0.39	2.97	0.40	3
4	3.97	0.49	3.97	0.50	3.97	0.52	3.96	0.54	4
5	4.96	0.61	4.96	0.63	4.96	0.65	4.95	0.67	5
6	5.96	0.73	5.95	0.76	5.95	0.78	5.95	0.81	6
7	6.95	0.85	6.94	0.88	6.94	0.91	6.94	0.94	7
8	7.94	0.97	7.94	1.01	7.93	1.04	7.93	1.08	8
9	8.93	1.10	8.93	1.14	8.92	1.17	8.92	1.21	9
10	9.93	1.22	9.92	1.26	9.91	1.31	9.91	1.35	10
11	10.92	1.34	10.91	1.39	10.91	1.44	10.90	1.48	11
12	11.91	1.46	11.90	1.51	11.90	1.57	11.89	1.62	12
13	12.90	1.58	12.90	1.64	12.89	1.70	12.88	1.75	13
14	13.90	1.71	13.89	1.77	13.88	1.83	13.87	1.89	14
15	14.89	1.83	14.88	1.89	14.87	1.96	14.86	2.02	15
16	15.88	1.95	15.87	2.02	15.86	2.09	15.85	2.16	16
17	16.87	2.07	16.86	2.15	16.85	2.22	16.84	2.29	17
18	17.87	2.19	17.86	2.27	17.85	2.35	17.84	2.43	18
19	18.86	2.32	18.85	2.40	18.84	2.48	18.83	2.56	19
20	19.85	2.44	19.84	2.52	19.83	2.61	19.82	2.70	20
21	20.84	2.56	20.83	2.65	20.82	2.74	20.81	2.83	21
22	21.84	2.68	21.82	2.78	21.81	2.87	21.80	2.97	22
23	22.83	2.80	22.82	2.90	22.80	3.00	22.79	3.10	23
24	23.82	2.92	23.81	3.03	23.79	3.13	23.78	3.24	24
25	24.81	3.05	24.80	3.15	24.79	3.26	24.77	3.37	25
26	25.81	3.17	25.79	3.28	25.78	3.39	25.76	3.51	26
27	26.80	3.29	26.78	3.41	26.77	3.52	26.75	3.64	27
28	27.79	3.41	27.78	3.53	27.76	3.65	27.74	3.78	28
29	28.78	3.53	28.77	3.66	28.75	3.79	28.74	3.91	29
30	29.78	3.66	29.76	3.79	29.74	3.92	29.73	4.05	30
31	30.77	3.78	30.75	3.91	30.73	4.05	30.72	4.18	31
32	31.76	3.90	31.74	4.04	31.73	4.18	31.71	4.32	32
33	32.75	4.02	32.74	4.16	32.72	4.31	32.70	4.45	33
34	33.75	4.14	33.73	4.29	33.71	4.44	33.69	4.58	34
35	34.74	4.27	34.72	4.42	34.70	4.57	34.68	4.72	35
36	35.73	4.39	35.71	4.54	35.69	4.70	35.67	4.85	36
37	36.72	4.51	36.70	4.67	36.68	4.83	36.66	4.99	37
38	37.72	4.63	37.70	4.80	37.67	4.96	37.65	5.12	38
39	38.71	4.75	38.69	4.92	38.67	5.09	38.64	5.26	39
40	39.70	4.87	39.68	5.05	39.66	5.22	39.63	5.39	40
41	40.70	5.00	40.67	5.17	40.65	5.35	40.63	5.53	41
42	41.69	5.12	41.66	5.30	41.64	5.48	41.62	5.66	42
43	42.68	5.24	42.66	5.43	42.63	5.61	42.61	5.80	43
44	43.67	5.36	43.65	5.55	43.62	5.74	43.60	5.93	44
45	44.67	5.48	44.64	5.68	44.62	5.87	44.59	6.07	45
46	45.66	5.61	45.63	5.81	45.61	6.00	45.58	6.20	46
47	46.65	5.73	46.62	5.93	46.60	6.13	46.57	6.34	47
48	47.64	5.85	47.62	6.06	47.59	6.27	47.56	6.47	48
49	48.63	5.97	48.61	6.18	48.58	6.40	48.55	6.61	49
50	49.63	6.09	49.60	6.31	49.57	6.53	49.54	6.74	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	83 Deg.		82¾ Deg.		82½ Deg.		82¼ Deg.		

Distance.	7 Deg.		7¼ Deg.		7½ Deg.		7¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	50.62	6.22	50.59	6.44	50.56	6.66	50.53	6.88	51
52	51.61	6.34	51.58	6.56	51.56	6.79	51.53	7.01	52
53	52.60	6.46	52.58	6.69	52.55	6.92	52.52	7.15	53
54	53.60	6.58	53.57	6.81	53.54	7.05	53.51	7.28	54
55	54.59	6.70	54.56	6.94	54.53	7.18	54.50	7.42	55
56	55.58	6.82	55.55	7.07	55.52	7.31	55.49	7.55	56
57	56.58	6.95	56.54	7.19	56.51	7.44	56.48	7.69	57
58	57.57	7.07	57.54	7.32	57.50	7.57	57.47	7.82	58
59	58.56	7.19	58.53	7.45	58.50	7.70	58.46	7.96	59
60	59.55	7.31	59.52	7.57	59.49	7.83	59.45	8.09	60
61	60.55	7.43	60.51	7.70	60.48	7.96	60.44	8.23	61
62	61.54	7.56	61.50	7.82	61.47	8.09	61.43	8.36	62
63	62.53	7.68	62.50	7.95	62.46	8.22	62.42	8.50	63
64	63.52	7.80	63.49	8.08	63.45	8.35	63.42	8.63	64
65	64.52	7.92	64.48	8.20	64.44	8.48	64.41	8.77	65
66	65.51	8.04	65.47	8.33	65.44	8.61	65.40	8.90	66
67	66.50	8.17	66.46	8.46	66.43	8.75	66.39	9.04	67
68	67.49	8.29	67.46	8.58	67.42	8.88	67.38	9.17	68
69	68.49	8.41	68.45	8.71	68.41	9.01	68.37	9.30	69
70	69.48	8.53	69.44	8.83	69.40	9.14	69.36	9.44	70
71	70.47	8.65	70.43	8.96	70.39	9.27	70.35	9.57	71
72	71.46	8.77	71.42	9.09	71.38	9.40	71.34	9.71	72
73	72.46	8.90	72.42	9.21	72.38	9.53	72.33	9.84	73
74	73.45	9.02	73.41	9.34	73.37	9.66	73.32	9.98	74
75	74.44	9.14	74.40	9.46	74.36	9.79	74.31	10.11	75
76	75.43	9.26	75.39	9.59	75.35	9.92	75.31	10.25	76
77	76.43	9.38	76.38	9.72	76.34	10.05	76.30	10.38	77
78	77.42	9.51	77.38	9.84	77.33	10.18	77.29	10.52	78
79	78.41	9.63	78.37	9.97	78.32	10.31	78.28	10.65	79
80	79.40	9.75	79.36	10.10	79.32	10.44	79.27	10.79	80
81	80.40	9.87	80.35	10.22	80.31	10.57	80.26	10.92	81
82	81.39	9.99	81.34	10.35	81.30	10.70	81.25	11.06	82
83	82.38	10.12	82.34	10.47	82.29	10.83	82.24	11.19	83
84	83.37	10.24	83.33	10.60	83.28	10.96	83.23	11.33	84
85	84.37	10.36	84.32	10.73	84.27	11.09	84.22	11.46	85
86	85.36	10.48	85.31	10.85	85.26	11.23	85.21	11.60	86
87	86.35	10.60	86.30	10.98	86.26	11.36	86.21	11.73	87
88	87.34	10.72	87.30	11.11	87.25	11.49	87.20	11.87	88
89	88.34	10.85	88.29	11.23	88.24	11.62	88.19	12.00	89
90	89.33	10.97	89.28	11.36	89.23	11.75	89.18	12.14	90
91	90.32	11.09	90.27	11.48	90.22	11.88	90.17	12.27	91
92	91.31	11.21	91.26	11.61	91.21	12.01	91.16	12.41	92
93	92.31	11.33	92.26	11.74	92.20	12.14	92.15	12.54	93
94	93.30	11.46	93.25	11.86	93.20	12.27	93.14	12.68	94
95	94.29	11.58	94.24	11.99	94.19	12.40	94.13	12.81	95
96	95.28	11.70	95.23	12.12	95.18	12.53	95.12	12.95	96
97	96.28	11.82	96.22	12.24	96.17	12.66	96.11	13.08	97
98	97.27	11.94	97.22	12.37	97.16	12.79	97.10	13.22	98
99	98.26	12.07	98.21	12.49	98.15	12.92	98.10	13.35	99
100	99.25	12.19	99.20	12.62	99.14	13.05	99.09	13.49	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	83 Deg.		82¾ Deg.		82½ Deg.		82¼ Deg.		

Distance.	8 Deg.		8¼ Deg.		8½ Deg.		8¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.99	0.14	0.99	0.14	0.99	0.15	0.99	0.15	1
2	1.98	0.28	1.98	0.29	1.98	0.30	1.98	0.30	2
3	2.97	0.42	2.97	0.43	2.97	0.44	2.97	0.46	3
4	3.96	0.56	3.96	0.57	3.96	0.59	3.95	0.61	4
5	4.95	0.70	4.95	0.72	4.95	0.74	4.94	0.76	5
6	5.94	0.84	5.94	0.86	5.93	0.89	5.93	0.91	6
7	6.93	0.97	6.93	1.00	6.92	1.03	6.92	1.06	7
8	7.92	1.11	7.92	1.15	7.91	1.18	7.91	1.22	8
9	8.91	1.25	8.91	1.29	8.90	1.33	8.90	1.37	9
10	9.90	1.39	9.90	1.43	9.89	1.48	9.88	1.52	10
11	10.89	1.53	10.89	1.58	10.88	1.63	10.87	1.67	11
12	11.88	1.67	11.88	1.72	11.87	1.77	11.86	1.83	12
13	12.87	1.81	12.87	1.87	12.86	1.92	12.85	1.98	13
14	13.86	1.95	13.86	2.01	13.85	2.07	13.84	2.13	14
15	14.85	2.09	14.85	2.15	14.84	2.22	14.83	2.28	15
16	15.84	2.23	15.84	2.30	15.82	2.36	15.81	2.43	16
17	16.83	2.37	16.83	2.44	16.81	2.51	16.80	2.59	17
18	17.82	2.51	17.81	2.58	17.80	2.66	17.79	2.74	18
19	18.82	2.64	18.80	2.73	18.79	2.81	18.78	2.89	19
20	19.81	2.78	19.79	2.87	19.78	2.96	19.77	3.04	20
21	20.80	2.92	20.78	3.01	20.77	3.10	20.76	3.19	21
22	21.79	3.06	21.77	3.16	21.76	3.25	21.74	3.35	22
23	22.78	3.20	22.76	3.30	22.75	3.40	22.73	3.50	23
24	23.77	3.34	23.75	3.44	23.74	3.55	23.72	3.65	24
25	24.76	3.48	24.74	3.59	24.73	3.70	24.71	3.80	25
26	25.75	3.62	25.73	3.73	25.71	3.84	25.70	3.96	26
27	26.74	3.76	26.72	3.87	26.70	3.99	26.69	4.11	27
28	27.73	3.90	27.71	4.02	27.69	4.14	27.67	4.26	28
29	28.72	4.04	28.70	4.16	28.68	4.29	28.66	4.41	29
30	29.71	4.18	29.69	4.30	29.67	4.43	29.65	4.56	30
31	30.70	4.31	30.68	4.45	30.66	4.58	30.64	4.72	31
32	31.69	4.45	31.67	4.59	31.65	4.73	31.63	4.87	32
33	32.68	4.59	32.66	4.74	32.64	4.88	32.62	5.02	33
34	33.67	4.73	33.65	4.88	33.63	5.03	33.60	5.17	34
35	34.66	4.87	34.64	5.02	34.62	5.17	34.59	5.32	35
36	35.65	5.01	35.63	5.17	35.60	5.32	35.58	5.48	36
37	36.64	5.15	36.62	5.31	36.59	5.47	36.57	5.63	37
38	37.63	5.29	37.61	5.45	37.58	5.62	37.56	5.78	38
39	38.62	5.43	38.60	5.60	38.57	5.76	38.55	5.93	39
40	39.61	5.57	39.59	5.74	39.56	5.91	39.53	6.08	40
41	40.60	5.71	40.58	5.88	40.55	6.06	40.52	6.24	41
42	41.59	5.85	41.57	6.03	41.54	6.21	41.51	6.39	42
43	42.58	5.98	42.56	6.17	42.53	6.36	42.50	6.54	43
44	43.57	6.12	43.54	6.31	43.52	6.50	43.49	6.69	44
45	44.56	6.26	44.53	6.46	44.51	6.65	44.48	6.85	45
46	45.55	6.40	45.52	6.60	45.49	6.80	45.46	7.00	46
47	46.54	6.54	46.51	6.74	46.48	6.95	46.45	7.15	47
48	47.53	6.68	47.50	6.89	47.47	7.09	47.44	7.30	48
49	48.52	6.82	48.49	7.03	48.46	7.24	48.43	7.45	49
50	49.51	6.96	49.48	7.17	49.45	7.39	49.42	7.61	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	82 Deg.		81¾ Deg.		81½ Deg.		81¼ Deg.		

Distance.	8 Deg.		8¼ Deg.		8½ Deg.		8¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	50.50	7.10	50.47	7.32	50.44	7.54	50.41	7.76	51
52	51.49	7.24	51.46	7.46	51.43	7.69	51.39	7.91	52
53	52.48	7.38	52.45	7.61	52.42	7.83	52.38	8.06	53
54	53.47	7.52	53.44	7.75	53.41	7.98	53.37	8.21	54
55	54.46	7.65	54.43	7.89	54.40	8.13	54.36	8.37	55
56	55.46	7.79	55.42	8.04	55.38	8.28	55.35	8.52	56
57	56.45	7.93	56.41	8.18	56.37	8.43	56.34	8.67	57
58	57.44	8.07	57.40	8.32	57.36	8.57	57.32	8.82	58
59	58.43	8.21	58.39	8.47	58.35	8.72	58.31	8.98	59
60	59.42	8.35	59.38	8.61	59.34	8.87	59.30	9.13	60
61	60.41	8.49	60.37	8.75	60.33	9.02	60.29	9.28	61
62	61.40	8.63	61.36	8.90	61.32	9.16	61.28	9.43	62
63	62.39	8.77	62.35	9.04	62.31	9.31	62.27	9.58	63
64	63.38	8.91	63.34	9.18	63.30	9.46	63.26	9.74	64
65	64.37	9.05	64.33	9.33	64.29	9.61	64.24	9.89	65
66	65.36	9.19	65.32	9.47	65.28	9.76	65.23	10.04	66
67	66.35	9.32	66.31	9.61	66.26	9.90	66.22	10.19	67
68	67.34	9.46	67.30	9.76	67.25	10.05	67.21	10.34	68
69	68.33	9.60	68.29	9.90	68.24	10.20	68.20	10.50	69
70	69.32	9.74	69.28	10.04	69.23	10.35	69.19	10.65	70
71	70.31	9.88	70.27	10.19	70.22	10.49	70.17	10.80	71
72	71.30	10.02	71.25	10.33	71.21	10.64	71.16	10.95	72
73	72.29	10.16	72.24	10.47	72.20	10.79	72.15	11.10	73
74	73.28	10.30	73.23	10.62	73.19	10.94	73.14	11.26	74
75	74.27	10.44	74.22	10.76	74.18	11.09	74.13	11.41	75
76	75.26	10.58	75.21	10.91	75.17	11.23	75.12	11.56	76
77	76.25	10.72	76.20	11.05	76.15	11.38	76.10	11.71	77
78	77.24	10.86	77.19	11.19	77.14	11.53	77.09	11.87	78
79	78.23	10.99	78.18	11.34	78.13	11.68	78.08	12.02	79
80	79.22	11.13	79.17	11.48	79.12	11.82	79.07	12.17	80
81	80.21	11.27	80.16	11.62	80.11	11.97	80.06	12.32	81
82	81.20	11.41	81.15	11.77	81.10	12.12	81.05	12.47	82
83	82.19	11.55	82.14	11.91	82.09	12.27	82.03	12.63	83
84	83.18	11.69	83.13	12.05	83.08	12.42	83.02	12.78	84
85	84.17	11.83	84.12	12.20	84.07	12.56	84.01	12.93	85
86	85.16	11.97	85.11	12.34	85.06	12.71	85.00	13.08	86
87	86.15	12.11	86.10	12.48	86.04	12.86	85.99	13.23	87
88	87.14	12.25	87.09	12.63	87.03	13.01	86.98	13.39	88
89	88.13	12.39	88.08	12.77	88.02	13.16	87.96	13.54	89
90	89.12	12.53	89.07	12.91	89.01	13.30	88.95	13.69	90
91	90.11	12.66	90.06	13.06	90.00	13.45	89.94	13.84	91
92	91.10	12.80	91.05	13.20	90.99	13.60	90.93	14.00	92
93	92.09	12.94	92.04	13.34	91.98	13.75	91.92	14.15	93
94	93.09	13.08	93.03	13.49	92.97	13.89	92.91	14.30	94
95	94.08	13.22	94.02	13.63	93.96	14.04	93.89	14.45	95
96	95.07	13.36	95.01	13.78	94.95	14.19	94.88	14.60	96
97	96.06	13.50	96.00	13.92	95.93	14.34	95.87	14.76	97
98	97.05	13.64	96.99	14.06	96.92	14.49	96.86	14.91	98
99	98.04	13.78	97.98	14.21	97.91	14.63	97.85	15.06	99
100	99.03	13.92	98.97	14.35	98.90	14.78	98.84	15.21	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	82 Deg.		81¼ Deg.		81½ Deg.		81¾ Deg.		

Distance.	9 Deg.		9¼ Deg.		9½ Deg.		9¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.99	0.16	0.99	0.16	0.99	0.17	0.99	0.17	1
2	1.98	0.31	1.97	0.32	1.97	0.33	1.97	0.34	2
3	2.96	0.47	2.96	0.48	2.96	0.50	2.96	0.51	3
4	3.95	0.63	3.95	0.64	3.95	0.66	3.94	0.68	4
5	4.94	0.78	4.93	0.80	4.93	0.83	4.93	0.85	5
6	5.93	0.94	5.92	0.96	5.92	0.99	5.91	1.02	6
7	6.91	1.10	6.91	1.13	6.90	1.16	6.90	1.19	7
8	7.90	1.25	7.90	1.29	7.89	1.32	7.88	1.35	8
9	8.89	1.41	8.88	1.45	8.88	1.49	8.87	1.52	9
10	9.88	1.56	9.87	1.61	9.86	1.65	9.86	1.69	10
11	10.86	1.72	10.86	1.77	10.85	1.82	10.84	1.86	11
12	11.85	1.88	11.84	1.93	11.84	1.98	11.83	2.03	12
13	12.84	2.03	12.83	2.09	12.82	2.15	12.81	2.20	13
14	13.83	2.19	13.82	2.25	13.81	2.31	13.80	2.37	14
15	14.82	2.35	14.80	2.41	14.79	2.48	14.78	2.54	15
16	15.80	2.50	15.79	2.57	15.78	2.64	15.77	2.71	16
17	16.79	2.66	16.78	2.73	16.77	2.81	16.75	2.88	17
18	17.78	2.82	17.77	2.89	17.75	2.97	17.74	3.05	18
19	18.77	2.97	18.75	3.05	18.74	3.14	18.73	3.22	19
20	19.75	3.13	19.74	3.21	19.73	3.30	19.71	3.39	20
21	20.74	3.29	20.73	3.38	20.71	3.47	20.70	3.56	21
22	21.73	3.44	21.71	3.54	21.70	3.63	21.68	3.73	22
23	22.72	3.60	22.70	3.70	22.68	3.80	22.67	3.90	23
24	23.70	3.75	23.69	3.86	23.67	3.96	23.65	4.06	24
25	24.69	3.91	24.67	4.02	24.66	4.13	24.64	4.23	25
26	25.68	4.07	25.66	4.18	25.64	4.29	25.62	4.40	26
27	26.67	4.22	26.65	4.34	26.63	4.46	26.61	4.57	27
28	27.66	4.38	27.64	4.50	27.62	4.62	27.60	4.74	28
29	28.64	4.54	28.62	4.66	28.60	4.79	28.58	4.91	29
30	29.63	4.69	29.61	4.82	29.59	4.95	29.57	5.08	30
31	30.62	4.85	30.60	4.98	30.57	5.12	30.55	5.25	31
32	31.61	5.01	31.58	5.14	31.56	5.28	31.54	5.42	32
33	32.59	5.16	32.57	5.30	32.55	5.45	32.52	5.59	33
34	33.58	5.32	33.56	5.47	33.53	5.61	33.51	5.76	34
35	34.57	5.48	34.54	5.63	34.52	5.78	34.49	5.93	35
36	35.56	5.63	35.53	5.79	35.51	5.94	35.48	6.10	36
37	36.54	5.79	36.52	5.95	36.49	6.11	36.47	6.27	37
38	37.53	5.94	37.51	6.11	37.48	6.27	37.45	6.44	38
39	38.52	6.10	38.49	6.27	38.47	6.44	38.44	6.60	39
40	39.51	6.26	39.48	6.43	39.45	6.60	39.42	6.77	40
41	40.50	6.41	40.47	6.59	40.44	6.77	40.41	6.94	41
42	41.48	6.57	41.45	6.75	41.42	6.92	41.39	7.11	42
43	42.47	6.73	42.44	6.91	42.41	7.10	42.38	7.28	43
44	43.46	6.88	43.43	7.07	43.40	7.26	43.36	7.45	44
45	44.45	7.04	44.41	7.23	44.38	7.43	44.35	7.62	45
46	45.43	7.20	45.40	7.39	45.37	7.59	45.34	7.79	46
47	46.42	7.35	46.39	7.55	46.36	7.76	46.32	7.96	47
48	47.41	7.51	47.38	7.72	47.34	7.92	47.31	8.13	48
49	48.40	7.67	48.36	7.88	48.33	8.09	48.29	8.30	49
50	49.38	7.82	49.35	8.04	49.32	8.25	49.28	8.47	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	81 Deg.		80¾ Deg.		80½ Deg.		80¼ Deg.		

Distance.	9 Deg.		9¼ Deg.		9½ Deg.		9¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	50.37	7.98	50.34	8.20	50.30	8.42	50.26	8.64	51
52	51.36	8.13	51.32	8.36	51.29	8.58	51.25	8.81	52
53	52.35	8.29	52.31	8.52	52.27	8.75	52.23	8.98	53
54	53.34	8.45	53.30	8.68	53.26	8.91	53.22	9.14	54
55	54.32	8.60	54.28	8.84	54.25	9.08	54.21	9.31	55
56	55.31	8.76	55.27	9.00	55.23	9.24	55.19	9.48	56
57	56.30	8.92	56.26	9.16	56.22	9.41	56.18	9.65	57
58	57.29	9.07	57.25	9.32	57.20	9.57	57.16	9.82	58
59	58.27	9.23	58.23	9.48	58.19	9.74	58.15	9.99	59
60	59.26	9.39	59.22	9.64	59.18	9.90	59.13	10.16	60
61	60.25	9.54	60.21	9.81	60.16	10.07	60.12	10.33	61
62	61.24	9.70	61.19	9.97	61.15	10.23	61.10	10.50	62
63	62.22	9.86	62.18	10.13	62.14	10.40	62.09	10.67	63
64	63.21	10.01	63.17	10.29	63.12	10.56	63.08	10.84	64
65	64.20	10.17	64.15	10.45	64.11	10.73	64.06	11.01	65
66	65.19	10.32	65.14	10.61	65.09	10.89	65.05	11.18	66
67	66.18	10.48	66.13	10.77	66.08	11.06	66.03	11.35	67
68	67.16	10.64	67.12	10.93	67.07	11.22	67.02	11.52	68
69	68.15	10.79	68.10	11.09	68.05	11.39	68.00	11.69	69
70	69.14	10.95	69.09	11.25	69.04	11.55	68.99	11.85	70
71	70.13	11.11	70.08	11.41	70.03	11.72	69.97	12.02	71
72	71.11	11.26	71.06	11.57	71.01	11.88	70.96	12.19	72
73	72.10	11.42	72.05	11.73	72.00	12.05	71.95	12.36	73
74	73.09	11.58	73.04	11.89	72.99	12.21	72.93	12.53	74
75	74.08	11.73	74.02	12.06	73.97	12.38	73.92	12.70	75
76	75.06	11.89	75.01	12.22	74.96	12.54	74.90	12.87	76
77	76.05	12.05	76.00	12.38	75.94	12.71	75.89	13.04	77
78	77.04	12.20	76.99	12.54	76.93	12.87	76.87	13.21	78
79	78.03	12.36	77.97	12.70	77.92	13.04	77.86	13.38	79
80	79.02	12.51	78.96	12.86	78.90	13.20	78.84	13.55	80
81	80.00	12.67	79.95	13.02	79.89	13.37	79.83	13.72	81
82	80.99	12.83	80.93	13.18	80.88	13.53	80.82	13.89	82
83	81.98	12.98	81.92	13.34	81.86	13.70	81.80	14.06	83
84	82.97	13.14	82.91	13.50	82.85	13.86	82.79	14.23	84
85	83.95	13.30	83.89	13.66	83.83	14.03	83.77	14.39	85
86	84.94	13.45	84.88	13.82	84.82	14.19	84.76	14.56	86
87	85.93	13.61	85.87	13.98	85.81	14.36	85.74	14.73	87
88	86.92	13.77	86.86	14.15	86.79	14.52	86.73	14.90	88
89	87.90	13.92	87.84	14.31	87.78	14.69	87.71	15.07	89
90	88.89	14.08	88.83	14.47	88.77	14.85	88.70	15.24	90
91	89.88	14.24	89.82	14.63	89.75	15.02	89.69	15.41	91
92	90.87	14.39	90.80	14.79	90.74	15.18	90.67	15.58	92
93	91.86	14.55	91.79	14.95	91.72	15.35	91.66	15.75	93
94	92.84	14.70	92.78	15.11	92.71	15.51	92.64	15.92	94
95	93.83	14.86	93.76	15.27	93.70	15.68	93.63	16.09	95
96	94.82	15.02	94.75	15.43	94.68	15.84	94.61	16.26	96
97	95.81	15.17	95.74	15.59	95.67	16.01	95.60	16.43	97
98	96.79	15.33	96.73	15.75	96.66	16.17	96.58	16.60	98
99	97.78	15.49	97.71	15.91	97.64	16.34	97.57	16.77	99
100	98.77	15.64	98.70	16.07	98.63	16.50	98.56	16.93	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	81 Deg.		80¾ Deg.		80½ Deg.		80¼ Deg.		

Distance.	10 Deg.		10¼ Deg.		10½ Deg.		10¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.98	0.17	0.98	0.18	0.98	0.18	0.98	0.19	1
2	1.97	0.35	1.97	0.36	1.97	0.36	1.96	0.37	2
3	2.95	0.52	2.95	0.53	2.95	0.55	2.95	0.56	3
4	3.94	0.69	3.94	0.71	3.93	0.73	3.93	0.75	4
5	4.92	0.87	4.92	0.89	4.92	0.91	4.91	0.93	5
6	5.91	1.04	5.90	1.07	5.90	1.09	5.89	1.12	6
7	6.89	1.22	6.89	1.25	6.88	1.28	6.88	1.31	7
8	7.88	1.39	7.87	1.42	7.87	1.46	7.86	1.49	8
9	8.86	1.56	8.86	1.60	8.85	1.64	8.84	1.68	9
10	9.85	1.74	9.84	1.78	9.83	1.82	9.82	1.87	10
11	10.83	1.91	10.82	1.96	10.82	2.00	10.81	2.05	11
12	11.82	2.08	11.81	2.14	11.80	2.19	11.79	2.24	12
13	12.80	2.26	12.79	2.31	12.78	2.37	12.77	2.42	13
14	13.79	2.43	13.78	2.49	13.77	2.55	13.75	2.61	14
15	14.77	2.60	14.76	2.67	14.75	2.73	14.74	2.80	15
16	15.76	2.78	15.74	2.85	15.73	2.92	15.72	2.98	16
17	16.74	2.95	16.73	3.03	16.72	3.10	16.70	3.17	17
18	17.73	3.13	17.71	3.20	17.70	3.28	17.68	3.36	18
19	18.71	3.30	18.70	3.38	18.68	3.46	18.67	3.54	19
20	19.70	3.47	19.68	3.56	19.67	3.64	19.65	3.73	20
21	20.68	3.65	20.66	3.74	20.65	3.83	20.63	3.92	21
22	21.67	3.82	21.65	3.91	21.63	4.01	21.61	4.10	22
23	22.65	3.99	22.63	4.09	22.61	4.19	22.60	4.29	23
24	23.64	4.17	23.62	4.27	23.60	4.37	23.58	4.48	24
25	24.62	4.34	24.60	4.45	24.58	4.56	24.56	4.66	25
26	25.61	4.51	25.59	4.63	25.56	4.74	25.54	4.85	26
27	26.59	4.69	26.57	4.80	26.55	4.92	26.53	5.04	27
28	27.57	4.86	27.55	4.98	27.53	5.10	27.51	5.22	28
29	28.56	5.04	28.54	5.16	28.51	5.28	28.49	5.41	29
30	29.54	5.21	29.52	5.34	29.50	5.47	29.47	5.60	30
31	30.53	5.38	30.51	5.52	30.48	5.65	30.46	5.78	31
32	31.51	5.56	31.49	5.69	31.46	5.83	31.44	5.97	32
33	32.50	5.73	32.47	5.87	32.45	6.01	32.42	6.16	33
34	33.48	5.90	33.46	6.05	33.43	6.20	33.40	6.34	34
35	34.47	6.08	34.44	6.23	34.41	6.38	34.39	6.53	35
36	35.45	6.25	35.43	6.41	35.40	6.56	35.37	6.71	36
37	36.44	6.42	36.41	6.58	36.38	6.74	36.35	6.90	37
38	37.42	6.60	37.39	6.76	37.36	6.92	37.33	7.09	38
39	38.41	6.77	38.38	6.94	38.35	7.11	38.32	7.27	39
40	39.39	6.95	39.36	7.12	39.33	7.29	39.30	7.46	40
41	40.38	7.12	40.35	7.30	40.31	7.47	40.28	7.65	41
42	41.36	7.29	41.33	7.47	41.30	7.65	41.26	7.83	42
43	42.35	7.47	42.31	7.65	42.28	7.84	42.25	8.02	43
44	43.33	7.64	43.30	7.83	43.26	8.02	43.23	8.21	44
45	44.32	7.81	44.28	8.01	44.25	8.20	44.21	8.39	45
46	45.30	7.99	45.27	8.19	45.23	8.38	45.19	8.58	46
47	46.29	8.16	46.25	8.36	46.21	8.57	46.18	8.77	47
48	47.27	8.34	47.23	8.54	47.20	8.75	47.16	8.95	48
49	48.26	8.51	48.22	8.72	48.18	8.93	48.14	9.14	49
50	49.24	8.68	49.20	8.90	49.16	9.11	49.12	9.33	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	80 Deg.		79¾ Deg.		79½ Deg.		79¼ Deg.		

Distance.	10 Deg.		10½ Deg.		10½ Deg.		10¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	50.23	8.86	50.19	9.08	50.15	9.29	50.10	9.51	51
52	51.21	9.03	51.17	9.25	51.13	9.48	51.09	9.70	52
53	52.19	9.20	52.15	9.43	52.11	9.66	52.07	9.89	53
54	53.18	9.38	53.14	9.61	53.10	9.84	53.05	10.07	54
55	54.16	9.55	54.12	9.79	54.08	10.02	54.03	10.26	55
56	55.15	9.72	55.11	9.96	55.06	10.21	55.02	10.45	56
57	56.13	9.90	56.09	10.14	56.05	10.39	56.00	10.63	57
58	57.12	10.07	57.07	10.32	57.03	10.57	56.98	10.82	58
59	58.10	10.25	58.06	10.50	58.01	10.75	57.96	11.00	59
60	59.09	10.42	59.04	10.68	59.00	10.93	58.95	11.19	60
61	60.07	10.59	60.03	10.85	59.98	11.12	59.93	11.38	61
62	61.06	10.77	61.01	11.03	60.96	11.30	60.91	11.56	62
63	62.04	10.94	61.99	11.21	61.95	11.48	61.89	11.75	63
64	63.03	11.11	62.98	11.39	62.93	11.66	62.88	11.94	64
65	64.01	11.29	63.96	11.57	63.91	11.85	63.86	12.12	65
66	65.00	11.46	64.95	11.74	64.89	12.03	64.84	12.31	66
67	65.98	11.63	65.93	11.92	65.88	12.21	65.82	12.50	67
68	66.97	11.81	66.91	12.10	66.86	12.39	66.81	12.68	68
69	67.95	11.98	67.90	12.28	67.84	12.57	67.79	12.87	69
70	68.94	12.16	68.88	12.46	68.83	12.76	68.77	13.06	70
71	69.92	12.33	69.87	12.63	69.81	12.94	69.75	13.24	71
72	70.91	12.50	70.85	12.81	70.79	13.12	70.74	13.43	72
73	71.89	12.68	71.83	12.99	71.78	13.30	71.72	13.62	73
74	72.88	12.85	72.82	13.17	72.76	13.49	72.70	13.80	74
75	73.86	13.02	73.80	13.35	73.74	13.67	73.68	13.99	75
76	74.85	13.20	74.79	13.52	74.73	13.85	74.67	14.18	76
77	75.83	13.37	75.77	13.70	75.71	14.03	75.65	14.36	77
78	76.82	13.54	76.76	13.88	76.69	14.21	76.63	14.55	78
79	77.80	13.72	77.74	14.06	77.68	14.40	77.61	14.74	79
80	78.78	13.89	78.72	14.24	78.66	14.58	78.60	14.92	80
81	79.77	14.07	79.71	14.41	79.64	14.76	79.58	15.11	81
82	80.75	14.24	80.69	14.59	80.63	14.94	80.56	15.29	82
83	81.74	14.41	81.68	14.77	81.61	15.13	81.54	15.48	83
84	82.72	14.59	82.66	14.95	82.59	15.31	82.53	15.67	84
85	83.71	14.76	83.64	15.13	83.58	15.49	83.51	15.85	85
86	84.69	14.93	84.63	15.30	84.56	15.67	84.49	16.04	86
87	85.68	15.11	85.61	15.48	85.54	15.85	85.47	16.23	87
88	86.66	15.28	86.60	15.66	86.53	16.04	86.46	16.41	88
89	87.65	15.45	87.58	15.84	87.51	16.22	87.44	16.60	89
90	88.63	15.63	88.56	16.01	88.49	16.40	88.42	16.79	90
91	89.62	15.80	89.55	16.19	89.48	16.58	89.40	16.97	91
92	90.60	15.98	90.53	16.37	90.46	16.77	90.39	17.16	92
93	91.59	16.15	91.52	16.55	91.44	16.95	91.37	17.35	93
94	92.57	16.32	92.50	16.73	92.43	17.13	92.35	17.53	94
95	93.56	16.50	93.48	16.90	93.41	17.31	93.33	17.72	95
96	94.54	16.67	94.47	17.08	94.39	17.49	94.32	17.91	96
97	95.53	16.84	95.45	17.26	95.38	17.68	95.30	18.09	97
98	96.51	17.02	96.44	17.44	96.36	17.86	96.28	18.28	98
99	97.50	17.19	97.42	17.62	97.34	18.04	97.26	18.47	99
100	98.48	17.36	98.40	17.79	98.33	18.22	98.25	18.65	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	80 Deg.		79¾ Deg.		79½ Deg.		79¼ Deg.		

Distance.	11 Deg.		11 $\frac{1}{4}$ Deg.		11 $\frac{1}{2}$ Deg.		11 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.98	0.19	0.98	0.20	0.98	0.20	0.98	0.20	1
2	1.96	0.38	1.96	0.39	1.96	0.40	1.96	0.41	2
3	2.94	0.57	2.94	0.59	2.94	0.60	2.94	0.61	3
4	3.93	0.76	3.92	0.78	3.92	0.80	3.92	0.82	4
5	4.91	0.95	4.90	0.98	4.90	1.00	4.90	1.02	5
6	5.89	1.14	5.88	1.17	5.88	1.20	5.87	1.22	6
7	6.87	1.34	6.87	1.37	6.86	1.40	6.85	1.43	7
8	7.85	1.53	7.85	1.56	7.84	1.59	7.83	1.63	8
9	8.83	1.72	8.83	1.76	8.82	1.79	8.81	1.83	9
10	9.82	1.91	9.81	1.95	9.80	1.99	9.79	2.04	10
11	10.80	2.10	10.79	2.15	10.78	2.19	10.77	2.24	11
12	11.78	2.29	11.77	2.34	11.76	2.39	11.75	2.44	12
13	12.76	2.48	12.75	2.54	12.74	2.59	12.73	2.65	13
14	13.74	2.67	13.73	2.73	13.72	2.79	13.71	2.85	14
15	14.72	2.86	14.71	2.93	14.70	2.99	14.69	3.06	15
16	15.71	3.05	15.69	3.12	15.68	3.19	15.66	3.26	16
17	16.69	3.24	16.67	3.32	16.66	3.39	16.64	3.46	17
18	17.67	3.43	17.65	3.51	17.64	3.59	17.62	3.66	18
19	18.65	3.63	18.63	3.71	18.62	3.79	18.60	3.87	19
20	19.63	3.82	19.62	3.90	19.60	3.99	19.58	4.07	20
21	20.61	4.01	20.60	4.10	20.58	4.19	20.56	4.28	21
22	21.60	4.20	21.58	4.29	21.56	4.39	21.54	4.48	22
23	22.58	4.39	22.56	4.49	22.54	4.59	22.52	4.68	23
24	23.56	4.58	23.54	4.68	23.52	4.78	23.50	4.89	24
25	24.54	4.77	24.52	4.88	24.50	4.98	24.48	5.09	25
26	25.52	4.96	25.50	5.07	25.48	5.18	25.46	5.30	26
27	26.50	5.15	26.48	5.27	26.46	5.38	26.43	5.50	27
28	27.49	5.34	27.46	5.46	27.44	5.58	27.41	5.70	28
29	28.47	5.53	28.44	5.66	28.42	5.78	28.39	5.91	29
30	29.45	5.72	29.42	5.85	29.40	5.98	29.37	6.11	30
31	30.43	5.92	30.40	6.05	30.38	6.18	30.35	6.31	31
32	31.41	6.11	31.39	6.24	31.36	6.38	31.33	6.52	32
33	32.39	6.30	32.37	6.44	32.34	6.58	32.31	6.72	33
34	33.38	6.49	33.35	6.63	33.32	6.78	33.29	6.92	34
35	34.36	6.68	34.33	6.83	34.30	6.98	34.27	7.13	35
36	35.34	6.87	35.31	7.02	35.28	7.18	35.25	7.33	36
37	36.32	7.06	36.29	7.22	36.26	7.38	36.22	7.53	37
38	37.30	7.25	37.27	7.41	37.24	7.58	37.20	7.74	38
39	38.28	7.44	38.25	7.61	38.22	7.78	38.18	7.94	39
40	39.27	7.63	39.23	7.80	39.20	7.97	39.16	8.15	40
41	40.25	7.82	40.21	8.00	40.18	8.17	40.14	8.35	41
42	41.23	8.01	41.19	8.19	41.16	8.37	41.12	8.55	42
43	42.21	8.20	42.17	8.39	42.14	8.57	42.10	8.76	43
44	43.19	8.40	43.15	8.58	43.12	8.77	43.08	8.96	44
45	44.17	8.59	44.14	8.78	44.10	8.97	44.06	9.16	45
46	45.15	8.78	45.12	8.97	45.08	9.17	45.04	9.37	46
47	46.14	8.97	46.10	9.17	46.06	9.37	46.02	9.57	47
48	47.12	9.16	47.08	9.36	47.04	9.57	46.99	9.78	48
49	48.10	9.35	48.06	9.56	48.02	9.77	47.97	9.98	49
50	49.08	9.54	49.04	9.75	49.00	9.97	48.95	10.18	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	79 Deg.		78 $\frac{3}{4}$ Deg.		78 $\frac{1}{2}$ Deg.		78 $\frac{1}{4}$ Deg.		

Distance	11 Deg.		11¼ Deg.		11½ Deg.		11¾ Deg.		Distance
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	50.06	9.73	50.02	9.95	49.98	10.17	49.93	10.39	51
52	51.04	9.92	51.00	10.14	50.96	10.37	50.91	10.59	52
53	52.03	10.11	51.98	10.34	51.94	10.57	51.89	10.79	53
54	53.01	10.30	52.96	10.53	52.92	10.77	52.87	11.00	54
55	53.99	10.49	53.94	10.73	53.90	10.97	53.85	11.20	55
56	54.97	10.69	54.92	10.93	54.88	11.16	54.83	11.40	56
57	55.95	10.88	55.90	11.12	55.86	11.36	55.81	11.61	57
58	56.93	11.07	56.89	11.32	56.84	11.56	56.78	11.81	58
59	57.92	11.26	57.87	11.51	57.82	11.76	57.76	12.01	59
60	58.90	11.45	58.85	11.71	58.80	11.96	58.74	12.22	60
61	59.88	11.64	59.83	11.90	59.78	12.16	59.72	12.42	61
62	60.86	11.83	60.81	12.10	60.76	12.36	60.70	12.63	62
63	61.84	12.02	61.79	12.29	61.74	12.56	61.68	12.83	63
64	62.82	12.21	62.77	12.49	62.72	12.76	62.66	13.03	64
65	63.81	12.40	63.75	12.68	63.70	12.96	63.64	13.24	65
66	64.79	12.59	64.73	12.88	64.68	13.16	64.62	13.44	66
67	65.77	12.78	65.71	13.07	65.66	13.36	65.60	13.64	67
68	66.75	12.98	66.69	13.27	66.63	13.56	66.58	13.85	68
69	67.73	13.17	67.67	13.46	67.61	13.76	67.55	14.05	69
70	68.71	13.36	68.66	13.66	68.59	13.96	68.53	14.25	70
71	69.70	13.55	69.64	13.85	69.57	14.16	69.51	14.46	71
72	70.68	13.74	70.62	14.05	70.55	14.35	70.49	14.66	72
73	71.66	13.93	71.60	14.24	71.53	14.55	71.47	14.87	73
74	72.64	14.12	72.58	14.44	72.51	14.75	72.45	15.07	74
75	73.62	14.31	73.56	14.63	73.49	14.95	73.43	15.27	75
76	74.60	14.50	74.54	14.83	74.47	15.15	74.41	15.48	76
77	75.59	14.69	75.52	15.02	75.45	15.35	75.39	15.68	77
78	76.57	14.88	76.50	15.22	76.43	15.55	76.37	15.88	78
79	77.55	15.07	77.48	15.41	77.41	15.75	77.34	16.09	79
80	78.53	15.26	78.46	15.61	78.39	15.95	78.32	16.29	80
81	79.51	15.46	79.44	15.80	79.37	16.15	79.30	16.49	81
82	80.49	15.65	80.42	16.00	80.35	16.35	80.28	16.70	82
83	81.48	15.84	81.41	16.19	81.33	16.55	81.26	16.90	83
84	82.46	16.03	82.39	16.39	82.31	16.75	82.24	17.11	84
85	83.44	16.22	83.37	16.58	83.29	16.95	83.22	17.31	85
86	84.42	16.41	84.35	16.78	84.27	17.15	84.20	17.51	86
87	85.40	16.60	85.33	16.97	85.25	17.35	85.18	17.72	87
88	86.38	16.79	86.31	17.17	86.23	17.54	86.16	17.92	88
89	87.36	16.98	87.29	17.36	87.21	17.74	87.14	18.12	89
90	88.35	17.17	88.27	17.56	88.19	17.94	88.11	18.33	90
91	89.33	17.36	89.25	17.75	89.17	18.14	89.09	18.53	91
92	90.31	17.55	90.23	17.95	90.15	18.34	90.07	18.74	92
93	91.29	17.75	91.21	18.14	91.13	18.54	91.05	18.94	93
94	92.27	17.94	92.19	18.34	92.11	18.74	92.03	19.14	94
95	93.25	18.13	93.17	18.53	93.09	18.94	93.01	19.35	95
96	94.24	18.32	94.16	18.73	94.07	19.14	93.99	19.55	96
97	95.22	18.51	95.14	18.92	95.05	19.34	94.97	19.75	97
98	96.20	18.70	96.12	19.12	96.03	19.54	95.95	19.96	98
99	97.18	18.89	97.10	19.31	97.01	19.74	96.93	20.16	99
100	98.16	19.08	98.08	19.51	97.99	19.94	97.90	20.36	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	79 Deg.		78¼ Deg.		78½ Deg.		78¾ Deg.		

Distance.	12 Deg		12 $\frac{1}{4}$ Deg.		12 $\frac{1}{2}$ Deg.		12 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.98	0.21	0.98	0.21	0.98	0.22	0.98	0.22	1
2	1.96	0.42	1.95	0.42	1.95	0.43	1.95	0.44	2
3	2.93	0.62	2.93	0.64	2.93	0.65	2.93	0.66	3
4	3.91	0.83	3.91	0.85	3.91	0.87	3.90	0.88	4
5	4.89	1.04	4.89	1.06	4.88	1.08	4.88	1.10	5
6	5.87	1.25	5.86	1.27	5.86	1.30	5.85	1.32	6
7	6.85	1.46	6.84	1.49	6.83	1.52	6.83	1.54	7
8	7.83	1.66	7.82	1.70	7.81	1.73	7.80	1.77	8
9	8.80	1.87	8.80	1.91	8.79	1.95	8.78	1.99	9
10	9.78	2.08	9.77	2.12	9.76	2.16	9.75	2.21	10
11	10.76	2.29	10.75	2.33	10.74	2.38	10.73	2.43	11
12	11.74	2.49	11.73	2.55	11.72	2.60	11.70	2.65	12
13	12.72	2.70	12.70	2.76	12.69	2.81	12.68	2.87	13
14	13.69	2.91	13.68	2.97	13.67	3.03	13.65	3.09	14
15	14.67	3.12	14.66	3.18	14.64	3.25	14.63	3.31	15
16	15.65	3.33	15.64	3.39	15.62	3.46	15.61	3.53	16
17	16.63	3.53	16.61	3.61	16.60	3.68	16.58	3.75	17
18	17.61	3.74	17.59	3.82	17.57	3.90	17.56	3.97	18
19	18.58	3.95	18.57	4.03	18.55	4.11	18.53	4.19	19
20	19.56	4.16	19.54	4.24	19.53	4.33	19.51	4.41	20
21	20.54	4.37	20.52	4.46	20.50	4.55	20.48	4.63	21
22	21.52	4.57	21.50	4.67	21.48	4.76	21.46	4.86	22
23	22.50	4.78	22.48	4.88	22.45	4.98	22.43	5.08	23
24	23.48	4.99	23.45	5.09	23.43	5.19	23.41	5.30	24
25	24.45	5.20	24.43	5.30	24.41	5.41	24.38	5.52	25
26	25.43	5.41	25.41	5.52	25.38	5.63	25.36	5.74	26
27	26.41	5.61	26.39	5.73	26.36	5.84	26.33	5.96	27
28	27.39	5.82	27.36	5.94	27.34	6.06	27.31	6.18	28
29	28.37	6.03	28.34	6.15	28.31	6.28	28.28	6.40	29
30	29.34	6.24	29.32	6.37	29.29	6.49	29.26	6.62	30
31	30.32	6.45	30.29	6.58	30.27	6.71	30.24	6.84	31
32	31.30	6.65	31.27	6.79	31.24	6.93	31.21	7.06	32
33	32.28	6.86	32.25	7.00	32.22	7.14	32.19	7.28	33
34	33.26	7.07	33.23	7.21	33.19	7.36	33.16	7.50	34
35	34.24	7.28	34.20	7.43	34.17	7.58	34.14	7.72	35
36	35.21	7.48	35.18	7.64	35.15	7.79	35.11	7.95	36
37	36.19	7.69	36.16	7.85	36.12	8.01	36.09	8.17	37
38	37.17	7.90	37.13	8.06	37.10	8.22	37.06	8.39	38
39	38.15	8.11	38.11	8.27	38.08	8.44	38.04	8.61	39
40	39.13	8.32	39.09	8.49	39.05	8.66	39.01	8.83	40
41	40.10	8.52	40.07	8.70	40.03	8.87	39.99	9.05	41
42	41.08	8.73	41.04	8.91	41.00	9.09	40.96	9.27	42
43	42.06	8.94	42.02	9.12	41.98	9.31	41.94	9.49	43
44	43.04	9.15	43.00	9.34	42.96	9.52	42.92	9.71	44
45	44.02	9.36	43.98	9.55	43.93	9.74	43.89	9.93	45
46	44.99	9.56	44.95	9.76	44.91	9.96	44.87	10.15	46
47	45.97	9.77	45.93	9.97	45.89	10.17	45.84	10.37	47
48	46.95	9.98	46.91	10.18	46.86	10.39	46.82	10.59	48
49	47.93	10.19	47.88	10.40	47.84	10.61	47.79	10.81	49
50	48.91	10.40	48.86	10.61	48.81	10.82	48.77	11.03	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	78 Deg.		77 $\frac{3}{4}$ Deg.		77 $\frac{1}{2}$ Deg.		77 $\frac{1}{4}$ Deg.		

Distance.	12 Deg.		12 $\frac{1}{4}$ Deg.		12 $\frac{1}{2}$ Deg.		12 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	49.89	10.60	49.84	10.82	49.79	11.04	49.74	11.26	51
52	50.86	10.81	50.82	11.03	50.77	11.25	50.72	11.48	52
53	51.84	11.02	51.79	11.25	51.74	11.47	51.69	11.70	53
54	52.82	11.23	52.77	11.46	52.72	11.69	52.67	11.92	54
55	53.80	11.44	53.75	11.67	53.70	11.90	53.64	12.14	55
56	54.78	11.64	54.72	11.88	54.67	12.12	54.62	12.36	56
57	55.75	11.85	55.70	12.09	55.65	12.34	55.59	12.58	57
58	56.73	12.06	56.68	12.31	56.63	12.55	56.57	12.80	58
59	57.71	12.27	57.66	12.52	57.60	12.77	57.55	13.02	59
60	58.69	12.47	58.63	12.73	58.58	12.99	58.52	13.24	60
61	59.67	12.68	59.61	12.94	59.55	13.20	59.50	13.46	61
62	60.65	12.89	60.59	13.16	60.53	13.42	60.47	13.68	62
63	61.62	13.10	61.57	13.37	61.51	13.64	61.45	13.90	63
64	62.60	13.31	62.54	13.58	62.48	13.85	62.42	14.12	64
65	63.58	13.51	63.52	13.79	63.46	14.07	63.40	14.35	65
66	64.56	13.72	64.50	14.00	64.44	14.29	64.37	14.57	66
67	65.54	13.93	65.47	14.22	65.41	14.50	65.35	14.79	67
68	66.51	14.14	66.45	14.43	66.39	14.72	66.32	15.01	68
69	67.49	14.35	67.43	14.64	67.36	14.93	67.30	15.23	69
70	68.47	14.55	68.41	14.85	68.34	15.15	68.27	15.45	70
71	69.45	14.76	69.38	15.06	69.32	15.37	69.25	15.67	71
72	70.43	14.97	70.36	15.28	70.29	15.58	70.22	15.89	72
73	71.40	15.18	71.34	15.49	71.27	15.80	71.20	16.11	73
74	72.38	15.39	72.32	15.70	72.25	16.02	72.18	16.33	74
75	73.36	15.59	73.29	15.91	73.22	16.23	73.15	16.55	75
76	74.34	15.80	74.27	16.13	74.20	16.45	74.13	16.77	76
77	75.32	16.01	75.25	16.34	75.17	16.67	75.10	16.99	77
78	76.30	16.22	76.22	16.55	76.15	16.88	76.08	17.21	78
79	77.27	16.43	77.20	16.76	77.13	17.10	77.05	17.44	79
80	78.25	16.63	78.18	16.97	78.10	17.32	78.03	17.66	80
81	79.23	16.84	79.16	17.19	79.08	17.53	79.00	17.88	81
82	80.21	17.05	80.13	17.40	80.06	17.75	79.98	18.10	82
83	81.19	17.26	81.11	17.61	81.03	17.96	80.95	18.32	83
84	82.16	17.46	82.09	17.82	82.01	18.18	81.93	18.54	84
85	83.14	17.67	83.06	18.04	82.99	18.40	82.90	18.76	85
86	84.12	17.88	84.04	18.25	83.96	18.61	83.88	18.98	86
87	85.10	18.09	85.02	18.46	84.94	18.83	84.85	19.20	87
88	86.08	18.30	86.00	18.67	85.91	19.05	85.83	19.42	88
89	87.06	18.50	86.97	18.88	86.89	19.26	86.81	19.64	89
90	88.03	18.71	87.95	19.10	87.87	19.48	87.78	19.86	90
91	89.01	18.92	88.93	19.31	88.84	19.70	88.76	20.08	91
92	89.99	19.13	89.91	19.52	89.82	19.91	89.73	20.30	92
93	90.97	19.34	90.88	19.73	90.80	20.13	90.71	20.52	93
94	91.95	19.54	91.86	19.94	91.77	20.35	91.68	20.75	94
95	92.92	19.75	92.84	20.16	92.75	20.56	92.66	20.97	95
96	93.90	19.96	93.81	20.37	93.72	20.78	93.63	21.19	96
97	94.88	20.17	94.79	20.58	94.70	20.99	94.61	21.41	97
98	95.86	20.38	95.77	20.79	95.68	21.21	95.58	21.63	98
99	96.84	20.58	96.75	21.01	96.65	21.43	96.56	21.85	99
100	97.81	20.79	97.72	21.22	97.63	21.64	97.53	22.07	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	73 Deg.		77 $\frac{1}{4}$ Deg		$\frac{1}{2}$ Deg.		77 $\frac{1}{4}$ Deg.		

Distance.	13 Deg.		13 $\frac{1}{4}$ Deg.		13 $\frac{1}{2}$ Deg.		13 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.97	0.23	0.97	0.23	0.97	0.23	0.97	0.24	1
2	1.95	0.45	1.95	0.46	1.95	0.47	1.94	0.48	2
3	2.92	0.67	2.92	0.69	2.92	0.70	2.91	0.71	3
4	3.90	0.90	3.89	0.92	3.89	0.93	3.89	0.95	4
5	4.87	1.12	4.87	1.15	4.86	1.17	4.86	1.19	5
6	5.85	1.35	5.84	1.38	5.83	1.40	5.83	1.43	6
7	6.82	1.57	6.81	1.60	6.81	1.63	6.80	1.66	7
8	7.80	1.80	7.79	1.83	7.78	1.87	7.77	1.90	8
9	8.77	2.02	8.76	2.06	8.75	2.10	8.74	2.14	9
10	9.74	2.25	9.73	2.29	9.72	2.33	9.71	2.38	10
11	10.72	2.47	10.71	2.52	10.70	2.57	10.68	2.61	11
12	11.69	2.70	11.68	2.75	11.67	2.80	11.66	2.85	12
13	12.67	2.92	12.65	2.98	12.64	3.03	12.63	3.09	13
14	13.64	3.15	13.63	3.21	13.61	3.27	13.60	3.33	14
15	14.62	3.37	14.60	3.44	14.59	3.50	14.57	3.57	15
16	15.59	3.60	15.57	3.67	15.56	3.74	15.54	3.80	16
17	16.57	3.82	16.55	3.90	16.53	3.97	16.51	4.04	17
18	17.54	4.05	17.52	4.13	17.50	4.20	17.48	4.28	18
19	18.51	4.27	18.49	4.35	18.48	4.44	18.46	4.52	19
20	19.49	4.50	19.47	4.58	19.45	4.67	19.43	4.75	20
21	20.46	4.72	20.44	4.81	20.42	4.90	20.40	4.99	21
22	21.44	4.95	21.41	5.04	21.39	5.14	21.37	5.23	22
23	22.41	5.17	22.39	5.27	22.36	5.37	22.34	5.47	23
24	23.38	5.40	23.36	5.50	23.34	5.60	23.31	5.70	24
25	24.36	5.62	24.33	5.73	24.31	5.84	24.28	5.94	25
26	25.33	5.85	25.31	5.96	25.28	6.07	25.25	6.18	26
27	26.31	6.07	26.28	6.19	26.25	6.30	26.23	6.42	27
28	27.28	6.30	27.25	6.42	27.23	6.54	27.20	6.66	28
29	28.26	6.52	28.23	6.65	28.20	6.77	28.17	6.89	29
30	29.23	6.75	29.20	6.88	29.17	7.00	29.14	7.13	30
31	30.21	6.97	30.17	7.11	30.14	7.24	30.11	7.37	31
32	31.18	7.20	31.15	7.33	31.12	7.47	31.08	7.61	32
33	32.15	7.42	32.12	7.56	32.09	7.70	32.05	7.84	33
34	33.13	7.65	33.09	7.79	33.06	7.94	33.03	8.08	34
35	34.10	7.87	34.07	8.02	34.03	8.17	34.00	8.32	35
36	35.08	8.10	35.04	8.25	35.01	8.40	34.97	8.56	36
37	36.05	8.32	36.02	8.48	35.98	8.64	35.94	8.79	37
38	37.03	8.55	36.99	8.71	36.95	8.87	36.91	9.03	38
39	38.00	8.77	37.96	8.94	37.92	9.10	37.88	9.27	39
40	38.97	9.00	38.94	9.17	38.89	9.34	38.85	9.51	40
41	39.95	9.22	39.91	9.40	39.87	9.57	39.83	9.75	41
42	40.92	9.45	40.88	9.63	40.84	9.80	40.80	9.98	42
43	41.90	9.67	41.86	9.86	41.81	10.04	41.77	10.22	43
44	42.87	9.90	42.83	10.08	42.78	10.27	42.74	10.46	44
45	43.85	10.12	43.80	10.31	43.76	10.51	43.71	10.70	45
46	44.82	10.35	44.78	10.54	44.73	10.74	44.68	10.93	46
47	45.80	10.57	45.75	10.77	45.70	10.97	45.65	11.17	47
48	46.77	10.80	46.72	11.00	46.67	11.21	46.62	11.41	48
49	47.74	11.02	47.70	11.23	47.65	11.44	47.60	11.65	49
50	48.72	11.25	48.67	11.46	48.62	11.67	48.57	11.88	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	77 Deg.		76 $\frac{3}{4}$ Deg.		76 $\frac{1}{2}$ Deg.		76 $\frac{1}{4}$ Deg.		

Distance.	13 Deg.		13 $\frac{1}{4}$ Deg.		13 $\frac{1}{2}$ Deg.		13 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	49.69	11.47	49.64	11.69	49.59	11.91	49.54	12.12	51
52	50.67	11.70	50.62	11.92	50.56	12.14	50.51	12.36	52
53	51.64	11.92	51.59	12.15	51.54	12.37	51.48	12.60	53
54	52.62	12.15	52.56	12.38	52.51	12.61	52.45	12.84	54
55	53.59	12.37	53.54	12.61	53.48	12.84	53.42	13.07	55
56	54.56	12.60	54.51	12.84	54.45	13.07	54.40	13.31	56
57	55.54	12.82	55.48	13.06	55.43	13.31	55.37	13.55	57
58	56.51	13.05	56.46	13.29	56.40	13.54	56.34	13.79	58
59	57.49	13.27	57.43	13.52	57.37	13.77	57.31	14.02	59
60	58.46	13.50	58.40	13.75	58.34	14.01	58.28	14.26	60
61	59.44	13.72	59.38	13.98	59.31	14.24	59.25	14.50	61
62	60.41	13.95	60.35	14.21	60.29	14.47	60.22	14.74	62
63	61.39	14.17	61.32	14.44	61.26	14.71	61.19	14.97	63
64	62.36	14.40	62.30	14.67	62.23	14.94	62.17	15.21	64
65	63.33	14.62	63.27	14.90	63.20	15.17	63.14	15.45	65
66	64.31	14.85	64.24	15.13	64.18	15.41	64.11	15.69	66
67	65.28	15.07	65.22	15.36	65.15	15.64	65.08	15.93	67
68	66.26	15.30	66.19	15.59	66.12	15.87	66.05	16.16	68
69	67.23	15.52	67.16	15.81	67.09	16.11	67.02	16.40	69
70	68.21	15.75	68.14	16.04	68.07	16.34	67.99	16.64	70
71	69.18	15.97	69.11	16.27	69.04	16.57	68.97	16.88	71
72	70.15	16.20	70.08	16.50	70.01	16.81	69.94	17.11	72
73	71.13	16.42	71.06	16.73	70.98	17.04	70.91	17.35	73
74	72.10	16.65	72.03	16.96	71.96	17.28	71.88	17.59	74
75	73.08	16.87	73.00	17.19	72.93	17.50	72.85	17.83	75
76	74.05	17.10	73.98	17.42	73.90	17.74	73.82	18.06	76
77	75.03	17.32	74.95	17.65	74.87	17.98	74.79	18.30	77
78	76.00	17.55	75.92	17.88	75.84	18.21	75.76	18.54	78
79	76.98	17.77	76.90	18.11	76.82	18.44	76.74	18.78	79
80	77.95	18.00	77.87	18.34	77.79	18.68	77.71	19.01	80
81	78.92	18.22	78.84	18.57	78.76	18.91	78.68	19.25	81
82	79.90	18.45	79.82	18.79	79.73	19.14	79.65	19.49	82
83	80.87	18.67	80.79	19.02	80.71	19.38	80.62	19.73	83
84	81.85	18.90	81.76	19.25	81.68	19.61	81.59	19.97	84
85	82.82	19.12	82.74	19.48	82.65	19.84	82.56	20.20	85
86	83.80	19.35	83.71	19.71	83.62	20.08	83.54	20.44	86
87	84.77	19.57	84.68	19.94	84.60	20.31	84.51	20.68	87
88	85.74	19.80	85.66	20.17	85.57	20.54	85.48	20.92	88
89	86.72	20.02	86.63	20.40	86.54	20.78	86.45	21.15	89
90	87.69	20.25	87.60	20.63	87.51	21.01	87.42	21.39	90
91	88.67	20.47	88.58	20.86	88.49	21.24	88.39	21.63	91
92	89.64	20.70	89.55	21.09	89.46	21.48	89.36	21.87	92
93	90.62	20.92	90.52	21.32	90.43	21.71	90.33	22.10	93
94	91.59	21.15	91.50	21.54	91.40	21.94	91.31	22.34	94
95	92.57	21.37	92.47	21.77	92.38	22.18	92.28	22.58	95
96	93.54	21.60	93.44	22.00	93.35	22.41	93.25	22.82	96
97	94.51	21.82	94.42	22.23	94.32	22.64	94.22	23.06	97
98	95.49	22.05	95.39	22.46	95.29	22.88	95.19	23.29	98
99	96.46	22.27	96.36	22.69	96.26	23.11	96.16	23.53	99
100	97.44	22.50	97.34	22.92	97.24	23.34	97.13	23.77	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	77 Deg.		76 $\frac{3}{4}$ Deg.		76 $\frac{1}{2}$ Deg.		76 $\frac{1}{4}$ Deg.		

Distance.	14 Deg.		14 $\frac{1}{4}$ Deg.		14 $\frac{1}{2}$ Deg.		14 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.97	0.24	0.97	0.25	0.97	0.25	0.97	0.25	1
2	1.94	0.48	1.94	0.49	1.94	0.50	1.93	0.51	2
3	2.91	0.73	2.91	0.74	2.90	0.75	2.90	0.76	3
4	3.88	0.97	3.88	0.98	3.87	1.00	3.87	1.02	4
5	4.85	1.21	4.85	1.23	4.84	1.25	4.84	1.27	5
6	5.82	1.45	5.82	1.48	5.81	1.50	5.80	1.53	6
7	6.79	1.69	6.78	1.72	6.78	1.75	6.77	1.78	7
8	7.76	1.94	7.75	1.97	7.75	2.00	7.74	2.04	8
9	8.73	2.18	8.72	2.22	8.71	2.25	8.70	2.29	9
10	9.70	2.42	9.69	2.46	9.68	2.50	9.67	2.55	10
11	10.67	2.66	10.66	2.71	10.65	2.75	10.64	2.80	11
12	11.64	2.90	11.63	2.95	11.62	3.00	11.60	3.06	12
13	12.61	3.15	12.60	3.20	12.59	3.25	12.57	3.31	13
14	13.58	3.39	13.57	3.45	13.55	3.51	13.54	3.56	14
15	14.55	3.63	14.54	3.69	14.52	3.76	14.51	3.82	15
16	15.52	3.87	15.51	3.94	15.49	4.01	15.47	4.07	16
17	16.50	4.11	16.48	4.18	16.46	4.26	16.44	4.33	17
18	17.47	4.35	17.45	4.43	17.43	4.51	17.41	4.58	18
19	18.44	4.60	18.42	4.63	18.39	4.76	18.37	4.84	19
20	19.41	4.84	19.38	4.92	19.36	5.01	19.34	5.09	20
21	20.38	5.08	20.35	5.17	20.33	5.26	20.31	5.35	21
22	21.35	5.32	21.32	5.42	21.30	5.51	21.28	5.60	22
23	22.32	5.56	22.29	5.66	22.27	5.76	22.24	5.86	23
24	23.29	5.81	23.26	5.91	23.24	6.01	23.21	6.11	24
25	24.26	6.05	24.23	6.15	24.20	6.26	24.18	6.37	25
26	25.23	6.29	25.20	6.40	25.17	6.51	25.14	6.62	26
27	26.20	6.53	26.17	6.65	26.14	6.76	26.11	6.87	27
28	27.17	6.77	27.14	6.89	27.11	7.01	27.08	7.13	28
29	28.14	7.02	28.11	7.14	28.08	7.26	28.04	7.38	29
30	29.11	7.26	29.08	7.38	29.04	7.51	29.01	7.64	30
31	30.08	7.50	30.05	7.63	30.01	7.76	29.98	7.89	31
32	31.05	7.74	31.02	7.88	30.98	8.01	30.95	8.15	32
33	32.02	7.98	31.98	8.12	31.95	8.26	31.91	8.40	33
34	32.99	8.23	32.95	8.37	32.92	8.51	32.88	8.66	34
35	33.96	8.47	33.92	8.62	33.89	8.76	33.85	8.91	35
36	34.93	8.71	34.89	8.86	34.85	9.01	34.81	9.17	36
37	35.90	8.95	35.86	9.11	35.82	9.26	35.78	9.42	37
38	36.87	9.19	36.83	9.35	36.79	9.51	36.75	9.67	38
39	37.84	9.44	37.80	9.60	37.76	9.76	37.71	9.93	39
40	38.81	9.68	38.77	9.85	38.73	10.02	38.68	10.18	40
41	39.78	9.92	39.74	10.09	39.69	10.27	39.65	10.44	41
42	40.75	10.16	40.71	10.34	40.66	10.52	40.62	10.69	42
43	41.72	10.40	41.68	10.58	41.63	10.77	41.58	10.95	43
44	42.69	10.64	42.65	10.83	42.60	11.02	42.55	11.20	44
45	43.66	10.89	43.62	11.08	43.57	11.27	43.52	11.46	45
46	44.63	11.13	44.58	11.32	44.53	11.52	44.48	11.71	46
47	45.60	11.37	45.55	11.57	45.50	11.77	45.45	11.97	47
48	46.57	11.61	46.52	11.82	46.47	12.02	46.42	12.22	48
49	47.54	11.85	47.49	12.06	47.44	12.27	47.39	12.48	49
50	48.51	12.10	48.46	12.31	48.41	12.52	48.35	12.73	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	76 Deg.		75 $\frac{3}{4}$ Deg.		75 $\frac{1}{2}$ Deg.		75 $\frac{1}{4}$ Deg.		

Distance.	14 Deg.		14 $\frac{1}{4}$ Deg.		14 $\frac{1}{2}$ Deg.		14 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	49.49	12.34	49.43	12.55	49.38	12.77	49.32	12.98	51
52	50.46	12.58	50.40	12.80	50.34	13.02	50.29	13.24	52
53	51.43	12.82	51.37	13.05	51.31	13.27	51.25	13.49	53
54	52.40	13.06	52.34	13.29	52.28	13.52	52.22	13.75	54
55	53.37	13.31	53.31	13.54	53.25	13.77	53.19	14.00	55
56	54.34	13.55	54.28	13.78	54.22	14.02	54.15	14.26	56
57	55.31	13.79	55.25	14.03	55.18	14.27	55.12	14.51	57
58	56.28	14.03	56.22	14.28	56.15	14.52	56.09	14.77	58
59	57.25	14.27	57.18	14.52	57.12	14.77	57.06	15.02	59
60	58.22	14.52	58.15	14.77	58.09	15.02	58.02	15.28	60
61	59.19	14.76	59.12	15.02	59.06	15.27	58.99	15.53	61
62	60.16	15.00	60.09	15.26	60.03	15.52	59.96	15.79	62
63	61.13	15.24	61.06	15.51	60.99	15.77	60.92	16.04	63
64	62.10	15.48	62.03	15.75	61.96	16.02	61.89	16.29	64
65	63.07	15.72	63.00	16.00	62.93	16.27	62.86	16.55	65
66	64.04	15.97	63.97	16.25	63.90	16.53	63.83	16.80	66
67	65.01	16.21	64.94	16.49	64.87	16.78	64.79	17.06	67
68	65.98	16.45	65.91	16.74	65.83	17.03	65.76	17.31	68
69	66.95	16.69	66.88	16.98	66.80	17.28	66.73	17.57	69
70	67.92	16.93	67.85	17.23	67.77	17.53	67.69	17.82	70
71	68.89	17.18	68.82	17.48	68.74	17.78	68.66	18.08	71
72	69.86	17.42	69.78	17.72	69.71	18.03	69.63	18.33	72
73	70.83	17.66	70.75	17.97	70.67	18.28	70.59	18.59	73
74	71.80	17.90	71.72	18.22	71.64	18.53	71.56	18.84	74
75	72.77	18.14	72.69	18.46	72.61	18.78	72.53	19.10	75
76	73.74	18.39	73.66	18.71	73.58	19.03	73.50	19.35	76
77	74.71	18.63	74.63	18.95	74.55	19.28	74.46	19.60	77
78	75.68	18.87	75.60	19.20	75.52	19.53	75.43	19.86	78
79	76.65	19.11	76.57	19.45	76.48	19.78	76.40	20.11	79
80	77.62	19.35	77.54	19.69	77.45	20.03	77.36	20.37	80
81	78.59	19.60	78.51	19.94	78.42	20.28	78.33	20.62	81
82	79.56	19.84	79.48	20.18	79.39	20.53	79.30	20.88	82
83	80.53	20.08	80.45	20.43	80.36	20.78	80.26	21.13	83
84	81.50	20.32	81.42	20.68	81.32	21.03	81.23	21.39	84
85	82.48	20.56	82.38	20.92	82.29	21.28	82.20	21.64	85
86	83.45	20.81	83.35	21.17	83.26	21.53	83.17	21.90	86
87	84.42	21.05	84.32	21.42	84.23	21.78	84.13	22.15	87
88	85.39	21.29	85.29	21.66	85.20	22.03	85.10	22.41	88
89	86.36	21.53	86.26	21.91	86.17	22.28	86.07	22.66	89
90	87.33	21.77	87.23	22.15	87.13	22.53	87.03	22.91	90
91	88.30	22.01	88.20	22.40	88.10	22.78	88.00	23.17	91
92	89.27	22.26	89.17	22.65	89.07	23.04	88.97	23.42	92
93	90.24	22.50	90.14	22.89	90.04	23.29	89.94	23.68	93
94	91.21	22.74	91.11	23.14	91.01	23.54	90.90	23.93	94
95	92.18	22.98	92.08	23.38	91.97	23.79	91.87	24.19	95
96	93.15	23.22	93.05	23.63	92.94	24.04	92.84	24.44	96
97	94.12	23.47	94.02	23.88	93.91	24.29	93.80	24.70	97
98	95.09	23.71	94.98	24.12	94.88	24.54	94.77	24.95	98
99	96.06	23.95	95.95	24.37	95.85	24.79	95.74	25.21	99
100	97.03	24.19	96.92	24.62	96.81	25.04	96.70	25.46	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	76 Deg.		75 $\frac{3}{4}$ Deg		75 $\frac{1}{2}$ Deg.		75 $\frac{1}{4}$ Deg		

Distance.	15 Deg.		15¼ Deg.		15½ Deg.		15¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.97	0.26	0.96	0.26	0.96	0.27	0.96	0.27	1
2	1.93	0.52	1.93	0.53	1.93	0.53	1.92	0.54	2
3	2.90	0.78	2.39	0.79	2.89	0.80	2.89	0.81	3
4	3.86	1.04	3.86	1.05	3.85	1.07	3.85	1.09	4
5	4.83	1.29	4.82	1.32	4.82	1.34	4.81	1.36	5
6	5.80	1.55	5.79	1.58	5.78	1.60	5.77	1.63	6
7	6.76	1.81	6.75	1.84	6.75	1.87	6.74	1.90	7
8	7.73	2.07	7.72	2.10	7.71	2.14	7.70	2.17	8
9	8.69	2.33	8.68	2.37	8.67	2.41	8.66	2.44	9
10	9.66	2.59	9.65	2.63	9.64	2.67	9.62	2.71	10
11	10.63	2.85	10.61	2.89	10.60	2.94	10.59	2.99	11
12	11.59	3.11	11.58	3.16	11.56	3.21	11.55	3.26	12
13	12.56	3.36	12.54	3.42	12.53	3.47	12.51	3.53	13
14	13.52	3.62	13.51	3.68	13.49	3.74	13.47	3.80	14
15	14.49	3.88	14.47	3.95	14.45	4.01	14.44	4.07	15
16	15.45	4.14	15.44	4.21	15.42	4.28	15.40	4.34	16
17	16.42	4.40	16.40	4.47	16.38	4.54	16.36	4.61	17
18	17.39	4.66	17.37	4.73	17.35	4.81	17.32	4.89	18
19	18.35	4.92	18.33	5.00	18.31	5.08	18.29	5.16	19
20	19.32	5.18	19.30	5.26	19.27	5.34	19.25	5.43	20
21	20.28	5.44	20.26	5.52	20.24	5.61	20.21	5.70	21
22	21.25	5.69	21.23	5.79	21.20	5.88	21.17	5.97	22
23	22.22	5.95	22.19	6.05	22.16	6.15	22.14	6.24	23
24	23.18	6.21	23.15	6.31	23.13	6.41	23.10	6.51	24
25	24.15	6.47	24.12	6.58	24.09	6.63	24.06	6.79	25
26	25.11	6.73	25.08	6.84	25.05	6.95	25.02	7.06	26
27	26.08	6.99	26.05	7.10	26.02	7.22	25.99	7.33	27
28	27.05	7.25	27.01	7.36	26.98	7.48	26.95	7.60	28
29	28.01	7.51	27.98	7.63	27.95	7.75	27.91	7.87	29
30	28.98	7.76	28.94	7.89	28.91	8.02	28.87	8.14	30
31	29.94	8.02	29.91	8.15	29.87	8.28	29.84	8.41	31
32	30.91	8.28	30.87	8.42	30.84	8.55	30.80	8.69	32
33	31.88	8.54	31.84	8.68	31.80	8.82	31.76	8.96	33
34	32.84	8.80	32.80	8.94	32.76	9.09	32.72	9.23	34
35	33.81	9.06	33.77	9.21	33.73	9.35	33.69	9.50	35
36	34.77	9.32	34.73	9.47	34.69	9.62	34.65	9.77	36
37	35.74	9.58	35.70	9.73	35.65	9.89	35.61	10.04	37
38	36.71	9.84	36.66	10.00	36.62	10.16	36.57	10.31	38
39	37.67	10.09	37.63	10.26	37.58	10.42	37.54	10.59	39
40	38.64	10.35	38.59	10.52	38.55	10.69	38.50	10.86	40
41	39.60	10.61	39.56	10.78	39.51	10.96	39.46	11.13	41
42	40.57	10.87	40.52	11.05	40.47	11.22	40.42	11.40	42
43	41.53	11.13	41.49	11.31	41.44	11.49	41.39	11.67	43
44	42.50	11.39	42.45	11.57	42.40	11.76	42.35	11.94	44
45	43.47	11.65	43.42	11.84	43.36	12.03	43.31	12.21	45
46	44.43	11.91	44.38	12.10	44.33	12.29	44.27	12.49	46
47	45.40	12.16	45.35	12.36	45.29	12.56	45.24	12.76	47
48	46.36	12.42	46.31	12.63	46.25	12.83	46.20	13.03	48
49	47.33	12.68	47.27	12.89	47.22	13.09	47.16	13.30	49
50	48.30	12.94	48.24	13.15	48.18	13.36	48.12	13.57	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	75 Deg.		74¾ Deg.		74½ Deg.		74¼ Deg.		

Distance.	15 Deg.		15¼ Deg.		15½ Deg.		15¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	49.26	13.20	49.20	13.41	49.15	13.63	49.09	13.84	51
52	50.23	13.46	50.17	13.68	50.11	13.90	50.05	14.11	52
53	51.19	13.72	51.13	13.94	51.07	14.16	51.01	14.39	53
54	52.16	13.98	52.10	14.20	52.04	14.43	51.97	14.66	54
55	53.13	14.24	53.06	14.47	53.00	14.70	52.94	14.93	55
56	54.09	14.49	54.03	14.73	53.96	14.97	53.90	15.20	56
57	55.06	14.75	54.99	14.99	54.93	15.23	54.86	15.47	57
58	56.02	15.01	55.96	15.26	55.89	15.50	55.82	15.74	58
59	56.99	15.27	56.92	15.52	56.85	15.77	56.78	16.01	59
60	57.96	15.53	57.89	15.78	57.82	16.03	57.75	16.29	60
61	58.92	15.79	58.85	16.04	58.78	16.30	58.71	16.56	61
62	59.89	16.05	59.82	16.31	59.75	16.57	59.67	16.83	62
63	60.85	16.31	60.78	16.57	60.71	16.84	60.63	17.10	63
64	61.82	16.56	61.75	16.83	61.67	17.10	61.60	17.37	64
65	62.79	16.82	62.71	17.10	62.64	17.37	62.56	17.64	65
66	63.75	17.08	63.68	17.35	63.60	17.64	63.52	17.92	66
67	64.72	17.34	64.64	17.62	64.56	17.90	64.48	18.19	67
68	65.68	17.60	65.61	17.89	65.53	18.17	65.45	18.46	68
69	66.65	17.86	66.57	18.15	66.49	18.44	66.41	18.73	69
70	67.61	18.12	67.54	18.41	67.45	18.71	67.37	19.00	70
71	68.58	18.38	68.50	18.68	68.42	18.97	68.33	19.27	71
72	69.55	18.63	69.46	18.94	69.38	19.24	69.30	19.54	72
73	70.51	18.89	70.43	19.20	70.35	19.51	70.26	19.82	73
74	71.48	19.15	71.39	19.46	71.31	19.78	71.22	20.09	74
75	72.44	19.41	72.36	19.73	72.27	20.04	72.18	20.36	75
76	73.41	19.67	73.32	19.99	73.24	20.31	73.15	20.63	76
77	74.38	19.93	74.29	20.25	74.20	20.58	74.11	20.90	77
78	75.34	20.19	75.25	20.52	75.16	20.84	75.07	21.17	78
79	76.31	20.45	76.22	20.78	76.13	21.11	76.03	21.44	79
80	77.27	20.71	77.18	21.04	77.09	21.38	77.00	21.72	80
81	78.24	20.96	78.15	21.31	78.05	21.65	77.96	21.99	81
82	79.21	21.22	79.11	21.57	79.02	21.91	78.92	22.26	82
83	80.17	21.48	80.08	21.83	79.98	22.18	79.88	22.53	83
84	81.14	21.74	81.04	22.09	80.94	22.45	80.85	22.80	84
85	82.10	22.00	82.01	22.36	81.91	22.72	81.81	23.07	85
86	83.07	22.26	82.97	22.62	82.87	22.98	82.77	23.34	86
87	84.04	22.52	83.94	22.88	83.84	23.25	83.73	23.62	87
88	85.00	22.78	84.90	23.15	84.80	23.52	84.70	23.89	88
89	85.97	23.03	85.87	23.41	85.76	23.78	85.66	24.16	89
90	86.93	23.29	86.83	23.67	86.73	24.05	86.62	24.43	90
91	87.90	23.55	87.80	23.94	87.69	24.32	87.58	24.70	91
92	88.87	23.81	88.76	24.20	88.65	24.59	88.55	24.97	92
93	89.83	24.07	89.73	24.46	89.62	24.85	89.51	25.24	93
94	90.80	24.33	90.69	24.72	90.58	25.12	90.47	25.52	94
95	91.76	24.59	91.65	24.99	91.54	25.39	91.43	25.79	95
96	92.73	24.85	92.62	25.25	92.51	25.65	92.40	26.06	96
97	93.69	25.11	93.58	25.51	93.47	25.92	93.36	26.33	97
98	94.66	25.36	94.55	25.78	94.44	26.19	94.32	26.60	98
99	95.63	25.62	95.51	26.04	95.40	26.46	95.28	26.87	99
100	96.59	25.88	96.48	26.30	96.36	26.72	96.25	27.14	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	75 Deg.		74¾ Deg.		74½ Deg.		74¼ Deg.		

Distance.	16 Deg.		16¼ Deg.		16½ Deg.		16¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.96	0.28	0.96	0.28	0.96	0.28	0.96	0.29	1
2	1.92	0.55	1.92	0.56	1.92	0.57	1.92	0.58	2
3	2.88	0.83	2.88	0.84	2.88	0.85	2.87	0.86	3
4	3.85	1.10	3.84	1.12	3.84	1.14	3.83	1.15	4
5	4.81	1.38	4.80	1.40	4.79	1.42	4.79	1.44	5
6	5.77	1.65	5.76	1.68	5.75	1.70	5.75	1.73	6
7	6.73	1.93	6.72	1.96	6.71	1.99	6.70	2.02	7
8	7.69	2.21	7.68	2.24	7.67	2.27	7.66	2.31	8
9	8.65	2.48	8.64	2.52	8.63	2.56	8.62	2.59	9
10	9.61	2.76	9.60	2.80	9.59	2.84	9.58	2.88	10
11	10.57	3.03	10.56	3.08	10.55	3.12	10.53	3.17	11
12	11.54	3.31	11.52	3.36	11.51	3.41	11.49	3.46	12
13	12.50	3.58	12.48	3.64	12.46	3.69	12.45	3.75	13
14	13.46	3.86	13.44	3.92	13.42	3.98	13.41	4.03	14
15	14.42	4.13	14.40	4.20	14.38	4.26	14.36	4.32	15
16	15.38	4.41	15.36	4.48	15.34	4.54	15.32	4.61	16
17	16.34	4.69	16.32	4.76	16.30	4.83	16.28	4.90	17
18	17.30	4.96	17.28	5.04	17.26	5.11	17.24	5.19	18
19	18.26	5.24	18.24	5.32	18.22	5.40	18.19	5.48	19
20	19.23	5.51	19.20	5.60	19.18	5.68	19.15	5.76	20
21	20.19	5.79	20.16	5.88	20.14	5.96	20.11	6.05	21
22	21.15	6.06	21.12	6.16	21.09	6.25	21.07	6.34	22
23	22.11	6.34	22.08	6.44	22.05	6.53	22.02	6.63	23
24	23.07	6.62	23.04	6.72	23.01	6.82	22.98	6.92	24
25	24.03	6.89	24.00	7.00	23.97	7.10	23.94	7.20	25
26	24.99	7.17	24.96	7.28	24.93	7.38	24.90	7.49	26
27	25.95	7.44	25.92	7.56	25.89	7.67	25.85	7.78	27
28	26.92	7.72	26.88	7.84	26.85	7.95	26.81	8.07	28
29	27.88	7.99	27.84	8.11	27.81	8.24	27.77	8.36	29
30	28.84	8.27	28.80	8.39	28.76	8.52	28.73	8.65	30
31	29.80	8.54	29.76	8.67	29.72	8.80	29.68	8.93	31
32	30.76	8.82	30.72	8.95	30.68	9.09	30.64	9.22	32
33	31.72	9.10	31.68	9.23	31.64	9.37	31.60	9.51	33
34	32.68	9.37	32.64	9.51	32.60	9.66	32.56	9.80	34
35	33.64	9.65	33.60	9.79	33.56	9.94	33.51	10.09	35
36	34.61	9.92	34.56	10.07	34.52	10.22	34.47	10.38	36
37	35.57	10.20	35.52	10.35	35.48	10.51	35.43	10.66	37
38	36.53	10.47	36.48	10.63	36.44	10.79	36.39	10.95	38
39	37.49	10.75	37.44	10.91	37.39	11.08	37.35	11.24	39
40	38.45	11.03	38.40	11.19	38.35	11.36	38.30	11.53	40
41	39.41	11.30	39.36	11.47	39.31	11.64	39.26	11.82	41
42	40.37	11.58	40.32	11.75	40.27	11.93	40.22	12.10	42
43	41.33	11.85	41.28	12.03	41.23	12.21	41.18	12.39	43
44	42.30	12.13	42.24	12.31	42.19	12.50	42.13	12.68	44
45	43.26	12.40	43.20	12.59	43.15	12.78	43.09	12.97	45
46	44.22	12.68	44.16	12.87	44.11	13.06	44.05	13.26	46
47	45.18	12.95	45.12	13.15	45.06	13.35	45.01	13.55	47
48	46.14	13.23	46.08	13.43	46.02	13.63	45.96	13.83	48
49	47.10	13.51	47.04	13.71	46.98	13.92	46.92	14.12	49
50	48.06	13.78	48.00	13.99	47.94	14.20	47.88	14.41	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	74 Deg.		73¾ Deg.		73½ Deg.		73¼ Deg.		

Distance.	16 Deg.		16 $\frac{1}{4}$ Deg.		16 $\frac{1}{2}$ Deg.		16 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	49.02	14.06	48.96	14.27	48.90	14.48	48.84	14.70	51
52	49.99	14.33	49.92	14.55	49.86	14.77	49.79	14.99	52
53	50.95	14.61	50.88	14.83	50.82	15.05	50.75	15.27	53
54	51.91	14.88	51.84	15.11	51.78	15.34	51.71	15.56	54
55	52.87	15.16	52.80	15.39	52.74	15.62	52.67	15.85	55
56	53.83	15.44	53.76	15.67	53.69	15.90	53.62	16.14	56
57	54.79	15.71	54.72	15.95	54.65	16.19	54.58	16.43	57
58	55.75	15.99	55.68	16.23	55.61	16.47	55.54	16.72	58
59	56.71	16.26	56.64	16.51	56.57	16.76	56.50	17.00	59
60	57.68	16.54	57.60	16.79	57.53	17.04	57.45	17.29	60
61	58.64	16.81	58.56	17.07	58.49	17.32	58.41	17.58	61
62	59.60	17.09	59.52	17.35	59.45	17.61	59.37	17.87	62
63	60.56	17.37	60.48	17.63	60.41	17.89	60.33	18.16	63
64	61.52	17.64	61.44	17.91	61.36	18.18	61.28	18.44	64
65	62.48	17.92	62.40	18.19	62.32	18.46	62.24	18.73	65
66	63.44	18.19	63.36	18.47	63.28	18.74	63.20	19.02	66
67	64.40	18.47	64.32	18.75	64.24	19.03	64.16	19.31	67
68	65.37	18.74	65.28	19.03	65.20	19.31	65.11	19.60	68
69	66.33	19.02	66.24	19.31	66.16	19.60	66.07	19.89	69
70	67.29	19.29	67.20	19.59	67.12	19.88	67.03	20.17	70
71	68.25	19.57	68.16	19.87	68.08	20.17	67.99	20.46	71
72	69.21	19.85	69.12	20.15	69.03	20.45	68.95	20.75	72
73	70.17	20.12	70.08	20.43	69.99	20.73	69.90	21.04	73
74	71.13	20.40	71.04	20.71	70.95	21.02	70.86	21.33	74
75	72.09	20.67	72.00	20.99	71.91	21.30	71.82	21.61	75
76	73.06	20.95	72.96	21.27	72.87	21.59	72.78	21.90	76
77	74.02	21.22	73.92	21.55	73.83	21.87	73.73	22.19	77
78	74.98	21.50	74.88	21.83	74.79	22.15	74.69	22.48	78
79	75.94	21.78	75.84	22.11	75.75	22.44	75.65	22.77	79
80	76.90	22.05	76.80	22.39	76.71	22.72	76.61	23.06	80
81	77.86	22.33	77.76	22.67	77.66	23.01	77.56	23.34	81
82	78.82	22.60	78.72	22.95	78.62	23.29	78.52	23.63	82
83	79.78	22.88	79.68	23.23	79.58	23.57	79.48	23.92	83
84	80.75	23.15	80.64	23.51	80.54	23.86	80.44	24.21	84
85	81.71	23.43	81.60	23.79	81.50	24.14	81.39	24.50	85
86	82.67	23.70	82.56	24.07	82.46	24.43	82.35	24.78	86
87	83.63	23.98	83.52	24.35	83.42	24.71	83.31	25.07	87
88	84.59	24.26	84.48	24.62	84.38	24.99	84.27	25.36	88
89	85.55	24.53	85.44	24.90	85.33	25.28	85.22	25.65	89
90	86.51	24.81	86.40	25.18	86.29	25.56	86.18	25.94	90
91	87.47	25.08	87.36	25.46	87.25	25.85	87.14	26.23	91
92	88.44	25.36	88.32	25.74	88.21	26.13	88.10	26.51	92
93	89.40	25.63	89.28	26.02	89.17	26.41	89.05	26.80	93
94	90.36	25.91	90.24	26.30	90.13	26.70	90.01	27.09	94
95	91.32	26.19	91.20	26.58	91.09	26.98	90.97	27.38	95
96	92.28	26.46	92.16	26.86	92.05	27.27	91.93	27.67	96
97	93.24	26.74	93.12	27.14	93.01	27.55	92.88	27.95	97
98	94.20	27.01	94.08	27.42	93.96	27.83	93.84	28.24	98
99	95.16	27.29	95.04	27.70	94.92	28.12	94.80	28.53	99
100	96.13	27.56	96.00	27.98	95.88	28.40	95.76	28.82	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	74 Deg.		73 $\frac{3}{4}$ Deg.		73 $\frac{1}{2}$ Deg.		73 $\frac{1}{4}$ Deg.		

Distance.	17 Deg.		17 $\frac{1}{4}$ Deg.		17 $\frac{1}{2}$ Deg.		17 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.96	0.29	0.95	0.30	0.95	0.30	0.95	0.30	1
2	1.91	0.58	1.91	0.59	1.91	0.60	1.90	0.61	2
3	2.87	0.88	2.87	0.89	2.86	0.90	2.86	0.91	3
4	3.83	1.17	3.82	1.19	3.81	1.20	3.81	1.22	4
5	4.78	1.46	4.78	1.48	4.77	1.50	4.76	1.52	5
6	5.74	1.75	5.73	1.78	5.72	1.80	5.71	1.83	6
7	6.69	2.05	6.69	2.08	6.68	2.10	6.67	2.13	7
8	7.65	2.34	7.64	2.37	7.63	2.41	7.62	2.44	8
9	8.61	2.63	8.60	2.67	8.58	2.71	8.57	2.74	9
10	9.56	2.92	9.55	2.97	9.54	3.01	9.52	3.05	10
11	10.52	3.22	10.51	3.26	10.49	3.31	10.48	3.35	11
12	11.48	3.51	11.46	3.56	11.44	3.61	11.43	3.66	12
13	12.43	3.80	12.42	3.85	12.40	3.91	12.38	3.96	13
14	13.39	4.09	13.37	4.15	13.35	4.21	13.33	4.27	14
15	14.34	4.39	14.33	4.45	14.31	4.51	14.29	4.57	15
16	15.30	4.68	15.28	4.74	15.26	4.81	15.24	4.88	16
17	16.26	4.97	16.24	5.04	16.21	5.11	16.19	5.18	17
18	17.21	5.26	17.19	5.34	17.17	5.41	17.14	5.49	18
19	18.17	5.56	18.15	5.63	18.12	5.71	18.10	5.79	19
20	19.13	5.85	19.10	5.93	19.07	6.01	19.05	6.10	20
21	20.08	6.14	20.06	6.23	20.03	6.31	20.00	6.40	21
22	21.04	6.43	21.01	6.52	20.98	6.62	20.95	6.71	22
23	21.99	6.72	21.97	6.82	21.94	6.92	21.91	7.01	23
24	22.95	7.02	22.92	7.12	22.89	7.22	22.86	7.32	24
25	23.91	7.31	23.88	7.41	23.84	7.52	23.81	7.62	25
26	24.86	7.60	24.83	7.71	24.80	7.82	24.76	7.93	26
27	25.82	7.89	25.79	8.01	25.75	8.12	25.71	8.23	27
28	26.78	8.19	26.74	8.30	26.70	8.42	26.67	8.54	28
29	27.73	8.48	27.70	8.60	27.66	8.72	27.62	8.84	29
30	28.69	8.77	28.65	8.90	28.61	9.02	28.57	9.15	30
31	29.65	9.06	29.61	9.19	29.57	9.32	29.52	9.45	31
32	30.60	9.36	30.56	9.49	30.52	9.62	30.48	9.76	32
33	31.56	9.65	31.52	9.79	31.47	9.92	31.43	10.06	33
34	32.51	9.94	32.47	10.08	32.43	10.22	32.38	10.37	34
35	33.47	10.23	33.43	10.38	33.38	10.52	33.33	10.67	35
36	34.43	10.53	34.38	10.68	34.33	10.83	34.29	10.98	36
37	35.38	10.82	35.34	10.97	35.29	11.13	35.24	11.28	37
38	36.34	11.11	36.29	11.27	36.24	11.43	36.19	11.58	38
39	37.30	11.40	37.25	11.57	37.19	11.73	37.14	11.89	39
40	38.25	11.69	38.20	11.86	38.15	12.03	38.10	12.19	40
41	39.21	11.99	39.16	12.16	39.10	12.33	39.05	12.50	41
42	40.16	12.28	40.11	12.45	40.06	12.63	40.00	12.80	42
43	41.12	12.57	41.07	12.75	41.01	12.93	40.95	13.11	43
44	42.08	12.86	42.02	13.05	41.96	13.23	41.91	13.41	44
45	43.03	13.16	42.98	13.34	42.92	13.53	42.86	13.72	45
46	43.99	13.45	43.93	13.64	43.87	13.83	43.81	14.02	46
47	44.95	13.74	44.89	13.94	44.82	14.13	44.76	14.33	47
48	45.90	14.03	45.84	14.23	45.78	14.43	45.71	14.63	48
49	46.86	14.33	46.80	14.53	46.73	14.73	46.67	14.94	49
50	47.82	14.62	47.75	14.83	47.69	15.04	47.62	15.24	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	73 Deg.		72 $\frac{3}{4}$ Deg.		72 $\frac{1}{2}$ Deg.		72 $\frac{1}{4}$ Deg.		

Distance.	17 Deg.		17½ Deg.		17½ Deg.		17½ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	48.77	14.91	48.71	15.12	48.64	15.34	48.57	15.55	51
52	49.73	15.20	49.66	15.42	49.59	15.64	49.52	15.85	52
53	50.68	15.50	50.62	15.72	50.55	15.94	50.48	16.16	53
54	51.64	15.79	51.57	16.01	51.50	16.24	51.43	16.46	54
55	52.60	16.08	52.53	16.31	52.45	16.54	52.38	16.77	55
56	53.55	16.37	53.48	16.61	53.41	16.84	53.33	17.07	56
57	54.51	16.67	54.44	16.90	54.36	17.14	54.29	17.33	57
58	55.47	16.96	55.39	17.20	55.32	17.44	55.24	17.68	58
59	56.42	17.25	56.35	17.50	56.27	17.74	56.19	17.99	59
60	57.38	17.54	57.30	17.79	57.22	18.04	57.14	18.29	60
61	58.33	17.83	58.26	18.09	58.18	18.34	58.10	18.60	61
62	59.29	18.13	59.21	18.39	59.13	18.64	59.05	18.90	62
63	60.25	18.42	60.17	18.68	60.08	18.94	60.00	19.21	63
64	61.20	18.71	61.12	18.93	61.04	19.25	60.95	19.51	64
65	62.16	19.00	62.08	19.23	61.99	19.55	61.91	19.82	65
66	63.12	19.30	63.03	19.57	62.95	19.85	62.86	20.12	66
67	64.07	19.59	63.99	19.87	63.90	20.15	63.81	20.43	67
68	65.03	19.88	64.94	20.16	64.85	20.45	64.76	20.73	68
69	65.99	20.17	65.90	20.46	65.81	20.75	65.72	21.04	69
70	66.94	20.47	66.85	20.75	66.76	21.05	66.67	21.34	70
71	67.90	20.76	67.81	21.05	67.71	21.35	67.62	21.65	71
72	68.85	21.05	68.75	21.35	68.67	21.65	68.57	21.95	72
73	69.81	21.34	69.72	21.65	69.62	21.95	69.52	22.26	73
74	70.77	21.64	70.67	21.94	70.58	22.25	70.48	22.56	74
75	71.72	21.93	71.63	22.24	71.53	22.55	71.43	22.86	75
76	72.68	22.22	72.53	22.54	72.48	22.85	72.38	23.17	76
77	73.64	22.51	73.54	22.83	73.44	23.15	73.33	23.47	77
78	74.59	22.80	74.49	23.13	74.39	23.46	74.29	23.78	78
79	75.55	23.10	75.45	23.43	75.34	23.76	75.24	24.08	79
80	76.50	23.39	76.40	23.72	76.30	24.06	76.19	24.39	80
81	77.46	23.68	77.35	24.02	77.25	24.36	77.14	24.69	81
82	78.42	23.97	78.31	24.32	78.20	24.66	78.10	25.00	82
83	79.37	24.27	79.27	24.61	79.16	25.96	79.05	25.30	83
84	80.33	24.56	80.22	24.91	80.11	25.26	80.09	25.61	84
85	81.29	24.85	81.18	25.21	81.07	25.56	80.95	25.91	85
86	82.24	25.14	82.13	25.50	82.02	25.86	81.91	26.22	86
87	83.20	25.44	83.09	25.80	82.97	26.16	82.86	26.52	87
88	84.15	25.73	84.04	26.10	83.93	26.46	83.81	26.83	88
89	85.11	26.02	85.00	26.39	84.88	26.76	84.76	27.13	89
90	86.07	26.31	85.95	26.69	85.83	27.06	85.72	27.44	90
91	87.02	26.61	86.91	26.99	86.79	27.36	86.67	27.74	91
92	87.98	26.90	87.86	27.28	87.74	27.66	87.62	28.05	92
93	88.94	27.19	88.82	27.58	88.70	27.97	88.57	28.35	93
94	89.89	27.48	89.77	27.87	89.65	28.27	89.53	28.66	94
95	90.85	27.78	90.73	28.17	90.60	28.57	90.48	28.96	95
96	91.81	28.07	91.68	28.47	91.56	28.87	91.43	29.27	96
97	92.76	28.36	92.64	28.76	92.51	29.17	92.38	29.57	97
98	93.72	28.65	93.59	29.06	93.46	29.47	93.33	29.88	98
99	94.67	28.94	94.55	29.36	94.42	29.77	94.29	30.18	99
100	95.63	29.24	95.50	29.65	95.37	30.07	95.24	30.49	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	73 Deg.		72½ Deg.		72½ Deg.		72½ Deg.		

Distance.	18 Deg.		18¼ Deg.		18½ Deg.		18¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.95	0.31	0.95	0.31	0.95	0.32	0.95	0.32	1
2	1.90	0.62	1.90	0.63	1.90	0.63	1.89	0.64	2
3	2.85	0.93	2.85	0.94	2.84	0.95	2.84	0.96	3
4	3.80	1.24	3.80	1.25	3.79	1.27	3.79	1.29	4
5	4.76	1.55	4.75	1.57	4.74	1.59	4.73	1.61	5
6	5.71	1.85	5.70	1.88	5.69	1.90	5.68	1.93	6
7	6.66	2.16	6.65	2.19	6.64	2.22	6.63	2.25	7
8	7.61	2.47	7.60	2.51	7.59	2.54	7.58	2.57	8
9	8.56	2.78	8.55	2.82	8.53	2.86	8.52	2.89	9
10	9.51	3.09	9.50	3.13	9.48	3.17	9.47	3.21	10
11	10.46	3.40	10.45	3.44	10.43	3.49	10.42	3.54	11
12	11.41	3.71	11.40	3.76	11.38	3.81	11.36	3.86	12
13	12.36	4.02	12.35	4.07	12.33	4.12	12.31	4.18	13
14	13.31	4.33	13.30	4.38	13.28	4.44	13.26	4.50	14
15	14.27	4.64	14.25	4.70	14.22	4.76	14.20	4.82	15
16	15.22	4.94	15.20	5.01	15.17	5.08	15.15	5.14	16
17	16.17	5.25	16.14	5.32	16.12	5.39	16.10	5.46	17
18	17.12	5.56	17.09	5.64	17.07	5.71	17.04	5.79	18
19	18.07	5.87	18.04	5.95	18.02	6.03	17.99	6.11	19
20	19.02	6.18	18.99	6.26	18.97	6.35	18.94	6.43	20
21	19.97	6.49	19.94	6.58	19.91	6.66	19.89	6.75	21
22	20.92	6.80	20.89	6.89	20.86	6.98	20.83	7.07	22
23	21.87	7.11	21.84	7.20	21.81	7.30	21.78	7.39	23
24	22.83	7.42	22.79	7.52	22.76	7.62	22.73	7.71	24
25	23.78	7.73	23.74	7.83	23.71	7.93	23.67	8.04	25
26	24.73	8.03	24.69	8.14	24.66	8.25	24.62	8.36	26
27	25.68	8.34	25.64	8.46	25.60	8.57	25.57	8.68	27
28	26.63	8.65	26.59	8.77	26.55	8.88	26.51	9.00	28
29	27.58	8.96	27.54	9.08	27.50	9.20	27.45	9.32	29
30	28.53	9.27	28.49	9.39	28.45	9.52	28.41	9.64	30
31	29.48	9.58	29.44	9.71	29.40	9.84	29.35	9.96	31
32	30.43	9.89	30.39	10.02	30.35	10.15	30.30	10.29	32
33	31.38	10.20	31.34	10.33	31.29	10.47	31.25	10.61	33
34	32.34	10.51	32.29	10.65	32.24	10.79	32.20	10.93	34
35	33.29	10.82	33.24	10.96	33.19	11.11	33.14	11.25	35
36	34.24	11.12	34.19	11.27	34.14	11.42	34.09	11.57	36
37	35.19	11.43	35.14	11.59	35.09	11.74	35.04	11.89	37
38	36.14	11.74	36.09	11.90	36.04	12.06	35.98	12.21	38
39	37.09	12.05	37.04	12.21	36.98	12.37	36.93	12.54	39
40	38.04	12.36	37.99	12.53	37.93	12.69	37.88	12.86	40
41	38.99	12.67	38.94	12.84	38.88	13.01	38.82	13.18	41
42	39.94	12.98	39.89	13.15	39.83	13.33	39.77	13.50	42
43	40.90	13.29	40.84	13.47	40.78	13.64	40.72	13.82	43
44	41.85	13.60	41.79	13.78	41.73	13.96	41.66	14.14	44
45	42.80	13.91	42.74	14.09	42.67	14.28	42.61	14.46	45
46	43.75	14.21	43.69	14.41	43.62	14.60	43.56	14.79	46
47	44.70	14.52	44.64	14.72	44.57	14.91	44.51	15.11	47
48	45.65	14.83	45.59	15.03	45.52	15.23	45.45	15.43	48
49	46.60	15.14	46.54	15.35	46.47	15.55	46.40	15.75	49
50	47.55	15.45	47.48	15.66	47.42	15.87	47.35	16.07	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	72 Deg.		71¾ Deg.		71½ Deg.		71¼ Deg.		

Distance.	18 Deg.		18¼ Deg.		18½ Deg.		18¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	18.50	15.76	48.43	15.97	48.36	16.18	48.29	16.39	51
52	49.45	16.07	49.38	16.28	49.31	16.50	49.24	16.71	52
53	50.41	16.38	50.33	16.60	50.26	16.82	50.19	17.04	53
54	51.36	16.69	51.28	16.91	51.21	17.13	51.13	17.36	54
55	52.31	17.00	52.23	17.22	52.16	17.45	52.08	17.68	55
56	53.26	17.30	53.18	17.54	53.11	17.77	53.03	18.00	56
57	54.21	17.61	54.13	17.85	54.05	18.09	53.98	18.32	57
58	55.16	17.92	55.08	18.16	55.00	18.40	54.92	18.64	58
59	56.11	18.23	56.03	18.48	55.95	18.72	55.87	18.96	59
60	57.06	18.54	56.98	18.79	56.90	19.04	56.82	19.29	60
61	58.01	18.85	57.93	19.10	57.85	19.36	57.76	19.61	61
62	58.97	19.16	58.88	19.42	58.80	19.67	58.71	19.93	62
63	59.92	19.47	59.83	19.73	59.74	19.99	59.66	20.25	63
64	60.87	19.78	60.78	20.04	60.69	20.31	60.60	20.57	64
65	61.82	20.09	61.73	20.36	61.64	20.62	61.55	20.89	65
66	62.77	20.40	62.68	20.67	62.59	20.94	62.50	21.22	66
67	63.72	20.70	63.63	20.98	63.54	21.26	63.44	21.54	67
68	64.67	21.01	64.58	21.30	64.49	21.58	64.39	21.86	68
69	65.62	21.32	65.53	21.61	65.43	21.89	65.34	22.18	69
70	66.57	21.63	66.48	21.92	66.38	22.21	66.29	22.50	70
71	67.53	21.94	67.43	22.23	67.33	22.53	67.23	22.82	71
72	68.48	22.25	68.38	22.55	68.28	22.85	68.18	23.14	72
73	69.43	22.56	69.33	22.86	69.23	23.16	69.13	23.47	73
74	70.38	22.87	70.28	23.17	70.18	23.48	70.07	23.79	74
75	71.33	23.18	71.23	23.49	71.12	23.80	71.02	24.11	75
76	72.28	23.49	72.18	23.80	72.07	24.12	71.97	24.43	76
77	73.23	23.79	73.13	24.11	73.02	24.43	72.91	24.75	77
78	74.18	24.10	74.08	24.43	73.97	24.75	73.86	25.07	78
79	75.13	24.41	75.03	24.74	74.92	25.07	74.81	25.39	79
80	76.08	24.72	75.98	25.05	75.87	25.38	75.75	25.72	80
81	77.04	25.03	76.93	25.37	76.81	25.70	76.70	26.04	81
82	77.99	25.34	77.88	25.68	77.76	26.02	77.65	26.36	82
83	78.94	25.65	78.83	25.99	78.71	26.34	78.60	26.68	83
84	79.89	25.96	79.77	26.31	79.66	26.65	79.54	27.00	84
85	80.84	26.27	80.72	26.62	80.61	26.97	80.49	27.32	85
86	81.79	26.58	81.67	26.93	81.56	27.29	81.44	27.64	86
87	82.74	26.88	82.62	27.25	82.50	27.61	82.38	27.97	87
88	83.69	27.19	83.57	27.56	83.45	27.92	83.33	28.29	88
89	84.64	27.50	84.52	27.87	84.40	28.24	84.28	28.61	89
90	85.60	27.81	85.47	28.18	85.35	28.56	85.22	28.93	90
91	86.55	28.12	86.42	28.50	86.30	28.87	86.17	29.25	91
92	87.50	28.43	87.37	28.81	87.25	29.19	87.12	29.57	92
93	88.45	28.74	88.32	29.12	88.19	29.51	88.06	29.89	93
94	89.40	29.05	89.27	29.44	89.14	29.83	89.01	30.22	94
95	90.35	29.36	90.22	29.75	90.09	30.14	89.96	30.54	95
96	91.30	29.67	91.17	30.06	91.04	30.46	90.91	30.86	96
97	92.25	29.97	92.12	30.38	91.99	30.78	91.85	31.18	97
98	93.20	30.28	93.07	30.69	92.94	31.10	92.80	31.50	98
99	94.15	30.59	94.02	31.00	93.88	31.41	93.75	31.82	99
100	95.11	30.90	94.97	31.32	94.83	31.73	94.69	32.14	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	72 Deg.		71¾ Deg.		71½ Deg.		71¼ Deg.		

Distance.	19 Deg.		19¼ Deg.		19½ Deg.		19¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.95	0.33	0.94	0.33	0.94	0.33	0.94	0.34	1
2	1.89	0.65	1.89	0.66	1.89	0.67	1.88	0.68	2
3	2.84	0.98	2.83	0.99	2.83	1.00	2.82	1.01	3
4	3.78	1.30	3.78	1.32	3.77	1.34	3.76	1.35	4
5	4.73	1.63	4.72	1.65	4.71	1.67	4.71	1.69	5
6	5.67	1.95	5.66	1.98	5.66	2.00	5.65	2.03	6
7	6.62	2.28	6.61	2.31	6.60	2.34	6.59	2.37	7
8	7.56	2.60	7.55	2.64	7.54	2.67	7.53	2.70	8
9	8.51	2.93	8.50	2.97	8.48	3.00	8.47	3.04	9
10	9.46	3.26	9.44	3.30	9.43	3.34	9.41	3.38	10
11	10.40	3.58	10.38	3.63	10.37	3.67	10.35	3.72	11
12	11.35	3.91	11.33	3.96	11.31	4.01	11.29	4.06	12
13	12.29	4.23	12.27	4.29	12.25	4.34	12.24	4.39	13
14	13.24	4.56	13.22	4.62	13.20	4.67	13.18	4.73	14
15	14.18	4.88	14.16	4.95	14.14	5.01	14.12	5.07	15
16	15.13	5.21	15.11	5.28	15.08	5.34	15.06	5.41	16
17	16.07	5.53	16.05	5.60	16.02	5.67	16.00	5.74	17
18	17.02	5.86	16.99	5.93	16.97	6.01	16.94	6.08	18
19	17.96	6.19	17.94	6.26	17.91	6.34	17.88	6.42	19
20	18.91	6.51	18.88	6.59	18.85	6.68	18.82	6.76	20
21	19.86	6.84	19.83	6.92	19.80	7.01	19.76	7.10	21
22	20.80	7.16	20.77	7.25	20.74	7.34	20.71	7.43	22
23	21.75	7.49	21.71	7.58	21.68	7.68	21.65	7.77	23
24	22.69	7.81	22.66	7.91	22.62	8.01	22.59	8.11	24
25	23.64	8.14	23.60	8.24	23.57	8.35	23.53	8.45	25
26	24.58	8.46	24.55	8.57	24.51	8.68	24.47	8.79	26
27	25.53	8.79	25.49	8.90	25.45	9.01	25.41	9.12	27
28	26.47	9.12	26.43	9.23	26.39	9.35	26.35	9.46	28
29	27.42	9.44	27.38	9.56	27.34	9.68	27.29	9.80	29
30	28.37	9.77	28.32	9.89	28.28	10.01	28.24	10.14	30
31	29.31	10.09	29.27	10.22	29.22	10.35	29.18	10.48	31
32	30.26	10.42	30.21	10.55	30.16	10.68	30.12	10.81	32
33	31.20	10.74	31.15	10.88	31.11	11.02	31.06	11.15	33
34	32.15	11.07	32.10	11.21	32.05	11.35	32.00	11.49	34
35	33.09	11.39	33.04	11.54	32.99	11.68	32.94	11.83	35
36	34.04	11.72	33.99	11.87	33.94	12.02	33.88	12.17	36
37	34.98	12.05	34.93	12.20	34.88	12.35	34.82	12.50	37
38	35.93	12.37	35.88	12.53	35.82	12.68	35.76	12.84	38
39	36.88	12.70	36.82	12.86	36.76	13.02	36.71	13.18	39
40	37.82	13.02	37.76	13.19	37.71	13.35	37.65	13.52	40
41	38.77	13.35	38.71	13.52	38.65	13.69	38.59	13.85	41
42	39.71	13.67	39.65	13.85	39.59	14.02	39.53	14.19	42
43	40.66	14.00	40.60	14.18	40.53	14.35	40.47	14.53	43
44	41.60	14.32	41.54	14.51	41.48	14.69	41.41	14.87	44
45	42.55	14.65	42.48	14.84	42.42	15.02	42.35	15.21	45
46	43.49	14.98	43.43	15.17	43.36	15.36	43.29	15.54	46
47	44.44	15.30	44.37	15.50	44.30	15.69	44.24	15.88	47
48	45.38	15.63	45.32	15.83	45.25	16.02	45.18	16.22	48
49	46.33	15.95	46.26	16.15	46.19	16.36	46.12	16.56	49
50	47.28	16.28	47.20	16.48	47.13	16.69	47.06	16.90	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	71 Deg.		70¾ Deg.		70½ Deg.		70¼ Deg.		

Distance.	19 Deg.		19½ Deg.		19½ Deg.		19¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	48.22	16.60	48.15	16.81	48.07	17.02	48.00	17.23	51
52	49.17	16.93	49.09	17.14	49.02	17.36	48.94	17.57	52
53	50.11	17.26	50.04	17.47	49.96	17.69	49.88	17.91	53
54	51.06	17.58	50.98	17.80	50.90	18.03	50.82	18.25	54
55	52.00	17.91	51.92	18.13	51.85	18.36	51.76	18.59	55
56	52.95	18.23	52.87	18.46	52.79	18.69	52.71	18.92	56
57	53.89	18.56	53.81	18.79	53.73	19.03	53.65	19.26	57
58	54.84	18.88	54.76	19.12	54.67	19.36	54.59	19.60	58
59	55.79	19.21	55.70	19.45	55.62	19.69	55.53	19.94	59
60	56.73	19.53	56.65	19.78	56.56	20.03	56.47	20.27	60
61	57.68	19.86	57.59	20.11	57.50	20.36	57.41	20.61	61
62	58.62	20.19	58.53	20.44	58.44	20.70	58.35	20.95	62
63	59.57	20.51	59.48	20.77	59.39	21.03	59.29	21.29	63
64	60.51	20.84	60.42	21.10	60.33	21.36	60.24	21.63	64
65	61.46	21.16	61.37	21.43	61.27	21.70	61.18	21.96	65
66	62.40	21.49	62.31	21.76	62.21	22.03	62.12	22.30	66
67	63.35	21.81	63.25	22.09	63.16	22.37	63.06	22.64	67
68	64.30	22.14	64.20	22.42	64.10	22.70	64.00	22.98	68
69	65.24	22.46	65.14	22.75	65.04	23.03	64.94	23.32	69
70	66.19	22.79	66.09	23.08	65.98	23.37	65.88	23.65	70
71	67.13	23.12	67.03	23.41	66.93	23.70	66.82	23.99	71
72	68.08	23.44	67.97	23.74	67.87	24.03	67.76	24.33	72
73	69.02	23.77	68.92	24.07	68.81	24.37	68.71	24.67	73
74	69.97	24.09	69.86	24.40	69.76	24.70	69.65	25.01	74
75	70.91	24.42	70.81	24.73	70.70	25.04	70.59	25.34	75
76	71.86	24.74	71.75	25.06	71.64	25.37	71.53	25.68	76
77	72.80	25.07	72.69	25.39	72.58	25.70	72.47	26.02	77
78	73.75	25.39	73.64	25.72	73.53	26.04	73.41	26.36	78
79	74.70	25.72	74.58	26.05	74.47	26.37	74.35	26.70	79
80	75.64	26.05	75.53	26.38	75.41	26.70	75.29	27.03	80
81	76.59	26.37	76.47	26.70	76.35	27.04	76.24	27.37	81
82	77.53	26.70	77.42	27.03	77.30	27.37	77.18	27.71	82
83	78.48	27.02	78.36	27.36	78.24	27.71	78.12	28.05	83
84	79.42	27.35	79.30	27.69	79.18	28.04	79.06	28.39	84
85	80.37	27.67	80.25	28.02	80.12	28.37	80.00	28.72	85
86	81.31	28.00	81.19	28.35	81.07	28.71	80.94	29.06	86
87	82.26	28.32	82.14	28.68	82.01	29.04	81.88	29.40	87
88	83.21	28.65	83.08	29.01	92.95	29.37	82.82	29.74	88
89	84.15	28.98	84.02	29.34	83.90	29.71	83.76	30.07	89
90	85.10	29.30	84.97	29.67	84.84	30.04	84.71	30.41	90
91	86.04	29.63	85.91	30.00	85.78	30.38	85.65	30.75	91
92	86.99	29.95	86.86	30.33	86.72	30.71	86.59	31.09	92
93	87.93	30.28	87.80	30.66	87.67	31.04	87.53	31.43	93
94	88.88	30.60	88.74	30.99	88.61	31.38	88.47	31.76	94
95	89.82	30.93	89.69	31.32	89.55	31.71	89.41	32.10	95
96	90.77	31.25	90.63	31.65	90.49	32.05	90.35	32.44	96
97	91.72	31.58	91.58	31.98	91.44	32.38	91.29	32.78	97
98	92.66	31.91	92.52	32.31	92.38	32.71	92.24	33.12	98
99	93.61	32.23	93.46	32.64	93.32	33.05	93.18	33.45	99
100	94.55	32.56	94.41	32.97	94.26	33.38	94.12	33.79	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	71 Deg.		70¾ Deg.		70½ Deg.		70¼ Deg.		

Distance.	20 Deg.		20 $\frac{1}{4}$ Deg.		20 $\frac{1}{2}$ Deg.		20 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.94	0.34	0.94	0.35	0.94	0.35	0.94	0.35	1
2	1.88	0.68	1.88	0.69	1.87	0.70	1.87	0.71	2
3	2.82	1.03	2.81	1.04	2.81	1.05	2.81	1.06	3
4	3.76	1.37	3.75	1.38	3.75	1.40	3.74	1.42	4
5	4.70	1.71	4.69	1.73	4.68	1.75	4.68	1.77	5
6	5.64	2.05	5.63	2.08	5.62	2.10	5.61	2.13	6
7	6.58	2.39	6.57	2.42	6.56	2.45	6.55	2.48	7
8	7.52	2.74	7.51	2.77	7.49	2.80	7.48	2.83	8
9	8.46	3.08	8.44	3.12	8.43	3.15	8.42	3.19	9
10	9.40	3.42	9.38	3.46	9.37	3.50	9.35	3.54	10
11	10.34	3.76	10.32	3.81	10.30	3.85	10.29	3.90	11
12	11.28	4.10	11.26	4.15	11.24	4.20	11.22	4.25	12
13	12.22	4.45	12.20	4.50	12.18	4.55	12.16	4.61	13
14	13.16	4.79	13.13	4.85	13.11	4.90	13.09	4.96	14
15	14.10	5.13	14.07	5.19	14.05	5.25	14.03	5.31	15
16	15.04	5.47	15.01	5.54	14.99	5.60	14.96	5.67	16
17	15.97	5.81	15.95	5.88	15.92	5.95	15.90	6.02	17
18	16.91	6.16	16.89	6.23	16.86	6.30	16.83	6.38	18
19	17.85	6.50	17.83	6.58	17.80	6.65	17.77	6.73	19
20	18.79	6.84	18.76	6.92	18.73	7.00	18.70	7.09	20
21	19.73	7.18	19.70	7.27	19.67	7.35	19.64	7.44	21
22	20.67	7.52	20.64	7.61	20.61	7.70	20.57	7.79	22
23	21.61	7.87	21.58	7.96	21.54	8.05	21.51	8.15	23
24	22.55	8.21	22.52	8.31	22.48	8.40	22.44	8.50	24
25	23.49	8.55	23.45	8.65	23.42	8.76	23.38	8.86	25
26	24.43	8.89	24.39	9.00	24.35	9.11	24.31	9.21	26
27	25.37	9.23	25.33	9.35	25.29	9.46	25.25	9.57	27
28	26.31	9.58	26.27	9.69	26.23	9.81	26.18	9.92	28
29	27.25	9.92	27.21	10.04	27.16	10.16	27.12	10.27	29
30	28.19	10.26	28.15	10.38	28.10	10.51	28.05	10.63	30
31	29.13	10.60	29.08	10.73	29.04	10.86	28.99	10.98	31
32	30.07	10.94	30.02	11.08	29.97	11.21	29.92	11.34	32
33	31.01	11.29	30.96	11.42	30.91	11.56	30.86	11.69	33
34	31.95	11.63	31.90	11.77	31.85	11.91	31.79	12.05	34
35	32.89	11.97	32.84	12.11	32.78	12.26	32.73	12.40	35
36	33.83	12.31	33.77	12.46	33.72	12.61	33.66	12.75	36
37	34.77	12.65	34.71	12.81	34.66	12.96	34.60	13.11	37
38	35.71	13.00	35.65	13.15	35.59	13.31	35.54	13.46	38
39	36.65	13.34	36.59	13.50	36.53	13.66	36.47	13.82	39
40	37.59	13.68	37.53	13.84	37.47	14.01	37.41	14.17	40
41	38.53	14.02	38.47	14.19	38.40	14.36	38.34	14.53	41
42	39.47	14.36	39.40	14.54	39.34	14.71	39.28	14.88	42
43	40.41	14.71	40.34	14.88	40.28	15.06	40.21	15.23	43
44	41.35	15.05	41.28	15.23	41.21	15.41	41.15	15.59	44
45	42.29	15.39	42.22	15.58	42.15	15.76	42.08	15.94	45
46	43.23	15.73	43.16	15.92	43.09	16.11	43.02	16.30	46
47	44.17	16.07	44.09	16.27	44.02	16.46	43.95	16.65	47
48	45.11	16.42	45.03	16.61	44.96	16.81	44.89	17.01	48
49	46.04	16.76	45.97	16.96	45.90	17.16	45.82	17.36	49
50	46.98	17.10	46.91	17.31	46.83	17.51	46.76	17.71	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	70 Deg.		69 $\frac{3}{4}$ Deg.		69 $\frac{1}{2}$ Deg.		69 $\frac{1}{4}$ Deg.		

Distance.	20 Deg.		20 $\frac{1}{4}$ Deg.		20 $\frac{1}{2}$ Deg.		20 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	47.92	17.44	47.35	17.65	47.77	17.86	47.69	18.07	51
52	48.86	17.79	48.79	18.00	48.71	18.21	48.63	18.42	52
53	49.80	18.13	49.72	18.34	49.64	18.56	49.56	18.78	53
54	50.74	18.47	50.66	18.69	50.58	18.91	50.50	19.13	54
55	51.68	18.81	51.60	19.04	51.52	19.26	51.43	19.49	55
56	52.62	19.15	52.54	19.38	52.45	19.61	52.37	19.84	56
57	53.56	19.50	53.48	19.73	53.39	19.96	53.30	20.19	57
58	54.50	19.84	54.42	20.07	54.33	20.31	54.24	20.55	58
59	55.44	20.18	55.35	20.42	55.26	20.66	55.17	20.90	59
60	56.38	20.52	56.29	20.77	56.20	21.01	56.11	21.26	60
61	57.32	20.86	57.23	21.11	57.14	21.36	57.04	21.61	61
62	58.26	21.21	58.17	21.46	58.07	21.71	57.98	21.97	62
63	59.20	21.55	59.11	21.81	59.01	22.06	58.91	22.32	63
64	60.14	21.89	60.04	22.15	59.95	22.41	59.85	22.67	64
65	61.08	22.23	60.98	22.50	60.88	22.76	60.78	23.03	65
66	62.02	22.57	61.92	22.84	61.82	23.11	61.72	23.38	66
67	62.96	22.92	62.86	23.19	62.76	23.46	62.65	23.74	67
68	63.90	23.26	63.80	23.54	63.69	23.81	63.59	24.09	68
69	64.84	23.60	64.74	23.88	64.63	24.16	64.52	24.45	69
70	65.78	23.94	65.67	24.23	65.57	24.51	65.46	24.80	70
71	66.72	24.28	66.61	24.57	66.50	24.86	66.39	25.15	71
72	67.66	24.63	67.55	24.92	67.44	25.21	67.33	25.51	72
73	68.60	24.97	68.49	25.27	68.38	25.57	68.26	25.86	73
74	69.54	25.31	69.43	25.61	69.31	25.92	69.20	26.22	74
75	70.48	25.65	70.36	25.96	70.25	26.27	70.14	26.57	75
76	71.42	25.99	71.30	26.30	71.19	26.62	71.07	26.93	76
77	72.36	26.34	72.24	26.65	72.12	26.97	72.01	27.28	77
78	73.30	26.68	73.18	27.00	73.06	27.32	72.94	27.63	78
79	74.24	27.02	74.12	27.34	74.00	27.67	73.88	27.99	79
80	75.18	27.36	75.06	27.69	74.93	28.02	74.81	28.34	80
81	76.12	27.70	75.99	28.04	75.87	28.37	75.75	28.70	81
82	77.05	28.05	76.93	28.38	76.81	28.72	76.68	29.05	82
83	77.99	28.39	77.87	28.73	77.74	29.07	77.62	29.41	83
84	78.93	28.73	78.81	29.07	78.68	29.42	78.55	29.76	84
85	79.87	29.07	79.75	29.42	79.62	29.77	79.49	30.11	85
86	80.81	29.41	80.68	29.77	80.55	30.12	80.42	30.47	86
87	81.75	29.76	81.62	30.11	81.49	30.47	81.36	30.82	87
88	82.69	30.10	82.56	30.46	82.43	30.82	82.29	31.18	88
89	83.63	30.44	83.50	30.80	83.36	31.17	83.23	31.53	89
90	84.57	30.78	84.44	31.15	84.30	31.52	84.16	31.89	90
91	85.51	31.12	85.38	31.50	85.24	31.87	85.10	32.24	91
92	86.45	31.47	86.31	31.84	86.17	32.22	86.03	32.59	92
93	87.39	31.81	87.25	32.19	87.11	32.57	86.97	32.95	93
94	88.33	32.15	88.19	32.54	88.05	32.92	87.90	33.30	94
95	89.27	32.49	89.13	32.88	88.98	33.27	88.84	33.66	95
96	90.21	32.83	90.07	33.23	89.92	33.62	89.77	34.01	96
97	91.15	33.18	91.00	33.57	90.86	33.97	90.71	34.37	97
98	92.09	33.52	91.94	33.92	91.79	34.32	91.64	34.72	98
99	93.03	33.86	92.88	34.27	92.73	34.67	92.58	35.07	99
100	93.97	34.20	93.82	34.61	93.67	35.02	93.51	35.43	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	70 Deg.		69 $\frac{3}{4}$ Deg.		69 $\frac{1}{2}$ Deg.		69 $\frac{1}{4}$ Deg.		

Distance.	21 Deg.		21¼ Deg.		21½ Deg.		21¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.93	0.36	0.93	0.36	0.93	0.37	0.93	0.37	1
2	1.87	0.72	1.86	0.72	1.86	0.73	1.86	0.74	2
3	2.80	1.08	2.80	1.09	2.79	1.10	2.79	1.11	3
4	3.73	1.43	3.73	1.45	3.72	1.47	3.72	1.48	4
5	4.67	1.79	4.66	1.81	4.65	1.83	4.64	1.85	5
6	5.60	2.15	5.59	2.17	5.58	2.20	5.57	2.22	6
7	6.54	2.51	6.52	2.54	6.51	2.57	6.50	2.59	7
8	7.47	2.87	7.46	2.90	7.44	2.93	7.43	2.96	8
9	8.40	3.23	8.39	3.26	8.37	3.30	8.36	3.34	9
10	9.34	3.58	9.32	3.62	9.30	3.67	9.29	3.71	10
11	10.27	3.94	10.25	3.99	10.23	4.03	10.22	4.08	11
12	11.20	4.30	11.18	4.35	11.17	4.40	11.15	4.45	12
13	12.14	4.66	12.12	4.71	12.10	4.76	12.07	4.82	13
14	13.07	5.02	13.05	5.07	13.03	5.13	13.00	5.19	14
15	14.00	5.38	13.98	5.44	13.96	5.50	13.93	5.56	15
16	14.94	5.73	14.91	5.80	14.89	5.86	14.86	5.93	16
17	15.87	6.09	15.84	6.16	15.82	6.23	15.79	6.30	17
18	16.80	6.45	16.78	6.52	16.75	6.60	16.72	6.67	18
19	17.74	6.81	17.71	6.89	17.68	6.96	17.65	7.04	19
20	18.67	7.17	18.64	7.25	18.61	7.33	18.58	7.41	20
21	19.61	7.53	19.57	7.61	19.54	7.70	19.50	7.78	21
22	20.54	7.88	20.50	7.97	20.47	8.06	20.43	8.15	22
23	21.47	8.24	21.44	8.34	21.40	8.43	21.36	8.52	23
24	22.41	8.60	22.37	8.70	22.33	8.80	22.29	8.89	24
25	23.34	8.96	23.30	9.06	23.26	9.16	23.22	9.26	25
26	24.27	9.32	24.23	9.42	24.19	9.53	24.15	9.63	26
27	25.21	9.68	25.16	9.79	25.12	9.90	25.08	10.01	27
28	26.14	10.03	26.10	10.15	26.05	10.26	26.01	10.38	28
29	27.07	10.39	27.03	10.51	26.98	10.63	26.94	10.75	29
30	28.01	10.75	27.96	10.87	27.91	11.00	27.86	11.12	30
31	28.94	11.11	28.89	11.24	28.84	11.36	28.79	11.49	31
32	29.87	11.47	29.82	11.60	29.77	11.73	29.72	11.86	32
33	30.81	11.83	30.76	11.96	30.70	12.09	30.65	12.23	33
34	31.74	12.18	31.69	12.32	31.63	12.46	31.58	12.60	34
35	32.68	12.54	32.62	12.69	32.56	12.83	32.51	12.97	35
36	33.61	12.90	33.55	13.05	33.50	13.19	33.44	13.34	36
37	34.54	13.26	34.48	13.41	34.43	13.56	34.37	13.71	37
38	35.48	13.62	35.42	13.77	35.36	13.93	35.29	14.08	38
39	36.41	13.98	36.35	14.14	36.29	14.29	36.22	14.45	39
40	37.34	14.33	37.28	14.50	37.22	14.66	37.15	14.82	40
41	38.28	14.69	38.21	14.86	38.15	15.03	38.08	15.19	41
42	39.21	15.05	39.14	15.22	39.08	15.39	39.01	15.56	42
43	40.14	15.41	40.08	15.58	40.01	15.76	39.94	15.93	43
44	41.08	15.77	41.01	15.95	40.94	16.13	40.87	16.30	44
45	42.01	16.13	41.94	16.31	41.87	16.49	41.80	16.68	45
46	42.94	16.48	42.87	16.67	42.80	16.86	42.73	17.05	46
47	43.88	16.84	43.80	17.03	43.73	17.23	43.65	17.42	47
48	44.81	17.20	44.74	17.40	44.66	17.59	44.58	17.79	48
49	45.75	17.56	45.67	17.76	45.59	17.96	45.51	18.16	49
50	46.68	17.92	46.60	18.12	46.52	18.33	46.44	18.53	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	69 Deg.		68¾ Deg.		68½ Deg.		68¼ Deg.		

Distance.	21 Deg.		21¼ Deg.		21½ Deg.		21¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	47.61	18.28	47.53	18.48	47.45	18.69	47.37	18.90	51
52	48.55	18.64	48.46	18.85	48.38	19.06	48.30	19.27	52
53	49.48	18.99	49.40	19.21	49.31	19.42	49.23	19.64	53
54	50.41	19.35	50.33	19.57	50.24	19.79	50.16	20.01	54
55	51.35	19.71	51.26	19.93	51.17	20.16	51.08	20.38	55
56	52.28	20.07	52.19	20.30	52.10	20.52	52.01	20.75	56
57	53.21	20.43	53.12	20.66	53.03	20.89	52.94	21.12	57
58	54.15	20.79	54.06	21.02	53.96	21.26	53.87	21.49	58
59	55.08	21.14	54.99	21.38	54.89	21.62	54.80	21.86	59
60	56.01	21.50	55.92	21.75	55.83	21.99	55.73	22.23	60
61	56.95	21.86	56.85	22.11	56.76	22.36	56.66	22.60	61
62	57.88	22.22	57.78	22.47	57.69	22.72	57.59	22.97	62
63	58.82	22.58	58.72	22.83	58.62	23.09	58.52	23.35	63
64	59.75	22.94	59.65	23.20	59.55	23.46	59.44	23.72	64
65	60.68	23.29	60.58	23.56	60.48	23.82	60.37	24.09	65
66	61.62	23.65	61.51	23.92	61.41	24.19	61.30	24.46	66
67	62.55	24.01	62.44	24.28	62.34	24.56	62.23	24.83	67
68	63.48	24.37	63.38	24.65	63.27	24.92	63.16	25.20	68
69	64.42	24.73	64.31	25.01	64.20	25.29	64.09	25.57	69
70	65.35	25.09	65.24	25.37	65.13	25.66	65.02	25.94	70
71	66.28	25.44	66.17	25.73	66.06	26.02	65.95	26.31	71
72	67.22	25.80	67.10	26.10	66.99	26.39	66.87	26.68	72
73	68.15	26.16	68.04	26.46	67.92	26.75	67.80	27.05	73
74	69.08	26.52	68.97	26.82	68.85	27.12	68.73	27.42	74
75	70.02	26.88	69.90	27.18	69.78	27.49	69.66	27.79	75
76	70.95	27.24	70.83	27.55	70.71	27.85	70.59	28.16	76
77	71.89	27.59	71.76	27.91	71.64	28.22	71.52	28.53	77
78	72.82	27.95	72.70	28.27	72.57	28.59	72.45	28.90	78
79	73.75	28.31	73.63	28.63	73.50	28.95	73.38	29.27	79
80	74.69	28.67	74.56	29.00	74.43	29.32	74.30	29.64	80
81	75.62	29.03	75.49	29.36	75.36	29.69	75.23	30.02	81
82	76.55	29.39	76.42	29.72	76.29	30.05	76.16	30.39	82
83	77.49	29.74	77.36	30.08	77.22	30.42	77.09	30.76	83
84	78.42	30.10	78.29	30.44	78.16	30.79	78.02	31.13	84
85	79.35	30.46	79.22	30.81	79.09	31.15	78.95	31.50	85
86	80.29	30.82	80.15	31.17	80.02	31.52	79.88	31.87	86
87	81.22	31.18	81.08	31.53	80.95	31.89	80.81	32.24	87
88	82.16	31.54	82.02	31.89	81.88	32.25	81.74	32.61	88
89	83.09	31.89	82.95	32.26	82.81	32.62	82.66	32.98	89
90	84.02	32.25	83.88	32.62	83.74	32.99	83.59	33.35	90
91	84.96	32.61	84.81	32.98	84.67	33.35	84.52	33.72	91
92	85.89	32.97	85.74	33.34	85.60	33.72	85.45	34.09	92
93	86.82	33.33	86.68	33.71	86.53	34.08	86.38	34.46	93
94	87.76	33.69	87.61	34.07	87.46	34.45	87.31	34.83	94
95	88.69	34.04	88.54	34.43	88.39	34.82	88.24	35.20	95
96	89.62	34.40	89.47	34.79	89.32	35.18	89.17	35.57	96
97	90.56	34.76	90.40	35.16	90.25	35.55	90.09	35.94	97
98	91.49	35.12	91.34	35.52	91.18	35.92	91.02	36.31	98
99	92.42	35.48	92.27	35.88	92.11	36.28	91.95	36.69	99
100	93.36	35.84	93.20	36.24	93.04	36.65	92.88	37.06	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	69 Deg.		68¾ Deg.		68½ Deg.		68¼ Deg.		

Distance.	22 Deg.		22 $\frac{1}{4}$ Deg.		22 $\frac{1}{2}$ Deg.		22 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.93	0.37	0.93	0.33	0.92	0.33	0.92	0.39	1
2	1.85	0.75	1.85	0.76	1.85	0.77	1.84	0.77	2
3	2.78	1.12	2.78	1.14	2.77	1.15	2.77	1.16	3
4	3.71	1.50	3.70	1.51	3.70	1.53	3.69	1.55	4
5	4.64	1.87	4.63	1.89	4.62	1.91	4.61	1.93	5
6	5.56	2.25	5.55	2.27	5.54	2.30	5.53	2.32	6
7	6.49	2.62	6.48	2.65	6.47	2.68	6.46	2.71	7
8	7.42	3.00	7.40	3.03	7.39	3.06	7.38	3.09	8
9	8.34	3.37	8.33	3.41	8.31	3.44	8.30	3.48	9
10	9.27	3.75	9.26	3.79	9.24	3.83	9.22	3.87	10
11	10.20	4.12	10.18	4.17	10.16	4.21	10.14	4.25	11
12	11.13	4.50	11.11	4.54	11.09	4.59	11.07	4.64	12
13	12.05	4.87	12.03	4.92	12.01	4.97	11.99	5.03	13
14	12.98	5.24	12.96	5.30	12.93	5.36	12.91	5.41	14
15	13.91	5.62	13.88	5.68	13.86	5.74	13.83	5.80	15
16	14.83	5.99	14.81	6.06	14.78	6.12	14.76	6.19	16
17	15.76	6.37	15.73	6.44	15.71	6.51	15.68	6.57	17
18	16.69	6.74	16.66	6.82	16.63	6.89	16.60	6.96	18
19	17.62	7.12	17.59	7.19	17.55	7.27	17.52	7.35	19
20	18.54	7.49	18.51	7.57	18.48	7.65	18.44	7.73	20
21	19.47	7.87	19.44	7.95	19.40	8.04	19.37	8.12	21
22	20.40	8.24	20.36	8.33	20.33	8.42	20.29	8.51	22
23	21.33	8.62	21.29	8.71	21.25	8.80	21.21	8.89	23
24	22.25	8.99	22.21	9.09	22.17	9.18	22.13	9.28	24
25	23.18	9.37	23.14	9.47	23.10	9.57	23.05	9.67	25
26	24.11	9.74	24.06	9.84	24.02	9.95	23.98	10.05	26
27	25.03	10.11	24.99	10.22	24.94	10.33	24.90	10.44	27
28	25.96	10.49	25.92	10.60	25.87	10.72	25.82	10.83	28
29	26.89	10.86	26.84	10.93	26.79	11.10	26.74	11.21	29
30	27.82	11.24	27.77	11.33	27.72	11.48	27.67	11.60	30
31	28.74	11.61	28.69	11.74	28.64	11.86	28.59	11.99	31
32	29.67	11.99	29.62	12.12	29.56	12.25	29.51	12.37	32
33	30.60	12.36	30.54	12.50	30.49	12.63	30.43	12.76	33
34	31.52	12.74	31.47	12.87	31.41	13.01	31.35	13.15	34
35	32.45	13.11	32.39	13.25	32.34	13.39	32.28	13.53	35
36	33.38	13.49	33.32	13.63	33.26	13.78	33.20	13.92	36
37	34.31	13.86	34.24	14.01	34.18	14.16	34.12	14.31	37
38	35.23	14.24	35.17	14.39	35.11	14.54	35.04	14.70	38
39	36.16	14.61	36.10	14.77	36.03	14.92	35.97	15.08	39
40	37.09	14.98	37.02	15.15	36.96	15.31	36.89	15.47	40
41	38.01	15.36	37.95	15.52	37.88	15.69	37.81	15.86	41
42	38.94	15.73	38.87	15.90	38.80	16.07	38.73	16.24	42
43	39.87	16.11	39.80	16.28	39.73	16.46	39.65	16.63	43
44	40.80	16.48	40.72	16.66	40.65	16.84	40.58	17.02	44
45	41.72	16.86	41.65	17.04	41.57	17.22	41.50	17.40	45
46	42.65	17.23	42.57	17.42	42.50	17.60	42.42	17.79	46
47	43.58	17.61	43.50	17.80	43.42	17.99	43.34	18.18	47
48	44.50	17.98	44.43	18.18	44.35	18.37	44.27	18.56	48
49	45.43	18.36	45.35	18.55	45.27	18.75	45.19	18.95	49
50	46.36	18.73	46.28	18.93	46.19	19.13	46.11	19.34	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	68 Deg.		67 $\frac{1}{4}$ Deg.		67 $\frac{1}{2}$ Deg.		67 $\frac{3}{4}$ Deg.		

Distance.	22 Deg.		22½ Deg.		22½ Deg.		22¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	47.29	19.10	47.20	19.31	47.12	19.52	47.03	19.72	51
52	48.21	19.48	48.13	19.69	48.04	19.90	47.95	20.11	52
53	49.14	19.85	49.05	20.07	48.97	20.28	48.88	20.50	53
54	50.07	20.23	49.98	20.45	49.89	20.66	49.80	20.88	54
55	51.00	20.60	50.90	20.83	50.81	21.05	50.72	21.27	55
56	51.92	20.98	51.83	21.20	51.74	21.43	51.64	21.66	56
57	52.85	21.35	52.76	21.58	52.66	21.81	52.57	22.04	57
58	53.78	21.73	53.68	21.96	53.59	22.20	53.49	22.43	58
59	54.70	22.10	54.61	22.34	54.51	22.58	54.41	22.82	59
60	55.63	22.48	55.53	22.72	55.43	22.96	55.33	23.20	60
61	56.56	22.85	56.47	23.10	56.36	23.34	56.25	23.59	61
62	57.49	23.23	57.38	23.48	57.28	23.73	57.18	23.98	62
63	58.41	23.60	58.31	23.85	58.20	24.11	58.10	24.36	63
64	59.34	23.97	59.23	24.23	59.13	24.49	59.02	24.75	64
65	60.27	24.35	60.16	24.61	60.05	24.87	59.94	25.14	65
66	61.19	24.72	61.09	24.99	60.98	25.26	60.87	25.52	66
67	62.12	25.10	62.01	25.37	61.90	25.64	61.79	25.91	67
68	63.05	25.47	62.94	25.75	62.82	26.02	62.71	26.30	68
69	63.98	25.85	63.86	26.13	63.75	26.41	63.63	26.68	69
70	64.90	26.22	64.79	26.51	64.67	26.79	64.55	27.07	70
71	65.83	26.60	65.71	26.88	65.60	27.17	65.48	27.46	71
72	66.76	26.97	66.64	27.26	66.52	27.55	66.40	27.84	72
73	67.68	27.35	67.56	27.64	67.44	27.94	67.32	28.23	73
74	68.61	27.72	68.49	28.02	68.37	28.32	68.24	28.62	74
75	69.54	28.10	69.42	28.40	69.29	28.70	69.17	29.00	75
76	70.47	28.47	70.34	28.78	70.21	29.08	70.09	29.39	76
77	71.39	28.84	71.27	29.16	71.14	29.47	71.01	29.78	77
78	72.32	29.22	72.19	29.53	72.06	29.85	71.93	30.16	78
79	73.25	29.59	73.12	29.91	72.99	30.23	72.85	30.55	79
80	74.17	29.97	74.04	30.29	73.91	30.61	73.78	30.94	80
81	75.10	30.34	74.97	30.67	74.83	31.00	74.70	31.32	81
82	76.03	30.72	75.89	31.05	75.76	31.38	75.62	31.71	82
83	76.96	31.09	76.82	31.43	76.68	31.76	76.54	32.10	83
84	77.88	31.47	77.75	31.81	77.61	32.15	77.46	32.48	84
85	78.81	31.84	78.67	32.19	78.53	32.53	78.39	32.87	85
86	79.74	32.22	79.60	32.56	79.45	32.91	79.31	33.26	86
87	80.66	32.59	80.52	32.94	80.38	33.29	80.23	33.64	87
88	81.59	32.97	81.45	33.32	81.30	33.68	81.15	34.03	88
89	82.52	33.34	82.37	33.70	82.23	34.06	82.08	34.42	89
90	83.45	33.71	83.30	34.08	83.15	34.44	83.00	34.80	90
91	84.37	34.09	84.22	34.46	84.07	34.82	83.92	35.19	91
92	85.30	34.46	85.15	34.84	85.00	35.21	84.84	35.58	92
93	86.23	34.84	86.08	35.21	85.92	35.59	85.76	35.96	93
94	87.16	35.21	87.00	35.59	86.84	35.97	86.69	36.35	94
95	88.08	35.59	87.93	35.97	87.77	36.35	87.61	36.74	95
96	89.01	35.96	88.85	36.35	88.69	36.74	88.53	37.12	96
97	89.94	36.34	89.78	36.73	89.62	37.12	89.45	37.51	97
98	90.86	36.71	90.70	37.11	90.54	37.50	90.38	37.90	98
99	91.79	37.09	91.63	37.49	91.46	37.89	91.30	38.28	99
100	92.72	37.46	92.55	37.86	92.39	38.27	92.22	38.67	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	68 Deg.		67¾ Deg.		67½ Deg.		67¼ Deg.		

Distance.	23 Deg.		23 $\frac{1}{4}$ Deg.		23 $\frac{1}{2}$ Deg.		23 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.92	0.39	0.92	0.39	0.92	0.40	0.92	0.40	1
2	1.84	0.78	1.84	0.79	1.83	0.80	1.83	0.81	2
3	2.76	1.17	2.76	1.18	2.75	1.20	2.75	1.21	3
4	3.68	1.56	3.68	1.58	3.67	1.59	3.66	1.61	4
5	4.60	1.95	4.59	1.97	4.59	1.99	4.58	2.01	5
6	5.52	2.34	5.51	2.37	5.50	2.39	5.49	2.42	6
7	6.44	2.74	6.43	2.76	6.42	2.79	6.41	2.82	7
8	7.36	3.13	7.35	3.16	7.34	3.19	7.32	3.22	8
9	8.28	3.52	8.27	3.55	8.25	3.59	8.24	3.62	9
10	9.20	3.91	9.19	3.95	9.17	3.99	9.15	4.03	10
11	10.13	4.30	10.11	4.34	10.09	4.39	10.07	4.43	11
12	11.05	4.69	11.03	4.74	11.00	4.78	10.98	4.83	12
13	11.97	5.08	11.94	5.13	11.92	5.18	11.90	5.24	13
14	12.89	5.47	12.86	5.53	12.84	5.58	12.81	5.64	14
15	13.81	5.86	13.78	5.92	13.76	5.98	13.73	6.04	15
16	14.73	6.25	14.70	6.32	14.67	6.38	14.64	6.44	16
17	15.65	6.64	15.62	6.71	15.59	6.78	15.56	6.85	17
18	16.57	7.03	16.54	7.11	16.51	7.18	16.48	7.25	18
19	17.49	7.42	17.46	7.50	17.42	7.58	17.39	7.65	19
20	18.41	7.81	18.38	7.89	18.34	7.97	18.31	8.05	20
21	19.33	8.21	19.29	8.29	19.26	8.37	19.22	8.46	21
22	20.25	8.60	20.21	8.68	20.18	8.77	20.14	8.86	22
23	21.17	8.99	21.13	9.08	21.09	9.17	21.05	9.26	23
24	22.09	9.38	22.05	9.47	22.01	9.57	21.97	9.67	24
25	23.01	9.77	22.97	9.87	22.93	9.97	22.88	10.07	25
26	23.93	10.16	23.89	10.26	23.84	10.37	23.80	10.47	26
27	24.85	10.55	24.81	10.66	24.76	10.77	24.71	10.87	27
28	25.77	10.94	25.73	11.05	25.68	11.16	25.63	11.28	28
29	26.69	11.33	26.64	11.45	26.59	11.56	26.54	11.68	29
30	27.62	11.72	27.56	11.84	27.51	11.96	27.46	12.08	30
31	28.54	12.11	28.48	12.24	28.43	12.36	28.37	12.49	31
32	29.46	12.50	29.40	12.63	29.35	12.76	29.29	12.89	32
33	30.38	12.89	30.32	13.03	30.26	13.16	30.21	13.29	33
34	31.30	13.28	31.24	13.42	31.18	13.56	31.12	13.69	34
35	32.22	13.68	32.16	13.82	32.10	13.96	32.04	14.10	35
36	33.14	14.07	33.08	14.21	33.01	14.35	32.95	14.50	36
37	34.06	14.46	34.00	14.61	33.93	14.75	33.87	14.90	37
38	34.98	14.85	34.91	15.00	34.85	15.15	34.78	15.30	38
39	35.90	15.24	35.83	15.39	35.77	15.55	35.70	15.71	39
40	36.82	15.63	36.75	15.79	36.68	15.95	36.61	16.11	40
41	37.74	16.02	37.67	16.18	37.60	16.35	37.53	16.51	41
42	38.66	16.41	38.59	16.58	38.52	16.75	38.44	16.92	42
43	39.58	16.80	39.51	16.97	39.43	17.15	39.36	17.32	43
44	40.50	17.19	40.43	17.37	40.35	17.54	40.27	17.72	44
45	41.42	17.58	41.35	17.76	41.27	17.94	41.19	18.12	45
46	42.34	17.97	42.26	18.16	42.18	18.34	42.10	18.53	46
47	43.26	18.36	43.18	18.55	43.10	18.74	43.02	18.93	47
48	44.18	18.76	44.10	18.95	44.02	19.14	43.93	19.33	48
49	45.10	19.15	45.02	19.34	44.94	19.54	44.85	19.73	49
50	46.03	19.54	45.94	19.74	45.85	19.94	45.77	20.14	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	67 Deg		66 $\frac{3}{4}$ Deg.		66 $\frac{1}{2}$ Deg.		66 $\frac{1}{4}$ Deg.		

Distance.	23 Deg.		23 $\frac{1}{4}$ Deg.		23 $\frac{1}{2}$ Deg.		23 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	46.95	19.93	46.86	20.13	46.77	20.34	46.68	20.54	51
52	47.87	20.32	47.78	20.53	47.69	20.73	47.60	20.94	52
53	48.79	20.71	48.70	20.92	48.60	21.13	48.51	21.35	53
54	49.71	21.10	49.61	21.32	49.52	21.53	49.43	21.75	54
55	50.63	21.49	50.53	21.71	50.44	21.93	50.34	22.15	55
56	51.55	21.88	51.45	22.11	51.36	22.33	51.26	22.55	56
57	52.47	22.27	52.37	22.50	52.27	22.73	52.17	22.96	57
58	53.39	22.66	53.29	22.90	53.19	23.13	53.09	23.36	58
59	54.31	23.05	54.21	23.29	54.11	23.53	54.00	23.76	59
60	55.23	23.44	55.13	23.68	55.02	23.92	54.92	24.16	60
61	56.15	23.83	56.05	24.08	55.94	24.32	55.83	24.57	61
62	57.07	24.23	56.97	24.47	56.86	24.72	56.75	24.97	62
63	57.99	24.62	57.88	24.87	57.77	25.12	57.66	25.37	63
64	58.91	25.01	58.80	25.26	58.69	25.52	58.58	25.78	64
65	59.83	25.40	59.72	25.66	59.61	25.92	59.50	26.18	65
66	60.75	25.79	60.64	26.05	60.53	26.32	60.41	26.58	66
67	61.67	26.18	61.56	26.45	61.44	26.72	61.33	26.98	67
68	62.59	26.57	62.48	26.84	62.36	27.11	62.24	27.39	68
69	63.51	26.96	63.40	27.24	63.28	27.51	63.16	27.79	69
70	64.44	27.35	64.32	27.63	64.19	27.91	64.07	28.19	70
71	65.36	27.74	65.23	28.03	65.11	28.31	64.99	28.59	71
72	66.28	28.13	66.15	28.42	66.03	28.71	65.90	29.00	72
73	67.20	28.52	67.07	28.82	66.95	29.11	66.82	29.40	73
74	68.12	28.91	67.99	29.21	67.86	29.51	67.73	29.80	74
75	69.04	29.30	68.91	29.61	68.78	29.91	68.65	30.21	75
76	69.96	29.70	69.83	30.00	69.70	30.30	69.56	30.61	76
77	70.88	30.09	70.75	30.40	70.61	30.70	70.48	31.01	77
78	71.80	30.48	71.67	30.79	71.53	31.10	71.39	31.41	78
79	72.72	30.87	72.58	31.18	72.45	31.50	72.31	31.82	79
80	73.64	31.26	73.50	31.58	73.36	31.90	73.22	32.22	80
81	74.56	31.65	74.42	31.97	74.28	32.30	74.14	32.62	81
82	75.48	32.04	75.34	32.37	75.20	32.70	75.06	33.03	82
83	76.40	32.43	76.26	32.76	76.12	33.10	75.97	33.43	83
84	77.32	32.82	77.18	33.16	77.03	33.49	76.89	33.83	84
85	78.24	33.21	78.10	33.55	77.95	33.89	77.80	34.23	85
86	79.16	33.60	79.02	33.95	78.87	34.29	78.72	34.64	86
87	80.08	33.99	79.93	34.34	79.78	34.69	79.63	35.04	87
88	81.00	34.38	80.85	34.74	80.70	35.09	80.55	35.44	88
89	81.92	34.78	81.77	35.13	81.62	35.49	81.46	35.84	89
90	82.85	35.17	82.69	35.53	82.54	35.89	82.38	36.25	90
91	83.77	35.56	83.61	35.92	83.45	36.29	83.29	36.65	91
92	84.69	35.95	84.53	36.32	84.37	36.68	84.21	37.05	92
93	85.61	36.34	85.45	36.71	85.29	37.08	85.12	37.46	93
94	86.53	36.73	86.37	37.11	86.20	37.48	86.04	37.86	94
95	87.45	37.12	87.29	37.50	87.12	37.88	86.95	38.26	95
96	88.37	37.51	88.20	37.90	88.04	38.28	87.87	38.66	96
97	89.29	37.90	89.12	38.29	88.95	38.68	88.79	39.07	97
98	90.21	38.29	90.04	38.68	89.87	39.08	89.70	39.47	98
99	91.13	38.68	90.96	39.08	90.79	39.48	90.62	39.87	99
100	92.05	39.07	91.88	39.47	91.71	39.87	91.53	40.27	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	67 Deg.		66 $\frac{3}{4}$ Deg.		66 $\frac{1}{2}$ Deg.		66 $\frac{1}{4}$ Deg.		

Distance.	24 Deg.		24 $\frac{1}{4}$ Deg.		24 $\frac{1}{2}$ Deg.		24 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.91	0.41	0.91	0.41	0.91	0.41	0.91	0.42	1
2	1.83	0.81	1.82	0.82	1.82	0.83	1.82	0.84	2
3	2.74	1.22	2.74	1.23	2.73	1.24	2.72	1.26	3
4	3.65	1.63	3.65	1.64	3.64	1.66	3.63	1.67	4
5	4.57	2.03	4.56	2.05	4.55	2.07	4.54	2.09	5
6	5.48	2.44	5.47	2.46	5.46	2.49	5.45	2.51	6
7	6.39	2.85	6.38	2.87	6.37	2.90	6.36	2.93	7
8	7.31	3.25	7.29	3.29	7.28	3.32	7.27	3.35	8
9	8.22	3.66	8.21	3.70	8.19	3.73	8.17	3.77	9
10	9.14	4.07	9.12	4.11	9.10	4.15	9.08	4.19	10
11	10.05	4.47	10.03	4.52	10.01	4.56	9.99	4.61	11
12	10.96	4.88	10.94	4.93	10.92	4.98	10.90	5.02	12
13	11.88	5.29	11.85	5.34	11.83	5.39	11.81	5.44	13
14	12.79	5.69	12.76	5.75	12.74	5.81	12.71	5.86	14
15	13.70	6.10	13.68	6.16	13.65	6.22	13.62	6.28	15
16	14.62	6.51	14.59	6.57	14.56	6.64	14.53	6.70	16
17	15.53	6.92	15.50	6.98	15.47	7.05	15.44	7.12	17
18	16.44	7.32	16.41	7.39	16.38	7.46	16.35	7.54	18
19	17.36	7.73	17.32	7.80	17.29	7.88	17.25	7.95	19
20	18.27	8.13	18.24	8.21	18.20	8.29	18.16	8.37	20
21	19.18	8.54	19.15	8.63	19.11	8.71	19.07	8.79	21
22	20.10	8.95	20.06	9.04	20.02	9.12	19.98	9.21	22
23	21.01	9.35	20.97	9.45	20.93	9.54	20.89	9.63	23
24	21.93	9.76	21.88	9.86	21.84	9.95	21.80	10.05	24
25	22.84	10.17	22.79	10.27	22.75	10.37	22.70	10.47	25
26	23.75	10.58	23.71	10.68	23.66	10.78	23.61	10.89	26
27	24.67	10.98	24.62	11.09	24.57	11.20	24.52	11.30	27
28	25.58	11.39	25.53	11.50	25.48	11.61	25.43	11.72	28
29	26.49	11.80	26.44	11.91	26.39	12.03	26.34	12.14	29
30	27.41	12.20	27.35	12.32	27.30	12.44	27.24	12.56	30
31	28.32	12.61	28.26	12.73	28.21	12.86	28.15	12.98	31
32	29.23	13.02	29.18	13.14	29.12	13.27	29.06	13.40	32
33	30.15	13.42	30.09	13.55	30.03	13.68	29.97	13.82	33
34	31.06	13.83	31.00	13.96	30.94	14.10	30.88	14.23	34
35	31.97	14.24	31.91	14.38	31.85	14.51	31.78	14.65	35
36	32.89	14.64	32.82	14.79	32.76	14.93	32.69	15.07	36
37	33.80	15.05	33.74	15.20	33.67	15.34	33.60	15.49	37
38	34.71	15.46	34.65	15.61	34.58	15.76	34.51	15.91	38
39	35.63	15.86	35.56	16.02	35.49	16.17	35.42	16.33	39
40	36.54	16.27	36.47	16.43	36.40	16.59	36.33	16.75	40
41	37.46	16.68	37.38	16.84	37.31	17.00	37.23	17.16	41
42	38.37	17.08	38.29	17.25	38.22	17.42	38.14	17.58	42
43	39.28	17.49	39.21	17.66	39.13	17.83	39.05	18.00	43
44	40.20	17.90	40.12	18.07	40.04	18.25	39.96	18.42	44
45	41.11	18.30	41.03	18.48	40.95	18.66	40.87	18.84	45
46	42.02	18.71	41.94	18.89	41.86	19.08	41.77	19.26	46
47	42.94	19.12	42.85	19.30	42.77	19.49	42.68	19.68	47
48	43.85	19.52	43.76	19.71	43.68	19.91	43.59	20.10	48
49	44.76	19.93	44.68	20.13	44.59	20.32	44.50	20.51	49
50	45.68	20.34	45.59	20.54	45.50	20.73	45.41	20.93	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	66 Deg.		65 $\frac{3}{4}$ Deg.		65 $\frac{1}{2}$ Deg.		65 $\frac{1}{4}$ Deg.		

Distance.	24 Deg.		24 $\frac{1}{4}$ Deg.		24 $\frac{1}{2}$ Deg.		24 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	46.59	20.74	46.50	20.95	46.41	21.15	46.32	21.35	51
52	47.50	21.15	47.41	21.36	47.32	21.56	47.22	21.77	52
53	48.42	21.56	48.32	21.77	48.23	21.98	48.13	22.19	53
54	49.33	21.96	49.24	22.18	49.14	22.39	49.04	22.61	54
55	50.24	22.37	50.15	22.59	50.05	22.81	49.95	23.03	55
56	51.16	22.78	51.06	23.00	50.96	23.22	50.86	23.44	56
57	52.07	23.18	51.97	23.41	51.87	23.64	51.76	23.86	57
58	52.99	23.59	52.88	23.82	52.78	24.05	52.67	24.28	58
59	53.90	24.00	53.79	24.23	53.69	24.47	53.58	24.70	59
60	54.81	24.40	54.71	24.64	54.60	24.88	54.49	25.12	60
61	55.73	24.81	55.62	25.05	55.51	25.30	55.40	25.54	61
62	56.64	25.22	56.53	25.46	56.42	25.71	56.30	25.96	62
63	57.55	25.62	57.44	25.88	57.33	26.13	57.21	26.38	63
64	58.47	26.03	58.35	26.29	58.24	26.54	58.12	26.79	64
65	59.38	26.44	59.26	26.70	59.15	26.96	59.03	27.21	65
66	60.29	26.84	60.18	27.11	60.06	27.37	59.94	27.63	66
67	61.21	27.25	61.09	27.52	60.97	27.78	60.85	28.05	67
68	62.12	27.66	62.00	27.93	61.88	28.20	61.75	28.47	68
69	63.03	28.06	62.91	28.34	62.79	28.61	62.66	28.89	69
70	63.95	28.47	63.82	28.75	63.70	29.03	63.57	29.31	70
71	64.86	28.88	64.74	29.16	64.61	29.44	64.48	29.72	71
72	65.78	29.28	65.65	29.57	65.52	29.86	65.39	30.14	72
73	66.69	29.69	66.56	29.98	66.43	30.27	66.29	30.56	73
74	67.60	30.10	67.47	30.39	67.34	30.69	67.20	30.98	74
75	68.52	30.51	68.38	30.80	68.25	31.10	68.11	31.40	75
76	69.43	30.91	69.29	31.21	69.16	31.52	69.02	31.82	76
77	70.34	31.32	70.21	31.63	70.07	31.93	69.93	32.24	77
78	71.26	31.73	71.12	32.04	70.98	32.35	70.84	32.66	78
79	72.17	32.13	72.03	32.45	71.89	32.76	71.74	33.07	79
80	73.08	32.54	72.94	32.86	72.80	33.18	72.65	33.49	80
81	74.00	32.95	73.85	33.27	73.71	33.59	73.56	33.91	81
82	74.91	33.35	74.76	33.68	74.62	34.00	74.47	34.33	82
83	75.82	33.76	75.68	34.09	75.53	34.42	75.38	34.75	83
84	76.74	34.17	76.59	34.50	76.44	34.83	76.28	35.17	84
85	77.65	34.57	77.50	34.91	77.35	35.25	77.19	35.59	85
86	78.56	34.98	78.41	35.32	78.26	35.66	78.10	36.00	86
87	79.48	35.39	79.32	35.73	79.17	36.08	79.01	36.42	87
88	80.39	35.79	80.24	36.14	80.08	36.49	79.92	36.84	88
89	81.31	36.20	81.15	36.55	80.99	36.91	80.82	37.26	89
90	82.22	36.61	82.06	36.96	81.90	37.32	81.73	37.68	90
91	83.13	37.01	82.97	37.38	82.81	37.74	82.64	38.10	91
92	84.05	37.42	83.88	37.79	83.72	38.15	83.55	38.52	92
93	84.96	37.83	84.79	38.20	84.63	38.57	84.46	38.94	93
94	85.87	38.23	85.71	38.61	85.54	38.98	85.37	39.35	94
95	86.79	38.64	86.62	39.02	86.45	39.40	86.27	39.77	95
96	87.70	39.05	87.53	39.43	87.36	39.81	87.18	40.19	96
97	88.61	39.45	88.44	39.84	88.27	40.23	88.09	40.61	97
98	89.53	39.86	89.35	40.25	89.18	40.64	89.00	41.03	98
99	90.44	40.27	90.26	40.66	90.09	41.05	89.91	41.45	99
100	91.35	40.67	91.18	41.07	91.00	41.47	90.81	41.87	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	66 Deg.		65 $\frac{3}{4}$ Deg.		65 $\frac{1}{2}$ Deg.		65 $\frac{1}{4}$ Deg.		

Distance.	25 Deg.		25½ Deg.		25¾ Deg.		25¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.91	0.42	0.90	0.43	0.90	0.43	0.90	0.43	1
2	1.81	0.85	1.81	0.85	1.81	0.86	1.80	0.87	2
3	2.72	1.27	2.71	1.28	2.71	1.29	2.70	1.30	3
4	3.63	1.69	3.62	1.71	3.61	1.72	3.60	1.74	4
5	4.53	2.11	4.52	2.13	4.51	2.15	4.50	2.17	5
6	5.44	2.54	5.43	2.56	5.42	2.58	5.40	2.61	6
7	6.34	2.96	6.33	2.99	6.32	3.01	6.30	3.04	7
8	7.25	3.38	7.24	3.41	7.22	3.44	7.21	3.48	8
9	8.16	3.80	8.14	3.84	8.12	3.87	8.11	3.91	9
10	9.06	4.23	9.04	4.27	9.03	4.31	9.01	4.34	10
11	9.97	4.65	9.95	4.69	9.93	4.74	9.91	4.78	11
12	10.88	5.07	10.85	5.12	10.83	5.17	10.81	5.21	12
13	11.78	5.49	11.76	5.55	11.73	5.60	11.71	5.65	13
14	12.69	5.92	12.66	5.97	12.64	6.03	12.61	6.08	14
15	13.59	6.34	13.57	6.40	13.54	6.46	13.51	6.52	15
16	14.50	6.76	14.47	6.83	14.44	6.89	14.41	6.95	16
17	15.41	7.18	15.38	7.25	15.34	7.32	15.31	7.39	17
18	16.31	7.61	16.28	7.68	16.25	7.75	16.21	7.82	18
19	17.22	8.03	17.18	8.10	17.15	8.18	17.11	8.25	19
20	18.13	8.45	18.09	8.53	18.05	8.61	18.01	8.69	20
21	19.03	8.87	18.99	8.96	18.95	9.04	18.91	9.12	21
22	19.94	9.30	19.90	9.38	19.86	9.47	19.82	9.56	22
23	20.85	9.72	20.80	9.81	20.76	9.90	20.72	9.99	23
24	21.75	10.14	21.71	10.24	21.66	10.33	21.62	10.43	24
25	22.66	10.57	22.61	10.66	22.56	10.76	22.52	10.86	25
26	23.56	10.99	23.52	11.09	23.47	11.19	23.42	11.30	26
27	24.47	11.41	24.42	11.52	24.37	11.62	24.32	11.73	27
28	25.38	11.83	25.32	11.94	25.27	12.05	25.22	12.16	28
29	26.28	12.26	26.23	12.37	26.17	12.48	26.12	12.60	29
30	27.19	12.68	27.13	12.80	27.08	12.92	27.02	13.03	30
31	28.10	13.10	28.04	13.22	27.98	13.35	27.92	13.47	31
32	29.00	13.52	28.94	13.65	28.88	13.78	28.82	13.90	32
33	29.91	13.95	29.85	14.08	29.79	14.21	29.72	14.34	33
34	30.81	14.37	30.75	14.50	30.69	14.64	30.62	14.77	34
35	31.72	14.79	31.66	14.93	31.59	15.07	31.52	15.21	35
36	32.63	15.21	32.56	15.36	32.49	15.50	32.43	15.64	36
37	33.53	15.64	33.46	15.78	33.40	15.93	33.33	16.07	37
38	34.44	16.06	34.37	16.21	34.30	16.36	34.23	16.51	38
39	35.35	16.48	35.27	16.64	35.20	16.79	35.13	16.94	39
40	36.25	16.90	36.18	17.06	36.10	17.22	36.03	17.38	40
41	37.16	17.33	37.08	17.49	37.01	17.65	36.93	17.81	41
42	38.06	17.75	37.99	17.92	37.91	18.08	37.83	18.25	42
43	38.97	18.17	38.89	18.34	38.81	18.51	38.73	18.68	43
44	39.88	18.60	39.80	18.77	39.71	18.94	39.63	19.12	44
45	40.78	19.02	40.70	19.20	40.62	19.37	40.53	19.55	45
46	41.69	19.44	41.60	19.62	41.52	19.80	41.43	19.98	46
47	42.60	19.86	42.51	20.05	42.42	20.23	42.33	20.42	47
48	43.50	20.29	43.41	20.48	43.32	20.66	43.23	20.85	48
49	44.41	20.71	44.32	20.90	44.23	21.10	44.13	21.29	49
50	45.32	21.13	45.22	21.33	45.13	21.53	45.03	21.72	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	65 Deg.		64¾ Deg.		64½ Deg.		64¼ Deg.		

Distance.	25 Deg.		25¼ Deg.		25½ Deg.		25¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	46.22	21.55	46.13	21.75	46.03	21.96	45.94	22.16	51
52	47.13	21.98	47.03	22.18	46.93	22.39	46.84	22.59	52
53	48.03	22.40	47.94	22.61	47.84	22.82	47.74	23.03	53
54	48.94	22.82	48.84	23.03	48.74	23.25	48.64	23.46	54
55	49.85	23.24	49.74	23.46	49.64	23.68	49.54	23.89	55
56	50.75	23.67	50.65	23.89	50.54	24.11	50.44	24.33	56
57	51.66	24.09	51.55	24.31	51.45	24.54	51.34	24.76	57
58	52.57	24.51	52.46	24.74	52.35	24.97	52.24	25.20	58
59	53.47	24.93	53.36	25.17	53.25	25.40	53.14	25.63	59
60	54.38	25.36	54.27	25.59	54.16	25.83	54.04	26.07	60
61	55.28	25.78	55.17	26.02	55.06	26.26	54.94	26.50	61
62	56.19	26.20	56.08	26.45	55.96	26.69	55.84	26.94	62
63	57.10	26.62	56.98	26.87	56.86	27.12	56.74	27.37	63
64	58.00	27.05	57.89	27.30	57.77	27.55	57.64	27.80	64
65	58.91	27.47	58.79	27.73	58.67	27.98	58.55	28.24	65
66	59.82	27.89	59.69	28.15	59.57	28.41	59.45	28.67	66
67	60.72	28.32	60.60	28.58	60.47	28.84	60.35	29.11	67
68	61.63	28.74	61.50	29.01	61.38	29.27	61.25	29.54	68
69	62.54	29.16	62.41	29.43	62.28	29.71	62.15	29.98	69
70	63.44	29.58	63.31	29.86	63.18	30.14	63.05	30.41	70
71	64.35	30.01	64.22	30.29	64.08	30.57	63.95	30.85	71
72	65.25	30.43	65.12	30.71	64.99	31.00	64.85	31.28	72
73	66.16	30.85	66.03	31.14	65.89	31.43	65.75	31.71	73
74	67.07	31.27	66.93	31.57	66.79	31.86	66.65	32.15	74
75	67.97	31.70	67.83	31.99	67.69	32.29	67.55	32.58	75
76	68.88	32.12	68.74	32.42	68.60	32.72	68.45	33.02	76
77	69.79	32.54	69.64	32.85	69.50	33.15	69.35	33.45	77
78	70.69	32.96	70.55	33.27	70.40	33.58	70.25	33.89	78
79	71.60	33.39	71.45	33.70	71.30	34.01	71.16	34.32	79
80	72.50	33.81	72.36	34.13	72.21	34.44	72.06	34.76	80
81	73.41	34.23	73.26	34.55	73.11	34.87	72.96	35.19	81
82	74.32	34.65	74.17	34.98	74.01	35.30	73.86	35.62	82
83	75.22	35.08	75.07	35.41	74.91	35.73	74.76	36.06	83
84	76.13	35.50	75.97	35.83	75.82	36.16	75.66	36.49	84
85	77.04	35.92	76.88	36.26	76.72	36.59	76.56	36.93	85
86	77.94	36.35	77.78	36.68	77.62	37.02	77.46	37.36	86
87	78.85	36.77	78.69	37.11	78.52	37.45	78.36	37.80	87
88	79.76	37.19	79.59	37.54	79.43	37.88	79.26	38.23	88
89	80.66	37.61	80.50	37.96	80.33	38.32	80.16	38.67	89
90	81.57	38.04	81.40	38.39	81.23	38.75	81.06	39.10	90
91	82.47	38.46	82.31	38.82	82.14	39.18	81.96	39.53	91
92	83.38	38.88	83.21	39.24	83.04	39.61	82.86	39.97	92
93	84.29	39.30	84.11	39.67	83.94	40.04	83.76	40.40	93
94	85.19	39.73	85.02	40.10	84.84	40.47	84.67	40.84	94
95	86.10	40.15	85.92	40.52	85.75	40.90	85.57	41.27	95
96	87.01	40.57	86.83	40.95	86.65	41.33	86.47	41.71	96
97	87.91	40.99	87.73	41.38	87.55	41.76	87.37	42.14	97
98	88.82	41.42	88.64	41.80	88.45	42.19	88.27	42.58	98
99	89.72	41.84	89.54	42.23	89.36	42.62	89.17	43.01	99
100	90.63	42.26	90.45	42.66	90.26	43.05	90.07	43.44	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	65 Deg.		64¾ Deg.		64½ Deg.		64¼ Deg.		

Distance.	26 Deg.		26 $\frac{1}{4}$ Deg.		26 $\frac{1}{2}$ Deg.		26 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.90	0.44	0.90	0.44	0.89	0.45	0.89	0.45	1
2	1.80	0.88	1.79	0.88	1.79	0.89	1.79	0.90	2
3	2.70	1.32	2.69	1.33	2.68	1.34	2.68	1.35	3
4	3.60	1.75	3.59	1.77	3.58	1.78	3.57	1.80	4
5	4.49	2.19	4.48	2.21	4.47	2.23	4.46	2.25	5
6	5.39	2.63	5.38	2.65	5.37	2.68	5.36	2.70	6
7	6.29	3.07	6.28	3.10	6.26	3.12	6.25	3.15	7
8	7.19	3.51	7.17	3.54	7.16	3.57	7.14	3.60	8
9	8.09	3.95	8.07	3.98	8.05	4.02	8.04	4.05	9
10	8.99	4.38	8.97	4.42	8.95	4.46	8.93	4.50	10
11	9.89	4.82	9.87	4.87	9.84	4.91	9.82	4.95	11
12	10.79	5.26	10.76	5.31	10.74	5.35	10.72	5.40	12
13	11.68	5.70	11.66	5.75	11.63	5.80	11.61	5.85	13
14	12.58	6.14	12.56	6.19	12.53	6.25	12.50	6.30	14
15	13.48	6.58	13.45	6.63	13.42	6.69	13.39	6.75	15
16	14.38	7.01	14.35	7.08	14.32	7.14	14.29	7.20	16
17	15.28	7.45	15.25	7.52	15.21	7.59	15.18	7.65	17
18	16.18	7.89	16.14	7.96	16.11	8.03	16.07	8.10	18
19	17.08	8.33	17.04	8.40	17.00	8.48	16.97	8.55	19
20	17.98	8.77	17.94	8.85	17.90	8.92	17.86	9.00	20
21	18.87	9.21	18.83	9.29	18.79	9.37	18.75	9.45	21
22	19.77	9.64	19.73	9.73	19.69	9.82	19.65	9.90	22
23	20.67	10.08	20.63	10.17	20.58	10.26	20.54	10.35	23
24	21.57	10.52	21.52	10.61	21.48	10.71	21.43	10.80	24
25	22.47	10.96	22.42	11.06	22.37	11.15	22.32	11.25	25
26	23.37	11.40	23.32	11.50	23.27	11.60	23.22	11.70	26
27	24.27	11.84	24.22	11.94	24.16	12.05	24.11	12.15	27
28	25.17	12.27	25.11	12.38	25.06	12.49	25.00	12.60	28
29	26.06	12.71	26.01	12.83	25.95	12.94	25.90	13.05	29
30	26.96	13.15	26.91	13.27	26.85	13.39	26.79	13.50	30
31	27.86	13.59	27.80	13.71	27.74	13.83	27.68	13.95	31
32	28.76	14.03	28.70	14.15	28.64	14.28	28.58	14.40	32
33	29.66	14.47	29.60	14.60	29.53	14.72	29.47	14.85	33
34	30.56	14.90	30.49	15.04	30.43	15.17	30.36	15.30	34
35	31.46	15.34	31.39	15.48	31.32	15.62	31.25	15.75	35
36	32.36	15.78	32.29	15.92	32.22	16.06	32.15	16.20	36
37	33.26	16.22	33.18	16.36	33.11	16.51	33.04	16.65	37
38	34.15	16.66	34.08	16.81	34.01	16.96	33.93	17.10	38
39	35.05	17.10	34.98	17.25	34.90	17.40	34.83	17.55	39
40	35.95	17.53	35.87	17.69	35.80	17.85	35.72	18.00	40
41	36.85	17.97	36.77	18.13	36.69	18.29	36.61	18.45	41
42	37.75	18.41	37.67	18.58	37.59	18.74	37.51	18.90	42
43	38.65	18.85	38.57	19.02	38.48	19.19	38.40	19.35	43
44	39.55	19.29	39.46	19.46	39.38	19.63	39.29	19.80	44
45	40.45	19.73	40.36	19.90	40.27	20.08	40.18	20.25	45
46	41.34	20.17	41.26	20.35	41.17	20.53	41.08	20.70	46
47	42.24	20.60	42.15	20.79	42.06	20.97	41.97	21.15	47
48	43.14	21.04	43.05	21.23	42.96	21.42	42.86	21.60	48
49	44.04	21.48	43.95	21.67	43.85	21.86	43.76	22.05	49
50	44.94	21.92	44.84	22.11	44.75	22.31	44.65	22.50	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	64 Deg.		63 $\frac{3}{4}$ Deg.		63 $\frac{1}{2}$ Deg.		63 $\frac{1}{4}$ Deg.		

Distance.	26 Deg.		26 $\frac{1}{4}$ Deg.		26 $\frac{1}{2}$ Deg.		26 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	45.84	22.36	45.74	22.56	45.64	22.76	45.54	22.96	51
52	46.74	22.80	46.64	23.00	46.54	23.20	46.43	23.41	52
53	47.64	23.23	47.53	23.44	47.43	23.65	47.33	23.86	53
54	48.53	23.67	48.43	23.88	48.33	24.09	48.22	24.31	54
55	49.43	24.11	49.33	24.33	49.22	24.54	49.11	24.76	55
56	50.33	24.55	50.22	24.77	50.12	24.99	50.01	25.21	56
57	51.23	24.99	51.12	25.21	51.01	25.43	50.90	25.66	57
58	52.13	25.43	52.02	25.65	51.91	25.88	51.79	26.11	58
59	53.03	25.86	52.92	26.09	52.80	26.33	52.69	26.56	59
60	53.93	26.30	53.81	26.54	53.70	26.77	53.58	27.01	60
61	54.83	26.74	54.71	26.98	54.59	27.22	54.47	27.46	61
62	55.73	27.18	55.61	27.42	55.49	27.66	55.36	27.91	62
63	56.62	27.62	56.50	27.86	56.38	28.11	56.26	28.36	63
64	57.52	28.06	57.40	28.31	57.28	28.56	57.15	28.81	64
65	58.42	28.49	58.30	28.75	58.17	29.00	58.04	29.26	65
66	59.32	28.93	59.19	29.19	59.07	29.45	58.94	29.71	66
67	60.22	29.37	60.09	29.63	59.96	29.90	59.83	30.16	67
68	61.12	29.81	60.99	30.08	60.86	30.34	60.72	30.61	68
69	62.02	30.25	61.88	30.52	61.75	30.79	61.62	31.06	69
70	62.92	30.69	62.78	30.96	62.65	31.23	62.51	31.51	70
71	63.81	31.12	63.68	31.40	63.54	31.68	63.40	31.96	71
72	64.71	31.56	64.57	31.84	64.44	32.13	64.29	32.41	72
73	65.61	32.00	65.47	32.29	65.33	32.57	65.19	32.86	73
74	66.51	32.44	66.37	32.73	66.23	33.02	66.08	33.31	74
75	67.41	32.88	67.27	33.17	67.12	33.46	66.97	33.76	75
76	68.31	33.32	68.16	33.61	68.01	33.91	67.87	34.21	76
77	69.21	33.75	69.06	34.06	68.91	34.36	68.76	34.66	77
78	70.11	34.19	69.96	34.50	69.80	34.80	69.65	35.11	78
79	71.00	34.63	70.85	34.94	70.70	35.25	70.55	35.56	79
80	71.90	35.07	71.75	35.38	71.59	35.70	71.44	36.01	80
81	72.80	35.51	72.65	35.83	72.49	36.14	72.33	36.46	81
82	73.70	35.95	73.54	36.27	73.38	36.59	73.22	36.91	82
83	74.60	36.38	74.44	36.71	74.28	37.03	74.12	37.36	83
84	75.50	36.82	75.34	37.15	75.17	37.48	75.01	37.81	84
85	76.40	37.26	76.23	37.59	76.07	37.93	75.90	38.26	85
86	77.30	37.70	77.13	38.04	76.96	38.37	76.80	38.71	86
87	78.20	38.14	78.03	38.48	77.86	38.82	77.69	39.16	87
88	79.09	38.58	78.92	38.92	78.75	39.27	78.58	39.61	88
89	79.99	39.01	79.82	39.36	79.65	39.71	79.48	40.06	89
90	80.89	39.45	80.72	39.81	80.54	40.16	80.37	40.51	90
91	81.79	39.89	81.62	40.25	81.44	40.60	81.26	40.96	91
92	82.69	40.33	82.51	40.69	82.33	41.05	82.15	41.41	92
93	83.59	40.77	83.41	41.13	83.23	41.50	83.05	41.86	93
94	84.49	41.21	84.31	41.58	84.12	41.94	83.94	42.31	94
95	85.39	41.65	85.20	42.02	85.02	42.39	84.83	42.76	95
96	86.28	42.08	86.10	42.46	85.91	42.83	85.73	43.21	96
97	87.18	42.52	87.00	42.90	86.81	43.28	86.62	43.66	97
98	88.08	42.96	87.89	43.34	87.70	43.73	87.51	44.11	98
99	88.98	43.40	88.79	43.79	88.60	44.17	88.40	44.56	99
100	89.88	43.84	89.69	44.23	89.49	44.62	89.30	45.01	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	64 Deg.		63 $\frac{3}{4}$ Deg.		63 $\frac{1}{2}$ Deg.		63 $\frac{1}{4}$ Deg.		

Distance.	27 Deg.		27 $\frac{1}{4}$ Deg.		27 $\frac{1}{2}$ Deg.		27 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.89	0.45	0.89	0.46	0.89	0.46	0.88	0.47	1
2	1.78	0.91	1.78	0.92	1.77	0.92	1.77	0.93	2
3	2.67	1.36	2.67	1.37	2.66	1.39	2.65	1.40	3
4	3.56	1.82	3.56	1.83	3.55	1.85	3.54	1.86	4
5	4.45	2.27	4.45	2.29	4.44	2.31	4.42	2.33	5
6	5.35	2.72	5.33	2.75	5.32	2.77	5.31	2.79	6
7	6.24	3.18	6.22	3.21	6.21	3.23	6.19	3.26	7
8	7.13	3.63	7.11	3.66	7.10	3.69	7.08	3.72	8
9	8.02	4.09	8.00	4.12	7.98	4.16	7.96	4.19	9
10	8.91	4.54	8.89	4.58	8.87	4.62	8.85	4.66	10
11	9.80	4.99	9.78	5.04	9.76	5.08	9.73	5.12	11
12	10.69	5.45	10.67	5.49	10.64	5.54	10.62	5.59	12
13	11.58	5.90	11.56	5.95	11.53	6.00	11.50	6.05	13
14	12.47	6.36	12.45	6.41	12.42	6.46	12.39	6.52	14
15	13.37	6.81	13.34	6.87	13.31	6.93	13.27	6.98	15
16	14.26	7.26	14.22	7.33	14.19	7.39	14.16	7.45	16
17	15.15	7.72	15.11	7.78	15.08	7.85	15.04	7.92	17
18	16.04	8.17	16.00	8.24	15.97	8.31	15.93	8.38	18
19	16.93	8.63	16.89	8.70	16.85	8.77	16.81	8.85	19
20	17.82	9.08	17.78	9.16	17.74	9.23	17.70	9.31	20
21	18.71	9.53	18.67	9.62	18.63	9.70	18.58	9.78	21
22	19.60	9.99	19.56	10.07	19.51	10.16	19.47	10.24	22
23	20.49	10.44	20.45	10.53	20.40	10.62	20.35	10.71	23
24	21.38	10.90	21.34	10.99	21.29	11.08	21.24	11.17	24
25	22.28	11.35	22.23	11.45	22.18	11.54	22.12	11.64	25
26	23.17	11.80	23.11	11.90	23.06	12.01	23.01	12.11	26
27	24.06	12.26	24.00	12.36	23.95	12.47	23.89	12.57	27
28	24.95	12.71	24.89	12.82	24.84	12.93	24.78	13.04	28
29	25.84	13.17	25.78	13.28	25.72	13.39	25.66	13.50	29
30	26.73	13.62	26.67	13.74	26.61	13.85	26.55	13.97	30
31	27.62	14.07	27.56	14.19	27.50	14.31	27.43	14.43	31
32	28.51	14.53	28.45	14.65	28.38	14.78	28.32	14.90	32
33	29.40	14.98	29.34	15.11	29.27	15.24	29.20	15.37	33
34	30.29	15.44	30.23	15.57	30.16	15.70	30.09	15.83	34
35	31.19	15.89	31.12	16.03	31.05	16.16	30.97	16.30	35
36	32.08	16.34	32.00	16.48	31.93	16.62	31.86	16.76	36
37	32.97	16.80	32.89	16.94	32.82	17.08	32.74	17.23	37
38	33.86	17.25	33.78	17.40	33.71	17.55	33.63	17.69	38
39	34.75	17.71	34.67	17.86	34.59	18.01	34.51	18.16	39
40	35.64	18.16	35.56	18.31	35.48	18.47	35.40	18.62	40
41	36.53	18.61	36.45	18.77	36.37	18.93	36.28	19.09	41
42	37.42	19.07	37.34	19.23	37.25	19.39	37.17	19.56	42
43	38.31	19.52	38.23	19.69	38.14	19.86	38.05	20.02	43
44	39.20	19.98	39.12	20.15	39.03	20.32	38.94	20.49	44
45	40.10	20.43	40.01	20.60	39.92	20.78	39.82	20.95	45
46	40.99	20.88	40.89	21.06	40.80	21.24	40.71	21.42	46
47	41.88	21.34	41.78	21.52	41.69	21.70	41.59	21.88	47
48	42.77	21.79	42.67	21.98	42.58	22.16	42.48	22.35	48
49	43.66	22.25	43.56	22.44	43.46	22.63	43.36	22.82	49
50	44.55	22.70	44.45	22.89	44.35	23.09	44.25	23.28	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	63 Deg.		62 $\frac{3}{4}$ Deg.		62 $\frac{1}{2}$ Deg.		62 $\frac{1}{4}$ Deg.		

Distance.	27 Deg.		27¼ Deg.		27½ Deg.		27¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	45.44	23.15	45.34	23.35	45.24	23.55	45.13	23.75	51
52	46.33	23.61	46.23	23.81	46.12	24.01	46.02	24.21	52
53	47.22	24.06	47.12	24.27	47.01	24.47	46.90	24.68	53
54	48.11	24.52	48.01	24.73	47.90	24.93	47.79	25.14	54
55	49.01	24.97	48.90	25.18	48.79	25.40	48.67	25.61	55
56	49.90	25.42	49.78	25.64	49.67	25.86	49.56	26.07	56
57	50.79	25.88	50.67	26.10	50.56	26.32	50.44	26.54	57
58	51.68	26.33	51.56	26.56	51.45	26.78	51.33	27.01	58
59	52.57	26.79	52.45	27.01	52.33	27.24	52.21	27.47	59
60	53.46	27.24	53.34	27.47	53.22	27.70	53.10	27.94	60
61	54.35	27.69	54.23	27.93	54.11	28.17	53.98	28.40	61
62	55.24	28.15	55.12	28.39	54.99	28.63	54.87	28.87	62
63	56.13	28.60	56.01	28.85	55.88	29.09	55.75	29.33	63
64	57.02	29.06	56.90	29.30	56.77	29.55	56.64	29.80	64
65	57.92	29.51	57.79	29.76	57.66	30.01	57.52	30.26	65
66	58.81	29.96	58.68	30.22	58.54	30.48	58.41	30.73	66
67	59.70	30.42	59.56	30.68	59.43	30.94	59.29	31.20	67
68	60.59	30.87	60.45	31.14	60.32	31.40	60.18	31.66	68
69	61.48	31.33	61.34	31.59	61.20	31.86	61.06	32.13	69
70	62.37	31.78	62.23	32.05	62.09	32.32	61.95	32.59	70
71	63.26	32.23	63.12	32.51	62.98	32.78	62.83	33.06	71
72	64.15	32.69	64.01	32.97	63.86	33.25	63.72	33.52	72
73	65.04	33.14	64.90	33.42	64.75	33.71	64.60	33.99	73
74	65.93	33.60	65.79	33.88	65.64	34.17	65.49	34.46	74
75	66.83	34.05	66.68	34.34	66.53	34.63	66.37	34.92	75
76	67.72	34.50	67.57	34.80	67.41	35.09	67.26	35.39	76
77	68.61	34.96	68.45	35.26	68.30	35.55	68.14	35.85	77
78	69.50	35.41	69.34	35.71	69.19	36.02	69.03	36.32	78
79	70.39	35.87	70.23	36.17	70.07	36.48	69.91	36.78	79
80	71.28	36.32	71.12	36.63	70.96	36.94	70.80	37.25	80
81	72.17	36.77	72.01	37.09	71.85	37.40	71.68	37.71	81
82	73.06	37.23	72.90	37.55	72.73	37.86	72.57	38.18	82
83	73.95	37.68	73.79	38.00	73.62	38.33	73.45	38.65	83
84	74.84	38.14	74.68	38.46	74.51	38.79	74.34	39.11	84
85	75.74	38.59	75.57	38.92	75.40	39.25	75.22	39.58	85
86	76.63	39.04	76.46	39.38	76.28	39.71	76.11	40.04	86
87	77.52	39.50	77.34	39.83	77.17	40.17	76.99	40.51	87
88	78.41	39.95	78.23	40.29	78.06	40.63	77.88	40.97	88
89	79.30	40.41	79.12	40.75	78.94	41.10	78.76	41.44	89
90	80.19	40.86	80.01	41.21	79.83	41.56	79.65	41.91	90
91	81.08	41.31	80.90	41.67	80.72	42.02	80.53	42.37	91
92	81.97	41.77	81.79	42.12	81.60	42.48	81.42	42.84	92
93	82.86	42.22	82.68	42.58	82.49	42.94	82.30	43.30	93
94	83.75	42.68	83.57	43.04	83.38	43.40	83.19	43.77	94
95	84.65	43.13	84.46	43.50	84.27	43.87	84.07	44.23	95
96	85.54	43.58	85.35	43.96	85.15	44.33	84.96	44.70	96
97	86.43	44.04	86.23	44.41	86.04	44.79	85.84	45.16	97
98	87.32	44.49	87.12	44.87	86.93	45.25	86.73	45.63	98
99	88.21	44.95	88.01	45.33	87.81	45.71	87.61	46.10	99
100	89.10	45.40	88.90	45.79	88.70	46.17	88.50	46.56	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	63 Deg.		62¾ Deg.		62½ Deg.		62¼ Deg.		

Distance.	28 Deg.		28 $\frac{1}{4}$ Deg.		28 $\frac{1}{2}$ Deg.		28 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.88	0.47	0.88	0.47	0.88	0.48	0.88	0.48	1
2	1.77	0.94	1.76	0.95	1.76	0.95	1.75	0.96	2
3	2.65	1.41	2.64	1.42	2.64	1.43	2.63	1.44	3
4	3.53	1.88	3.52	1.89	3.52	1.91	3.51	1.92	4
5	4.41	2.35	4.40	2.37	4.39	2.39	4.38	2.40	5
6	5.30	2.82	5.29	2.84	5.27	2.86	5.26	2.89	6
7	6.18	3.29	6.17	3.31	6.15	3.34	6.14	3.37	7
8	7.06	3.76	7.05	3.79	7.03	3.82	7.01	3.85	8
9	7.95	4.23	7.93	4.26	7.91	4.29	7.89	4.33	9
10	8.83	4.69	8.81	4.73	8.79	4.77	8.77	4.81	10
11	9.71	5.16	9.69	5.21	9.67	5.25	9.64	5.29	11
12	10.60	5.63	10.57	5.68	10.55	5.73	10.52	5.77	12
13	11.48	6.10	11.45	6.15	11.42	6.20	11.40	6.25	13
14	12.36	6.57	12.33	6.63	12.30	6.68	12.27	6.73	14
15	13.24	7.04	13.21	7.10	13.18	7.16	13.15	7.21	15
16	14.13	7.51	14.09	7.57	14.06	7.63	14.03	7.70	16
17	15.01	7.98	14.98	8.05	14.94	8.11	14.90	8.18	17
18	15.89	8.45	15.86	8.52	15.82	8.59	15.78	8.66	18
19	16.78	8.92	16.74	8.99	16.70	9.07	16.66	9.14	19
20	17.66	9.39	17.62	9.47	17.58	9.54	17.53	9.62	20
21	18.54	9.86	18.50	9.94	18.46	10.02	18.41	10.10	21
22	19.42	10.33	19.38	10.41	19.33	10.50	19.29	10.58	22
23	20.31	10.80	20.26	10.89	20.21	10.97	20.16	11.06	23
24	21.19	11.27	21.14	11.36	21.09	11.45	21.04	11.54	24
25	22.07	11.74	22.02	11.83	21.97	11.93	21.92	12.02	25
26	22.96	12.21	22.90	12.31	22.85	12.41	22.79	12.51	26
27	23.84	12.68	23.78	12.78	23.73	12.88	23.67	12.99	27
28	24.72	13.15	24.66	13.25	24.61	13.36	24.55	13.47	28
29	25.61	13.61	25.55	13.73	25.49	13.84	25.43	13.95	29
30	26.49	14.08	26.43	14.20	26.36	14.31	26.30	14.43	30
31	27.37	14.55	27.31	14.67	27.24	14.79	27.18	14.91	31
32	28.25	15.02	28.19	15.15	28.12	15.27	28.06	15.39	32
33	29.14	15.49	29.07	15.62	29.00	15.75	28.93	15.87	33
34	30.02	15.96	29.95	16.09	29.88	16.22	29.81	16.35	34
35	30.90	16.43	30.83	16.57	30.76	16.70	30.69	16.83	35
36	31.79	16.90	31.71	17.04	31.64	17.18	31.56	17.32	36
37	32.67	17.37	32.59	17.51	32.52	17.65	32.44	17.80	37
38	33.55	17.84	33.47	17.99	33.39	18.13	33.32	18.28	38
39	34.43	18.31	34.35	18.46	34.27	18.61	34.19	18.76	39
40	35.32	18.78	35.24	18.93	35.15	19.09	35.07	19.24	40
41	36.20	19.25	36.12	19.41	36.03	19.56	35.95	19.72	41
42	37.08	19.72	37.00	19.88	36.91	20.04	36.82	20.20	42
43	37.97	20.19	37.88	20.35	37.79	20.52	37.70	20.68	43
44	38.85	20.66	38.76	20.83	38.67	20.99	38.58	21.16	44
45	39.73	21.13	39.64	21.30	39.55	21.47	39.45	21.64	45
46	40.62	21.60	40.52	21.77	40.43	21.95	40.33	22.13	46
47	41.50	22.07	41.40	22.25	41.30	22.43	41.21	22.61	47
48	42.38	22.53	42.28	22.72	42.18	22.90	42.08	23.09	48
49	43.26	23.00	43.16	23.19	43.06	23.38	42.96	23.57	49
50	44.15	23.47	44.04	23.67	43.94	23.86	43.84	24.05	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	62 Deg.		61 $\frac{3}{4}$ Deg.		61 $\frac{1}{2}$ Deg.		61 $\frac{1}{4}$ Deg.		

Distance.	28 Deg.		28½ Deg.		28¾ Deg.		28¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	45.03	23.94	44.93	24.14	44.82	24.34	44.71	24.53	51
52	45.91	24.41	45.81	24.61	45.70	24.81	45.59	25.01	52
53	46.80	24.88	46.69	25.09	46.58	25.29	46.47	25.49	53
54	47.68	25.35	47.57	25.56	47.46	25.77	47.34	25.97	54
55	48.56	25.82	48.45	26.03	48.33	26.24	48.22	26.45	55
56	49.45	26.29	49.33	26.51	49.21	26.72	49.10	26.94	56
57	50.33	26.76	50.21	26.98	50.09	27.20	49.97	27.42	57
58	51.21	27.23	51.09	27.45	50.97	27.68	50.85	27.90	58
59	52.09	27.70	51.97	27.93	51.85	28.15	51.73	28.38	59
60	52.98	28.17	52.85	28.40	52.73	28.63	52.60	28.86	60
61	53.86	28.64	53.73	28.87	53.61	29.11	53.48	29.34	61
62	54.74	29.11	54.62	29.35	54.49	29.58	54.36	29.82	62
63	55.63	29.58	55.50	29.82	55.37	30.06	55.23	30.30	63
64	56.51	30.05	56.38	30.29	56.24	30.54	56.11	30.78	64
65	57.39	30.52	57.26	30.77	57.12	31.02	56.99	31.26	65
66	58.27	30.99	58.14	31.24	58.00	31.49	57.86	31.75	66
67	59.16	31.45	59.02	31.71	58.88	31.97	58.74	32.23	67
68	60.04	31.92	59.90	32.19	59.76	32.45	59.62	32.71	68
69	60.92	32.39	60.78	32.66	60.64	32.92	60.49	33.19	69
70	61.81	32.86	61.66	33.13	61.52	33.40	61.37	33.67	70
71	62.69	33.33	62.54	33.61	62.40	33.88	62.25	34.15	71
72	63.57	33.80	63.42	34.08	63.27	34.36	63.12	34.63	72
73	64.46	34.27	64.30	34.55	64.15	34.83	64.00	35.11	73
74	65.34	34.74	65.19	35.03	65.03	35.31	64.88	35.59	74
75	66.22	35.21	66.07	35.50	65.91	35.79	65.75	36.07	75
76	67.10	35.68	66.95	35.97	66.79	36.26	66.63	36.56	76
77	67.99	36.15	67.83	36.45	67.67	36.74	67.51	37.04	77
78	68.87	36.62	68.71	36.92	68.55	37.22	68.38	37.52	78
79	69.75	37.09	69.59	37.39	69.43	37.70	69.26	38.00	79
80	70.64	37.56	70.47	37.87	70.31	38.17	70.14	38.48	80
81	71.52	38.03	71.35	38.34	71.18	38.65	71.01	38.96	81
82	72.40	38.50	72.23	38.81	72.06	39.13	71.89	39.44	82
83	73.28	38.97	73.11	39.29	72.94	39.60	72.77	39.92	83
84	74.17	39.44	73.99	39.76	73.82	40.08	73.64	40.40	84
85	75.05	39.91	74.88	40.23	74.70	40.56	74.52	40.88	85
86	75.93	40.37	75.76	40.71	75.58	41.04	75.40	41.36	86
87	76.82	40.84	76.64	41.18	76.46	41.51	76.28	41.85	87
88	77.70	41.31	77.52	41.65	77.34	41.99	77.15	42.33	88
89	78.58	41.78	78.40	42.13	78.21	42.47	78.03	42.81	89
90	79.47	42.25	79.28	42.60	79.09	42.94	78.91	43.29	90
91	80.35	42.72	80.16	43.07	79.97	43.42	79.78	43.77	91
92	81.23	43.19	81.04	43.55	80.85	43.90	80.66	44.25	92
93	82.11	43.66	81.92	44.02	81.73	44.38	81.54	44.73	93
94	83.00	44.13	82.80	44.49	82.61	44.85	82.41	45.21	94
95	83.88	44.60	83.68	44.97	83.49	45.33	83.29	45.69	95
96	84.76	45.07	84.57	45.44	84.37	45.81	84.17	46.17	96
97	85.65	45.54	85.45	45.91	85.25	46.28	85.04	46.66	97
98	86.53	46.01	86.33	46.39	86.12	46.76	85.92	47.14	98
99	87.41	46.48	87.21	46.86	87.00	47.24	86.80	47.62	99
100	88.29	46.95	88.09	47.33	87.88	47.72	87.67	48.10	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	62 Deg.		61½ Deg.		61½ Deg.		61½ Deg.		

Distance.	29 Deg.		29 $\frac{1}{4}$ Deg.		29 $\frac{1}{2}$ Deg.		29 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.87	0.48	0.87	0.49	0.87	0.49	0.87	0.50	1
2	1.75	0.97	1.74	0.98	1.74	0.98	1.74	0.99	2
3	2.62	1.45	2.62	1.47	2.61	1.48	2.60	1.49	3
4	3.50	1.94	3.49	1.95	3.48	1.97	3.47	1.98	4
5	4.37	2.42	4.36	2.44	4.35	2.46	4.34	2.48	5
6	5.25	2.91	5.23	2.93	5.22	2.95	5.21	2.98	6
7	6.12	3.39	6.11	3.42	6.09	3.45	6.08	3.47	7
8	7.00	3.88	6.98	3.91	6.96	3.94	6.95	3.97	8
9	7.87	4.36	7.85	4.40	7.83	4.43	7.81	4.47	9
10	8.75	4.85	8.72	4.89	8.70	4.92	8.68	4.96	10
11	9.62	5.33	9.60	5.37	9.57	5.42	9.55	5.46	11
12	10.50	5.82	10.47	5.86	10.44	5.91	10.42	5.95	12
13	11.37	6.30	11.34	6.35	11.31	6.40	11.29	6.45	13
14	12.24	6.79	12.21	6.84	12.18	6.89	12.15	6.95	14
15	13.12	7.27	13.09	7.33	13.06	7.39	13.02	7.44	15
16	13.99	7.76	13.96	7.82	13.93	7.88	13.89	7.94	16
17	14.87	8.24	14.83	8.31	14.80	8.37	14.76	8.44	17
18	15.74	8.73	15.70	8.80	15.67	8.86	15.63	8.93	18
19	16.62	9.21	16.58	9.28	16.54	9.36	16.50	9.43	19
20	17.49	9.70	17.45	9.77	17.41	9.85	17.36	9.92	20
21	18.37	10.18	18.32	10.26	18.28	10.34	18.23	10.42	21
22	19.24	10.67	19.19	10.75	19.15	10.83	19.10	10.92	22
23	20.12	11.15	20.07	11.24	20.02	11.33	19.97	11.41	23
24	20.99	11.64	20.94	11.73	20.89	11.82	20.84	11.91	24
25	21.87	12.12	21.81	12.22	21.76	12.31	21.70	12.41	25
26	22.74	12.60	22.68	12.70	22.63	12.80	22.57	12.90	26
27	23.61	13.09	23.56	13.19	23.50	13.30	23.44	13.40	27
28	24.49	13.57	24.43	13.68	24.37	13.79	24.31	13.89	28
29	25.36	14.06	25.30	14.17	25.24	14.28	25.18	14.39	29
30	26.24	14.54	26.17	14.66	26.11	14.77	26.05	14.89	30
31	27.11	15.03	27.05	15.15	26.98	15.27	26.91	15.38	31
32	27.99	15.51	27.92	15.64	27.85	15.76	27.78	15.88	32
33	28.86	16.00	28.79	16.12	28.72	16.25	28.65	16.38	33
34	29.74	16.48	29.66	16.61	29.59	16.74	29.52	16.87	34
35	30.61	16.97	30.54	17.10	30.46	17.23	30.39	17.37	35
36	31.49	17.45	31.41	17.59	31.33	17.73	31.26	17.86	36
37	32.36	17.94	32.28	18.08	32.20	18.22	32.12	18.36	37
38	33.24	18.42	33.15	18.57	33.07	18.71	32.99	18.86	38
39	34.11	18.91	34.03	19.06	33.94	19.20	33.86	19.35	39
40	34.98	19.39	34.90	19.54	34.81	19.70	34.73	19.85	40
41	35.86	19.88	35.77	20.03	35.68	20.19	35.60	20.34	41
42	36.73	20.36	36.64	20.52	36.55	20.68	36.46	20.84	42
43	37.61	20.85	37.52	21.01	37.43	21.17	37.33	21.34	43
44	38.48	21.33	38.39	21.50	38.30	21.67	38.20	21.83	44
45	39.36	21.82	39.26	21.99	39.17	22.16	39.07	22.33	45
46	40.23	22.30	40.13	22.48	40.04	22.65	39.94	22.83	46
47	41.11	22.79	41.01	22.97	40.91	23.14	40.81	23.32	47
48	41.98	23.27	41.88	23.45	41.78	23.63	41.67	23.82	48
49	42.86	23.76	42.75	23.94	42.65	24.13	42.54	24.31	49
50	43.73	24.24	43.62	24.43	43.52	24.62	43.41	24.81	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	61 Deg.		60 $\frac{3}{4}$ Deg.		60 $\frac{1}{2}$ Deg.		60 $\frac{1}{4}$ Deg.		

Distance.	29 Deg.		29 $\frac{1}{4}$ Deg.		29 $\frac{1}{2}$ Deg.		29 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	44.61	24.73	44.50	24.92	44.39	25.11	44.28	25.31	51
52	45.48	25.21	45.37	25.41	45.26	25.61	45.15	25.80	52
53	46.35	25.69	46.24	25.90	46.13	26.10	46.01	26.30	53
54	47.23	26.18	47.11	26.39	47.00	26.59	46.88	26.80	54
55	48.10	26.66	47.99	26.87	47.87	27.08	47.75	27.29	55
56	48.98	27.15	48.86	27.36	48.74	27.58	48.62	27.79	56
57	49.85	27.63	49.73	27.85	49.61	28.07	49.49	28.28	57
58	50.73	28.12	50.60	28.34	50.48	28.56	50.36	28.78	58
59	51.60	28.60	51.48	28.83	51.35	29.05	51.22	29.28	59
60	52.48	29.09	52.35	29.32	52.22	29.55	52.09	29.77	60
61	53.35	29.57	53.22	29.81	53.09	30.04	52.96	30.27	61
62	54.23	30.06	54.09	30.29	53.96	30.53	53.83	30.77	62
63	55.10	30.54	54.97	30.78	54.83	31.02	54.70	31.26	63
64	55.98	31.03	55.84	31.27	55.70	31.52	55.56	31.76	64
65	56.85	31.51	56.71	31.76	56.57	32.01	56.43	32.25	65
66	57.72	32.00	57.58	32.25	57.44	32.50	57.30	32.75	66
67	58.60	32.48	58.46	32.74	58.31	32.99	58.17	33.25	67
68	59.47	32.97	59.33	33.23	59.18	33.48	59.04	33.74	68
69	60.35	33.45	60.20	33.71	60.05	33.98	59.91	34.24	69
70	61.22	33.94	61.07	34.20	60.92	34.47	60.77	34.74	70
71	62.10	34.42	61.95	34.69	61.80	34.96	61.64	35.23	71
72	62.97	34.91	62.82	35.18	62.67	35.45	62.51	35.73	72
73	63.85	35.39	63.69	35.67	63.54	35.95	63.38	36.22	73
74	64.72	35.88	64.56	36.16	64.41	36.44	64.25	36.72	74
75	65.60	36.36	65.44	36.65	65.28	36.93	65.11	37.22	75
76	66.47	36.85	66.31	37.14	66.15	37.42	65.98	37.71	76
77	67.35	37.33	67.18	37.62	67.02	37.92	66.85	38.21	77
78	68.22	37.82	68.05	38.11	67.89	38.41	67.72	38.70	78
79	69.09	38.30	68.93	38.60	68.76	38.90	68.59	39.20	79
80	69.97	38.78	69.80	39.09	69.63	39.39	69.46	39.70	80
81	70.84	39.27	70.67	39.58	70.50	39.89	70.32	40.19	81
82	71.72	39.75	71.54	40.07	71.37	40.38	71.19	40.69	82
83	72.59	40.24	72.42	40.56	72.24	40.87	72.06	41.19	83
84	73.47	40.72	73.29	41.04	73.11	41.36	72.93	41.68	84
85	74.34	41.21	74.16	41.53	73.98	41.86	73.80	42.18	85
86	75.22	41.69	75.03	42.02	74.85	42.35	74.67	42.67	86
87	76.09	42.18	75.91	42.51	75.72	42.84	75.53	43.17	87
88	76.97	42.65	76.78	43.00	76.59	43.33	76.40	43.67	88
89	77.84	43.15	77.65	43.49	77.46	43.83	77.27	44.16	89
90	78.72	43.63	78.52	43.98	78.33	44.32	78.14	44.66	90
91	79.59	44.12	79.40	44.46	79.20	44.81	79.01	45.16	91
92	80.46	44.60	80.27	44.95	80.07	45.30	79.87	45.65	92
93	81.34	45.09	81.14	45.44	80.94	45.80	80.74	46.15	93
94	82.21	45.57	82.01	45.93	81.81	46.29	81.61	46.64	94
95	83.09	46.06	82.89	46.42	82.68	46.78	82.48	47.14	95
96	83.96	46.54	83.76	46.91	83.55	47.27	83.35	47.64	96
97	84.84	47.03	84.63	47.40	84.42	47.77	84.22	48.13	97
98	85.71	47.51	85.50	47.88	85.29	48.26	85.08	48.63	98
99	86.59	48.00	86.38	48.37	86.17	48.75	85.95	49.13	99
100	87.46	48.48	87.25	48.86	87.04	49.24	86.82	49.62	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	61 Deg.		60 $\frac{3}{4}$ Deg.		60 $\frac{1}{2}$ Deg.		60 $\frac{1}{4}$ Deg.		

Distance.	30 Deg.		30 $\frac{1}{4}$ Deg.		30 $\frac{1}{2}$ Deg.		30 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.87	0.50	0.86	0.50	0.86	0.51	0.86	0.51	1
2	1.73	1.00	1.73	1.01	1.72	1.02	1.72	1.02	2
3	2.60	1.50	2.59	1.51	2.58	1.52	2.58	1.53	3
4	3.46	2.00	3.46	2.02	3.45	2.03	3.44	2.05	4
5	4.33	2.50	4.32	2.52	4.31	2.54	4.30	2.56	5
6	5.20	3.00	5.18	3.02	5.17	3.05	5.16	3.07	6
7	6.06	3.50	6.05	3.53	6.03	3.55	6.02	3.58	7
8	6.93	4.00	6.91	4.03	6.89	4.06	6.88	4.09	8
9	7.79	4.50	7.77	4.53	7.75	4.57	7.73	4.60	9
10	8.66	5.00	8.64	5.04	8.62	5.08	8.59	5.11	10
11	9.53	5.50	9.50	5.54	9.48	5.58	9.45	5.62	11
12	10.39	6.00	10.37	6.05	10.34	6.09	10.31	6.14	12
13	11.26	6.50	11.23	6.55	11.20	6.60	11.17	6.65	13
14	12.12	7.00	12.09	7.05	12.06	7.11	12.03	7.16	14
15	12.99	7.50	12.96	7.56	12.92	7.61	12.89	7.67	15
16	13.86	8.00	13.82	8.06	13.79	8.12	13.75	8.18	16
17	14.72	8.50	14.69	8.56	14.65	8.63	14.61	8.69	17
18	15.59	9.00	15.55	9.07	15.51	9.14	15.47	9.20	18
19	16.45	9.50	16.41	9.57	16.37	9.64	16.33	9.71	19
20	17.32	10.00	17.28	10.08	17.23	10.15	17.19	10.23	20
21	18.19	10.50	18.14	10.58	18.09	10.66	18.05	10.74	21
22	19.05	11.00	19.00	11.08	18.96	11.17	18.91	11.25	22
23	19.92	11.50	19.87	11.59	19.82	11.67	19.77	11.76	23
24	20.78	12.00	20.73	12.09	20.68	12.18	20.63	12.27	24
25	21.65	12.50	21.60	12.59	21.54	12.69	21.49	12.78	25
26	22.52	13.00	22.46	13.10	22.40	13.20	22.34	13.29	26
27	23.38	13.50	23.32	13.60	23.26	13.70	23.20	13.80	27
28	24.25	14.00	24.19	14.11	24.13	14.21	24.06	14.32	28
29	25.11	14.50	25.05	14.61	24.99	14.72	24.92	14.83	29
30	25.98	15.00	25.92	15.11	25.85	15.23	25.78	15.34	30
31	26.85	15.50	26.78	15.62	26.71	15.73	26.64	15.85	31
32	27.71	16.00	27.64	16.12	27.57	16.24	27.50	16.36	32
33	28.58	16.50	28.51	16.62	28.43	16.75	28.36	16.87	33
34	29.44	17.00	29.37	17.13	29.30	17.26	29.22	17.38	34
35	30.31	17.50	30.23	17.63	30.16	17.76	30.08	17.90	35
36	31.18	18.00	31.10	18.14	31.02	18.27	30.94	18.41	36
37	32.04	18.50	31.96	18.64	31.88	18.78	31.80	18.92	37
38	32.91	19.00	32.83	19.14	32.74	19.29	32.66	19.43	38
39	33.77	19.50	33.69	19.65	33.60	19.79	33.52	19.94	39
40	34.64	20.00	34.55	20.15	34.47	20.30	34.38	20.45	40
41	35.51	20.50	35.42	20.65	35.33	20.81	35.24	20.96	41
42	36.37	21.00	36.28	21.16	36.19	21.32	36.10	21.47	42
43	37.24	21.50	37.14	21.66	37.05	21.82	36.95	21.99	43
44	38.11	22.00	38.01	22.17	37.91	22.33	37.81	22.50	44
45	38.97	22.50	38.87	22.67	38.77	22.84	38.67	23.01	45
46	39.84	23.00	39.74	23.17	39.63	23.35	39.53	23.52	46
47	40.70	23.50	40.60	23.68	40.50	23.85	40.39	24.03	47
48	41.57	24.00	41.46	24.18	41.36	24.36	41.25	24.54	48
49	42.44	24.50	42.33	24.68	42.22	24.87	42.11	25.05	49
50	43.30	25.00	43.19	25.19	43.08	25.38	42.97	25.56	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	60 Deg.		59 $\frac{3}{4}$ Deg.		59 $\frac{1}{2}$ Deg.		59 $\frac{1}{4}$ Deg.		

Distance.	30 Deg.		30¼ Deg.		30½ Deg.		30¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	44.17	25.50	44.06	25.69	43.94	25.88	43.83	26.08	51
52	45.03	26.00	44.92	26.20	44.80	26.39	44.69	26.59	52
53	45.90	26.50	45.78	26.70	45.67	26.90	45.55	27.10	53
54	46.77	27.00	46.65	27.20	46.53	27.41	46.41	27.61	54
55	47.63	27.50	47.51	27.71	47.39	27.91	47.27	28.12	55
56	48.50	28.00	48.37	28.21	48.25	28.42	48.13	28.63	56
57	49.36	28.50	49.24	28.72	49.11	28.93	48.99	29.14	57
58	50.23	29.00	50.10	29.22	49.97	29.44	49.85	29.65	58
59	51.10	29.50	50.97	29.72	50.84	29.94	50.70	30.17	59
60	51.96	30.00	51.83	30.23	51.70	30.45	51.56	30.68	60
61	52.83	30.50	52.69	30.73	52.56	30.96	52.42	31.19	61
62	53.69	31.00	53.56	31.23	53.42	31.47	53.28	31.70	62
63	54.56	31.50	54.42	31.74	54.28	31.97	54.14	32.21	63
64	55.43	32.00	55.29	32.24	55.14	32.48	55.00	32.72	64
65	56.29	32.50	56.15	32.75	56.01	32.99	55.86	33.23	65
66	57.16	33.00	57.01	33.25	56.87	33.50	56.72	33.75	66
67	58.02	33.50	57.88	33.75	57.73	34.01	57.58	34.26	67
68	58.89	34.00	58.74	34.26	58.59	34.51	58.44	34.77	68
69	59.76	34.50	59.60	34.76	59.45	35.02	59.30	35.28	69
70	60.62	35.00	60.47	35.26	60.31	35.53	60.16	35.79	70
71	61.49	35.50	61.33	35.77	61.18	36.04	61.02	36.30	71
72	62.35	36.00	62.20	36.27	62.04	36.54	61.88	36.81	72
73	63.22	36.50	63.06	36.78	62.90	37.05	62.74	37.32	73
74	64.09	37.00	63.92	37.28	63.76	37.56	63.60	37.84	74
75	64.95	37.50	64.79	37.78	64.62	38.07	64.46	38.35	75
76	65.82	38.00	65.65	38.29	65.48	38.57	65.31	38.86	76
77	66.68	38.50	66.52	38.79	66.35	39.08	66.17	39.37	77
78	67.55	39.00	67.38	39.29	67.21	39.59	67.03	39.88	78
79	68.42	39.50	68.24	39.80	68.07	40.10	67.89	40.39	79
80	69.28	40.00	69.11	40.30	68.93	40.60	68.75	40.90	80
81	70.15	40.50	69.97	40.81	69.79	41.11	69.61	41.41	81
82	71.01	41.00	70.83	41.31	70.65	41.62	70.47	41.93	82
83	71.88	41.50	71.70	41.81	71.52	42.13	71.33	42.44	83
84	72.75	42.00	72.56	42.32	72.38	42.63	72.19	42.95	84
85	73.61	42.50	73.43	42.82	73.24	43.14	73.05	43.46	85
86	74.48	43.00	74.29	43.32	74.10	43.65	73.91	43.97	86
87	75.34	43.50	75.15	43.83	74.96	44.16	74.77	44.48	87
88	76.21	44.00	76.02	44.33	75.82	44.66	75.63	44.99	88
89	77.08	44.50	76.88	44.84	76.68	45.17	76.49	45.51	89
90	77.94	45.00	77.75	45.34	77.55	45.68	77.35	46.02	90
91	78.81	45.50	78.61	45.84	78.41	46.19	78.21	46.53	91
92	79.67	46.00	79.47	46.35	79.27	46.69	79.07	47.04	92
93	80.54	46.50	80.34	46.85	80.13	47.20	79.92	47.55	93
94	81.41	47.00	81.20	47.35	80.99	47.71	80.78	48.06	94
95	82.27	47.50	82.06	47.86	81.85	48.22	81.64	48.57	95
96	83.14	48.00	82.93	48.36	82.72	48.72	82.50	49.08	96
97	84.00	48.50	83.79	48.87	83.58	49.23	83.36	49.60	97
98	84.87	49.00	84.66	49.37	84.44	49.74	84.22	50.11	98
99	85.74	49.50	85.52	49.87	85.30	50.25	85.08	50.62	99
100	86.60	50.00	86.38	50.38	86.16	50.75	85.94	51.13	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	60 Deg.		59¼ Deg.		59½ Deg.		59¾ Deg.		

Distance.	31 Deg.		31 $\frac{1}{4}$ Deg.		31 $\frac{1}{2}$ Deg.		31 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.86	0.51	0.85	0.52	0.85	0.52	0.85	0.53	1
2	1.71	1.03	1.71	1.04	1.71	1.04	1.70	1.05	2
3	2.57	1.55	2.56	1.56	2.56	1.57	2.55	1.58	3
4	3.43	2.06	3.42	2.08	3.41	2.09	3.40	2.10	4
5	4.29	2.58	4.27	2.59	4.26	2.61	4.25	2.63	5
6	5.14	3.09	5.13	3.11	5.12	3.13	5.10	3.16	6
7	6.00	3.61	5.98	3.63	5.97	3.66	5.95	3.68	7
8	6.86	4.12	6.84	4.15	6.82	4.18	6.80	4.21	8
9	7.71	4.64	7.69	4.67	7.67	4.70	7.65	4.74	9
10	8.57	5.15	8.55	5.19	8.53	5.22	8.50	5.26	10
11	9.43	5.67	9.40	5.71	9.38	5.75	9.35	5.79	11
12	10.29	6.18	10.26	6.23	10.23	6.27	10.20	6.31	12
13	11.14	6.70	11.11	6.74	11.08	6.79	11.05	6.84	13
14	12.00	7.21	11.97	7.26	11.94	7.31	11.90	7.37	14
15	12.86	7.73	12.82	7.78	12.79	7.84	12.76	7.89	15
16	13.71	8.24	13.68	8.30	13.64	8.36	13.61	8.42	16
17	14.57	8.76	14.53	8.82	14.49	8.88	14.46	8.95	17
18	15.43	9.27	15.39	9.34	15.35	9.40	15.31	9.47	18
19	16.29	9.79	16.24	9.86	16.20	9.93	16.16	10.00	19
20	17.14	10.30	17.10	10.38	17.05	10.45	17.01	10.52	20
21	18.00	10.82	17.95	10.89	17.91	10.97	17.86	11.05	21
22	18.86	11.33	18.81	11.41	18.76	11.49	18.71	11.58	22
23	19.71	11.85	19.66	11.93	19.61	12.02	19.56	12.10	23
24	20.57	12.36	20.52	12.45	20.46	12.54	20.41	12.63	24
25	21.43	12.88	21.37	12.97	21.32	13.06	21.26	13.16	25
26	22.29	13.39	22.23	13.49	22.17	13.58	22.11	13.68	26
27	23.14	13.91	23.08	14.01	23.02	14.11	22.96	14.21	27
28	24.00	14.42	23.94	14.53	23.87	14.63	23.81	14.73	28
29	24.86	14.94	24.79	15.04	24.73	15.15	24.66	15.26	29
30	25.71	15.45	25.65	15.56	25.58	15.67	25.51	15.79	30
31	26.57	15.97	26.50	16.08	26.43	16.20	26.36	16.31	31
32	27.43	16.48	27.36	16.60	27.28	16.72	27.21	16.84	32
33	28.29	17.00	28.21	17.12	28.14	17.24	28.06	17.37	33
34	29.14	17.51	29.07	17.64	28.99	17.76	28.91	17.89	34
35	30.00	18.03	29.92	18.16	29.84	18.29	29.76	18.42	35
36	30.86	18.54	30.78	18.68	30.70	18.81	30.61	18.94	36
37	31.72	19.06	31.63	19.19	31.55	19.33	31.46	19.47	37
38	32.57	19.57	32.49	19.71	32.40	19.85	32.31	20.00	38
39	33.43	20.09	33.34	20.23	33.25	20.38	33.16	20.52	39
40	34.29	20.60	34.20	20.75	34.11	20.90	34.01	21.05	40
41	35.14	21.12	35.05	21.27	34.96	21.42	34.86	21.57	41
42	36.00	21.63	35.91	21.79	35.81	21.94	35.71	22.10	42
43	36.86	22.15	36.76	22.31	36.66	22.47	36.57	22.63	43
44	37.72	22.66	37.62	22.83	37.52	22.99	37.42	23.15	44
45	38.57	23.18	38.47	23.34	38.37	23.51	38.27	23.68	45
46	39.43	23.69	39.33	23.86	39.22	24.03	39.12	24.21	46
47	40.29	24.21	40.18	24.38	40.07	24.56	39.97	24.73	47
48	41.14	24.72	41.04	24.90	40.93	25.08	40.82	25.26	48
49	42.00	25.24	41.89	25.42	41.78	25.60	41.67	25.78	49
50	42.86	25.75	42.75	25.94	42.63	26.12	42.52	26.31	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	59 Deg.		58 $\frac{3}{4}$ Deg.		58 $\frac{1}{2}$ Deg.		58 $\frac{1}{4}$ Deg.		

Distance.	31 Deg.		31¼ Deg.		31½ Deg.		31¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	43.72	26.27	43.60	26.46	43.48	26.65	43.37	26.84	51
52	44.57	26.78	44.46	26.98	44.34	27.17	44.22	27.36	52
53	45.43	27.30	45.31	27.49	45.19	27.69	45.07	27.89	53
54	46.29	27.81	46.17	28.01	46.04	28.21	45.92	28.42	54
55	47.14	28.33	47.02	28.53	46.90	28.74	46.77	28.94	55
56	48.00	28.84	47.88	29.05	47.75	29.26	47.62	29.47	56
57	48.86	29.36	48.73	29.57	48.60	29.78	48.47	29.99	57
58	49.72	29.87	49.58	30.09	49.45	30.30	49.32	30.52	58
59	50.57	30.39	50.44	30.61	50.31	30.83	50.17	31.05	59
60	51.43	30.90	51.29	31.13	51.16	31.35	51.02	31.57	60
61	52.29	31.42	52.15	31.65	52.01	31.87	51.87	32.10	61
62	53.14	31.93	53.00	32.16	52.86	32.39	52.72	32.63	62
63	54.00	32.45	53.86	32.68	53.72	32.92	53.57	33.15	63
64	54.86	32.96	54.71	33.20	54.57	33.44	54.42	33.68	64
65	55.72	33.48	55.57	33.72	55.42	33.96	55.27	34.20	65
66	56.57	33.99	56.42	34.24	56.27	34.48	56.12	34.73	66
67	57.43	34.51	57.28	34.76	57.13	35.01	56.98	35.26	67
68	58.29	35.02	58.13	35.28	57.98	35.53	57.82	35.78	68
69	59.14	35.54	58.99	35.80	58.83	36.05	58.67	36.31	69
70	60.00	36.05	59.84	36.31	59.68	36.57	59.52	36.83	70
71	60.86	36.57	60.70	36.83	60.54	37.10	60.37	37.36	71
72	61.72	37.08	61.55	37.35	61.39	37.62	61.23	37.89	72
73	62.57	37.60	62.41	37.87	62.24	38.14	62.08	38.41	73
74	63.43	38.11	63.26	38.39	63.10	38.66	62.93	38.94	74
75	64.29	38.63	64.12	38.91	63.95	39.19	63.78	39.47	75
76	65.14	39.14	64.97	39.43	64.80	39.71	64.63	39.99	76
77	66.00	39.66	65.83	39.95	65.65	40.23	65.48	40.52	77
78	66.86	40.17	66.68	40.46	66.51	40.75	66.33	41.04	78
79	67.72	40.69	67.54	40.98	67.36	41.28	67.18	41.57	79
80	68.57	41.20	68.39	41.50	68.21	41.80	68.03	42.10	80
81	69.43	41.72	69.25	42.02	69.06	42.32	68.88	42.62	81
82	70.29	42.23	70.10	42.54	69.92	42.84	69.73	43.15	82
83	71.14	42.75	70.96	43.06	70.77	43.37	70.58	43.68	83
84	72.00	43.26	71.81	43.58	71.62	43.89	71.43	44.20	84
85	72.86	43.78	72.67	44.10	72.47	44.41	72.28	44.73	85
86	73.72	44.29	73.52	44.61	73.33	44.93	73.13	45.25	86
87	74.57	44.81	74.38	45.13	74.18	45.46	73.98	45.78	87
88	75.43	45.32	75.23	45.65	75.03	45.98	74.83	46.31	88
89	76.29	45.84	76.09	46.17	75.88	46.50	75.68	46.83	89
90	77.15	46.35	76.94	46.69	76.74	47.02	76.53	47.36	90
91	78.00	46.87	77.80	47.21	77.59	47.55	77.38	47.89	91
92	78.86	47.38	78.65	47.73	78.44	48.07	78.23	48.41	92
93	79.72	47.90	79.51	48.25	79.30	48.59	79.08	48.94	93
94	80.57	48.41	80.36	48.76	80.15	49.11	79.93	49.47	94
95	81.43	48.93	81.22	49.28	81.00	49.64	80.78	49.99	95
96	82.29	49.44	82.07	49.80	81.85	50.16	81.63	50.52	96
97	83.15	49.96	82.93	50.32	82.71	50.68	82.48	51.04	97
98	84.00	50.47	83.78	50.84	83.56	51.20	83.33	51.57	98
99	84.86	50.99	84.64	51.36	84.41	51.73	84.18	52.10	99
100	85.72	51.50	85.49	51.88	85.26	52.25	85.04	52.62	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	59 Deg.		58¾ Deg.		58½ Deg.		58¼ Deg.		

Distance.	32 Deg.		32¼ Deg.		32½ Deg.		32¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.85	0.53	0.85	0.53	0.84	0.54	0.84	0.54	1
2	1.70	1.06	1.69	1.07	1.69	1.07	1.68	1.08	2
3	2.54	1.59	2.54	1.60	2.53	1.61	2.52	1.62	3
4	3.39	2.12	3.38	2.13	3.37	2.15	3.36	2.16	4
5	4.24	2.65	4.23	2.67	4.22	2.69	4.21	2.70	5
6	5.09	3.18	5.07	3.20	5.06	3.22	5.05	3.25	6
7	5.94	3.71	5.92	3.74	5.90	3.76	5.89	3.79	7
8	6.78	4.24	6.77	4.27	6.75	4.30	6.73	4.33	8
9	7.63	4.77	7.61	4.80	7.59	4.84	7.57	4.87	9
10	8.48	5.30	8.46	5.34	8.43	5.37	8.41	5.41	10
11	9.33	5.83	9.30	5.87	9.28	5.91	9.25	5.95	11
12	10.18	6.36	10.15	6.40	10.12	6.45	10.09	6.49	12
13	11.02	6.89	10.99	6.94	10.96	6.98	10.93	7.03	13
14	11.87	7.42	11.84	7.47	11.81	7.52	11.77	7.57	14
15	12.72	7.95	12.69	8.00	12.65	8.06	12.62	8.11	15
16	13.57	8.48	13.53	8.54	13.49	8.60	13.46	8.66	16
17	14.42	9.01	14.38	9.07	14.34	9.13	14.30	9.20	17
18	15.26	9.54	15.22	9.61	15.18	9.67	15.14	9.74	18
19	16.11	10.07	16.07	10.14	16.02	10.21	15.98	10.28	19
20	16.96	10.60	16.91	10.67	16.87	10.75	16.82	10.82	20
21	17.81	11.13	17.76	11.21	17.71	11.28	17.66	11.36	21
22	18.66	11.66	18.61	11.74	18.55	11.82	18.50	11.90	22
23	19.51	12.19	19.45	12.27	19.40	12.36	19.34	12.44	23
24	20.35	12.72	20.30	12.81	20.24	12.90	20.18	12.98	24
25	21.20	13.25	21.14	13.34	21.08	13.43	21.03	13.52	25
26	22.05	13.78	21.99	13.87	21.93	13.97	21.87	14.07	26
27	22.90	14.31	22.83	14.41	22.77	14.51	22.71	14.61	27
28	23.75	14.84	23.68	14.94	23.61	15.04	23.55	15.15	28
29	24.59	15.37	24.53	15.47	24.46	15.58	24.39	15.69	29
30	25.44	15.90	25.37	16.01	25.30	16.12	25.23	16.23	30
31	26.29	16.43	26.22	16.54	26.15	16.66	26.07	16.77	31
32	27.14	16.96	27.06	17.08	26.99	17.19	26.91	17.31	32
33	27.99	17.49	27.91	17.61	27.83	17.73	27.75	17.85	33
34	28.83	18.02	28.75	18.14	28.68	18.27	28.60	18.39	34
35	29.68	18.55	29.60	18.68	29.52	18.81	29.44	18.93	35
36	30.53	19.08	30.45	19.21	30.36	19.34	30.28	19.48	36
37	31.38	19.61	31.29	19.74	31.21	19.88	31.12	20.02	37
38	32.23	20.14	32.14	20.28	32.05	20.42	31.96	20.56	38
39	33.07	20.67	32.98	20.81	32.89	20.95	32.80	21.10	39
40	33.92	21.20	33.83	21.34	33.74	21.49	33.64	21.64	40
41	34.77	21.73	34.67	21.88	34.58	22.03	34.48	22.18	41
42	35.62	22.26	35.52	22.41	35.42	22.57	35.32	22.72	42
43	36.47	22.79	36.37	22.95	36.27	23.10	36.16	23.26	43
44	37.31	23.32	37.21	23.48	37.11	23.64	37.01	23.80	44
45	38.16	23.85	38.06	24.01	37.95	24.18	37.85	24.34	45
46	39.01	24.38	38.90	24.55	38.80	24.72	38.69	24.88	46
47	39.86	24.91	39.75	25.08	39.64	25.25	39.53	25.43	47
48	40.71	25.44	40.59	25.61	40.48	25.79	40.37	25.97	48
49	41.55	25.97	41.44	26.15	41.33	26.33	41.21	26.51	49
50	42.40	26.50	42.29	26.68	42.17	26.86	42.05	27.05	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	58 Deg.		57¾ Deg.		57½ Deg.		57¼ Deg.		

Distance.	32 Deg.		32 $\frac{1}{4}$ Deg.		32 $\frac{1}{2}$ Deg.		32 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	43.25	27.03	43.13	27.21	43.01	27.40	42.89	27.59	51
52	44.10	27.56	43.98	27.75	43.86	27.94	43.73	28.13	52
53	44.95	28.09	44.82	28.28	44.70	28.48	44.58	28.67	53
54	45.79	28.62	45.67	28.82	45.54	29.01	45.42	29.21	54
55	46.64	29.15	46.51	29.35	46.39	29.55	46.26	29.75	55
56	47.49	29.68	47.36	29.88	47.23	30.09	47.10	30.29	56
57	48.34	30.21	48.21	30.42	48.07	30.63	47.94	30.84	57
58	49.19	30.74	49.05	30.95	48.92	31.16	48.78	31.38	58
59	50.03	31.27	49.90	31.48	49.76	31.70	49.62	31.92	59
60	50.88	31.80	50.74	32.02	50.60	32.24	50.46	32.46	60
61	51.73	32.33	51.59	32.55	51.45	32.78	51.30	33.00	61
62	52.58	32.85	52.44	33.08	52.29	33.31	52.14	33.54	62
63	53.43	33.38	53.28	33.62	53.13	33.85	52.99	34.08	63
64	54.28	33.91	54.13	34.15	53.98	34.39	53.83	34.62	64
65	55.12	34.44	54.97	34.68	54.82	34.92	54.67	35.16	65
66	55.97	34.97	55.82	35.22	55.66	35.46	55.51	35.70	66
67	56.82	35.50	56.66	35.75	56.51	36.00	56.35	36.25	67
68	57.67	36.03	57.51	36.29	57.35	36.54	57.19	36.79	68
69	58.52	36.56	58.36	36.82	58.19	37.07	58.03	37.33	69
70	59.36	37.09	59.20	37.35	59.04	37.61	58.87	37.87	70
71	60.21	37.62	60.05	37.89	59.88	38.15	59.71	38.41	71
72	61.06	38.15	60.89	38.42	60.72	38.69	60.55	38.95	72
73	61.91	38.68	61.74	38.95	61.57	39.22	61.40	39.49	73
74	62.76	39.21	62.58	39.49	62.41	39.76	62.24	40.03	74
75	63.60	39.74	63.43	40.02	63.25	40.30	63.08	40.57	75
76	64.45	40.27	64.28	40.55	64.10	40.83	63.92	41.11	76
77	65.30	40.80	65.12	41.09	64.94	41.37	64.76	41.65	77
78	66.15	41.33	65.97	41.62	65.78	41.91	65.60	42.20	78
79	67.00	41.86	66.81	42.16	66.63	42.45	66.44	42.74	79
80	67.84	42.39	67.66	42.69	67.47	42.98	67.28	43.28	80
81	68.69	42.92	68.50	43.22	68.31	43.52	68.12	43.82	81
82	69.54	43.45	69.35	43.76	69.16	44.06	68.97	44.36	82
83	70.39	43.98	70.20	44.29	70.00	44.60	69.81	44.90	83
84	71.24	44.51	71.04	44.82	70.84	45.13	70.65	45.44	84
85	72.08	45.04	71.89	45.36	71.69	45.67	71.49	45.98	85
86	72.93	45.57	72.73	45.89	72.53	46.21	72.33	46.52	86
87	73.78	46.10	73.58	46.42	73.38	46.75	73.17	47.06	87
88	74.63	46.63	74.42	46.96	74.22	47.28	74.01	47.61	88
89	75.48	47.16	75.27	47.49	75.06	47.82	74.85	48.15	89
90	76.32	47.69	76.12	48.03	75.91	48.36	75.69	48.69	90
91	77.17	48.22	76.96	48.56	76.75	48.89	76.53	49.23	91
92	78.02	48.75	77.81	49.09	77.59	49.43	77.38	49.77	92
93	78.87	49.28	78.65	49.63	78.44	49.97	78.22	50.31	93
94	79.72	49.81	79.50	50.16	79.28	50.51	79.06	50.85	94
95	80.56	50.34	80.34	50.69	80.12	51.04	79.90	51.39	95
96	81.41	50.87	81.19	51.23	80.97	51.58	80.74	51.93	96
97	82.26	51.40	82.04	51.76	81.81	52.12	81.58	52.47	97
98	83.11	51.93	82.88	52.29	82.65	52.66	82.42	53.02	98
99	83.96	52.46	83.73	52.83	83.50	53.19	83.26	53.56	99
100	84.80	52.99	84.57	53.36	84.34	53.73	84.10	54.10	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	58 Deg.		57 $\frac{3}{4}$ Deg.		57 $\frac{1}{2}$ Deg.		57 $\frac{1}{4}$ Deg.		

Distance.	33 Deg.		33¼ Deg.		33½ Deg.		33¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.84	0.54	0.84	0.55	0.83	0.55	0.83	0.56	1
2	1.68	1.09	1.67	1.10	1.67	1.10	1.66	1.11	2
3	2.52	1.63	2.51	1.64	2.50	1.66	2.49	1.67	3
4	3.35	2.18	3.35	2.19	3.34	2.21	3.33	2.22	4
5	4.19	2.72	4.18	2.74	4.17	2.76	4.16	2.78	5
6	5.03	3.27	5.02	3.29	5.00	3.31	4.99	3.23	6
7	5.87	3.81	5.85	3.84	5.84	3.86	5.82	3.89	7
8	6.71	4.36	6.69	4.39	6.67	4.42	6.65	4.44	8
9	7.55	4.90	7.53	4.93	7.50	4.97	7.48	5.00	9
10	8.39	5.45	8.36	5.48	8.34	5.52	8.31	5.56	10
11	9.23	5.99	9.20	6.03	9.17	6.07	9.15	6.11	11
12	10.06	6.54	10.04	6.58	10.01	6.62	9.98	6.67	12
13	10.90	7.08	10.87	7.13	10.84	7.18	10.81	7.22	13
14	11.74	7.62	11.71	7.68	11.67	7.73	11.64	7.78	14
15	12.58	8.17	12.54	8.22	12.51	8.28	12.47	8.33	15
16	13.42	8.71	13.38	8.77	13.34	8.83	13.30	8.89	16
17	14.26	9.26	14.22	9.32	14.18	9.38	14.13	9.44	17
18	15.10	9.80	15.05	9.87	15.01	9.93	14.97	10.00	18
19	15.93	10.35	15.89	10.42	15.84	10.49	15.80	10.56	19
20	16.77	10.89	16.73	10.97	16.68	11.04	16.63	11.11	20
21	17.61	11.44	17.56	11.51	17.51	11.59	17.46	11.67	21
22	18.45	11.98	18.40	12.06	18.35	12.14	18.29	12.22	22
23	19.29	12.53	19.23	12.61	19.18	12.69	19.12	12.78	23
24	20.13	13.07	20.07	13.16	20.01	13.25	19.96	13.33	24
25	20.97	13.62	20.91	13.71	20.85	13.80	20.79	13.89	25
26	21.81	14.16	21.74	14.26	21.68	14.35	21.62	14.44	26
27	22.64	14.71	22.58	14.80	22.51	14.90	22.45	15.00	27
28	23.48	15.25	23.42	15.35	23.35	15.45	23.28	15.56	28
29	24.32	15.79	24.25	15.90	24.18	16.01	24.11	16.11	29
30	25.16	16.34	25.09	16.45	25.02	16.56	24.94	16.67	30
31	26.00	16.88	25.92	17.00	25.85	17.11	25.78	17.22	31
32	26.84	17.43	26.76	17.55	26.68	17.66	26.61	17.78	32
33	27.68	17.97	27.60	18.09	27.52	18.21	27.44	18.33	33
34	28.51	18.52	28.43	18.64	28.35	18.77	28.27	18.89	34
35	29.35	19.06	29.27	19.19	29.19	19.32	29.10	19.44	35
36	30.19	19.61	30.11	19.74	30.02	19.87	29.93	20.00	36
37	31.03	20.15	30.94	20.29	30.85	20.42	30.76	20.56	37
38	31.87	20.70	31.78	20.84	31.69	20.97	31.60	21.11	38
39	32.71	21.24	32.62	21.38	32.52	21.53	32.43	21.67	39
40	33.55	21.79	33.45	21.93	33.36	22.08	33.26	22.22	40
41	34.39	22.33	34.29	22.48	34.19	22.63	34.09	22.78	41
42	35.22	22.87	35.12	23.03	35.02	23.18	34.92	23.33	42
43	36.06	23.42	35.96	23.58	35.86	23.73	35.75	23.89	43
44	36.90	23.96	36.80	24.12	36.69	24.29	36.58	24.45	44
45	37.74	24.51	37.63	24.67	37.52	24.84	37.42	25.00	45
46	38.58	25.05	38.47	25.22	38.36	25.39	38.25	25.56	46
47	39.42	25.60	39.31	25.77	39.19	25.94	39.08	26.11	47
48	40.26	26.14	40.14	26.32	40.03	26.49	39.91	26.67	48
49	41.09	26.69	40.98	26.87	40.86	27.04	40.74	27.22	49
50	41.93	27.23	41.81	27.41	41.69	27.60	41.57	27.78	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	57 Deg.		56¾ Deg.		56½ Deg.		56¼ Deg.		

Distance.	33 Deg.		33 $\frac{1}{4}$ Deg.		33 $\frac{1}{2}$ Deg.		33 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	42.77	27.78	42.65	27.96	42.53	28.15	42.40	28.33	51
52	43.61	28.32	43.49	28.51	43.36	28.70	43.24	28.89	52
53	44.45	28.87	44.32	29.06	44.20	29.25	44.07	29.45	53
54	45.29	29.41	45.16	29.61	45.03	29.80	44.90	30.00	54
55	46.13	29.96	46.00	30.16	45.86	30.36	45.73	30.56	55
56	46.97	30.50	46.83	30.70	46.70	30.91	46.56	31.11	56
57	47.80	31.04	47.67	31.25	47.53	31.46	47.39	31.67	57
58	48.64	31.59	48.50	31.80	48.37	32.01	48.23	32.22	58
59	49.48	32.13	49.34	32.35	49.20	32.56	49.06	32.78	59
60	50.32	32.68	50.18	32.90	50.03	33.12	49.89	33.33	60
61	51.16	33.22	51.01	33.45	50.87	33.67	50.72	33.89	61
62	52.00	33.77	51.85	33.99	51.70	34.22	51.55	34.45	62
63	52.84	34.31	52.69	34.54	52.53	34.77	52.38	35.00	63
64	53.67	34.86	53.52	35.09	53.37	35.32	53.21	35.56	64
65	54.51	35.40	54.36	35.64	54.20	35.88	54.05	36.11	65
66	55.35	35.95	55.19	36.19	55.04	36.43	54.88	36.67	66
67	56.19	36.49	56.03	36.74	55.87	36.98	55.71	37.22	67
68	57.03	37.04	56.87	37.28	56.70	37.53	56.54	37.78	68
69	57.87	37.58	57.70	37.83	57.54	38.08	57.37	38.33	69
70	58.71	38.12	58.54	38.38	58.37	38.64	58.20	38.89	70
71	59.55	38.67	59.38	38.93	59.21	39.19	59.03	39.45	71
72	60.38	39.21	60.21	39.48	60.04	39.74	59.87	40.00	72
73	61.22	39.76	61.05	40.03	60.87	40.29	60.70	40.56	73
74	62.06	40.30	61.89	40.57	61.71	40.84	61.53	41.11	74
75	62.90	40.85	62.72	41.12	62.54	41.40	62.36	41.67	75
76	63.74	41.39	63.56	41.67	63.38	41.95	63.19	42.22	76
77	64.58	41.94	64.39	42.22	64.21	42.50	64.02	42.78	77
78	65.42	42.48	65.23	42.77	65.04	43.05	64.85	43.33	78
79	66.25	43.03	66.07	43.32	65.88	43.60	65.69	43.89	79
80	67.09	43.57	66.90	43.86	66.71	44.15	66.52	44.45	80
81	67.93	44.12	67.74	44.41	67.54	44.71	67.35	45.00	81
82	68.77	44.66	68.58	44.96	68.38	45.26	68.18	45.56	82
83	69.61	45.20	69.41	45.51	69.21	45.81	69.01	46.11	83
84	70.45	45.75	70.25	46.05	70.05	46.36	69.84	46.67	84
85	71.29	46.29	71.08	46.60	70.88	46.91	70.67	47.22	85
86	72.13	46.84	71.92	47.15	71.71	47.47	71.51	47.78	86
87	72.96	47.38	72.76	47.70	72.55	48.02	72.34	48.33	87
88	73.80	47.93	73.59	48.25	73.38	48.57	73.17	48.89	88
89	74.64	48.47	74.43	48.80	74.22	49.12	74.00	49.45	89
90	75.48	49.02	75.27	49.35	75.05	49.67	74.83	50.00	90
91	76.32	49.56	76.10	49.89	75.88	50.23	75.66	50.56	91
92	77.16	50.11	76.94	50.44	76.72	50.78	76.50	51.11	92
93	78.00	50.65	77.77	50.99	77.55	51.33	77.33	51.67	93
94	78.83	51.20	78.61	51.54	78.39	51.88	78.16	52.22	94
95	79.67	51.74	79.45	52.09	79.22	52.43	78.99	52.78	95
96	80.51	52.29	80.28	52.64	80.05	52.99	79.82	53.33	96
97	81.35	52.83	81.12	53.18	80.89	53.54	80.65	53.89	97
98	82.19	53.37	81.96	53.73	81.72	54.09	81.48	54.45	98
99	83.03	53.92	82.79	54.28	82.55	54.64	82.32	55.00	99
100	83.87	54.46	83.63	54.83	83.39	55.19	83.15	55.56	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	57 Deg.		56 $\frac{3}{4}$ Deg.		56 $\frac{1}{2}$ Deg.		56 $\frac{1}{4}$ Deg.		

Distance.	34 Deg.		34 $\frac{1}{4}$ Deg.		34 $\frac{1}{2}$ Deg.		34 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.83	0.56	0.83	0.56	0.82	0.57	0.82	0.57	1
2	1.66	1.12	1.65	1.13	1.65	1.13	1.64	1.14	2
3	2.49	1.68	2.48	1.69	2.47	1.70	2.46	1.71	3
4	3.32	2.24	3.31	2.25	3.30	2.27	3.29	2.28	4
5	4.15	2.80	4.13	2.81	4.12	2.83	4.11	2.85	5
6	4.97	3.36	4.96	3.38	4.94	3.40	4.93	3.42	6
7	5.80	3.91	5.79	3.94	5.77	3.96	5.75	3.99	7
8	6.63	4.47	6.61	4.50	6.59	4.53	6.57	4.56	8
9	7.46	5.03	7.44	5.07	7.42	5.10	7.39	5.13	9
10	8.29	5.59	8.27	5.63	8.24	5.66	8.22	5.70	10
11	9.12	6.15	9.09	6.19	9.07	6.23	9.04	6.27	11
12	9.95	6.71	9.92	6.75	9.89	6.80	9.86	6.84	12
13	10.78	7.27	10.75	7.32	10.71	7.36	10.68	7.41	13
14	11.61	7.83	11.57	7.88	11.54	7.93	11.50	7.98	14
15	12.44	8.39	12.40	8.44	12.36	8.50	12.32	8.55	15
16	13.26	8.95	13.23	9.00	13.19	9.06	13.15	9.12	16
17	14.09	9.51	14.05	9.57	14.01	9.63	13.97	9.69	17
18	14.92	10.07	14.88	10.13	14.83	10.20	14.79	10.26	18
19	15.75	10.62	15.71	10.69	15.66	10.76	15.61	10.83	19
20	16.58	11.18	16.53	11.26	16.48	11.33	16.43	11.40	20
21	17.41	11.74	17.36	11.82	17.31	11.89	17.25	11.97	21
22	18.24	12.30	18.18	12.38	18.13	12.46	18.08	12.54	22
23	19.07	12.86	19.01	12.94	18.95	13.03	18.90	13.11	23
24	19.90	13.42	19.84	13.51	19.78	13.59	19.72	13.68	24
25	20.73	13.98	20.66	14.07	20.60	14.16	20.54	14.25	25
26	21.55	14.54	21.49	14.63	21.43	14.73	21.36	14.82	26
27	22.38	15.10	22.32	15.20	22.25	15.29	22.18	15.39	27
28	23.21	15.66	23.14	15.76	23.08	15.86	23.01	15.96	28
29	24.04	16.22	23.97	16.32	23.90	16.43	23.83	16.53	29
30	24.87	16.78	24.80	16.88	24.72	16.99	24.65	17.10	30
31	25.70	17.33	25.62	17.45	25.55	17.56	25.47	17.67	31
32	26.53	17.89	26.45	18.01	26.37	18.12	26.29	18.24	32
33	27.36	18.45	27.28	18.57	27.20	18.69	27.11	18.81	33
34	28.19	19.01	28.10	19.14	28.02	19.26	27.94	19.38	34
35	29.02	19.57	28.93	19.70	28.84	19.82	28.76	19.95	35
36	29.85	20.13	29.76	20.26	29.67	20.39	29.58	20.52	36
37	30.67	20.69	30.58	20.82	30.49	20.96	30.40	21.09	37
38	31.50	21.25	31.41	21.39	31.32	21.52	31.22	21.66	38
39	32.33	21.81	32.24	21.95	32.14	22.09	32.04	22.23	39
40	33.16	22.37	33.06	22.51	32.97	22.66	32.87	22.80	40
41	33.99	22.93	33.89	23.07	33.79	23.22	33.69	23.37	41
42	34.82	23.49	34.72	23.64	34.61	23.79	34.51	23.94	42
43	35.65	24.05	35.54	24.20	35.44	24.36	35.33	24.51	43
44	36.48	24.60	36.37	24.76	36.26	24.92	36.15	25.08	44
45	37.31	25.16	37.20	25.33	37.09	25.49	36.97	25.65	45
46	38.14	25.72	38.02	25.89	37.91	26.05	37.80	26.22	46
47	38.96	26.28	38.85	26.45	38.73	26.62	38.62	26.79	47
48	39.79	26.84	39.68	27.01	39.56	27.19	39.44	27.36	48
49	40.62	27.40	40.50	27.58	40.38	27.75	40.26	27.93	49
50	41.45	27.96	41.33	28.14	41.21	28.32	41.08	28.50	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	56 Deg.		55 $\frac{1}{4}$ Deg.		55 $\frac{1}{2}$ Deg.		55 $\frac{3}{4}$ Deg.		

Distance.	34 Deg.		34 $\frac{1}{4}$ Deg.		34 $\frac{1}{2}$ Deg.		34 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	42.28	28.52	42.16	28.70	42.03	28.89	41.90	29.07	51
52	43.11	29.08	42.98	29.27	42.85	29.45	42.73	29.64	52
53	43.94	29.64	43.81	29.83	43.68	30.02	43.55	30.21	53
54	44.77	30.20	44.64	30.39	44.50	30.59	44.37	30.78	54
55	45.60	30.76	45.46	30.95	45.33	31.15	45.19	31.35	55
56	46.43	31.31	46.29	31.52	46.15	31.72	46.01	31.92	56
57	47.26	31.87	47.12	32.08	46.98	32.29	46.83	32.49	57
58	48.08	32.43	47.94	32.64	47.80	32.85	47.66	33.06	58
59	48.91	32.99	48.77	33.21	48.62	33.42	48.48	33.63	59
60	49.74	33.55	49.60	33.77	49.45	33.98	49.30	34.20	60
61	50.57	34.11	50.42	34.33	50.27	34.55	50.12	34.77	61
62	51.40	34.67	51.25	34.89	51.10	35.12	50.94	35.34	62
63	52.23	35.23	52.08	35.46	51.92	35.68	51.76	35.91	63
64	53.06	35.79	52.90	36.02	52.74	36.25	52.59	36.48	64
65	53.89	36.35	53.73	36.58	53.57	36.82	53.41	37.05	65
66	54.72	36.91	54.55	37.15	54.39	37.38	54.23	37.62	66
67	55.55	37.46	55.38	37.71	55.22	37.95	55.05	38.19	67
68	56.37	38.03	56.21	38.27	56.04	38.52	55.87	38.76	68
69	57.20	38.58	57.03	38.83	56.86	39.08	56.69	39.33	69
70	58.03	39.14	57.86	39.40	57.69	39.65	57.52	39.90	70
71	58.86	39.70	58.69	39.96	58.51	40.21	58.34	40.47	71
72	59.69	40.26	59.51	40.52	59.34	40.78	59.16	41.04	72
73	60.52	40.82	60.34	41.08	60.16	41.35	59.98	41.61	73
74	61.35	41.38	61.17	41.65	60.99	41.91	60.80	42.18	74
75	62.18	41.94	61.99	42.21	61.81	42.48	61.62	42.75	75
76	63.01	42.50	62.82	42.77	62.63	43.05	62.45	43.32	76
77	63.84	43.06	63.65	43.34	63.46	43.61	63.27	43.89	77
78	64.66	43.62	64.47	43.90	64.28	44.18	64.09	44.46	78
79	65.49	44.18	65.30	44.46	65.11	44.75	64.91	45.03	79
80	66.32	44.74	66.13	45.02	65.93	45.31	65.73	45.60	80
81	67.15	45.29	66.95	45.59	66.75	45.88	66.55	46.17	81
82	67.98	45.85	67.78	46.15	67.58	46.45	67.37	46.74	82
83	68.81	46.41	68.61	46.71	68.40	47.01	68.20	47.31	83
84	69.64	46.97	69.43	47.28	69.23	47.58	69.02	47.88	84
85	70.47	47.53	70.26	47.84	70.05	48.14	69.84	48.45	85
86	71.30	48.09	71.09	48.40	70.87	48.71	70.66	49.02	86
87	72.13	48.65	71.91	48.96	71.70	49.28	71.48	49.59	87
88	72.96	49.21	72.74	49.53	72.52	49.84	72.30	50.16	88
89	73.78	49.77	73.57	50.09	73.35	50.41	73.13	50.73	89
90	74.61	50.33	74.39	50.65	74.17	50.98	73.95	51.30	90
91	75.44	50.89	75.22	51.22	75.00	51.54	74.77	51.87	91
92	76.27	51.45	76.05	51.78	75.82	52.11	75.59	52.44	92
93	77.10	52.00	76.87	52.34	76.64	52.68	76.41	53.01	93
94	77.93	52.56	77.70	52.90	77.47	53.24	77.23	53.58	94
95	78.76	53.12	78.53	53.47	78.29	53.81	78.06	54.15	95
96	79.59	53.68	79.35	54.03	79.12	54.37	78.88	54.72	96
97	80.42	54.24	80.18	54.59	79.94	54.94	79.70	55.29	97
98	81.25	54.80	81.01	55.15	80.76	55.51	80.52	55.86	98
99	82.07	55.36	81.83	55.72	81.59	56.07	81.34	56.43	99
100	82.90	55.92	82.66	56.28	82.41	56.64	82.16	57.00	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	56 Deg.		55 $\frac{3}{4}$ Deg.		55 $\frac{1}{2}$ Deg.		55 $\frac{1}{4}$ Deg.		

Distance.	35 Deg.		35 $\frac{1}{4}$ De $\frac{g$.		35 $\frac{1}{2}$ Deg.		35 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.82	0.57	0.82	0.58	0.81	0.58	0.81	0.58	1
2	1.64	1.15	1.63	1.15	1.63	1.16	1.62	1.17	2
3	2.46	1.72	2.45	1.73	2.44	1.74	2.43	1.75	3
4	3.28	2.29	3.27	2.31	3.26	2.32	3.25	2.34	4
5	4.10	2.87	4.08	2.89	4.07	2.90	4.06	2.92	5
6	4.91	3.44	4.90	3.46	4.88	3.48	4.87	3.51	6
7	5.73	4.01	5.72	4.04	5.70	4.06	5.68	4.09	7
8	6.55	4.59	6.53	4.62	6.51	4.65	6.49	4.67	8
9	7.37	5.16	7.35	5.19	7.33	5.23	7.30	5.26	9
10	8.19	5.74	8.17	5.77	8.14	5.81	8.12	5.84	10
11	9.01	6.31	8.98	6.35	8.96	6.39	8.93	6.43	11
12	9.83	6.88	9.80	6.93	9.77	6.97	9.74	7.01	12
13	10.65	7.46	10.62	7.50	10.58	7.55	10.55	7.60	13
14	11.47	8.03	11.43	8.08	11.40	8.13	11.36	8.18	14
15	12.29	8.60	12.25	8.66	12.21	8.71	12.17	8.76	15
16	13.11	9.18	13.07	9.23	13.03	9.29	12.99	9.35	16
17	13.93	9.75	13.88	9.81	13.84	9.87	13.80	9.93	17
18	14.74	10.32	14.70	10.39	14.65	10.45	14.61	10.52	18
19	15.56	10.90	15.52	10.97	15.47	11.03	15.42	11.10	19
20	16.38	11.47	16.33	11.54	16.28	11.61	16.23	11.68	20
21	17.20	12.05	17.15	12.12	17.10	12.19	17.04	12.27	21
22	18.02	12.62	17.97	12.70	17.91	12.78	17.85	12.85	22
23	18.84	13.19	18.78	13.27	18.72	13.36	18.67	13.44	23
24	19.66	13.77	19.60	13.85	19.54	13.94	19.48	14.02	24
25	20.48	14.34	20.42	14.43	20.35	14.52	20.29	14.61	25
26	21.30	14.91	21.23	15.0 ¹	21.17	15.10	21.10	15.19	26
27	22.12	15.49	22.05	15.58	21.98	15.68	21.91	15.77	27
28	22.94	16.06	22.87	16.16	22.80	16.26	22.72	16.36	28
29	23.76	16.63	23.68	16.74	23.61	16.84	23.54	16.94	29
30	24.57	17.21	24.50	17.31	24.42	17.42	24.35	17.53	30
31	25.39	17.78	25.32	17.89	25.24	18.00	25.16	18.11	31
32	26.21	18.35	26.13	18.47	26.05	18.58	25.97	18.70	32
33	27.03	18.93	26.95	19.05	26.87	19.16	26.78	19.28	33
34	27.85	19.50	27.77	19.62	27.68	19.74	27.59	19.86	34
35	28.67	20.08	28.58	20.20	28.49	20.32	28.41	20.45	35
36	29.49	20.65	29.40	20.78	29.31	20.91	29.22	21.03	36
37	30.31	21.22	30.22	21.35	30.12	21.49	30.03	21.62	37
38	31.13	21.80	31.03	21.93	30.94	22.07	30.84	22.20	38
39	31.95	22.37	31.85	22.51	31.75	22.65	31.65	22.79	39
40	32.77	22.94	32.67	23.09	32.56	23.23	32.46	23.37	40
41	33.59	23.52	33.48	23.66	33.38	23.81	33.27	23.95	41
42	34.40	24.09	34.30	24.24	34.19	24.39	34.09	24.54	42
43	35.22	24.66	35.12	24.82	35.01	24.97	34.90	25.12	43
44	36.04	25.24	35.93	25.39	35.82	25.55	35.71	25.71	44
45	36.86	25.81	36.75	25.97	36.64	26.13	36.52	26.29	45
46	37.68	26.38	37.57	26.55	37.45	26.71	37.33	26.88	46
47	38.50	26.96	38.38	27.13	38.26	27.29	38.14	27.46	47
48	39.32	27.53	39.20	27.70	39.08	27.87	38.96	28.04	48
49	40.14	28.11	40.02	28.28	39.89	28.45	39.77	28.63	49
50	40.96	28.68	40.83	28.86	40.71	29.04	40.58	29.21	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	55 Deg.		54 $\frac{3}{4}$ Deg.		54 $\frac{1}{2}$ Deg.		54 $\frac{1}{4}$ Deg.		

Distance.	35 Deg.		35¼ Deg.		35½ Deg.		35¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	41.78	29.25	41.65	29.43	41.52	29.62	41.39	29.80	51
52	42.60	29.83	42.47	30.01	42.33	30.20	42.20	30.38	52
53	43.42	30.40	43.28	30.59	43.15	30.78	43.01	30.97	53
54	44.23	30.97	44.10	31.17	43.96	31.36	43.82	31.55	54
55	45.05	31.55	44.92	31.74	44.78	31.94	44.64	32.13	55
56	45.87	32.12	45.73	32.32	45.59	32.52	45.45	32.72	56
57	46.69	32.69	46.55	32.90	46.40	33.10	46.26	33.30	57
58	47.51	33.27	47.37	33.47	47.22	33.68	47.07	33.89	58
59	48.33	33.84	48.18	34.05	48.03	34.26	47.88	34.47	59
60	49.15	34.41	49.00	34.63	48.85	34.84	48.69	35.05	60
61	49.97	34.99	49.82	35.21	49.66	35.42	49.51	35.64	61
62	50.79	35.56	50.63	35.78	50.48	36.00	50.32	36.22	62
63	51.61	36.14	51.45	36.36	51.29	36.58	51.13	36.81	63
64	52.43	36.71	52.27	36.94	52.10	37.16	51.94	37.39	64
65	53.24	37.28	53.08	37.51	52.92	37.75	52.75	37.98	65
66	54.06	37.86	53.90	38.09	53.73	38.33	53.56	38.56	66
67	54.88	38.43	54.71	38.67	54.55	38.91	54.38	39.14	67
68	55.70	39.00	55.53	39.25	55.36	39.49	55.19	39.73	68
69	56.52	39.58	56.35	39.82	56.17	40.07	56.00	40.31	69
70	57.34	40.15	57.16	40.40	56.99	40.65	56.81	40.90	70
71	58.16	40.72	57.98	40.98	57.80	41.23	57.62	41.48	71
72	58.98	41.30	58.80	41.55	58.62	41.81	58.43	42.07	72
73	59.80	41.87	59.61	42.13	59.43	42.39	59.24	42.65	73
74	60.62	42.44	60.43	42.71	60.24	42.97	60.06	43.23	74
75	61.44	43.02	61.25	43.29	61.06	43.55	60.87	43.82	75
76	62.26	43.59	62.06	43.86	61.87	44.13	61.68	44.40	76
77	63.07	44.17	62.88	44.44	62.69	44.71	62.49	44.99	77
78	63.89	44.74	63.70	45.02	63.50	45.29	63.30	45.57	78
79	64.71	45.31	64.51	45.59	64.32	45.88	64.11	46.16	79
80	65.53	45.89	65.33	46.17	65.13	46.46	64.93	46.74	80
81	66.35	46.46	66.15	46.75	65.94	47.04	65.74	47.32	81
82	67.17	47.03	66.96	47.33	66.76	47.62	66.55	47.91	82
83	67.99	47.61	67.78	47.90	67.57	48.20	67.36	48.49	83
84	68.81	48.18	68.60	48.48	68.39	48.78	68.17	49.08	84
85	69.63	48.75	69.41	49.06	69.20	49.36	68.98	49.66	85
86	70.45	49.33	70.23	49.63	70.01	49.94	69.80	50.25	86
87	71.27	49.90	71.05	50.21	70.83	50.52	70.61	50.83	87
88	72.09	50.47	71.86	50.79	71.64	51.10	71.42	51.41	88
89	72.90	51.05	72.68	51.37	72.46	51.68	72.23	52.00	89
90	73.72	51.62	73.50	51.94	73.27	52.26	73.04	52.58	90
91	74.54	52.20	74.31	52.52	74.08	52.84	73.85	53.17	91
92	75.36	52.77	75.13	53.10	74.90	53.42	74.66	53.75	92
93	76.18	53.34	75.95	53.67	75.71	54.01	75.48	54.34	93
94	77.00	53.92	76.76	54.25	76.53	54.59	76.29	54.92	94
95	77.82	54.49	77.58	54.83	77.34	55.17	77.10	55.50	95
96	78.64	55.06	78.40	55.41	78.16	55.75	77.91	56.09	96
97	79.46	55.64	79.21	55.98	78.97	56.33	78.72	56.67	97
98	80.28	56.21	80.03	56.56	79.78	56.91	79.53	57.26	98
99	81.10	56.78	80.85	57.14	80.60	57.49	80.35	57.84	99
100	81.92	57.36	81.66	57.71	81.41	58.07	81.16	58.42	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	55 Deg.		54¾ Deg.		54½ Deg.		54¼ Deg.		

Distance.	36 Deg.		36¼ Deg.		36½ Deg.		36¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.81	0.59	0.81	0.59	0.80	0.59	0.80	0.60	1
2	1.62	1.18	1.61	1.18	1.61	1.19	1.60	1.20	2
3	2.43	1.76	2.42	1.77	2.41	1.78	2.40	1.79	3
4	3.24	2.35	3.23	2.37	3.22	2.38	3.20	2.39	4
5	4.05	2.94	4.03	2.96	4.02	2.97	4.01	2.99	5
6	4.85	3.53	4.84	3.55	4.82	3.57	4.81	3.59	6
7	5.66	4.11	5.65	4.14	5.63	4.16	5.61	4.19	7
8	6.47	4.70	6.45	4.73	6.43	4.76	6.41	4.79	8
9	7.28	5.29	7.26	5.32	7.23	5.35	7.21	5.38	9
10	8.09	5.88	8.06	5.91	8.04	5.95	8.01	5.98	10
11	8.90	6.47	8.87	6.50	8.84	6.54	8.81	6.58	11
12	9.71	7.05	9.68	7.10	9.65	7.14	9.61	7.18	12
13	10.52	7.64	10.48	7.69	10.45	7.73	10.42	7.78	13
14	11.33	8.23	11.29	8.28	11.25	8.33	11.22	8.38	14
15	12.14	8.82	12.10	8.87	12.06	8.92	12.02	8.97	15
16	12.94	9.40	12.90	9.46	12.86	9.52	12.82	9.57	16
17	13.75	9.99	13.71	10.05	13.67	10.11	13.62	10.17	17
18	14.56	10.58	14.52	10.64	14.47	10.71	14.42	10.77	18
19	15.37	11.17	15.32	11.23	15.27	11.30	15.22	11.37	19
20	16.18	11.76	16.13	11.83	16.08	11.90	16.03	11.97	20
21	16.99	12.34	16.94	12.42	16.88	12.49	16.83	12.56	21
22	17.80	12.93	17.74	13.01	17.68	13.09	17.63	13.16	22
23	18.61	13.52	18.55	13.60	18.49	13.68	18.43	13.76	23
24	19.42	14.11	19.35	14.19	19.29	14.28	19.23	14.36	24
25	20.23	14.69	20.16	14.78	20.10	14.87	20.03	14.96	25
26	21.03	15.28	20.97	15.37	20.90	15.47	20.83	15.56	26
27	21.84	15.87	21.77	15.97	21.70	16.06	21.63	16.15	27
28	22.65	16.46	22.58	16.56	22.51	16.65	22.44	16.75	28
29	23.46	17.05	23.39	17.15	23.31	17.25	23.24	17.35	29
30	24.27	17.63	24.19	17.74	24.12	17.84	24.04	17.95	30
31	25.08	18.22	25.00	18.33	24.92	18.44	24.84	18.55	31
32	25.89	18.81	25.81	18.92	25.72	19.03	25.64	19.15	32
33	26.70	19.40	26.61	19.51	26.53	19.63	26.44	19.74	33
34	27.51	19.98	27.42	20.10	27.33	20.22	27.24	20.34	34
35	28.32	20.57	28.23	20.70	28.13	20.82	28.04	20.94	35
36	29.12	21.16	29.03	21.29	28.94	21.41	28.85	21.54	36
37	29.93	21.75	29.84	21.88	29.74	22.01	29.65	22.14	37
38	30.74	22.34	30.64	22.47	30.55	22.60	30.45	22.74	38
39	31.55	22.92	31.45	23.06	31.35	23.20	31.25	23.33	39
40	32.36	23.51	32.26	23.65	32.15	23.79	32.05	23.93	40
41	33.17	24.10	33.06	24.24	32.96	24.39	32.85	24.53	41
42	33.98	24.69	33.87	24.83	33.76	24.98	33.65	25.13	42
43	34.79	25.27	34.68	25.43	34.57	25.58	34.45	25.73	43
44	35.60	25.86	35.48	26.02	35.37	26.17	35.26	26.33	44
45	36.41	26.45	36.29	26.61	36.17	26.77	36.06	26.92	45
46	37.21	27.04	37.10	27.20	36.98	27.36	36.86	27.52	46
47	38.02	27.63	37.90	27.79	37.78	27.96	37.66	28.12	47
48	38.83	28.21	38.71	28.38	38.59	28.55	38.46	28.72	48
49	39.64	28.80	39.52	28.97	39.39	29.15	39.26	29.32	49
50	40.45	29.39	40.32	29.57	40.19	29.74	40.06	29.92	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	54 Deg.		53¼ Deg.		53½ Deg.		53¾ Deg.		

Distance.	36 Deg.		36¼ Deg.		36½ Deg.		36¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	41.26	29.98	41.13	30.16	41.00	30.34	40.86	30.51	51
52	42.07	30.56	41.94	30.75	41.80	30.93	41.67	31.11	52
53	42.88	31.15	42.74	31.34	42.60	31.53	42.47	31.71	53
54	43.69	31.74	43.55	31.93	43.41	32.12	43.27	32.31	54
55	44.50	32.33	44.35	32.52	44.21	32.72	44.07	32.91	55
56	45.30	32.92	45.16	33.11	45.02	33.31	44.87	33.51	56
57	46.11	33.50	45.97	33.70	45.82	33.90	45.67	34.10	57
58	46.92	34.09	46.77	34.30	46.62	34.50	46.47	34.70	58
59	47.73	34.68	47.58	34.89	47.43	35.09	47.27	35.30	59
60	48.54	35.27	48.39	35.48	48.23	35.69	48.08	35.90	60
61	49.35	35.85	49.19	36.07	49.04	36.28	48.88	36.50	61
62	50.16	36.44	50.00	36.66	49.84	36.88	49.68	37.10	62
63	50.97	37.03	50.81	37.25	50.64	37.47	50.48	37.69	63
64	51.78	37.62	51.61	37.84	51.45	38.07	51.28	38.29	64
65	52.59	38.21	52.42	38.44	52.25	38.66	52.08	38.89	65
66	53.40	38.79	53.23	39.03	53.05	39.26	52.88	39.49	66
67	54.20	39.38	54.03	39.62	53.86	39.85	53.68	40.09	67
68	55.01	39.97	54.84	40.21	54.66	40.45	54.49	40.69	68
69	55.82	40.56	55.64	40.80	55.47	41.04	55.29	41.28	69
70	56.63	41.14	56.45	41.39	56.27	41.64	56.09	41.88	70
71	57.44	41.73	57.26	41.98	57.07	42.23	56.89	42.48	71
72	58.25	42.32	58.06	42.57	57.88	42.83	57.69	43.08	72
73	59.06	42.91	58.87	43.17	58.68	43.42	58.49	43.68	73
74	59.87	43.50	59.68	43.76	59.49	44.02	59.29	44.28	74
75	60.68	44.08	60.48	44.35	60.29	44.61	60.09	44.87	75
76	61.49	44.67	61.29	44.94	61.09	45.21	60.90	45.47	76
77	62.29	45.26	62.10	45.53	61.90	45.80	61.70	46.07	77
78	63.10	45.85	62.90	46.12	62.70	46.40	62.50	46.67	78
79	63.91	46.43	63.71	46.71	63.50	46.99	63.30	47.27	79
80	64.72	47.02	64.52	47.30	64.31	47.59	64.10	47.87	80
81	65.53	47.61	65.32	47.90	65.11	48.18	64.90	48.46	81
82	66.34	48.20	66.13	48.49	65.92	48.78	65.70	49.06	82
83	67.15	48.79	66.93	49.08	66.72	49.37	66.50	49.66	83
84	67.96	49.37	67.74	49.67	67.52	49.97	67.31	50.26	84
85	68.77	49.96	68.55	50.26	68.33	50.56	68.11	50.86	85
86	69.58	50.55	69.35	50.85	69.13	51.15	68.91	51.46	86
87	70.38	51.14	70.16	51.44	69.94	51.75	69.71	52.05	87
88	71.19	51.73	70.97	52.04	70.74	52.34	70.51	52.65	88
89	72.00	52.31	71.77	52.63	71.54	52.94	71.31	53.25	89
90	72.81	52.90	72.58	53.22	72.35	53.53	72.11	53.85	90
91	73.62	53.49	73.39	53.81	73.15	54.13	72.91	54.45	91
92	74.43	54.08	74.19	54.40	73.95	54.72	73.72	55.05	92
93	75.24	54.66	75.00	54.99	74.76	55.32	74.52	55.64	93
94	76.05	55.25	75.81	55.58	75.56	55.91	75.32	56.24	94
95	76.86	55.84	76.61	56.17	76.37	56.51	76.12	56.84	95
96	77.67	56.43	77.42	56.77	77.17	57.10	76.92	57.44	96
97	78.47	57.02	78.23	57.36	77.97	57.70	77.72	58.04	97
98	79.28	57.60	79.03	57.95	78.78	58.29	78.52	58.64	98
99	80.09	58.19	79.84	58.54	79.58	58.89	79.32	59.23	99
100	80.90	58.78	80.64	59.13	80.39	59.48	80.13	59.83	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	54 Deg.		53¼ Deg.		53½ Deg.		53¾ Deg.		

Distance.	37 Deg.		37½ Deg.		37¾ Deg.		37¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.80	0.60	0.80	0.61	0.79	0.61	0.79	0.61	1
2	1.60	1.20	1.59	1.21	1.59	1.22	1.58	1.22	2
3	2.40	1.81	2.39	1.82	2.38	1.83	2.37	1.84	3
4	3.19	2.41	3.18	2.42	3.17	2.13	3.16	2.45	4
5	3.99	3.01	3.98	3.03	3.97	3.04	3.95	3.06	5
6	4.79	3.61	4.78	3.63	4.76	3.65	4.74	3.67	6
7	5.59	4.21	5.57	4.24	5.55	4.26	5.53	4.29	7
8	6.39	4.81	6.37	4.84	6.35	4.87	6.33	4.90	8
9	7.19	5.42	7.16	5.45	7.14	5.48	7.12	5.51	9
10	7.99	6.02	7.96	6.05	7.93	6.09	7.91	6.12	10
11	8.78	6.62	8.76	6.66	8.73	6.70	8.70	6.73	11
12	9.58	7.22	9.55	7.26	9.52	7.31	9.49	7.35	12
13	10.38	7.82	10.35	7.87	10.31	7.91	10.28	7.96	13
14	11.18	8.43	11.14	8.47	11.11	8.52	11.07	8.57	14
15	11.98	9.03	11.94	9.08	11.90	9.13	11.86	9.18	15
16	12.78	9.63	12.74	9.68	12.69	9.74	12.65	9.80	16
17	13.58	10.23	13.53	10.29	13.49	10.35	13.44	10.41	17
18	14.38	10.83	14.33	10.90	14.28	10.96	14.23	11.02	18
19	15.17	11.43	15.12	11.50	15.07	11.57	15.02	11.63	19
20	15.97	12.04	15.92	12.11	15.87	12.18	15.81	12.24	20
21	16.77	12.64	16.72	12.71	16.66	12.78	16.60	12.86	21
22	17.57	13.24	17.51	13.32	17.45	13.39	17.40	13.47	22
23	18.37	13.84	18.31	13.92	18.25	14.00	18.19	14.08	23
24	19.17	14.44	19.10	14.53	19.04	14.61	18.98	14.69	24
25	19.97	15.05	19.90	15.13	19.83	15.22	19.77	15.31	25
26	20.76	15.65	20.70	15.74	20.63	15.83	20.56	15.92	26
27	21.56	16.25	21.49	16.34	21.42	16.44	21.35	16.53	27
28	22.36	16.85	22.29	16.95	22.21	17.05	22.14	17.14	28
29	23.16	17.45	23.08	17.55	23.01	17.65	22.93	17.75	29
30	23.96	18.05	23.88	18.16	23.80	18.26	23.72	18.37	30
31	24.76	18.66	24.68	18.76	24.59	18.87	24.51	18.98	31
32	25.56	19.26	25.47	19.37	25.39	19.48	25.30	19.59	32
33	26.35	19.86	26.27	19.97	26.18	20.09	26.09	20.20	33
34	27.15	20.46	27.06	20.58	26.97	20.70	26.88	20.82	34
35	27.95	21.06	27.86	21.19	27.77	21.31	27.67	21.43	35
36	28.75	21.67	28.66	21.79	28.56	21.92	28.46	22.04	36
37	29.55	22.27	29.45	22.40	29.35	22.52	29.26	22.65	37
38	30.35	22.87	30.25	23.00	30.15	23.13	30.05	23.26	38
39	31.15	23.47	31.04	23.61	30.94	23.74	30.84	23.88	39
40	31.95	24.07	31.84	24.21	31.73	24.35	31.63	24.49	40
41	32.74	24.67	32.64	24.82	32.53	24.96	32.42	25.10	41
42	33.54	25.28	33.43	25.42	33.32	25.57	33.21	25.71	42
43	34.34	25.88	34.23	26.03	34.11	26.18	34.00	26.33	43
44	35.14	26.48	35.02	26.63	34.91	26.79	34.79	26.94	44
45	35.94	27.08	35.82	27.24	35.70	27.39	35.58	27.55	45
46	36.74	27.68	36.62	27.84	36.49	28.00	36.37	28.16	46
47	37.54	28.29	37.41	28.45	37.29	28.61	37.16	28.77	47
48	38.33	28.89	38.21	29.05	38.08	29.22	37.95	29.39	48
49	39.13	29.49	39.00	29.66	38.87	29.83	38.74	30.00	49
50	39.93	30.09	39.80	30.26	39.67	30.44	39.53	30.61	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	53 Deg.		52½ Deg.		52½ Deg.		52½ Deg.		

Distance.	37 Deg.		37½ Deg.		37¾ Deg.		37¾ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	40.73	30.69	40.60	30.87	40.46	31.05	40.33	31.22	51
52	41.53	31.29	41.39	31.48	41.25	31.66	41.12	31.84	52
53	42.33	31.90	42.19	32.08	42.05	32.26	41.91	32.45	53
54	43.13	32.50	42.98	32.69	42.84	32.87	42.70	33.06	54
55	43.92	33.10	43.78	33.29	43.63	33.48	43.49	33.67	55
56	44.72	33.70	44.58	33.90	44.43	34.09	44.28	34.28	56
57	45.52	34.30	45.37	34.50	45.22	34.70	45.07	34.90	57
58	46.32	34.91	46.17	35.11	46.01	35.31	45.86	35.51	58
59	47.12	35.51	46.96	35.71	46.81	35.92	46.65	36.12	59
60	47.92	36.11	47.76	36.32	47.60	36.53	47.44	36.73	60
61	48.72	36.71	48.56	36.92	48.39	37.13	48.23	37.35	61
62	49.52	37.31	49.35	37.53	49.19	37.74	49.02	37.96	62
63	50.31	37.91	50.15	38.13	49.98	38.35	49.81	38.57	63
64	51.11	38.52	50.94	38.74	50.77	38.96	50.60	39.18	64
65	51.91	39.12	51.74	39.34	51.57	39.57	51.39	39.79	65
66	52.71	39.72	52.54	39.95	52.36	40.18	52.19	40.41	66
67	53.51	40.32	53.33	40.55	53.15	40.79	52.98	41.02	67
68	54.31	40.92	54.13	41.16	53.95	41.40	53.77	41.63	68
69	55.11	41.53	54.92	41.77	54.74	42.00	54.56	42.24	69
70	55.90	42.13	55.72	42.37	55.53	42.61	55.35	42.86	70
71	56.70	42.73	56.52	42.98	56.33	43.22	56.14	43.47	71
72	57.50	43.33	57.31	43.58	57.12	43.83	56.93	44.08	72
73	58.30	43.93	58.11	44.19	57.91	44.44	57.72	44.69	73
74	59.10	44.53	58.90	44.79	58.71	45.05	58.51	45.30	74
75	59.90	45.14	59.70	45.40	59.50	45.66	59.30	45.92	75
76	60.70	45.74	60.50	46.00	60.29	46.27	60.09	46.53	76
77	61.49	46.34	61.29	46.61	61.09	46.87	60.88	47.14	77
78	62.29	46.94	62.09	47.21	61.88	47.48	61.67	47.75	78
79	63.09	47.54	62.88	47.82	62.67	48.09	62.46	48.37	79
80	63.89	48.15	63.68	48.42	63.47	48.70	63.26	48.98	80
81	64.69	48.75	64.48	49.03	64.26	49.31	64.05	49.59	81
82	65.49	49.35	65.27	49.63	65.05	49.92	64.84	50.20	82
83	66.29	49.95	66.07	50.24	65.85	50.53	65.63	50.81	83
84	67.09	50.55	66.86	50.84	66.64	51.14	66.42	51.43	84
85	67.88	51.15	67.66	51.45	67.43	51.74	67.21	52.04	85
86	68.68	51.76	68.46	52.06	68.23	52.35	68.00	52.65	86
87	69.48	52.36	69.25	52.66	69.02	52.96	68.79	53.26	87
88	70.28	52.96	70.05	53.27	69.82	53.57	69.58	53.88	88
89	71.08	53.56	70.84	53.87	70.61	54.18	70.37	54.49	89
90	71.88	54.16	71.64	54.48	71.40	54.79	71.16	55.10	90
91	72.68	54.77	72.44	55.08	72.20	55.40	71.95	55.71	91
92	73.47	55.37	73.23	55.69	72.99	56.01	72.74	56.32	92
93	74.27	55.97	74.03	56.29	73.78	56.61	73.53	56.94	93
94	75.07	56.57	74.82	56.90	74.58	57.22	74.32	57.55	94
95	75.87	57.17	75.62	57.50	75.37	57.83	75.12	58.16	95
96	76.67	57.77	76.42	58.11	76.16	58.44	75.91	58.77	96
97	77.47	58.38	77.21	58.71	76.96	59.05	76.70	59.39	97
98	78.27	58.98	78.01	59.32	77.75	59.66	77.49	60.00	98
99	79.06	59.58	78.80	59.92	78.54	60.27	78.28	60.61	99
100	79.86	60.18	79.60	60.53	79.34	60.88	79.07	61.22	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	53 Deg.		52¾ Deg.		52½ Deg.		52¼ Deg.		

Distance.	38 Deg.		38½ Deg.		38¾ Deg.		39¼ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.79	0.62	0.79	0.62	0.78	0.62	0.78	0.63	1
2	1.58	1.23	1.57	1.24	1.57	1.24	1.56	1.25	2
3	2.36	1.85	2.36	1.86	2.35	1.87	2.34	1.88	3
4	3.15	2.46	3.14	2.48	3.13	2.49	3.12	2.50	4
5	3.94	3.08	3.93	3.10	3.91	3.11	3.90	3.13	5
6	4.73	3.69	4.71	3.71	4.70	3.74	4.68	3.76	6
7	5.52	4.31	5.50	4.33	5.48	4.36	5.46	4.38	7
8	6.30	4.93	6.28	4.95	6.26	4.98	6.24	5.01	8
9	7.09	5.54	7.07	5.57	7.04	5.60	7.02	5.63	9
10	7.88	6.16	7.85	6.19	7.83	6.23	7.80	6.26	10
11	8.67	6.77	8.64	6.81	8.61	6.85	8.58	6.89	11
12	9.46	7.39	9.42	7.43	9.39	7.47	9.36	7.51	12
13	10.24	8.00	10.21	8.05	10.17	8.09	10.14	8.14	13
14	11.03	8.62	10.99	8.67	10.96	8.72	10.92	8.76	14
15	11.82	9.23	11.78	9.29	11.74	9.34	11.70	9.39	15
16	12.61	9.85	12.57	9.91	12.52	9.96	12.48	10.01	16
17	13.40	10.47	13.35	10.52	13.30	10.58	13.26	10.64	17
18	14.18	11.08	14.14	11.14	14.09	11.21	14.04	11.27	18
19	14.97	11.70	14.92	11.76	14.87	11.83	14.82	11.89	19
20	15.76	12.31	15.71	12.38	15.65	12.45	15.60	12.52	20
21	16.55	12.93	16.49	13.00	16.43	13.07	16.38	13.14	21
22	17.34	13.54	17.28	13.62	17.22	13.70	17.16	13.77	22
23	18.12	14.16	18.06	14.24	18.00	14.32	17.94	14.40	23
24	18.91	14.78	18.85	14.86	18.78	14.94	18.72	15.02	24
25	19.70	15.39	19.63	15.48	19.57	15.56	19.50	15.65	25
26	20.49	16.01	20.42	16.10	20.35	16.19	20.28	16.27	26
27	21.28	16.62	21.20	16.72	21.13	16.81	21.06	16.90	27
28	22.06	17.24	21.99	17.33	21.91	17.43	21.84	17.53	28
29	22.85	17.85	22.77	17.95	22.70	18.05	22.62	18.15	29
30	23.64	18.47	23.56	18.57	23.48	18.68	23.40	18.78	30
31	24.43	19.09	24.34	19.19	24.26	19.30	24.18	19.40	31
32	25.22	19.70	25.13	19.81	25.04	19.92	24.96	20.03	32
33	26.00	20.32	25.92	20.43	25.83	20.54	25.74	20.66	33
34	26.79	20.93	26.70	21.05	26.61	21.17	26.52	21.28	34
35	27.58	21.55	27.49	21.67	27.39	21.79	27.30	21.91	35
36	28.37	22.16	28.27	22.29	28.17	22.41	28.08	22.53	36
37	29.16	22.78	29.06	22.91	28.96	23.03	28.86	23.16	37
38	29.94	23.40	29.84	23.53	29.74	23.66	29.64	23.79	38
39	30.73	24.01	30.63	24.14	30.52	24.28	30.42	24.41	39
40	31.52	24.63	31.41	24.76	31.30	24.90	31.20	25.04	40
41	32.31	25.24	32.20	25.38	32.09	25.52	31.98	25.66	41
42	33.10	25.86	32.98	26.00	32.87	26.15	32.76	26.29	42
43	33.88	26.47	33.77	26.62	33.65	26.77	33.53	26.91	43
44	34.67	27.09	34.55	27.24	34.43	27.39	34.31	27.54	44
45	35.46	27.70	35.34	27.86	35.22	28.01	35.09	28.17	45
46	36.25	28.32	36.12	28.48	36.00	28.64	35.87	28.79	46
47	37.04	28.94	36.91	29.10	36.78	29.26	36.65	29.42	47
48	37.82	29.55	37.70	29.72	37.57	29.88	37.43	30.04	48
49	38.61	30.17	38.48	30.34	38.35	30.50	38.21	30.67	49
50	39.40	30.78	39.27	30.95	39.13	31.13	38.99	31.30	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	52 Deg		51½ Deg.		51¼ Deg.		51¼ Deg.		

Distance.	38 Deg.		38½ Deg.		38¾ Deg.		39¼ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	40.19	31.40	40.05	31.57	39.91	31.75	39.77	31.92	51
52	40.98	32.01	40.84	32.19	40.70	32.37	40.55	32.55	52
53	41.76	32.63	41.62	32.81	41.48	32.99	41.33	33.17	53
54	42.55	33.25	42.41	33.43	42.26	33.62	42.11	33.80	54
55	43.34	33.86	43.19	34.05	43.04	34.24	42.89	34.43	55
56	44.13	34.48	43.98	34.67	43.83	34.86	43.67	35.05	56
57	44.92	35.09	44.76	35.29	44.61	35.48	44.45	35.68	57
58	45.70	35.71	45.55	35.91	45.39	36.11	45.23	36.30	58
59	46.49	36.32	46.33	36.53	46.17	36.73	46.01	36.93	59
60	47.28	36.94	47.12	37.15	46.96	37.35	46.79	37.56	60
61	48.07	37.56	47.90	37.76	47.74	37.97	47.57	38.18	61
62	48.86	38.17	48.69	38.38	48.52	38.60	48.35	38.81	62
63	49.64	38.79	49.47	39.00	49.30	39.22	49.13	39.43	63
64	50.43	39.40	50.26	39.62	50.09	39.84	49.91	40.06	64
65	51.22	40.02	51.05	40.24	50.87	40.46	50.69	40.68	65
66	52.01	40.63	51.83	40.86	51.65	41.09	51.47	41.31	66
67	52.80	41.25	52.62	41.48	52.43	41.71	52.25	41.94	67
68	53.58	41.86	53.40	42.10	53.22	42.33	53.03	42.56	68
69	54.37	42.48	54.19	42.72	54.00	42.95	53.81	43.19	69
70	55.16	43.10	54.97	43.34	54.78	43.58	54.59	43.81	70
71	55.95	43.71	55.76	43.96	55.57	44.20	55.37	44.44	71
72	56.74	44.33	56.54	44.57	56.35	44.82	56.15	45.07	72
73	57.52	44.94	57.33	45.19	57.13	45.44	56.93	45.69	73
74	58.31	45.56	58.11	45.81	57.91	46.07	57.71	46.32	74
75	59.10	46.17	58.90	46.43	58.70	46.69	58.49	46.94	75
76	59.89	46.79	59.68	47.05	59.48	47.31	59.27	47.57	76
77	60.68	47.41	60.47	47.67	60.26	47.93	60.05	48.20	77
78	61.46	48.02	61.25	48.29	61.04	48.56	60.83	48.82	78
79	62.25	48.64	62.04	48.91	61.83	49.18	61.61	49.45	79
80	63.04	49.25	62.83	49.53	62.61	49.80	62.39	50.07	80
81	63.83	49.87	63.61	50.15	63.39	50.42	63.17	50.70	81
82	64.62	50.48	64.40	50.77	64.17	51.05	63.95	51.33	82
83	65.40	51.10	65.18	51.38	64.96	51.67	64.73	51.95	83
84	66.19	51.72	65.97	52.00	65.74	52.29	65.51	52.58	84
85	66.98	52.33	66.75	52.62	66.52	52.91	66.29	53.20	85
86	67.77	52.95	67.54	53.24	67.30	53.54	67.07	53.83	86
87	68.56	53.56	68.32	53.86	68.09	54.16	67.85	54.46	87
88	69.34	54.18	69.11	54.48	68.87	54.78	68.63	55.08	88
89	70.13	54.79	69.89	55.10	69.65	55.40	69.41	55.71	89
90	70.92	55.41	70.68	55.72	70.43	56.03	70.19	56.33	90
91	71.71	56.03	71.46	56.34	71.22	56.65	70.97	56.96	91
92	72.50	56.64	72.25	56.96	72.00	57.27	71.75	57.58	92
93	73.28	57.26	73.03	57.58	72.78	57.89	72.53	58.21	93
94	74.07	57.87	73.82	58.19	73.57	58.52	73.31	58.84	94
95	74.86	58.49	74.61	58.81	74.35	59.14	74.09	59.46	95
96	75.65	59.10	75.39	59.43	75.13	59.76	74.87	60.09	96
97	76.44	59.72	76.18	60.05	75.91	60.38	75.65	60.71	97
98	77.22	60.33	76.96	60.67	76.70	61.01	76.43	61.34	98
99	78.01	60.95	77.75	61.29	77.48	61.63	77.21	61.97	99
100	78.80	61.57	78.53	61.91	78.26	62.25	77.99	62.59	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	52 Deg.		51¾ Deg.		51½ Deg.		51¼ Deg.		

Distance.	39 Deg.		39 $\frac{1}{4}$ Deg.		39 $\frac{1}{2}$ Deg.		39 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.78	0.63	0.77	0.63	0.77	0.64	0.77	0.64	1
2	1.55	1.26	1.55	1.27	1.54	1.27	1.54	1.28	2
3	2.33	1.89	2.32	1.90	2.31	1.91	2.31	1.92	3
4	3.11	2.52	3.10	2.53	3.09	2.54	3.08	2.56	4
5	3.89	3.15	3.87	3.16	3.86	3.18	3.84	3.20	5
6	4.66	3.78	4.65	3.80	4.63	3.82	4.61	3.84	6
7	5.44	4.41	5.42	4.43	5.40	4.45	5.38	4.48	7
8	6.22	5.03	6.20	5.06	6.17	5.09	6.15	5.12	8
9	6.99	5.66	6.97	5.69	6.94	5.72	6.92	5.75	9
10	7.77	6.29	7.74	6.33	7.72	6.36	7.69	6.39	10
11	8.55	6.92	8.52	6.96	8.49	7.00	8.46	7.03	11
12	9.33	7.55	9.29	7.59	9.26	7.63	9.23	7.67	12
13	10.10	8.18	10.07	8.23	10.03	8.27	9.99	8.31	13
14	10.88	8.81	10.84	8.86	10.80	8.91	10.76	8.95	14
15	11.66	9.44	11.62	9.49	11.57	9.54	11.53	9.59	15
16	12.43	10.07	12.39	10.12	12.35	10.18	12.30	10.23	16
17	13.21	10.70	13.16	10.76	13.12	10.81	13.07	10.87	17
18	13.99	11.33	13.94	11.39	13.89	11.45	13.84	11.51	18
19	14.77	11.96	14.71	12.02	14.66	12.09	14.61	12.15	19
20	15.54	12.59	15.49	12.65	15.43	12.72	15.38	12.79	20
21	16.32	13.22	16.26	13.29	16.20	13.36	16.15	13.43	21
22	17.10	13.84	17.04	13.92	16.98	13.99	16.91	14.07	22
23	17.87	14.47	17.81	14.55	17.75	14.63	17.68	14.71	23
24	18.65	15.10	18.59	15.18	18.52	15.27	18.45	15.35	24
25	19.43	15.73	19.36	15.82	19.29	15.90	19.22	15.99	25
26	20.21	16.36	20.13	16.45	20.06	16.54	19.99	16.63	26
27	20.98	16.99	20.91	17.08	20.83	17.17	20.76	17.26	27
28	21.76	17.62	21.68	17.72	21.61	17.81	21.53	17.90	28
29	22.54	18.25	22.46	18.35	22.38	18.45	22.30	18.54	29
30	23.31	18.88	23.23	18.98	23.15	19.08	23.07	19.18	30
31	24.09	19.51	24.01	19.61	23.92	19.72	23.83	19.82	31
32	24.87	20.14	24.78	20.25	24.69	20.35	24.60	20.46	32
33	25.65	20.77	25.55	20.88	25.46	20.99	25.37	21.10	33
34	26.42	21.40	26.33	21.51	26.24	21.63	26.14	21.74	34
35	27.20	22.03	27.10	22.14	27.01	22.26	26.91	22.38	35
36	27.98	22.66	27.88	22.78	27.78	22.90	27.68	23.02	36
37	28.75	23.28	28.65	23.41	28.55	23.53	28.45	23.66	37
38	29.53	23.91	29.43	24.04	29.32	24.17	29.22	24.30	38
39	30.31	24.54	30.20	24.68	30.09	24.81	29.98	24.94	39
40	31.09	25.17	30.98	25.31	30.86	25.44	30.75	25.58	40
41	31.86	25.80	31.75	25.94	31.64	26.08	31.52	26.22	41
42	32.64	26.43	32.52	26.57	32.41	26.72	32.29	26.86	42
43	33.42	27.06	33.30	27.21	33.18	27.35	33.06	27.50	43
44	34.19	27.69	34.07	27.84	33.95	27.99	33.83	28.14	44
45	34.97	28.32	34.85	28.47	34.72	28.62	34.60	28.77	45
46	35.75	28.95	35.62	29.10	35.49	29.26	35.37	29.41	46
47	36.53	29.58	36.40	29.74	36.27	29.90	36.14	30.05	47
48	37.30	30.21	37.17	30.37	37.04	30.53	36.90	30.69	48
49	38.08	30.84	37.95	31.00	37.81	31.17	37.67	31.33	49
50	38.86	31.47	38.72	31.64	38.58	31.80	38.44	31.97	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	51 Deg.		50 $\frac{3}{4}$ Deg.		50 $\frac{1}{2}$ Deg.		50 $\frac{1}{4}$ Deg.		

Distance.	39 Deg.		39 $\frac{1}{4}$ Deg.		39 $\frac{1}{2}$ Deg.		39 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	39.63	32.10	39.49	32.27	39.35	32.44	39.21	32.61	51
52	40.41	32.72	40.27	32.90	40.12	33.08	39.98	33.25	52
53	41.19	33.35	41.04	33.53	40.90	33.71	40.75	33.89	53
54	41.97	33.98	41.82	34.17	41.67	34.35	41.52	34.53	54
55	42.74	34.61	42.59	34.80	42.44	34.98	42.29	35.17	55
56	43.52	35.24	43.37	35.43	43.21	35.62	43.06	35.81	56
57	44.30	35.87	44.14	36.06	43.98	36.26	43.82	36.45	57
58	45.07	36.50	44.91	36.70	44.75	36.89	44.59	37.09	58
59	45.85	37.13	45.69	37.33	45.53	37.53	45.36	37.73	59
60	46.63	37.76	46.46	37.96	46.30	38.16	46.13	38.37	60
61	47.41	38.39	47.24	38.60	47.07	38.80	46.90	39.01	61
62	48.18	39.02	48.01	39.23	47.84	39.44	47.67	39.65	62
63	48.96	39.65	48.79	39.86	48.61	40.07	48.44	40.28	63
64	49.74	40.28	49.56	40.49	49.38	40.71	49.21	40.92	64
65	50.51	40.91	50.34	41.13	50.16	41.35	49.97	41.56	65
66	51.29	41.54	51.11	41.76	50.93	41.98	50.74	42.20	66
67	52.07	42.16	51.88	42.39	51.70	42.62	51.51	42.84	67
68	52.85	42.79	52.66	43.02	52.47	43.25	52.28	43.48	68
69	53.52	43.42	53.43	43.66	53.24	43.89	53.05	44.12	69
70	54.40	44.05	54.21	44.29	54.01	44.53	53.82	44.76	70
71	55.18	44.68	54.98	44.92	54.79	45.16	54.59	45.40	71
72	55.95	45.31	55.76	45.55	55.56	45.80	55.36	46.04	72
73	56.73	45.94	56.53	46.19	56.33	46.43	56.13	46.68	73
74	57.51	46.57	57.31	46.82	57.10	47.07	56.89	47.32	74
75	58.29	47.20	58.08	47.45	57.87	47.71	57.66	47.96	75
76	59.06	47.83	58.85	48.09	58.64	48.34	58.43	48.60	76
77	59.84	48.46	59.63	48.72	59.42	48.98	59.20	49.24	77
78	60.62	49.09	60.40	49.35	60.19	49.61	59.97	49.88	78
79	61.39	49.72	61.18	49.98	60.96	50.25	60.74	50.52	79
80	62.17	50.35	61.95	50.62	61.73	50.89	61.51	51.16	80
81	62.95	50.97	62.73	51.25	62.50	51.52	62.28	51.79	81
82	63.73	51.60	63.50	51.88	63.27	52.16	63.04	52.43	82
83	64.50	52.23	64.27	52.51	64.04	52.79	63.81	53.07	83
84	65.28	52.86	65.05	53.15	64.82	53.43	64.58	53.71	84
85	66.06	53.49	65.82	53.78	65.59	54.07	65.35	54.35	85
86	66.83	54.12	66.60	54.41	66.36	54.70	66.12	54.99	86
87	67.61	54.75	67.37	55.05	67.13	55.34	66.89	55.63	87
88	68.39	55.38	68.15	55.68	67.90	55.97	67.66	56.27	88
89	69.17	56.01	68.92	56.32	68.67	56.61	68.43	56.91	89
90	69.94	56.64	69.70	56.94	69.45	57.25	69.20	57.55	90
91	70.72	57.27	70.47	57.58	70.22	57.88	69.96	58.19	91
92	71.50	57.90	71.24	58.21	70.99	58.52	70.73	58.83	92
93	72.27	58.53	72.02	58.84	71.76	59.16	71.50	59.47	93
94	73.05	59.16	72.79	59.47	72.53	59.79	72.27	60.11	94
95	73.83	59.79	73.57	60.11	73.30	60.43	73.04	60.75	95
96	74.61	60.41	74.34	60.74	74.08	61.06	73.81	61.39	96
97	75.38	61.04	75.12	61.37	74.85	61.70	74.58	62.03	97
98	76.16	61.67	75.89	62.01	75.62	62.34	75.35	62.66	98
99	76.94	62.30	76.66	62.64	76.39	62.97	76.12	63.30	99
100	77.71	62.93	77.44	63.27	77.16	63.61	76.88	63.94	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	51 Deg.		50 $\frac{3}{4}$ Deg.		50 $\frac{1}{2}$ Deg.		50 $\frac{1}{4}$ Deg.		

Distance.	40 Deg.		40 $\frac{1}{4}$ Deg.		40 $\frac{1}{2}$ Deg.		40 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.77	0.64	0.76	0.65	0.76	0.65	0.76	0.65	1
2	1.53	1.29	1.53	1.29	1.52	1.30	1.52	1.31	2
3	2.30	1.93	2.29	1.94	2.28	1.95	2.27	1.96	3
4	3.06	2.57	3.05	2.58	3.04	2.60	3.03	2.61	4
5	3.83	3.21	3.82	3.23	3.80	3.25	3.79	3.26	5
6	4.60	3.86	4.58	3.88	4.56	3.90	4.55	3.92	6
7	5.36	4.50	5.34	4.52	5.32	4.55	5.30	4.57	7
8	6.13	5.14	6.11	5.17	6.08	5.20	6.06	5.22	8
9	6.89	5.79	6.87	5.82	6.84	5.84	6.82	5.87	9
10	7.66	6.43	7.63	6.46	7.60	6.49	7.58	6.53	10
11	8.43	7.07	8.40	7.11	8.36	7.14	8.33	7.18	11
12	9.19	7.71	9.16	7.75	9.12	7.79	9.09	7.83	12
13	9.96	8.36	9.92	8.40	9.89	8.44	9.85	8.49	13
14	10.72	9.00	10.69	9.05	10.65	9.09	10.61	9.14	14
15	11.49	9.64	11.45	9.69	11.41	9.74	11.36	9.79	15
16	12.26	10.28	12.21	10.34	12.17	10.39	12.12	10.44	16
17	13.02	10.93	12.97	10.98	12.93	11.04	12.88	11.10	17
18	13.79	11.57	13.74	11.63	13.69	11.69	13.64	11.75	18
19	14.55	12.21	14.50	12.28	14.45	12.34	14.39	12.40	19
20	15.32	12.86	15.26	12.92	15.21	12.99	15.15	13.06	20
21	16.09	13.50	16.03	13.57	15.97	13.64	15.91	13.71	21
22	16.85	14.14	16.79	14.21	16.73	14.29	16.67	14.36	22
23	17.62	14.78	17.55	14.86	17.49	14.94	17.42	15.01	23
24	18.39	15.43	18.32	15.51	18.25	15.59	18.18	15.67	24
25	19.15	16.07	19.08	16.15	19.01	16.24	18.94	16.32	25
26	19.92	16.71	19.84	16.80	19.77	16.89	19.70	16.97	26
27	20.68	17.36	20.61	17.45	20.53	17.54	20.45	17.62	27
28	21.45	18.00	21.37	18.09	21.29	18.18	21.21	18.28	28
29	22.22	18.64	22.13	18.74	22.05	18.83	21.97	18.93	29
30	22.98	19.28	22.90	19.38	22.81	19.48	22.73	19.58	30
31	23.75	19.93	23.66	20.03	23.57	20.13	23.48	20.24	31
32	24.51	20.57	24.42	20.68	24.33	20.78	24.24	20.89	32
33	25.28	21.21	25.19	21.32	25.09	21.43	25.00	21.54	33
34	26.05	21.85	25.95	21.97	25.85	22.08	25.76	22.19	34
35	26.81	22.50	26.71	22.61	26.61	22.73	26.51	22.85	35
36	27.58	23.14	27.48	23.26	27.37	23.38	27.27	23.50	36
37	28.34	23.78	28.24	23.91	28.13	24.03	28.03	24.15	37
38	29.11	24.43	29.00	24.55	28.90	24.68	28.79	24.80	38
39	29.88	25.07	29.77	25.20	29.66	25.33	29.54	25.46	39
40	30.64	25.71	30.53	25.84	30.42	25.98	30.30	26.11	40
41	31.41	26.35	31.29	26.49	31.18	26.63	31.06	26.76	41
42	32.17	27.00	32.06	27.14	31.94	27.28	31.82	27.42	42
43	32.94	27.64	32.82	27.78	32.70	27.93	32.58	28.07	43
44	33.71	28.28	33.58	28.43	33.46	28.58	33.33	28.72	44
45	34.47	28.93	34.35	29.08	34.22	29.23	34.09	29.37	45
46	35.24	29.57	35.11	29.72	34.98	29.87	34.85	30.03	46
47	36.00	30.21	35.87	30.37	35.74	30.52	35.61	30.68	47
48	36.77	30.85	36.64	31.01	36.50	31.17	36.36	31.33	48
49	37.54	31.50	37.40	31.66	37.26	31.82	37.12	31.99	49
50	38.30	32.14	38.16	32.31	38.02	32.47	37.88	32.64	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	50 Deg.		49 $\frac{1}{4}$ Deg.		49 $\frac{1}{2}$ Deg.		49 $\frac{3}{4}$ Deg.		

Distance.	40 Deg.		40 $\frac{1}{4}$ Deg.		40 $\frac{1}{2}$ Deg.		40 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	39.07	32.78	38.92	32.95	38.78	33.12	38.64	33.29	51
52	39.83	33.42	39.69	33.60	39.54	33.77	39.39	33.94	52
53	40.60	34.07	40.45	34.24	40.30	34.42	40.15	34.60	53
54	41.37	34.71	41.21	34.89	41.06	35.07	40.91	35.25	54
55	42.13	35.35	41.98	35.54	41.82	35.72	41.67	35.90	55
56	42.90	36.00	42.74	36.18	42.58	36.37	42.42	36.55	56
57	43.66	36.64	43.50	36.83	43.34	37.02	43.18	37.21	57
58	44.43	37.28	44.27	37.48	44.10	37.67	43.94	37.86	58
59	45.20	37.92	45.03	38.12	44.86	38.32	44.70	38.51	59
60	45.96	38.57	45.79	38.77	45.62	38.97	45.45	39.17	60
61	46.73	39.21	46.56	39.41	46.38	39.62	46.21	39.82	61
62	47.49	39.85	47.32	40.06	47.15	40.27	46.97	40.47	62
63	48.26	40.50	48.08	40.71	47.91	40.92	47.73	41.12	63
64	49.03	41.14	48.85	41.35	48.67	41.56	48.48	41.78	64
65	49.79	41.78	49.61	42.00	49.43	42.21	49.24	42.43	65
66	50.56	42.42	50.37	42.64	50.19	42.86	50.00	43.08	66
67	51.32	43.07	51.14	43.29	50.95	43.51	50.76	43.73	67
68	52.09	43.71	51.90	43.94	51.71	44.16	51.51	44.39	68
69	52.86	44.35	52.66	44.58	52.47	44.81	52.27	45.04	69
70	53.62	45.00	53.43	45.23	53.23	45.46	53.03	45.69	70
71	54.39	45.64	54.19	45.87	53.99	46.11	53.79	46.35	71
72	55.16	46.28	54.95	46.52	54.75	46.76	54.54	47.00	72
73	55.92	46.92	55.72	47.17	55.51	47.41	55.30	47.65	73
74	56.69	47.57	56.48	47.81	56.27	48.06	56.06	48.30	74
75	57.45	48.21	57.24	48.46	57.03	48.71	56.82	48.96	75
76	58.22	48.85	58.01	49.11	57.79	49.36	57.57	49.61	76
77	58.99	49.49	58.77	49.75	58.55	50.01	58.33	50.26	77
78	59.75	50.14	59.53	50.40	59.31	50.66	59.09	50.92	78
79	60.52	50.78	60.30	51.04	60.07	51.31	59.85	51.57	79
80	61.28	51.42	61.06	51.69	60.83	51.96	60.61	52.22	80
81	62.05	52.07	61.82	52.34	61.59	52.61	61.36	52.87	81
82	62.82	52.71	62.59	52.98	62.35	53.25	62.12	53.53	82
83	63.58	53.35	63.35	53.63	63.11	53.90	62.88	54.18	83
84	64.35	53.99	64.11	54.27	63.87	54.55	63.64	54.83	84
85	65.11	54.64	64.87	54.92	64.63	55.20	64.39	55.48	85
86	65.88	55.28	65.64	55.57	65.39	55.85	65.15	56.14	86
87	66.65	55.92	66.40	56.21	66.16	56.50	65.91	56.79	87
88	67.41	56.57	67.16	56.86	66.92	57.15	66.67	57.44	88
89	68.18	57.21	67.93	57.50	67.68	57.80	67.42	58.10	89
90	68.94	57.85	68.69	58.15	68.44	58.45	68.18	58.75	90
91	69.71	58.49	69.45	58.80	69.20	59.10	68.94	59.40	91
92	70.48	59.14	70.22	59.44	69.96	59.75	69.70	60.05	92
93	71.24	59.78	70.98	60.09	70.72	60.40	70.45	60.71	93
94	72.01	60.42	71.74	60.74	71.48	61.05	71.21	61.36	94
95	72.77	61.06	72.51	61.38	72.24	61.70	71.97	62.01	95
96	73.54	61.71	73.27	62.03	73.00	62.35	72.73	62.66	96
97	74.31	62.35	74.03	62.67	73.76	63.00	73.48	63.32	97
98	75.07	62.99	74.80	63.32	74.52	63.65	74.24	63.97	98
99	75.84	63.64	75.56	63.97	75.28	64.30	75.00	64.62	99
100	76.60	64.28	76.32	64.61	76.04	64.94	75.76	65.28	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	50 Deg.		49 $\frac{3}{4}$ Deg.		49 $\frac{1}{2}$ Deg.		49 $\frac{1}{4}$ Deg.		

Distance.	41 Deg.		41 $\frac{1}{4}$ Deg.		41 $\frac{1}{2}$ Deg.		41 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.75	0.66	0.75	0.66	0.75	0.66	0.75	0.67	1
2	1.51	1.31	1.50	1.32	1.50	1.33	1.49	1.33	2
3	2.26	1.97	2.26	1.98	2.25	1.99	2.24	2.00	3
4	3.02	2.62	3.01	2.64	3.00	2.65	2.98	2.66	4
5	3.77	3.28	3.76	3.30	3.74	3.31	3.73	3.33	5
6	4.53	3.94	4.51	3.96	4.49	3.98	4.48	4.00	6
7	5.28	4.59	5.26	4.62	5.24	4.64	5.22	4.66	7
8	6.04	5.25	6.01	5.27	5.99	5.30	5.97	5.33	8
9	6.79	5.90	6.77	5.93	6.74	5.96	6.71	5.99	9
10	7.55	6.56	7.52	6.59	7.49	6.63	7.46	6.66	10
11	8.30	7.22	8.27	7.25	8.24	7.29	8.21	7.32	11
12	9.06	7.87	9.02	7.91	8.99	7.95	8.95	7.99	12
13	9.81	8.53	9.77	8.57	9.74	8.61	9.70	8.66	13
14	10.57	9.18	10.53	9.23	10.49	9.28	10.44	9.32	14
15	11.32	9.84	11.28	9.89	11.23	9.94	11.19	9.99	15
16	12.08	10.50	12.03	10.55	11.98	10.60	11.94	10.65	16
17	12.83	11.15	12.78	11.21	12.73	11.26	12.68	11.32	17
18	13.58	11.81	13.53	11.87	13.48	11.93	13.43	11.99	18
19	14.34	12.47	14.28	12.53	14.23	12.59	14.18	12.65	19
20	15.09	13.12	15.04	13.19	14.98	13.25	14.92	13.32	20
21	15.85	13.78	15.79	13.85	15.73	13.91	15.67	13.98	21
22	16.60	14.43	16.54	14.51	16.48	14.58	16.41	14.65	22
23	17.36	15.09	17.29	15.16	17.23	15.24	17.16	15.32	23
24	18.11	15.75	18.04	15.82	17.97	15.90	17.91	15.98	24
25	18.87	16.40	18.80	16.48	18.72	16.57	18.65	16.65	25
26	19.62	17.06	19.55	17.14	19.47	17.23	19.40	17.31	26
27	20.38	17.71	20.30	17.80	20.22	17.89	20.14	17.98	27
28	21.13	18.37	21.05	18.46	20.97	18.55	20.89	18.64	28
29	21.89	19.03	21.80	19.12	21.72	19.22	21.64	19.31	29
30	22.64	19.68	22.56	19.78	22.47	19.88	22.38	19.98	30
31	23.40	20.34	23.31	20.44	23.22	20.54	23.13	20.64	31
32	24.15	20.99	24.06	21.10	23.97	21.20	23.87	21.31	32
33	24.91	21.65	24.81	21.76	24.72	21.87	24.62	21.97	33
34	25.66	22.31	25.56	22.42	25.46	22.53	25.37	22.64	34
35	26.41	22.96	26.31	23.08	26.21	23.19	26.11	23.31	35
36	27.17	23.62	27.07	23.74	26.96	23.85	26.86	23.97	36
37	27.92	24.27	27.82	24.40	27.71	24.52	27.60	24.64	37
38	28.68	24.93	28.57	25.06	28.46	25.18	28.35	25.30	38
39	29.43	25.59	29.32	25.71	29.21	25.84	29.10	25.97	39
40	30.19	26.24	30.07	26.37	29.96	26.50	29.84	26.64	40
41	30.94	26.90	30.83	27.03	30.71	27.17	30.59	27.30	41
42	31.70	27.55	31.58	27.69	31.46	27.83	31.33	27.97	42
43	32.45	28.21	32.33	28.35	32.21	28.49	32.08	28.63	43
44	33.21	28.87	33.08	29.01	32.95	29.16	32.83	29.30	44
45	33.96	29.52	33.83	29.67	33.70	29.82	33.57	29.97	45
46	34.72	30.18	34.58	30.33	34.45	30.48	34.32	30.63	46
47	35.47	30.83	35.34	30.99	35.20	31.14	35.06	31.30	47
48	36.23	31.49	36.09	31.65	35.95	31.81	35.81	31.96	48
49	36.98	32.15	36.84	32.31	36.70	32.47	36.56	32.63	49
50	37.74	32.80	37.59	32.97	37.45	33.13	37.30	33.29	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	49 Deg.		48 $\frac{3}{4}$ Deg.		48 $\frac{1}{2}$ Deg.		48 $\frac{1}{4}$ Deg.		

Distance.	41 Deg.		41 $\frac{1}{4}$ Deg.		41 $\frac{1}{2}$ Deg.		41 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	38.49	33.46	38.34	33.63	38.20	33.79	38.05	33.96	51
52	39.24	34.12	39.10	34.29	38.95	34.46	38.79	34.63	52
53	40.00	34.77	39.85	34.95	39.69	35.12	39.54	35.29	53
54	40.75	35.43	40.60	35.60	40.44	35.78	40.29	35.96	54
55	41.51	36.08	41.35	36.26	41.19	36.44	41.03	36.62	55
56	42.26	36.74	42.10	36.92	41.94	37.11	41.78	37.29	56
57	43.02	37.40	42.85	37.58	42.69	37.77	42.53	37.96	57
58	43.77	38.05	43.61	38.24	43.44	38.43	43.27	38.62	58
59	44.53	38.71	44.36	38.90	44.19	39.09	44.02	39.29	59
60	45.28	39.36	45.11	39.56	44.94	39.76	44.76	39.95	60
61	46.04	40.02	45.86	40.22	45.69	40.42	45.51	40.62	61
62	46.79	40.68	46.61	40.88	46.44	41.08	46.26	41.28	62
63	47.55	41.33	47.37	41.54	47.18	41.75	47.00	41.95	63
64	48.30	41.99	48.12	42.20	47.93	42.41	47.75	42.62	64
65	49.06	42.64	48.87	42.86	48.68	43.07	48.49	43.28	65
66	49.81	43.30	49.62	43.52	49.43	43.73	49.24	43.95	66
67	50.57	43.96	50.37	44.18	50.18	44.40	49.99	44.61	67
68	51.32	44.61	51.13	44.84	50.93	45.06	50.73	45.28	68
69	52.07	45.27	51.88	45.49	51.68	45.72	51.48	45.95	69
70	52.83	45.92	52.63	46.15	52.43	46.38	52.22	46.61	70
71	53.58	46.58	53.38	46.81	53.18	47.05	52.97	47.28	71
72	54.34	47.24	54.13	47.47	53.92	47.71	53.72	47.94	72
73	55.09	47.89	54.88	48.13	54.67	48.37	54.46	48.61	73
74	55.85	48.55	55.64	48.79	55.42	49.03	55.21	49.28	74
75	56.60	49.20	56.39	49.45	56.17	49.70	55.95	49.94	75
76	57.36	49.86	57.14	50.11	56.92	50.36	56.70	50.61	76
77	58.11	50.52	57.89	50.77	57.67	51.02	57.45	51.27	77
78	58.87	51.17	58.64	51.43	58.42	51.68	58.19	51.94	78
79	59.62	51.83	59.40	52.09	59.17	52.35	58.94	52.60	79
80	60.38	52.48	60.15	52.75	59.92	53.01	59.68	53.27	80
81	61.13	53.14	60.90	53.41	60.67	53.67	60.43	53.94	81
82	61.89	53.80	61.65	54.07	61.41	54.33	61.18	54.60	82
83	62.64	54.45	62.40	54.73	62.16	55.00	61.92	55.27	83
84	63.40	55.11	63.15	55.38	62.91	55.66	62.67	55.93	84
85	64.15	55.76	63.91	56.04	63.66	56.32	63.41	56.60	85
86	64.90	56.42	64.66	56.70	64.41	56.99	64.16	57.27	86
87	65.66	57.08	65.41	57.36	65.16	57.65	64.91	57.93	87
88	66.41	57.73	66.16	58.02	65.91	58.31	65.65	58.60	88
89	67.17	58.39	66.91	58.68	66.66	58.97	66.40	59.26	89
90	67.92	59.05	67.67	59.34	67.41	59.64	67.15	59.93	90
91	68.68	59.70	68.42	60.00	68.15	60.30	67.89	60.60	91
92	69.43	60.36	69.17	60.66	68.90	60.96	68.64	61.26	92
93	70.19	61.01	69.92	61.32	69.65	61.62	69.38	61.93	93
94	70.94	61.67	70.67	61.98	70.40	62.29	70.13	62.59	94
95	71.70	62.33	71.43	62.64	71.15	62.95	70.88	63.26	95
96	72.45	62.98	72.18	63.30	71.90	63.61	71.62	63.92	96
97	73.21	63.64	72.93	63.96	72.65	64.27	72.37	64.59	97
98	73.96	64.29	73.68	64.62	73.40	64.94	73.11	65.26	98
99	74.72	64.95	74.43	65.28	74.15	65.60	73.86	65.92	99
100	75.47	65.61	75.18	65.93	74.90	66.26	74.61	66.59	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	49 Deg.		48 $\frac{3}{4}$ Deg.		48 $\frac{1}{2}$ Deg.		48 $\frac{1}{4}$ Deg.		

Distance.	42 Deg.		42 $\frac{1}{4}$ Deg.		42 $\frac{1}{2}$ Deg.		42 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.74	0.67	0.74	0.67	0.74	0.68	0.73	0.68	1
2	1.49	1.34	1.48	1.34	1.47	1.35	1.47	1.36	2
3	2.23	2.01	2.22	2.02	2.21	2.03	2.20	2.04	3
4	2.97	2.68	2.96	2.69	2.95	2.70	2.94	2.72	4
5	3.72	3.35	3.70	3.36	3.69	3.38	3.67	3.39	5
6	4.46	4.01	4.44	4.03	4.42	4.05	4.41	4.07	6
7	5.20	4.68	5.18	4.71	5.16	4.73	5.14	4.75	7
8	5.95	5.35	5.92	5.38	5.90	5.40	5.87	5.43	8
9	6.69	6.02	6.66	6.05	6.64	6.08	6.61	6.11	9
10	7.43	6.69	7.40	6.72	7.37	6.76	7.34	6.79	10
11	8.17	7.36	8.14	7.40	8.11	7.43	8.08	7.47	11
12	8.92	8.03	8.88	8.07	8.85	8.11	8.81	8.15	12
13	9.66	8.70	9.62	8.74	9.58	8.78	9.55	8.82	13
14	10.40	9.37	10.36	9.41	10.32	9.46	10.28	9.50	14
15	11.15	10.04	11.10	10.09	11.06	10.13	11.01	10.18	15
16	11.89	10.71	11.84	10.76	11.80	10.81	11.75	10.86	16
17	12.63	11.38	12.58	11.43	12.53	11.48	12.48	11.54	17
18	13.38	12.04	13.32	12.10	13.27	12.16	13.22	12.22	18
19	14.12	12.71	14.06	12.77	14.01	12.84	13.95	12.90	19
20	14.86	13.38	14.80	13.45	14.75	13.51	14.69	13.58	20
21	15.61	14.05	15.54	14.12	15.48	14.19	15.42	14.25	21
22	16.35	14.72	16.28	14.79	16.22	14.86	16.16	14.93	22
23	17.09	15.39	17.02	15.46	16.96	15.54	16.89	15.61	23
24	17.84	16.06	17.77	16.14	17.69	16.21	17.62	16.29	24
25	18.58	16.73	18.51	16.81	18.43	16.89	18.36	16.97	25
26	19.32	17.40	19.25	17.48	19.17	17.57	19.09	17.65	26
27	20.06	18.07	19.99	18.15	19.91	18.24	19.83	18.33	27
28	20.81	18.74	20.73	18.83	20.64	18.92	20.56	19.01	28
29	21.55	19.40	21.47	19.50	21.38	19.59	21.30	19.69	29
30	22.29	20.07	22.21	20.17	22.12	20.27	22.03	20.36	30
31	23.04	20.74	22.95	20.84	22.86	20.94	22.76	21.04	31
32	23.78	21.41	23.69	21.52	23.59	21.62	23.50	21.72	32
33	24.52	22.08	24.43	22.19	24.33	22.29	24.23	22.40	33
34	25.27	22.75	25.17	22.86	25.07	22.97	24.97	23.08	34
35	26.01	23.42	25.91	23.53	25.80	23.65	25.70	23.76	35
36	26.75	24.09	26.65	24.21	26.54	24.32	26.44	24.44	36
37	27.50	24.76	27.39	24.88	27.28	25.00	27.17	25.12	37
38	28.24	25.43	28.13	25.55	28.02	25.67	27.90	25.79	38
39	28.98	26.10	28.87	26.22	28.75	26.35	28.64	26.47	39
40	29.73	26.77	29.61	26.89	29.49	27.02	29.37	27.15	40
41	30.47	27.43	30.35	27.57	30.23	27.70	30.11	27.83	41
42	31.21	28.10	31.09	28.24	30.97	28.37	30.84	28.51	42
43	31.96	28.77	31.83	28.91	31.70	29.05	31.58	29.19	43
44	32.70	29.44	32.57	29.58	32.44	29.73	32.31	29.87	44
45	33.44	30.11	33.31	30.26	33.18	30.40	33.04	30.55	45
46	34.18	30.78	34.05	30.93	33.91	31.08	33.78	31.22	46
47	34.93	31.45	34.79	31.60	34.65	31.75	34.51	31.90	47
48	35.67	32.12	35.53	32.27	35.39	32.43	35.25	32.58	48
49	36.41	32.79	36.27	32.95	36.13	33.10	35.98	33.26	49
50	37.16	33.46	37.01	33.62	36.86	33.78	36.72	33.94	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	43 Deg.		47 $\frac{3}{4}$ Deg.		47 $\frac{1}{2}$ Deg.		47 $\frac{1}{4}$ Deg.		

Distance.	42 Deg.		42 $\frac{1}{4}$ Deg.		42 $\frac{1}{2}$ Deg.		42 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	37.90	34.13	37.75	34.29	37.60	34.46	37.45	34.62	51
52	38.64	34.79	38.49	34.96	38.34	35.13	38.18	35.30	52
53	39.39	35.46	39.23	35.64	39.08	35.81	38.92	35.98	53
54	40.13	36.13	39.97	36.31	39.81	36.48	39.65	36.66	54
55	40.87	36.80	40.71	36.98	40.55	37.16	40.39	37.33	55
56	41.62	37.47	41.45	37.65	41.29	37.83	41.12	38.01	56
57	42.36	38.14	42.19	38.32	42.02	38.51	41.86	38.69	57
58	43.10	38.81	42.93	39.00	42.76	39.18	42.59	39.37	58
59	43.85	39.48	43.67	39.67	43.50	39.86	43.32	40.05	59
60	44.59	40.15	44.41	40.34	44.24	40.54	44.06	40.73	60
61	45.33	40.82	45.15	41.01	44.97	41.21	44.79	41.41	61
62	46.07	41.49	45.89	41.69	45.71	41.89	45.53	42.09	62
63	46.82	42.16	46.63	42.36	46.45	42.56	46.26	42.76	63
64	47.56	42.82	47.37	43.03	47.19	43.24	47.00	43.44	64
65	48.30	43.49	48.11	43.70	47.92	43.91	47.73	44.12	65
66	49.05	44.16	48.85	44.38	48.66	44.59	48.47	44.80	66
67	49.79	44.83	49.59	45.05	49.40	45.26	49.20	45.48	67
68	50.53	45.50	50.33	45.72	50.13	45.94	49.93	46.16	68
69	51.28	46.17	51.07	46.39	50.87	46.62	50.67	46.84	69
70	52.02	46.84	51.82	47.07	51.61	47.29	51.40	47.52	70
71	52.76	47.51	52.56	47.74	52.35	47.97	52.14	48.19	71
72	53.51	48.18	53.30	48.41	53.08	48.64	52.87	48.87	72
73	54.25	48.85	54.04	49.08	53.82	49.32	53.61	49.55	73
74	54.99	49.52	54.78	49.76	54.56	49.99	54.34	50.23	74
75	55.74	50.18	55.52	50.43	55.30	50.67	55.07	50.91	75
76	56.48	50.85	56.26	51.10	56.03	51.34	55.81	51.59	76
77	57.22	51.52	57.00	51.77	56.77	52.02	56.54	52.27	77
78	57.97	52.19	57.74	52.44	57.51	52.70	57.28	52.95	78
79	58.71	52.86	58.48	53.12	58.24	53.37	58.01	53.63	79
80	59.45	53.53	59.22	53.79	58.98	54.05	58.75	54.30	80
81	60.19	54.20	59.96	54.46	59.72	54.72	59.48	54.98	81
82	60.94	54.87	60.70	55.13	60.46	55.40	60.21	55.66	82
83	61.68	55.54	61.44	55.81	61.19	56.07	60.95	56.34	83
84	62.42	56.21	62.18	56.48	61.93	56.75	61.68	57.02	84
85	63.17	56.88	62.92	57.15	62.67	57.43	62.42	57.70	85
86	63.91	57.55	63.66	57.82	63.41	58.10	63.15	58.38	86
87	64.65	58.21	64.40	58.50	64.14	58.78	63.89	59.06	87
88	65.40	58.88	65.14	59.17	64.88	59.45	64.62	59.73	88
89	66.14	59.55	65.88	59.84	65.62	60.13	65.35	60.41	89
90	66.88	60.22	66.62	60.51	66.35	60.80	66.09	61.09	90
91	67.63	60.89	67.36	61.19	67.09	61.48	66.82	61.77	91
92	68.37	61.56	68.10	61.86	67.83	62.15	67.56	62.45	92
93	69.11	62.23	68.84	62.53	68.57	62.83	68.29	63.13	93
94	69.86	62.90	69.58	63.20	69.30	63.51	69.03	63.81	94
95	70.60	63.57	70.32	63.87	70.04	64.18	69.76	64.49	95
96	71.34	64.24	71.06	64.55	70.78	64.86	70.49	65.16	96
97	72.08	64.91	71.80	65.22	71.52	65.53	71.23	65.84	97
98	72.83	65.57	72.54	65.89	72.25	66.21	71.96	66.52	98
99	73.57	66.24	73.28	66.56	72.99	66.88	72.70	67.20	99
100	74.31	66.91	74.02	67.24	73.73	67.56	73.43	67.88	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	48 Deg.		47 $\frac{3}{4}$ Deg.		47 $\frac{1}{2}$ Deg.		47 $\frac{1}{4}$ Deg.		

Distance.	43 Deg.		43 $\frac{1}{4}$ Deg.		43 $\frac{1}{2}$ Deg.		43 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.73	0.68	0.73	0.69	0.73	0.69	0.72	0.69	1
2	1.46	1.36	1.46	1.37	1.45	1.38	1.44	1.38	2
3	2.19	2.05	2.19	2.06	2.18	2.07	2.17	2.07	3
4	2.93	2.73	2.91	2.74	2.90	2.75	2.89	2.77	4
5	3.66	3.41	3.64	3.43	3.63	3.44	3.61	3.46	5
6	4.39	4.09	4.37	4.11	4.35	4.13	4.33	4.15	6
7	5.12	4.77	5.10	4.80	5.08	4.82	5.06	4.84	7
8	5.85	5.46	5.83	5.48	5.80	5.51	5.78	5.53	8
9	6.58	6.14	6.56	6.17	6.53	6.20	6.50	6.22	9
10	7.31	6.82	7.28	6.85	7.25	6.88	7.22	6.92	10
11	8.04	7.50	8.01	7.54	7.98	7.57	7.95	7.61	11
12	8.78	8.18	8.74	8.22	8.70	8.26	8.67	8.30	12
13	9.51	8.87	9.47	8.91	9.43	8.95	9.39	8.99	13
14	10.24	9.55	10.20	9.59	10.16	9.64	10.11	9.68	14
15	10.97	10.23	10.93	10.28	10.88	10.33	10.84	10.37	15
16	11.70	10.91	11.65	10.96	11.61	11.01	11.56	11.06	16
17	12.43	11.59	12.38	11.65	12.33	11.70	12.28	11.76	17
18	13.16	12.28	13.11	12.33	13.06	12.39	13.00	12.45	18
19	13.90	12.96	13.84	13.02	13.78	13.08	13.72	13.14	19
20	14.63	13.64	14.57	13.70	14.51	13.77	14.45	13.83	20
21	15.36	14.32	15.30	14.39	15.23	14.46	15.17	14.52	21
22	16.09	15.00	15.02	15.07	15.96	15.14	15.89	15.21	22
23	16.82	15.69	16.75	15.76	16.68	15.83	16.61	15.90	23
24	17.55	16.37	17.48	16.44	17.41	16.52	17.34	16.60	24
25	18.28	17.05	18.21	17.13	18.13	17.21	18.06	17.29	25
26	19.02	17.73	18.94	17.81	18.86	17.90	18.78	17.98	26
27	19.75	18.41	19.67	18.50	19.59	18.59	19.50	18.67	27
28	20.48	19.10	20.39	19.19	20.31	19.27	20.23	19.36	28
29	21.21	19.78	21.12	19.87	21.04	19.96	20.95	20.05	29
30	21.94	20.46	21.85	20.56	21.76	20.65	21.67	20.75	30
31	22.67	21.14	22.58	21.24	22.49	21.34	22.39	21.44	31
32	23.40	21.82	23.31	21.93	23.21	22.03	23.12	22.13	32
33	24.13	22.51	24.04	22.61	23.94	22.72	23.84	22.82	33
34	24.87	23.19	24.76	23.30	24.66	23.40	24.56	23.51	34
35	25.60	23.87	25.49	23.98	25.39	24.09	25.28	24.20	35
36	26.33	24.55	26.22	24.67	26.11	24.78	26.01	24.89	36
37	27.06	25.23	26.95	25.35	26.84	25.47	26.73	25.59	37
38	27.79	25.92	27.68	26.04	27.56	26.16	27.45	26.28	38
39	28.52	26.60	28.41	26.72	28.29	26.85	28.17	26.97	39
40	29.25	27.28	29.13	27.41	29.01	27.53	28.89	27.66	40
41	29.99	27.96	29.86	28.09	29.74	28.22	29.62	28.35	41
42	30.72	28.64	30.59	28.78	30.47	28.91	30.34	29.04	42
43	31.45	29.33	31.32	29.46	31.19	29.60	31.06	29.74	43
44	32.18	30.01	32.05	30.15	31.92	30.29	31.78	30.43	44
45	32.91	30.69	32.78	30.83	32.64	30.98	32.51	31.12	45
46	33.64	31.37	33.51	31.52	33.37	31.66	33.23	31.81	46
47	34.37	32.05	34.23	32.20	34.09	32.35	33.95	32.50	47
48	35.10	32.74	34.96	32.89	34.82	33.04	34.67	33.19	48
49	35.84	33.42	35.69	33.57	35.54	33.73	35.40	33.88	49
50	36.57	34.10	36.42	34.26	36.27	34.42	36.12	34.58	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	47 Deg.		46 $\frac{3}{4}$ Deg.		46 $\frac{1}{2}$ Deg.		46 $\frac{1}{4}$ Deg.		

Distance.	43 Deg.		43 $\frac{1}{4}$ Deg.		43 $\frac{1}{2}$ Deg.		43 $\frac{3}{4}$ Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	37.30	34.78	37.15	34.94	36.99	35.11	36.84	35.27	51
52	38.03	35.46	37.88	35.63	37.72	35.79	37.56	35.96	52
53	38.76	36.15	38.60	36.31	38.44	36.48	38.29	36.65	53
54	39.49	36.83	39.33	37.00	39.17	37.17	39.01	37.34	54
55	40.22	37.51	40.06	37.69	39.90	37.86	39.73	38.03	55
56	40.96	38.19	40.79	38.37	40.62	38.55	40.45	38.72	56
57	41.69	38.87	41.52	39.06	41.35	39.24	41.17	39.42	57
58	42.42	39.56	42.25	39.74	42.07	39.92	41.90	40.11	58
59	43.15	40.24	42.97	40.43	42.80	40.61	42.62	40.80	59
60	43.88	40.92	43.70	41.11	43.52	41.30	43.34	41.49	60
61	44.61	41.60	44.43	41.80	44.25	41.99	44.06	42.18	61
62	45.34	42.28	45.16	42.48	44.97	42.68	44.79	42.87	62
63	46.08	42.97	45.89	43.17	45.70	43.37	45.51	43.57	63
64	46.81	43.65	46.62	43.85	46.42	44.05	46.23	44.26	64
65	47.54	44.33	47.34	44.54	47.15	44.74	46.95	44.95	65
66	48.27	45.01	48.07	45.22	47.87	45.43	47.68	45.64	66
67	49.00	45.69	48.80	45.91	48.60	46.12	48.40	46.33	67
68	49.73	46.38	49.53	46.59	49.33	46.81	49.12	47.02	68
69	50.46	47.06	50.26	47.28	50.05	47.50	49.84	47.71	69
70	51.19	47.74	50.99	47.96	50.78	48.18	50.57	48.41	70
71	51.93	48.42	51.71	48.65	51.50	48.87	51.29	49.10	71
72	52.66	49.10	52.44	49.33	52.23	49.56	52.01	49.79	72
73	53.39	49.79	53.17	50.02	52.95	50.25	52.73	50.48	73
74	54.12	50.47	53.90	50.70	53.68	50.94	53.45	51.17	74
75	54.85	51.15	54.63	51.39	54.40	51.63	54.18	51.86	75
76	55.58	51.83	55.36	52.07	55.13	52.31	54.90	52.55	76
77	56.31	52.51	56.08	52.76	55.85	53.00	55.62	53.25	77
78	57.05	53.20	56.81	53.44	56.58	53.69	56.34	53.94	78
79	57.78	53.88	57.54	54.13	57.30	54.38	57.07	54.63	79
80	58.51	54.56	58.27	54.81	58.03	55.07	57.79	55.32	80
81	59.24	55.24	59.00	55.50	58.76	55.76	58.51	56.01	81
82	59.97	55.92	59.73	56.18	59.48	56.45	59.23	56.70	82
83	60.70	56.61	60.45	56.87	60.21	57.13	59.96	57.40	83
84	61.43	57.29	61.18	57.56	60.93	57.82	60.68	58.09	84
85	62.17	57.97	61.91	58.24	61.66	58.51	61.40	58.78	85
86	62.90	58.65	62.64	58.93	62.38	59.20	62.12	59.47	86
87	63.63	59.33	63.37	59.61	63.11	59.89	62.85	60.16	87
88	64.36	60.02	64.10	60.30	63.83	60.58	63.57	60.85	88
89	65.09	60.70	64.82	60.98	64.56	61.26	64.29	61.54	89
90	65.82	61.38	65.55	61.67	65.28	61.95	65.01	62.24	90
91	66.55	62.06	66.28	62.35	66.01	62.64	65.74	62.93	91
92	67.28	62.74	67.01	63.04	66.73	63.33	66.46	63.62	92
93	68.02	63.43	67.74	63.72	67.46	64.02	67.18	64.31	93
94	68.75	64.11	68.47	64.41	68.19	64.71	67.90	65.00	94
95	69.48	64.79	69.20	65.09	68.91	65.39	68.62	65.69	95
96	70.21	65.47	69.92	65.78	69.64	66.08	69.35	66.39	96
97	70.94	66.15	70.65	66.46	70.36	66.77	70.07	67.08	97
98	71.67	66.84	71.37	67.15	71.09	67.46	70.79	67.77	98
99	72.40	67.52	72.11	67.83	71.81	68.15	71.51	68.46	99
100	73.14	68.20	72.84	68.52	72.54	68.84	72.24	69.15	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	47 Deg.		46 $\frac{3}{4}$ Deg.		46 $\frac{1}{2}$ Deg.		46 $\frac{1}{4}$ Deg.		

TRAVERSE TABLE.

Distance.	44 Deg.		44 $\frac{1}{4}$ Deg.		44 $\frac{1}{2}$ Deg.		44 $\frac{3}{4}$ Deg.		45 Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.72	0.69	0.72	0.70	0.71	0.70	0.71	0.71	0.71	0.71	1
2	1.44	1.39	1.43	1.40	1.43	1.40	1.42	1.41	1.41	1.41	2
3	2.16	2.08	2.15	2.09	2.14	2.10	2.13	2.11	2.12	2.12	3
4	2.88	2.78	2.87	2.79	2.85	2.80	2.84	2.82	2.83	2.83	4
5	3.60	3.47	3.58	3.49	3.57	3.50	3.55	3.52	3.54	3.54	5
6	4.32	4.17	4.30	4.19	4.28	4.21	4.26	4.22	4.24	4.24	6
7	5.04	4.86	5.01	4.88	4.99	4.91	4.97	4.93	4.95	4.95	7
8	5.75	5.56	5.73	5.58	5.71	5.61	5.68	5.63	5.66	5.66	8
9	6.47	6.25	6.45	6.28	6.42	6.31	6.39	6.34	6.36	6.36	9
10	7.19	6.95	7.16	6.98	7.13	7.01	7.10	7.04	7.07	7.07	10
11	7.91	7.64	7.88	7.68	7.85	7.71	7.81	7.74	7.78	7.78	11
12	8.63	8.34	8.60	8.37	8.56	8.41	8.52	8.45	8.49	8.49	12
13	9.35	9.03	9.31	9.07	9.27	9.11	9.23	9.15	9.19	9.19	13
14	10.07	9.73	10.03	9.77	9.99	9.81	9.94	9.86	9.90	9.90	14
15	10.79	10.42	10.74	10.47	10.70	10.51	10.65	10.56	10.61	10.61	15
16	11.51	11.11	11.46	11.16	11.41	11.21	11.36	11.26	11.31	11.31	16
17	12.23	11.81	12.18	11.86	12.13	11.92	12.07	11.97	12.02	12.02	17
18	12.95	12.50	12.89	12.56	12.84	12.62	12.78	12.67	12.73	12.73	18
19	13.67	13.20	13.61	13.26	13.55	13.32	13.49	13.38	13.43	13.43	19
20	14.39	13.89	14.33	13.96	14.26	14.02	14.20	14.08	14.14	14.14	20
21	15.11	14.59	15.04	14.65	14.98	14.72	14.91	14.78	14.85	14.85	21
22	15.83	15.28	15.76	15.35	15.69	15.42	15.62	15.49	15.56	15.56	22
23	16.54	15.98	16.47	16.05	16.40	16.12	16.33	16.19	16.26	16.26	23
24	17.26	16.67	17.19	16.75	17.12	16.82	17.04	16.90	16.97	16.97	24
25	17.98	17.37	17.91	17.44	17.83	17.52	17.75	17.60	17.68	17.68	25
26	18.70	18.06	18.62	18.14	18.54	18.22	18.46	18.30	18.38	18.38	26
27	19.42	18.76	19.34	18.84	19.26	18.92	19.17	19.01	19.09	19.09	27
28	20.14	19.45	20.06	19.54	19.97	19.63	19.89	19.71	19.80	19.80	28
29	20.86	20.15	20.77	20.24	20.68	20.33	20.60	20.42	20.51	20.51	29
30	21.58	20.84	21.49	20.93	21.40	21.03	21.31	21.12	21.21	21.21	30
31	22.30	21.53	22.21	21.63	22.11	21.73	22.02	21.82	21.92	21.92	31
32	23.02	22.23	22.92	22.33	22.82	22.43	22.73	22.53	22.63	22.63	32
33	23.74	22.92	23.64	23.03	23.54	23.13	23.44	23.23	23.33	23.33	33
34	24.46	23.62	24.35	23.72	24.25	23.83	24.15	23.94	24.04	24.04	34
35	25.18	24.31	25.07	24.42	24.96	24.53	24.86	24.64	24.75	24.75	35
36	25.90	25.01	25.79	25.12	25.68	25.23	25.57	25.34	25.46	25.46	36
37	26.62	25.70	26.50	25.82	26.39	25.93	26.28	26.05	26.16	26.16	37
38	27.33	26.40	27.22	26.52	27.10	26.63	26.99	26.75	26.87	26.87	38
39	28.05	27.09	27.94	27.21	27.82	27.34	27.70	27.46	27.58	27.58	39
40	28.77	27.79	28.65	27.91	28.53	28.04	28.41	28.16	28.28	28.28	40
41	29.49	28.48	29.37	28.61	29.24	28.74	29.12	28.86	28.99	28.99	41
42	30.21	29.18	30.08	29.31	29.96	29.44	29.83	29.57	29.70	29.70	42
43	30.93	29.87	30.80	30.00	30.67	30.14	30.54	30.27	30.41	30.41	43
44	31.65	30.56	31.52	30.70	31.38	30.84	31.25	30.98	31.11	31.11	44
45	32.37	31.26	32.23	31.40	32.10	31.54	31.96	31.68	31.82	31.82	45
46	33.09	31.95	32.95	32.10	32.81	32.24	32.67	32.38	32.53	32.53	46
47	33.81	32.65	33.67	32.80	33.52	32.94	33.38	33.09	33.23	33.23	47
48	34.53	33.34	34.38	33.49	34.24	33.64	34.09	33.79	33.94	33.94	48
49	35.25	34.04	35.10	34.19	34.95	34.34	34.80	34.50	34.65	34.65	49
50	35.97	34.73	35.82	34.89	35.66	35.05	35.51	35.20	35.36	35.36	50
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	46 Deg		45 $\frac{3}{4}$ Deg.		45 $\frac{1}{2}$ Deg.		45 $\frac{1}{4}$ Deg.		45 Deg.		

Distance.	44 Deg.		44½ Deg.		44¾ Deg.		44¾ Deg.		45 Deg.		Distance.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	36.69	35.43	36.53	35.59	36.38	35.75	36.22	35.90	36.06	36.06	51
52	37.41	36.12	37.25	36.29	37.09	36.45	36.93	36.61	36.77	36.77	52
53	38.12	36.82	37.96	36.98	37.80	37.15	37.64	37.31	37.48	37.48	53
54	38.84	37.51	38.68	37.68	38.52	37.85	38.35	38.02	38.18	38.18	54
55	39.56	38.21	39.40	38.38	39.23	38.55	39.06	38.72	38.89	38.89	55
56	40.28	38.90	40.11	39.08	39.94	39.25	39.77	39.42	39.60	39.60	56
57	41.00	39.60	40.83	39.77	40.66	39.95	40.48	40.13	40.31	40.31	57
58	41.72	40.29	41.55	40.47	41.37	40.65	41.19	40.83	41.01	41.01	58
59	42.44	40.98	42.26	41.17	42.08	41.35	41.90	41.54	41.72	41.72	59
60	43.16	41.68	42.98	41.87	42.79	42.05	42.61	42.24	42.43	42.43	60
61	43.88	42.37	43.69	42.57	43.51	42.76	43.32	42.94	43.13	43.13	61
62	44.60	43.07	44.41	43.26	44.22	43.46	44.03	43.65	43.84	43.84	62
63	45.32	43.76	45.13	43.96	44.93	44.16	44.74	44.35	44.55	44.55	63
64	46.04	44.46	45.84	44.66	45.65	44.86	45.45	45.06	45.25	45.25	64
65	46.76	45.15	46.56	45.36	46.36	45.56	46.16	45.76	45.96	45.96	65
66	47.48	45.85	47.28	46.05	47.07	46.26	46.87	46.46	46.67	46.67	66
67	48.20	46.54	47.99	46.75	47.79	46.96	47.58	47.17	47.38	47.38	67
68	48.92	47.24	48.71	47.45	48.50	47.66	48.29	47.87	48.08	48.08	68
69	49.63	47.93	49.42	48.15	49.21	48.36	49.00	48.58	48.79	48.79	69
70	50.35	48.63	50.14	48.85	49.93	49.06	49.71	49.28	49.50	49.50	70
71	51.07	49.32	50.86	49.54	50.64	49.76	50.42	49.98	50.20	50.20	71
72	51.79	50.02	51.57	50.24	51.35	50.47	51.13	50.69	50.91	50.91	72
73	52.51	50.71	52.29	50.94	52.07	51.17	51.84	51.39	51.62	51.62	73
74	53.23	51.40	53.01	51.64	52.78	51.87	52.55	52.10	52.33	52.33	74
75	53.95	52.10	53.72	52.33	53.49	52.57	53.26	52.80	53.03	53.03	75
76	54.67	52.79	54.44	53.03	54.21	53.27	53.97	53.51	53.74	53.74	76
77	55.39	53.49	55.16	53.73	54.92	53.97	54.68	54.21	54.45	54.45	77
78	56.11	54.18	55.87	54.43	55.63	54.67	55.39	54.91	55.15	55.15	78
79	56.83	54.88	56.59	55.13	56.35	55.37	56.10	55.62	55.86	55.86	79
80	57.55	55.57	57.30	55.82	57.06	56.07	56.81	56.32	56.57	56.57	80
81	58.27	56.27	58.02	56.52	57.77	56.77	57.52	57.03	57.28	57.28	81
82	58.99	56.96	58.74	57.22	58.49	57.47	58.24	57.73	57.98	57.98	82
83	59.71	57.66	59.45	57.92	59.20	58.18	58.95	58.43	58.69	58.69	83
84	60.42	58.35	60.17	58.61	59.91	58.88	59.66	59.14	59.40	59.40	84
85	61.14	59.05	60.89	59.31	60.63	59.58	60.37	59.84	60.10	60.10	85
86	61.86	59.74	61.60	60.01	61.34	60.28	61.08	60.55	60.81	60.81	86
87	62.58	60.44	62.32	60.71	62.05	60.98	61.79	61.25	61.52	61.52	87
88	63.30	61.13	63.03	61.41	62.77	61.68	62.50	61.95	62.23	62.23	88
89	64.02	61.82	63.75	62.10	63.48	62.38	63.21	62.66	62.93	62.93	89
90	64.74	62.52	64.47	62.80	64.19	63.08	63.92	63.36	63.64	63.64	90
91	65.46	63.21	65.18	63.50	64.91	63.78	64.63	64.07	64.35	64.35	91
92	66.18	63.91	65.90	64.20	65.62	64.48	65.34	64.77	65.05	65.05	92
93	66.90	64.60	66.62	64.89	66.33	65.18	66.05	65.47	65.76	65.76	93
94	67.62	65.30	67.33	65.59	67.05	65.89	66.76	66.18	66.47	66.47	94
95	68.34	65.99	68.05	66.29	67.76	66.59	67.47	66.88	67.18	67.18	95
96	69.06	66.69	68.76	66.99	68.47	67.29	68.18	67.59	67.88	67.88	96
97	69.78	67.38	69.48	67.69	69.19	67.99	68.89	68.29	68.59	68.59	97
98	70.50	68.08	70.20	68.38	69.90	68.69	69.60	68.99	69.30	69.30	98
99	71.21	68.77	70.91	69.08	70.61	69.39	70.31	69.70	70.00	70.00	99
100	71.93	69.47	71.63	69.78	71.33	70.09	71.02	70.40	70.71	70.71	100
Distance.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Distance.
	46 Deg.		45¾ Deg.		45 Deg.		45¼ Deg.		45 Deg.		

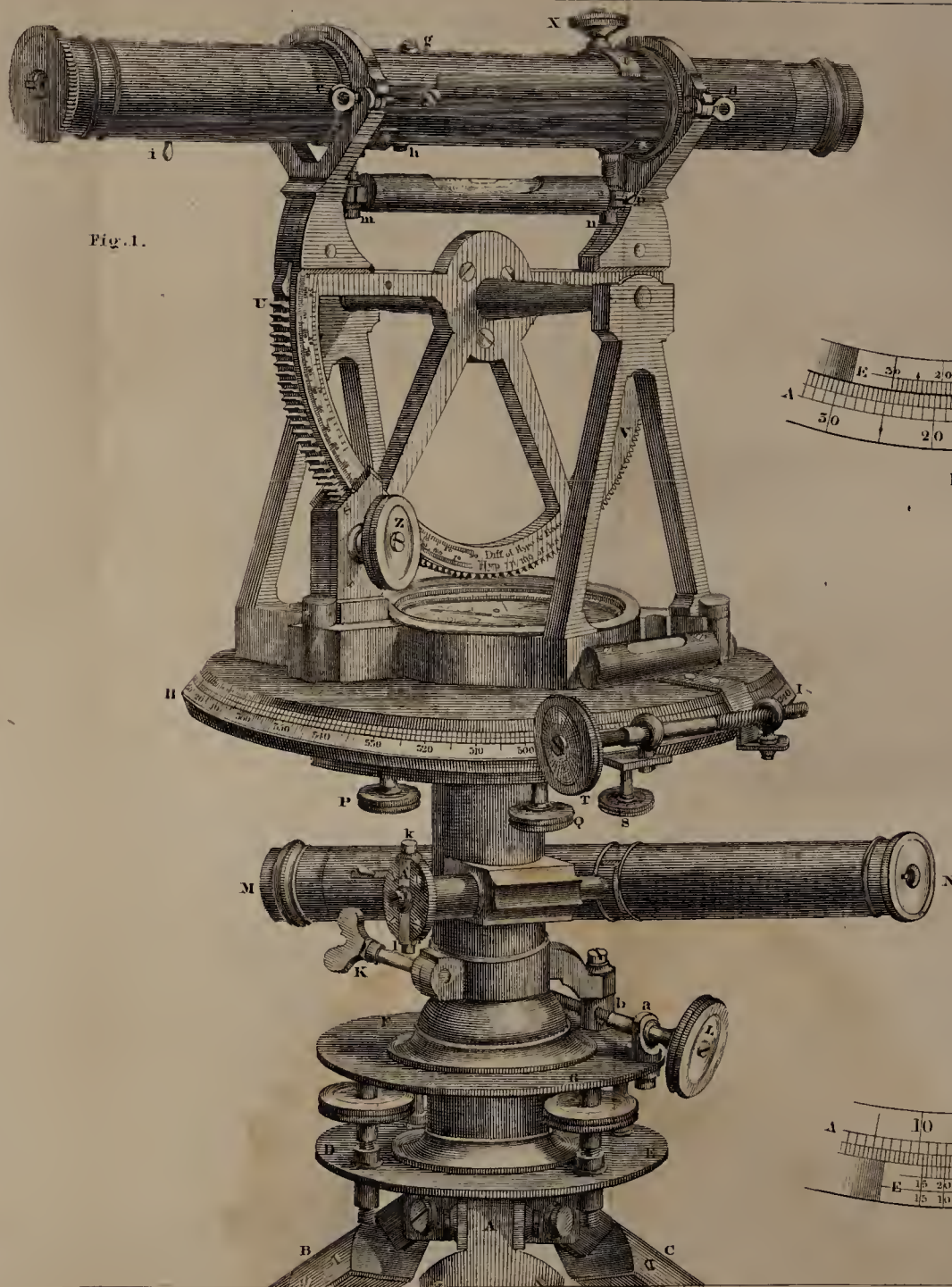


Fig. 1.

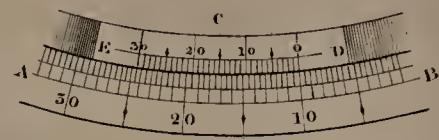


Fig. 2.

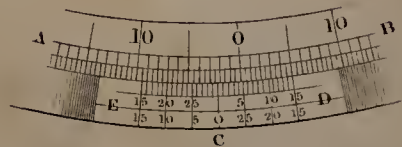


Fig. 3.



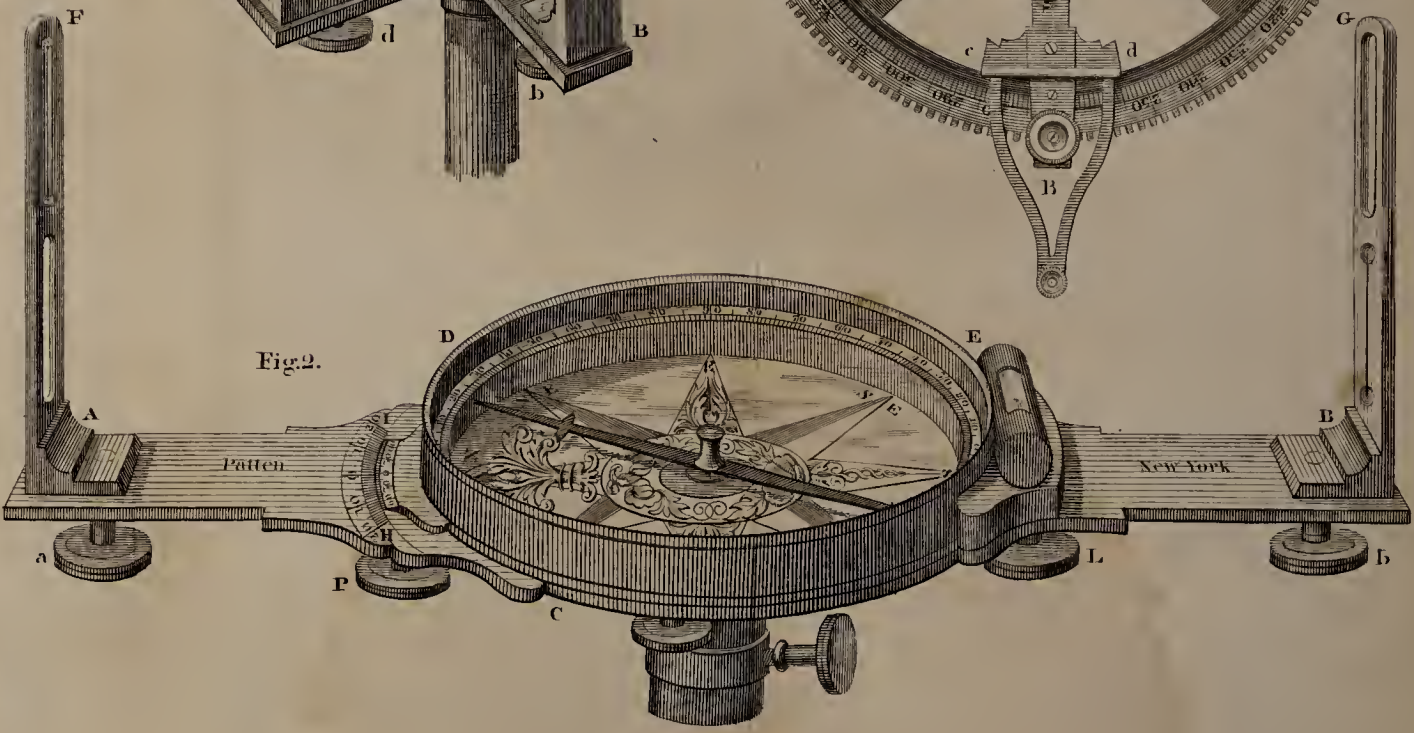
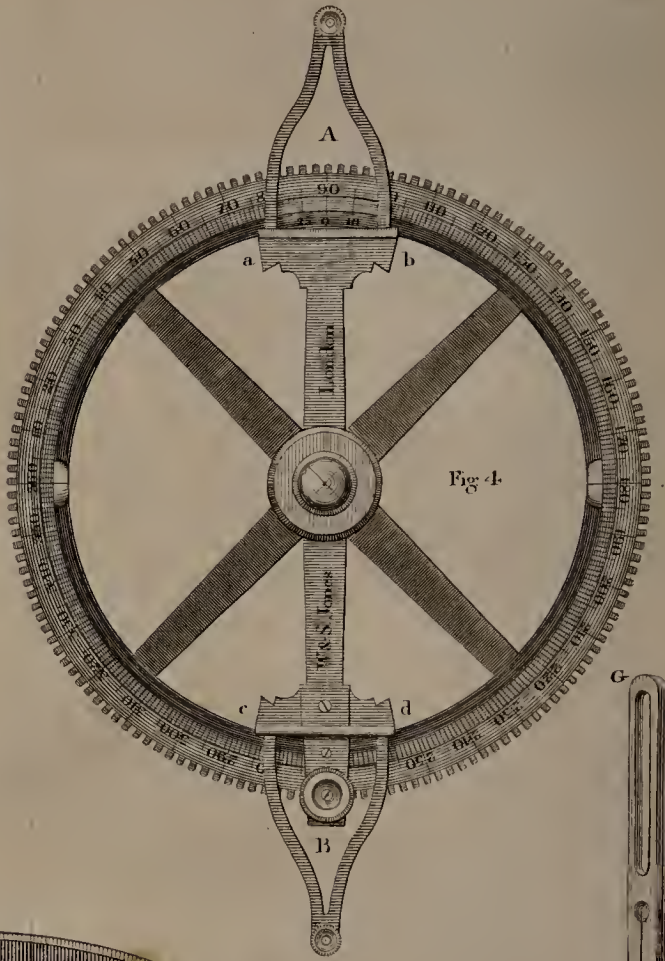
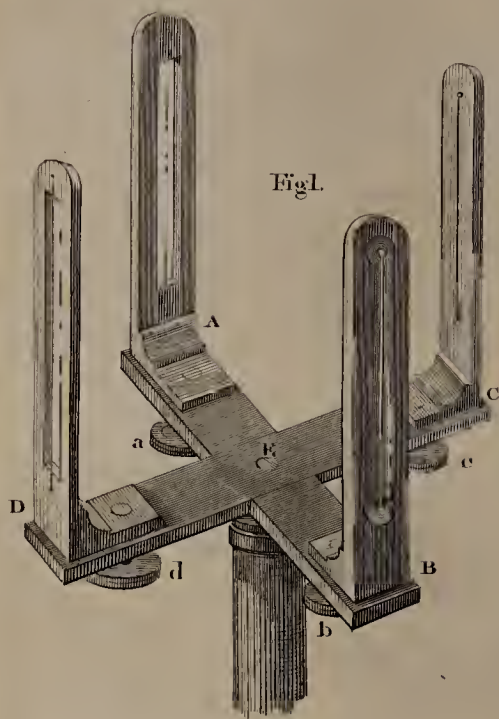
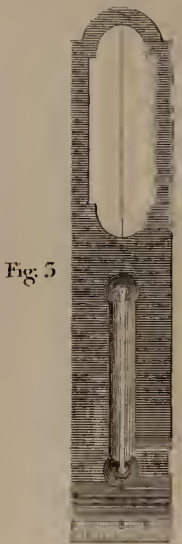




Fig. 5.

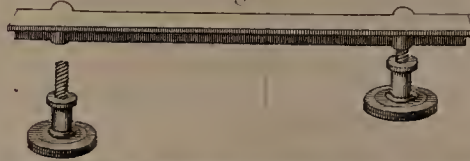
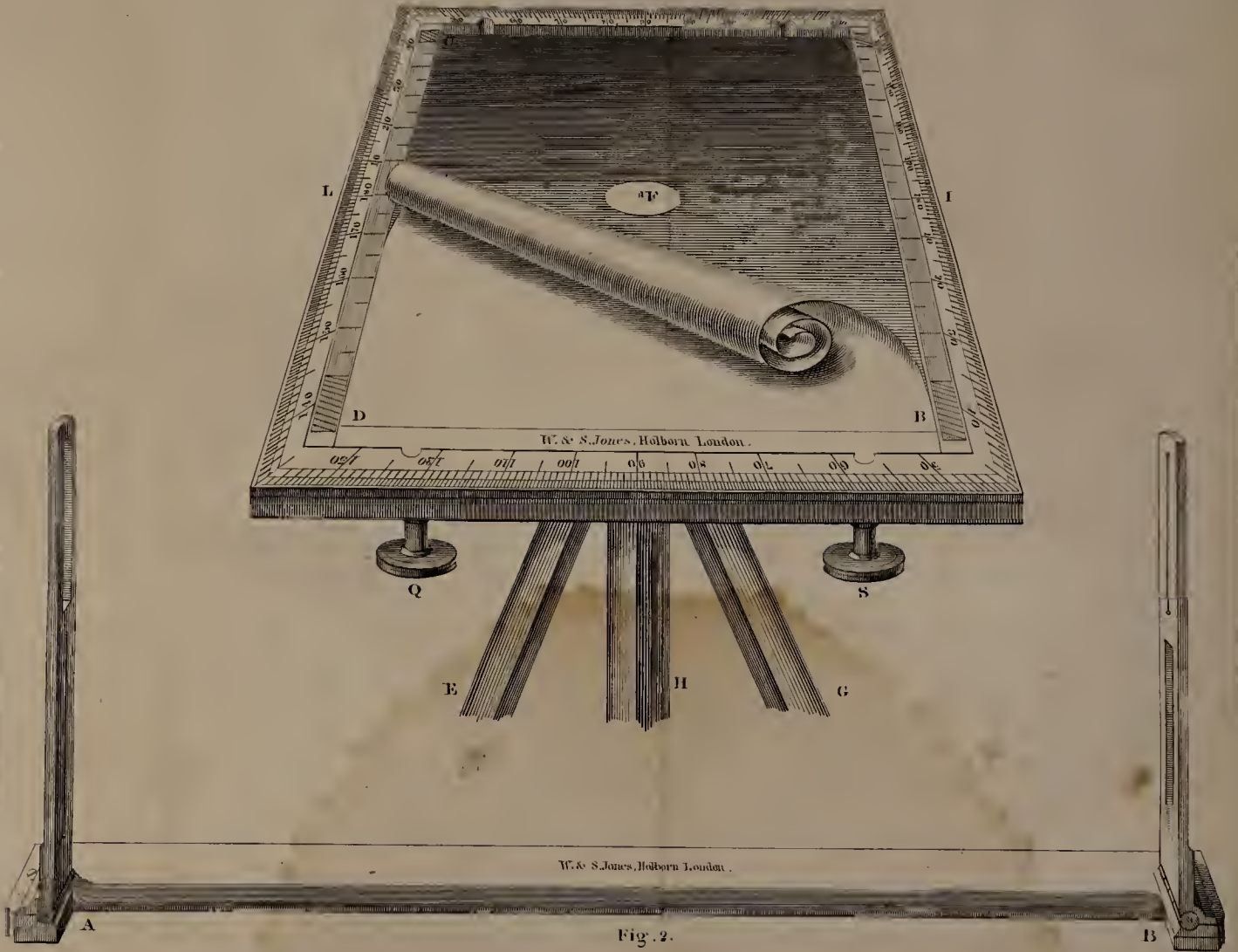


Fig. 1.



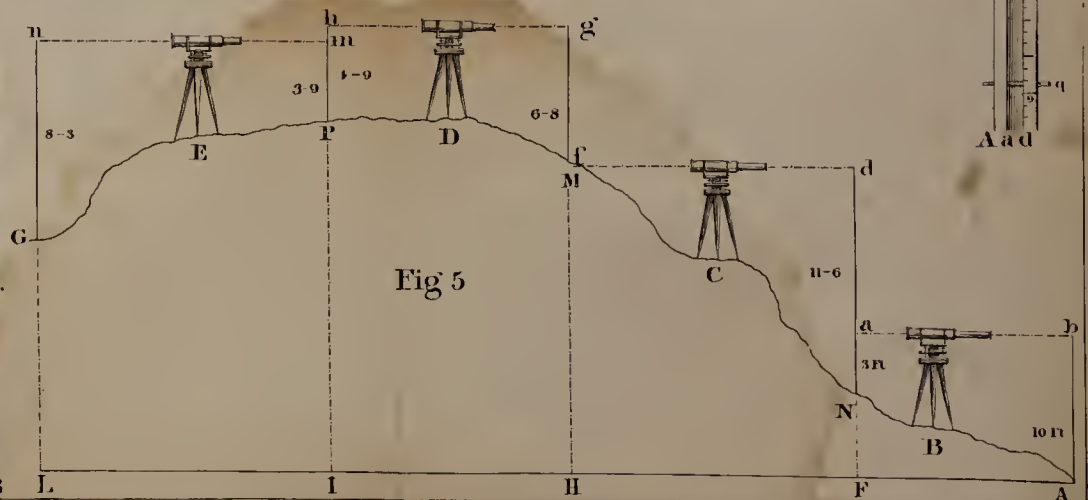
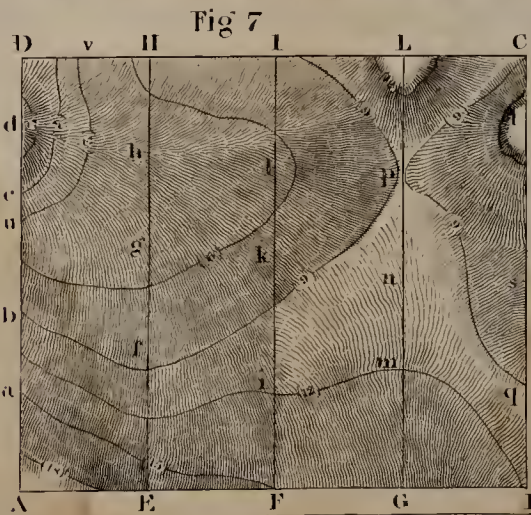
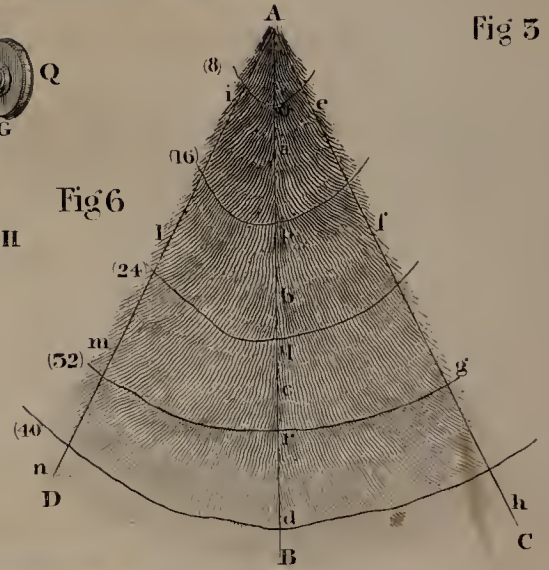
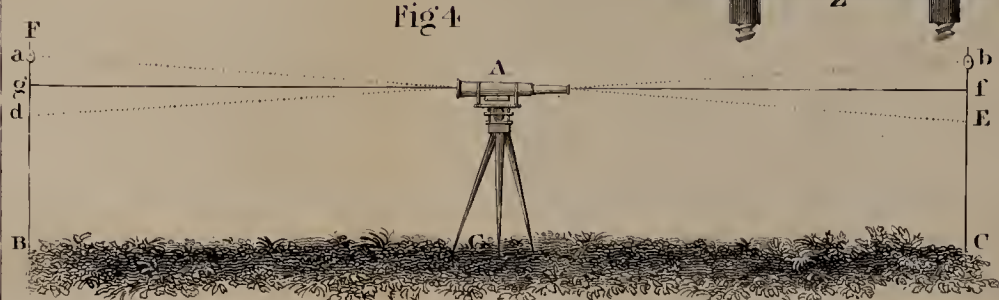
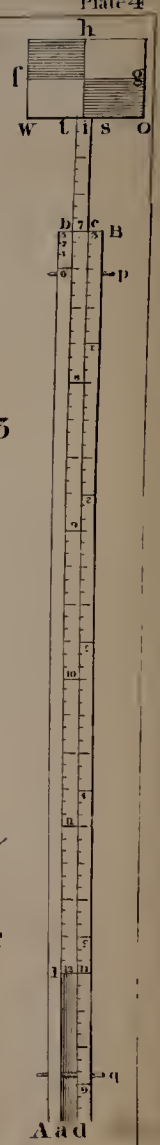
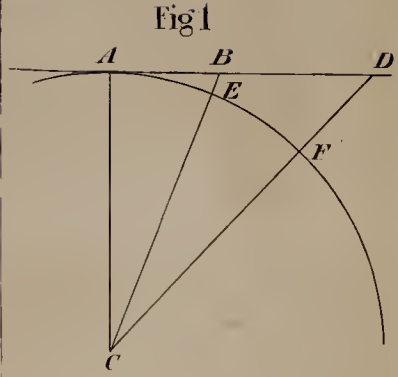
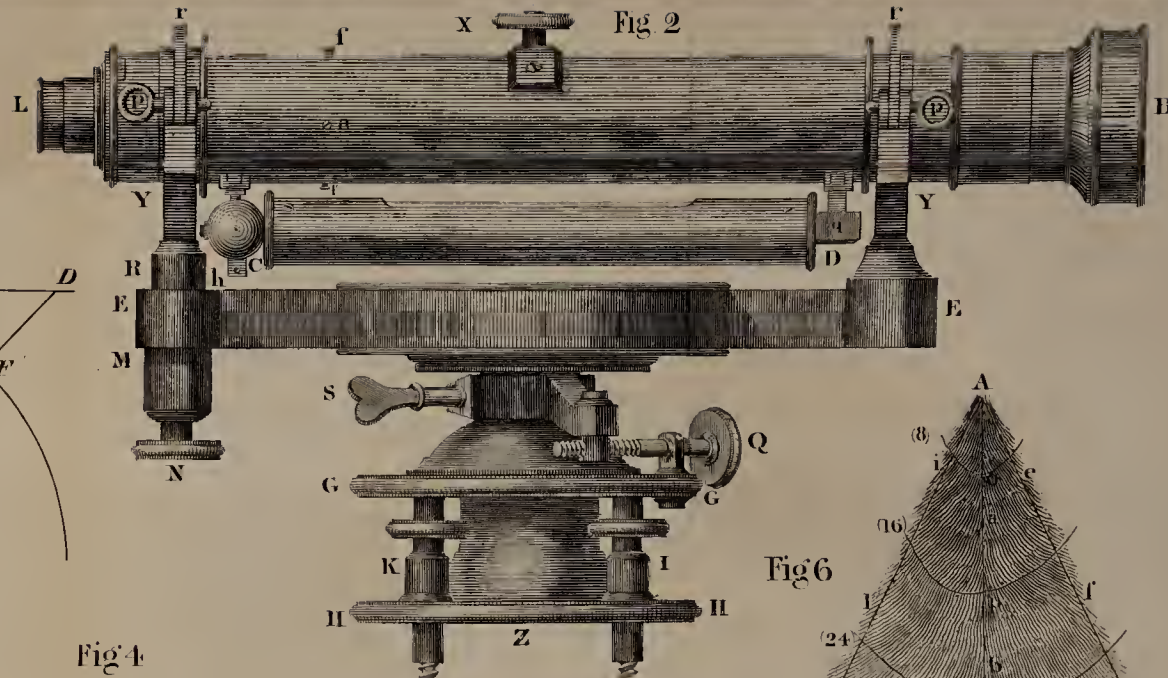
W. & S. Jones, Holborn London.


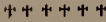

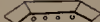






















Fig. 2.

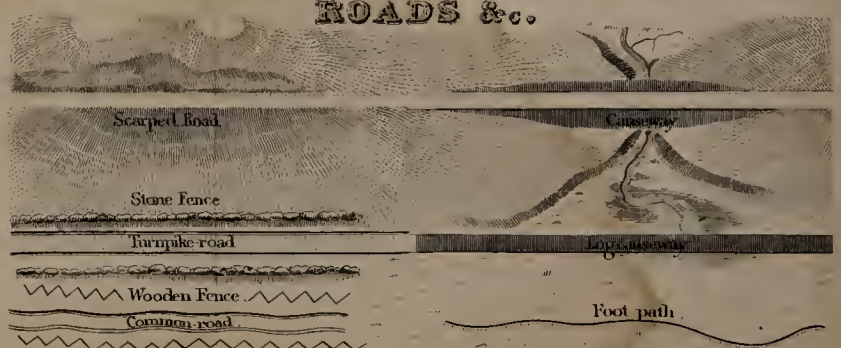
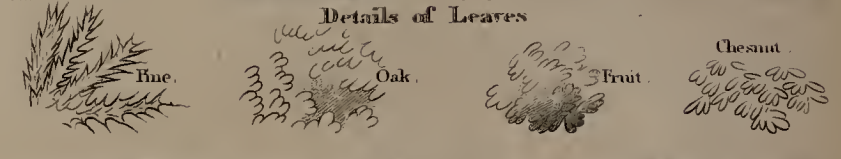
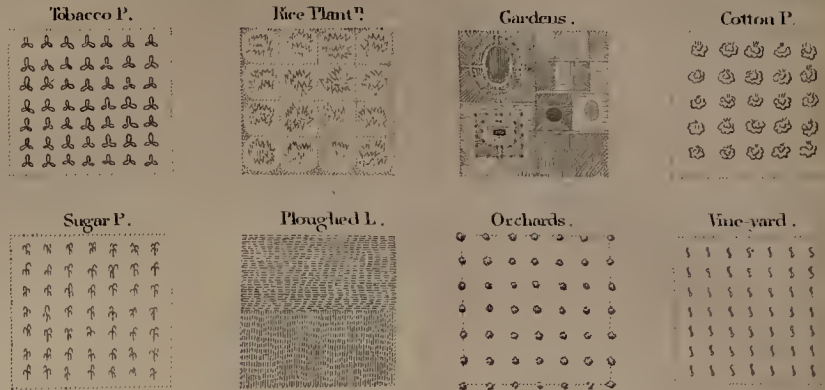
B

A










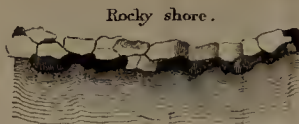
- Artillery* 
- Artillery Park* 
- Battery for Cannon* 
- Battery for Mortars* 
- Cemetery* 
- Grocery* 
- Court House* 
- Cotton Factory* 
- Tavern* 
- Furnace* 
- Glass Factory* 
- Church of a Village* 
- Church Detached* 
- Foundry* 
- Forge* 
- Cavalry* 
- Infantry* 
- House* 
- Mill Grist* 
- " Saw* 
- " Steam* 
- " of Stone* 
- " of Wood* 
- Post Office* 
- Trigonometrical Point* 
- Telegraph* 








Anchorage  for ships.
 Anchorage  for coasters.
 Rocks always \ddagger covered.

Buoys. 
 Wrecks. 
 Harbours. 



Light  house.
 Signal  house.
 Channel  marks.

