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**THE  
RAILROAD TAPER**

**THE THEORY AND APPLICATION OF A  
COMPOUND TRANSITION CURVE  
BASED UPON THIRTY-  
FOOT CHORDS**

**BY**

**LEE PERKINS**

**FORMERLY ASSISTANT ENGINEER, SOUTHERN PACIFIC LINES IN  
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## PREFACE

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A VARIETY of transition curves are used on the different railroads, most of them fully explained by published handbooks. A number of years ago Mr. Wm. Hood, Chief Engineer of the Southern Pacific, devised a compound transition curve of unusual simplicity, and developed several tables for this curve. For a number of years this taper has been used on many roads with somewhat incomplete data, usually in the form of blue prints.

This handbook has been prepared as an extension and elaboration of Mr. Hood's earlier work, in an effort to simplify the use of the taper, and to lessen the work of the man in the field. With this in view, to a brief explanation of the taper has been added the solution of all the usual curve problems as applied to tapered curves. Since the various transition curves differ only in their method of development and their numerical values, differing not at all in the method of inserting them between tangent and curve, or between curves, these curve problems for tapered curves are available for use with the tables of any transition curve.

The transition curve herein developed is, theoretically, a series of compound curves, each branch of the curve having a thirty-foot chord (in the metric system a ten-meter chord), the last branch compounding with the central circular curve, the degree of curvature of the various branches and ending with the main curve increasing in direct arithmetical progression. The various tables are to enable one to run in this series of compound curves with

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the ease of running in a simple curve, and from a single setting of the transit.

The primary taper tables give the various taper functions for every thirty feet of taper. That all the tapers may be available for use with all degrees and fractional degrees of main curve, avoiding the use of inappropriate taper lengths, additional tables have been furnished giving the taper functions for main curves of intermediate degree, the values having been trigonometrically interpolated. If further interpolation be necessary it may be linear between the values given in these tables of intermediate values. In addition, fairly simple equations are given for all the angular functions, frequently useful in setting intermediate points on the taper.

The radius of main curve is assumed based on a fifty-foot chord throughout, mainly because the roads that have always used this taper have always used that radius. However, this usage is in accordance with the present tendency, obviating the necessity of using long chain lengths in setting fifty-foot points, which are set much more frequently than not.

All the functions of the taper for both field and drawing-room work are given for eleven different tapers of increasing taper increment, which with their forty to eighty lengths comprise some seven hundred tapers. Three of these eleven, however, will be found to answer most needs except in mountainous country.

The taper numbers used are those which have long been employed for these curves, and are retained for the benefit of present records, though a more logical system of numbering, such as the degree of curvature increment per thirty feet of taper, might seem desirable, and is suggested for use where this taper is hereafter adopted.

The problem of tapering old circular curves is essentially a different one from locating new lines, and is handled separately. The insertion of tapers between the branches

of compound curves should receive more attention than it has generally had. A fairly simple solution of this problem is given.

The tapers have been calculated for metric curves for the use of the constantly increasing number of American engineers in Mexico and South America, where this taper is already extensively used.

Acknowledgments are due to the following, for the use of tables reprinted from their respective books:

Professor Daniel Carhart, *Logarithms of Numbers and Trigonometric and Miscellaneous Formulas*; Professor J. C. Nagle, *Logarithmic Sines and Cosines, Logarithmic Tangents and Cotangents, Functions of a One Degree Curve, Natural Secants and Cosecants, and Metric Conversion Table*; Mr. Walter Loring Webb, *Logarithmic Versed Sines and External Secants, Natural Sines, Cosines, Tangents and Cotangents, and Natural Versed Sines and External Secants*; and the American Railway Engineering Association, for the *Table of Theoretical Super-elevation of Rails*, prepared by its Committee on Track and published in the *Manual* of that Association.

LEE PERKINS.

SILVER CITY, NEW MEXICO,  
*March, 1915.*



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# THE RAILROAD TAPER

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## CHAPTER I

### INTRODUCTION

#### PURPOSE OF THE TAPER

1. Tapered curves have gained such wide usage that it is needless to dwell at length on their advantages. Where circular curves alone are used, the transition from tangent to curve is sudden, giving a decided lurch to the cars, unpleasant to passengers and damaging alike to rolling stock and track. Running the super-elevation back on the tangent does not obviate this, and it can be remedied only by increasing the curvature gradually, increasing the super-elevation of rails at the same time.

This the tapered curve accomplishes in a satisfactory and practical manner, much as it has always been done by track foremen, who lined in an approximate taper by eye. The proper use of the taper, however, insures a uniform curve beyond the taper, a result not easily obtained by the trackman unaided.

#### DEVELOPMENT OF THE TAPER

2. The railroad taper consists, theoretically, of a series of short curves, each of thirty-foot chord length, and of uniformly increasing curvature, compounding at the end with the central main curve. The various tapers differ merely in the curvature increment, and, therefore, in the length needed to lead up to the curvature of the main curve. Fig. 1 illustrates the first one hundred and twenty

THE RAILROAD TAPER

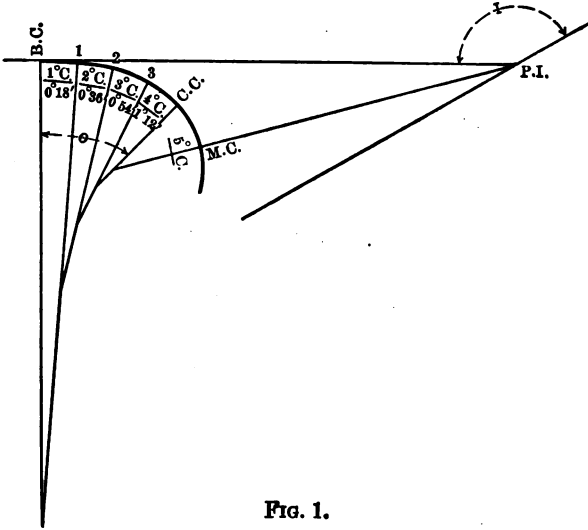


FIG. 1.

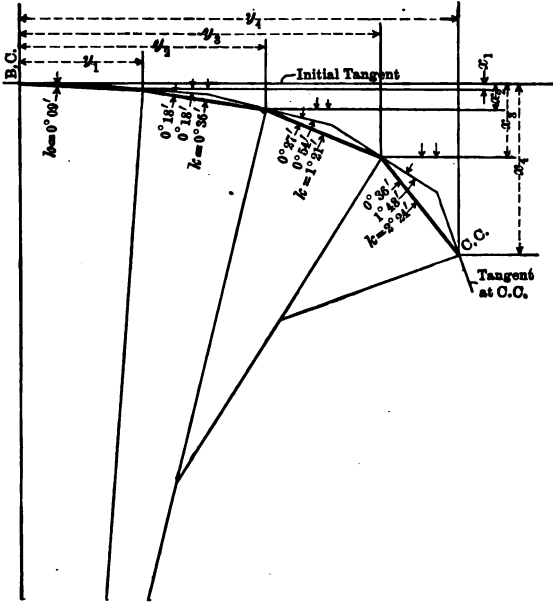


FIG. 2.

feet of Taper 2, compounding with the main five-degree curve.

3. The central angle ( $o$ ) of the taper is, of course, the summation of the central angles of its parts.

4. In Fig. 2 is shown the same curve represented by its thirty-foot chords, showing the method of obtaining the  $x$  and  $y$  co-ordinates of the chord-points referred to the initial tangent and the  $B.C.$  (beginning of curve) of the taper. The angle  $k$  is the azimuth of the various chords, referred to the initial tangent, and the  $x$  and  $y$  co-ordinates are the departures and latitudes of the chord-points. These co-ordinates are given in the tables.

5. From  $x$  and  $y$  were calculated for the tables the deflection angles ( $f$ ) from the initial tangent at the  $B.C.$  to the various chord-points, by the equation

$$\tan f = \frac{x}{y}. \quad (1)$$

The backsight deflection ( $b$ ) from tangent at any chord-point to the  $B.C.$  equals the central angle of the taper up to that point minus the deflection at the  $B.C.$  to that chord-point, and is given in the tables.

As shown in Fig. 3, the deflection from tangent at any chord-point to any other chord-point equals the azimuth of the long chord between the chord-points, minus the central angle of the taper up to the first chord-point.

This azimuth is the angle whose tangent is  $\frac{x'' - x'}{y'' - y'}$ .

As shown in Fig. 4, the backsight deflection from tangent at any chord-point to any other chord-point is

$$b''-1 = o'' - o' - f''-1,$$

and is given in the tables.

6. The long chord ( $lc$ ) from the  $B.C.$  to any chord-point, given in the tables, is

$$lc = \frac{y}{\cos f}. \quad (2)$$

THE RAILROAD TAPER

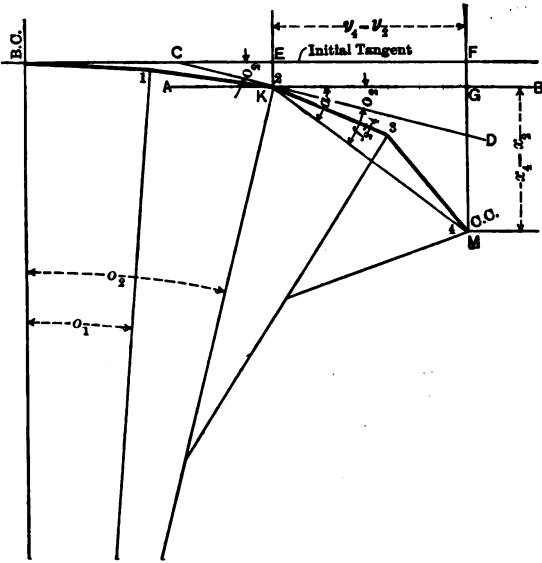


FIG. 3.

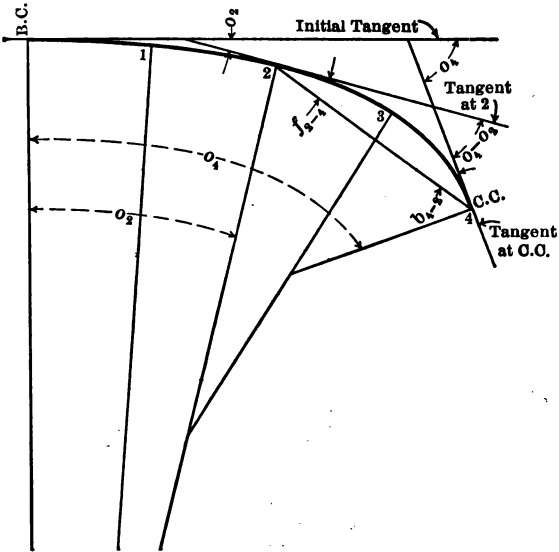


FIG. 4.

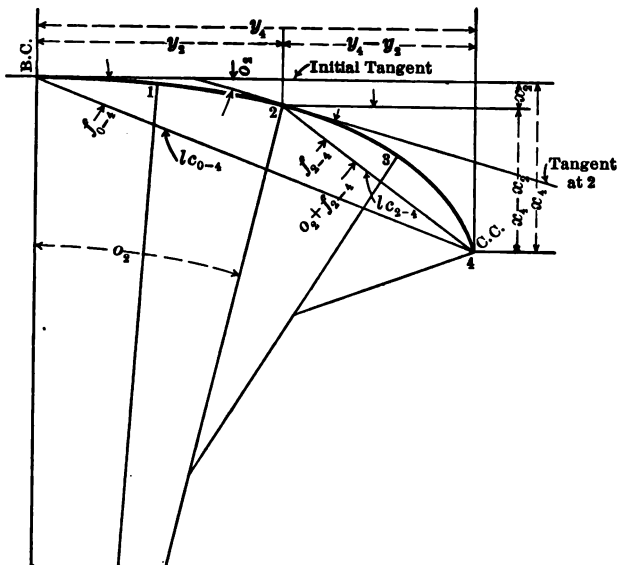


FIG. 5.

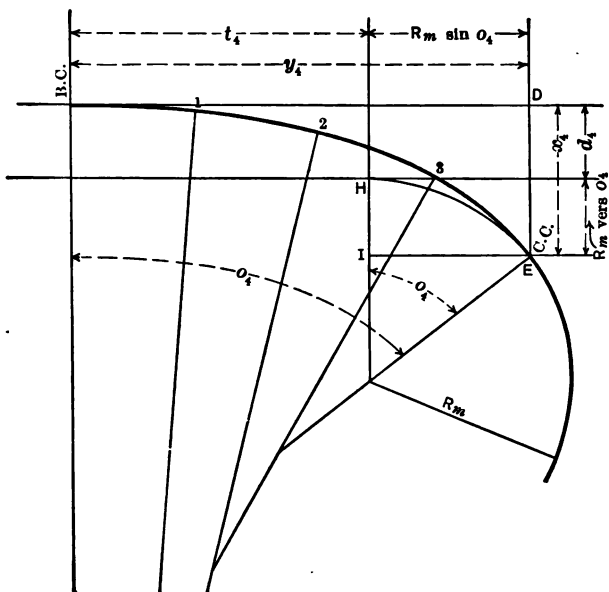


FIG. 6.



Similarly, as in Fig. 5, the long chord between any other chord-points is

$$lc'' = \frac{y'' - y'}{\cos(e' + f''')} \quad (3)$$

7. In order to make room for the taper, the simple curve may be considered as offset from its natural position a distance from the tangent that will be called  $d$ , the taper beginning at a point back of this offset position of the *B.C.* of the simple curve a distance along the tangent that will be called  $t$ .

This tangent distance,  $t$ , is very nearly half the length of the taper, its exact value, from Fig. 6, being

$$\begin{aligned} t &= BD - IE \\ &= y - R \sin o, \end{aligned} \quad (4)$$

where  $R$  is the radius of the main curve, and  $o$  the central angle of the taper.

The value of the circular curve offset,  $d$ , from Fig. 6, is

$$\begin{aligned} d &= DE - HI \\ &= x - R \text{ vers } o. \end{aligned} \quad (5)$$

The values of  $t$  and  $d$  are given in the tables.

These two equations, 4 and 5, are the fundamental equations of the taper, locating the center of curvature of the main curve with reference to the tangents and the beginning and end of curve. The equations are identical in form for all transition curves, and similar values under different letter designations are invariably given in their tables. On these two distances,  $t$  and  $d$ , are based all the solutions of curve problems in the succeeding chapters.

## CHAPTER II

### LOCATION PROBLEMS

**8. To Find the Semi-tangents of a Tapered Curve.**  
 Given  $R$  and  $I$  to find  $T$ .

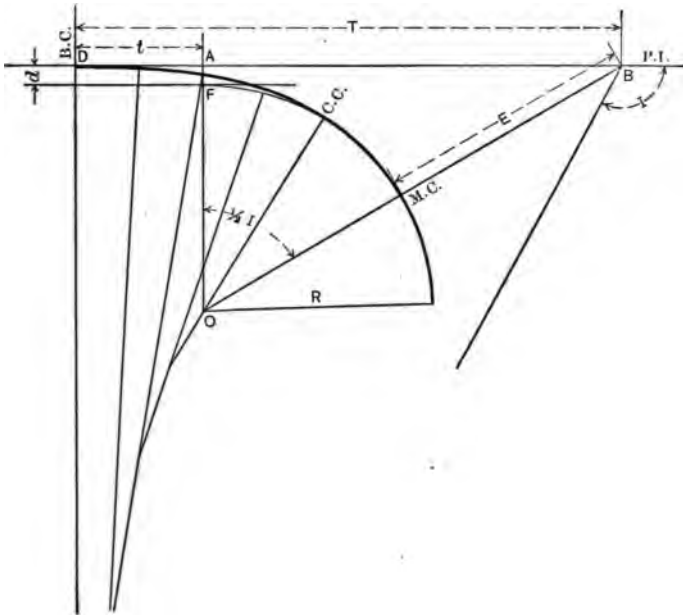


FIG. 7.

**CASE I.** *Tapered at both ends with the same taper.*  
 From Fig. 7,

$$\begin{aligned}
 T &= AD + AB \\
 &= t + OA \tan \frac{1}{2} I \\
 &= t + (R + d) \tan \frac{1}{2} I.
 \end{aligned}
 \tag{6}$$

In the tables is given a value  $D = R + d$ , so the above may be written

$$T = t + D \tan \frac{1}{2} I. \quad (7)$$

*Example.* Find the semi-tangent of a  $5^\circ 00'$  curve, tapered with Tap. 2, total angle of curve  $35^\circ 04'$ .

By Eqn. 7	$\log D_{5^\circ \text{ Tap. 2}}$	3.05949
	$\log \tan 17^\circ 32'$	9.49960
		2.55909
		362.32
	$t =$	59.99
	$T =$	422.31

CASE II. *Tapered at one end only.*

It may occasionally be necessary to taper one end only of a curve, or, considering the parallel offset tangent, to treat the curve as tapered at one end only.

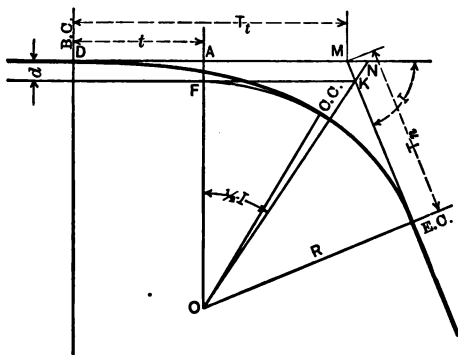


FIG. 8.

In this case the two semi-tangents will be of different lengths, the one for the tapered end being the longer, when  $I$  is less than  $90^\circ$ , by an amount less than  $t$ .

From Fig. 8.

$$\begin{aligned} MN &= MK = d \csc I, \\ T_t &= t + OA \tan \frac{1}{2} I - MN \\ &= t + D \tan \frac{1}{2} I - d \csc I, \end{aligned} \quad (8)$$

$$T_n = R \tan \frac{1}{2} I + d \csc I. \quad (9)$$

These equations do not change for angles greater than  $90^\circ$ , the algebraic sign of the last term remaining unchanged.

*Example.* Find the semi-tangents of a  $7^\circ 00'$  curve, tapered at the *B.C.* with Tap.  $2\frac{1}{2}$ , no taper at the *E.C.*, total angle of curve  $54^\circ 22'$ .

By Eqn. 8	$\csc 54^\circ 22'$	1.23037
	$d$	0.95
		615185
		1 007333
		1.0688515
	$\log D_{7^\circ \text{ Tap. } 2\frac{1}{2}}$	2.91360
	$\log \tan 27^\circ 11'$	9.71059
*:		2.62419
		420.91
	+ $t$	54.98
		475.89
	-	1.07
	<i>B.C. to P.I.</i>	474.82
By Eqn. 9	$\log R_{7^\circ}$	2.91309
	$\log \tan 27^\circ 11'$	9.71059
		2.62368
		420.42
	+	1.07
	<i>P.I. to E.C.</i>	421.49

**CASE III.** *Tapered at both ends, with different tapers.*

From Fig. 9,

$$MN = MK = d_1 \csc I,$$

$$BM = d_2 \csc I,$$

$$BJ = BN = MN - BM$$

$$= (d_1 - d_2) \csc I,$$

$$T_1 = t_1 + D_1 \tan \frac{1}{2} I - (d_1 - d_2) \csc I. \quad (10)$$

$$T_2 = t_2 + D_2 \tan \frac{1}{2} I - (d_2 - d_1) \csc I. \quad (11)$$

These equations do not change for angles greater than  $90^\circ$ , the algebraic sign of the last term remaining unchanged.

*Example.* Find the semi-tangents of a  $10^\circ 00'$  curve tapered at the *B.C.* with Tap.  $2\frac{1}{2}$ , and at the *E.C.* with Tap. 3, total angle of curve  $113^\circ 42'$ .

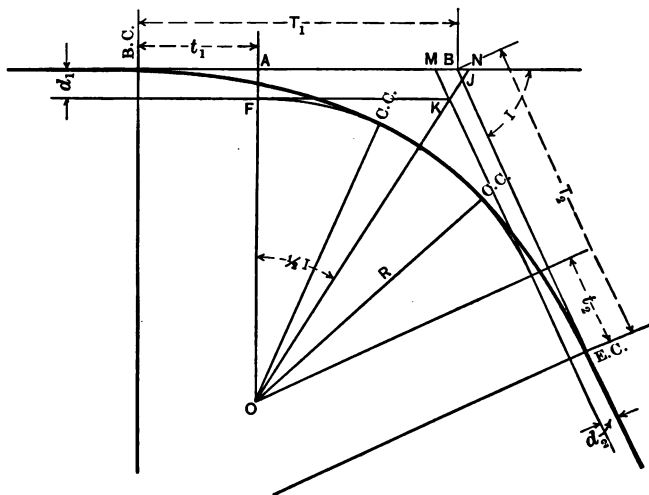


FIG. 9.

By Eqn. 10	$\csc 113^\circ 42'$ ( $\csc 66^\circ 18'$ )	1.09211	
	$d_1 - d_2 = 2.84 - 0.98 =$	1.86	
		<u>655266</u>	
		873688	
		1 09211	
		<u>2.03</u>	
	$\log D_{10^\circ \text{ Tap. } 2\frac{1}{2}}$	2.76041	
	$\log \tan 56^\circ 51'$	0.18500	
		<u>2.94541</u>	
		881.88	
	+ $t_1$	<u>84.88</u>	
		966.76	
	-	<u>2.03</u>	
	<i>B.C. to P.I.</i>	<u>964.73</u>	
By Eqn. 11	$\log D_{10^\circ \text{ Tap. } 3}$	2.75900	
	$\log \tan 56^\circ 51'$	0.18500	
		<u>2.94400</u>	

	879.02
+ $t_2$	44.97
	923.99
+	2.03
<i>P.I. to E.C.</i>	926.02

**9. Given  $R$  and  $I$ , to find the External,  $E$ .**

CASE I. *Tapered at both ends with the same taper.*

From Fig. 7,

$$\begin{aligned} E &= OB - R \\ &= D \sec \frac{1}{2} I - R, \end{aligned} \quad (12)$$

or

$$\begin{aligned} E &= (R + d) \sec \frac{1}{2} I - R - d + d \\ &= (R + d) (\sec \frac{1}{2} I - 1) + d \\ &= D \operatorname{exsec} \frac{1}{2} I + d. \end{aligned} \quad (13)$$

*Example.* Find the external of a  $5^\circ 00'$  curve, Tap. 2, total angle  $27^\circ 12'$ .

By Eqn. 12 or 13,  $E = 33.88$ .

CASE II. *Tapered at one end only, or at both ends, with different tapers.*

From Fig. 10,

$$\begin{aligned} E &= \sqrt{OA^2 + AB^2} - R \\ &= \sqrt{D^2 + (T - t)^2} - R, \end{aligned} \quad (14)$$

or

$$E = D \sec \tan^{-1} \frac{T - t}{D} - R, \quad (15)$$

where  $\tan^{-1} \frac{T - t}{D}$  is the angle whose tangent is  $\frac{T - t}{D}$ .

*Example.* Find the external to the curve given in the example under equations 8 and 9.

By Eqn. 14 or 15,  $E = 102.24$ .

**10. To Find the Tangent Offset and Tangent Distance to any Point on the Curve.**

From Fig. 11,

$$\begin{aligned} PD &= AC + d \\ &= R \operatorname{vers} I + d, \end{aligned} \quad (16)$$

$$\begin{aligned} ED &= BD + t \\ &= R \sin I + t. \end{aligned} \quad (17)$$

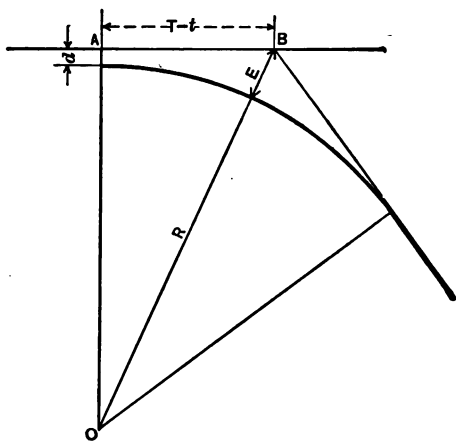


FIG. 10.

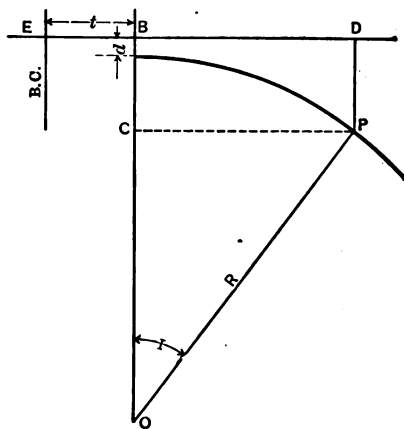


FIG. 11.

Or from the Table of Functions of a  $1^\circ$  curve,  $AC$  is the mid-ordinate for a central angle equal to  $2 I$ , and  $BD$  is half the long chord for a similar central angle.

**11. Given a Point,  $P$ , referred to the  $P.I.$ , to find the Radius of a Curve passing through  $P$  uniting the Given Tangents.**

Since the solution of this problem depends upon the taper chosen and its value of  $d$ , and the choice of taper depends largely upon the degree of curve, a trial solution for an untapered curve is first made.

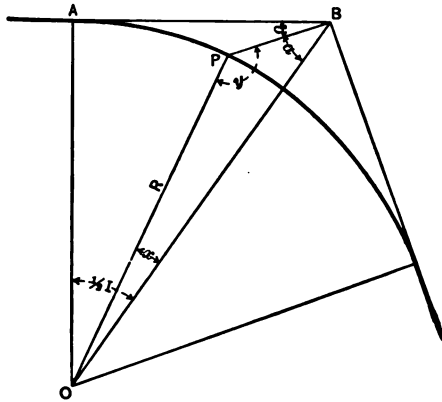


FIG. 12.

From Fig. 12,

$$\begin{aligned} \sin y &= \frac{OB}{OP} \sin a \\ &= \frac{R \sec \frac{1}{2} I}{R} \sin a \\ &= \frac{\sin a}{\cos \frac{1}{2} I}, \end{aligned} \tag{18}$$

$$\begin{aligned} R &= PO \\ &= \frac{\sin a}{\sin x} PB. \end{aligned} \tag{19}$$



Since this problem occurs mainly in location, and it is necessary merely to have the curve pass close to the determining point without using a curve of fractional degree, to allow room for the taper a curve of next higher even degree is chosen, and when desirable it may be determined as follows how close the chosen curve will pass to the given point.

In Fig. 13,  $P$  is the point through which the curve should pass,  $P'$  a point on the chosen curve radially opposite.

$$\begin{aligned}
 PP' &= OP - R \\
 &= \sqrt{OD^2 + DP^2} - R \\
 &= \sqrt{(OA - AD)^2 + (AB - CB)^2} - R \\
 &= \sqrt{(D - PB \sin b)^2 + (D \tan \frac{1}{2} I - PB \cos b)^2} - R. \quad (20)
 \end{aligned}$$

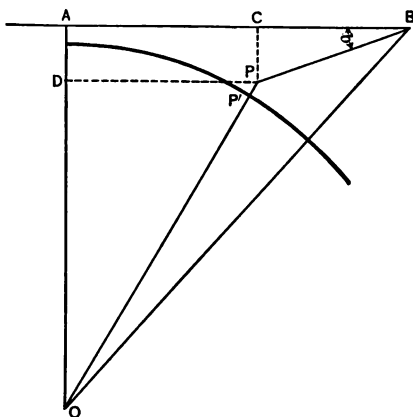


FIG. 13.

*Example.* In Fig. 13, let  $PB = 194.3$ ,  $b = 42^\circ 24'$ ,  
 $I = 54^\circ 22'$ . Then  $a = 90^\circ - \frac{54^\circ 22'}{2} - 42^\circ 24'$

$$= 20^\circ 25'.$$

By Eqn. 18,  $y = 23^\circ 05'$

$$x = y - a = 2^\circ 40',$$

By Eqn. 19,  $R = 1456.8$ .

$3^\circ 56'$  curve.

Deciding now upon a  $4^{\circ} 00'$  curve with Tap. 1, to determine how close this curve will pass to point  $P$ :

By Eqn. 20,  $(D - PB \sin b)^2 = 1698100$

$$(D \tan \frac{1}{2} I - PB \cos b)^2 = \frac{351675}{2049775}$$

$$\sqrt{2049775} = 1431.7$$

$$- R \quad 1432.5$$

$$PP' = - 0.8$$

The negative result shows that  $P$  is *inside* the curve 0.8 ft., which on most location is sufficiently close.

**12. Find the B.C. of a Curve of Given Radius that will pass through a Given Point referred to a Given Tangent.**

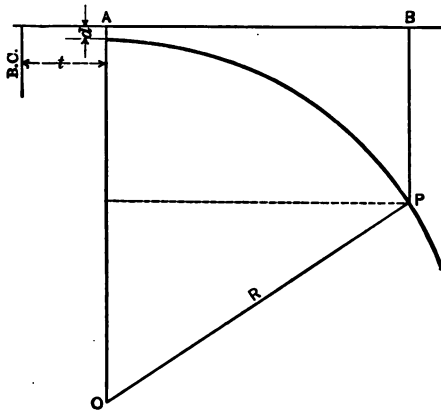


FIG. 14.

From Fig. 14,

$$AB = R \sin \text{vers}^{-1} \frac{BP - d}{D} \tag{21}$$

$(R \text{ times the sine of the angle whose versine is } \frac{BP - d}{D}),$

or  $R^2 = (D - BP)^2 + AB^2,$   
 $AB = \sqrt{R^2 - (D - BP)^2}.$  (22)

*Example.* Given  $BP = 82$  ft.,  $M = 6^\circ 00'$ , Tap. 2, then  $D = 956.41$ ,  $R = 955.04$ .

$$\text{By Eqn. 21, } \text{vers}^{-1} \frac{BP - d}{R} = 22^\circ 45\frac{1}{2}',$$

$$AB = 369.45.$$

**13. Given Two Points referred to a Tangent, to find the Radius and  $B.C.$  of a Curve passing through them and joining the Given Tangent with a Given Taper.**

Since the solution of this problem depends upon the taper chosen and its value of  $d$ , the choice of which depends largely upon the degree of curve, a trial solution for an untapered curve is first made.

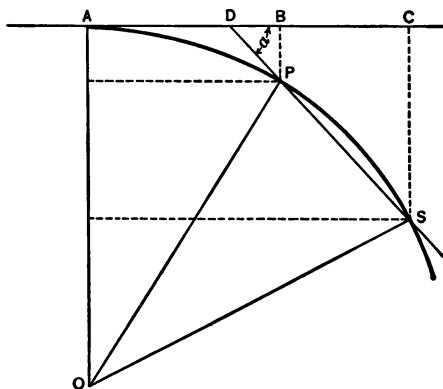


FIG. 15.

In Fig. 15, given points  $P$  and  $S$ , referred to the tangent by lengths  $DP$  and  $DS$ , and the angle  $\alpha$ , to find the radius  $OA$  and distance  $AD$ .

$$\begin{aligned} \text{By geometry } AD^2 &= DP \times DS, \\ AD &= \sqrt{DP \times DS}. \end{aligned} \quad (23)$$

$DB$  and  $BP$  may be obtained from a solution of the triangle  $BDP$ .

$$\begin{aligned}
 R^2 &= AB^2 + (R - BP)^2 \\
 &= AB^2 + R^2 - 2R \times BP + BP^2, \\
 R &= \frac{AB^2 + BP^2}{2BP}, \tag{24}
 \end{aligned}$$

or

$$R = \frac{AB}{\sin 2 \tan^{-1} \frac{BP}{AB}}. \tag{25}$$

A curve of next higher even degree is now chosen with an appropriate taper, passed through  $S$  as in paragraph 12, and the distance of  $P$  from the curve determined as follows.

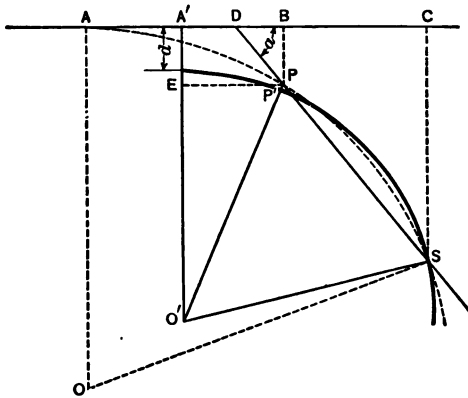


FIG. 16.

From Fig. 16,

$$A'C = R \sin \text{vers}^{-1} \frac{CS - d}{R}, \tag{26}$$

or

$$A'C = \sqrt{R^2 - (D - CS)^2}; \tag{27}$$

$$\begin{aligned}
 PP' &= OP - R \\
 &= \sqrt{OE^2 + EP^2} - R \\
 &= \sqrt{(D - BP)^2 + A'B^2} - R, \tag{28}
 \end{aligned}$$

or

$$PP' = \frac{D - BP}{\cos \tan^{-1} \frac{A'B}{D - BP}} - R. \tag{29}$$

*Example.*  $DP = 94$  ft.,  $PS = 127$  ft., angle  $a = 16^\circ 12'$ .

By Eqn. 23,  $AD = 144.1$ .

From  $\triangle BDP$ ,  $BP = 26.2$

and  $DB = 90.3$ ;

then  $AB = AD + DB = 234.4$ .

By Eqn. 25,  $\tan^{-1} \frac{BP}{AB} = 6^\circ 23'$ ,

and  $R = 1060.7$   
 $5^\circ 24'$  curve.

Deciding now upon a  $5^\circ 30'$  curve, Tap. 2, through  $S$ :

From  $\triangle DSC$ ,  $CS = 61.66$

$-d = 1.05$

$CS - d = \frac{1.05}{60.61}$

and  $DC = 212.2$

$-DB = 90.3$

$BC = \frac{90.3}{121.9}$ .

By Eqn. 26,  $\text{vers}^{-1} \frac{CS - d}{R} = 19^\circ 38'$

and  $A'C = 350.06$

$-BC = 121.9$

$A'B = \frac{121.9}{228.16}$ .

By Eqn. 29,  $\tan^{-1} \frac{A'B}{D - BP} = 12^\circ 39'$ ,

and  $PP' = 0.14$ .

From the positive value of  $PP'$ ,  $P$  lies outside the curve assumed. If the curve had not passed sufficiently close to  $P$ , a slightly sharper curve would pass further out at  $P'$ , or if the curve had passed outside of  $P$ , a slightly lighter curve would pass closer to  $P$ .

#### 14. To Fix upon a Tangent at the End of a Curve.

In the previous problem of passing the curve through two determining points and tangent to the back-located tangent, it is not practical to first locate the tangent

ahead and make an intersection. The curve must be run in beyond the determining points, then a meander line run to the next controlling point on the tangent ahead and the tangent located as follows:

When the curve has reached a point *A*, Fig. 17, from which a view may be had of the tangent desired, or of some controlling point, *B*, on it, through which it is desired to run the tangent because of properly supporting ground, a flag may be sent to *C*, opposite *B*, (the uncer-

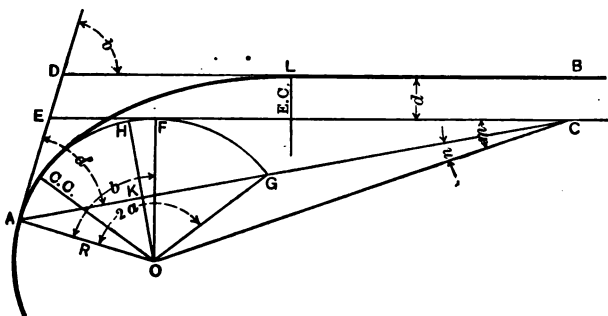


FIG. 17.

tainty of right angle direction will affect this very little), and a distance therefrom equal to *d* of the taper. With improvised targets of some nature, or double points and angle between, a fairly accurate stadia shot may be obtained, and with the angle from tangent at *A* to *C*, the distance *BL* and the central angle of the rest of the curve may readily be calculated.

From Fig. 17,

$$\begin{aligned}
 AG &= 2R \sin a, \\
 OK &= R \cos a, \\
 CF &= \sqrt{CG \times AC}, \\
 \tan n &= \frac{OK}{KC} \\
 &= \frac{R \cos a}{AC - R \sin a}, \tag{30}
 \end{aligned}$$

$$\begin{aligned}\tan m &= \frac{R}{CF} \\ &= \frac{R}{\sqrt{(AC - 2R \sin a) AC}},\end{aligned}\quad (31)$$

$$b = a + m - n. \quad (32)$$

Given  $b$ ,  $AD$  and  $DL$  may be calculated by equations 9 and 8. Then

$$\begin{aligned}LB &= CF - t \\ &= \sqrt{(AC - 2R \sin a) AC} - t.\end{aligned}\quad (33)$$

*Example.* Assume a  $5^\circ 30'$  curve, Tap. 2, to have been run to point  $A$ . Distance  $AC$  by stadia is 610 ft., and angle  $a$  is  $6^\circ 10'$ .

$$\text{By Eqn. 30,} \quad n = 64^\circ 19'.$$

$$\text{By Eqn. 31,} \quad m = 66^\circ 01'.$$

$$\text{By Eqn. 32,} \quad a \quad 6^\circ 10'$$

$$+ m \quad 66^\circ 01'$$

$$- n \quad 64^\circ 19'$$

$$b = 7^\circ 52'.$$

$$\text{By Eqn. 33,} \quad LB = 417.9.$$

### 15. To Connect two Located Curves by a Tangent.

In the preceding problem, if the next controlling point had been on a curve, instead of a tangent, it would often be necessary to locate this next curve first and then connect the two curves by a tangent.

#### CASE I. Curves of contrary flexure.

Let  $AB$  and  $CD$ , Fig. 18, be the two located curves, to locate tangent  $LM$  fitting the two curves with given tapers, the curves being offset from the tangent  $d_1$  and  $d_2$ , respectively, to provide room for the tapers.

From some point  $E$  on tangent at  $B$ , run one or more courses,  $EF$ , to some point  $F$  on tangent at  $D$ . Calculate the latitude and departures of  $N$  and  $O$  with reference to tangent at  $B$  as base and radius  $BN$  as meridian. The difference of the latitudes equals  $OG$ , the difference of the departures equals  $NG$ .

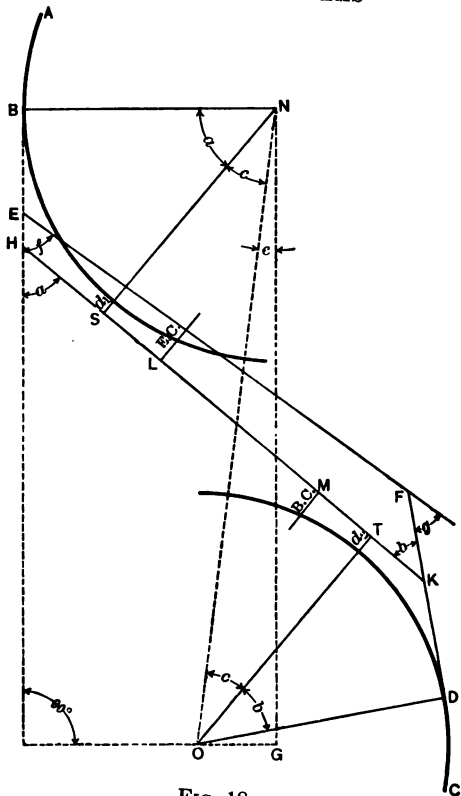


FIG. 18.

Then,

$$NO = \sqrt{OG^2 + NG^2}, \tag{34}$$

$$\tan e = \frac{OG}{NG'}, \tag{35}$$

$$\begin{aligned} \cos c &= \frac{R_1 + d_1 + R_2 + d_2}{NO} \\ &= \frac{D_1 + D_2}{NO}, \end{aligned} \tag{36}$$

$$a = 90^\circ - e - c, \tag{37}$$

$$f - g = a - b, \tag{38}$$

$$b = a - f + g, \tag{38}$$

$$\begin{aligned} LM &= ST - (t_1 + t_2) \\ &= NO \sin c - (t_1 + t_2). \end{aligned} \tag{39}$$



*Example.* Given a  $5^{\circ} 30'$  curve  $AB$  and a  $4^{\circ} 00'$  curve  $CD$ , to locate tangent connecting them, using Taper 2 on the  $5^{\circ} 30'$  curve and Taper  $1\frac{1}{2}$  on the  $4^{\circ} 00'$  curve.

At  $B$  turn tangent to curve and set point  $E$ , and at  $D$  turn tangent and set  $F$ . Assume  $BE = 100$  ft., angle  $f = 9^{\circ} 11'$ ,  $EF = 384.0$  ft., angle  $g = 6^{\circ} 38'$ ,  $FD = 100$  ft.

Then a traverse from  $N$  to  $O$  is as follows:

Course.	Length.	Asimuth.	Lat.	Dep.
$NB$ .....	1041.8	$180^{\circ} 00'$	-1041.8	0
$BE$ .....	100.0	$90^{\circ} 00'$	0	+100.0
$EF$ .....	384.0	$80^{\circ} 49'$	+ 61.3	+379.1
$FD$ .....	100.0	$87^{\circ} 27'$	+ 4.4	+ 99.9
$DO$ .....	1432.5	$177^{\circ} 27'$	-1431.1	+ 63.7
$NO$ .....	2491.5	$165^{\circ} 03'$	-2407.2	+642.7

From this traverse

$$NO = 2491.5,$$

$$NG = 642.7,$$

$$GO = 2407.2,$$

$$e = 75^{\circ} 03'.$$

$$\text{By Eqn. 36, } c = 6^{\circ} 23'.$$

$$\text{By Eqn. 37, } a = 8^{\circ} 34'.$$

$$\text{By Eqn. 38, } b = 6^{\circ} 01'.$$

$$\text{By Eqn. 39, } LM = 144.5.$$

$$\text{By Eqn. 9, } BH = 85.08.$$

$$\text{By Eqn. 8, } HL = 138.54.$$

$$\text{By Eqn. 8, } MK = 133.54.$$

$$\text{By Eqn. 9, } KD = 82.05.$$

If in this solution  $LM$  had been too short, or even negative, one of the curves would have to be shifted or sharpened, or the tapers shortened.

CASE II. *Curves of similar flexure.*

Determine  $NG$  and  $GO$  as in Case I.

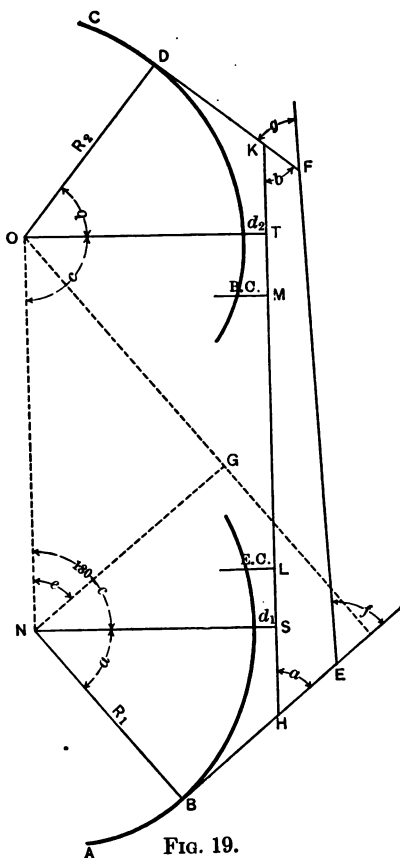


FIG. 19.

Then from Fig. 19,

$$NO = \sqrt{OG^2 + NG^2}, \quad (34)$$

$$\tan e = \frac{OG}{NG}, \quad (35)$$

$$\cos c = \frac{D_2 - D_1}{NO}, \quad (36a)$$

$$a = e + c - 90^\circ, \quad (37a)$$

$$b = f + g - a, \quad (38a)$$

$$LM = NO \sin c - (t_1 + t_2). \quad (39)$$

*Example.* Assume the same conditions as in the example under Case I, angle  $g$  merely being in the opposite direction.

Then a traverse from  $N$  to  $O$  is as follows:

Course.	Length.	Azimuth.	Lat.	Dep.
$NB$ .....	1041.8	$180^\circ 00'$	-1041.8	0
$BE$ .....	100.0	$90^\circ 00'$	0	+100.0
$EF$ .....	384.0	$80^\circ 49'$	+ 61.3	+379.1
$FD$ .....	100.0	$74^\circ 11'$	+ 27.3	+ 96.2
$DO$ .....	1432.5	$344^\circ 11'$	+1378.3	-390.4
$NO$ .....	485.4	$23^\circ 30'$	+ 425.1	+184.9

From this traverse

$$\begin{aligned}
 NO &= 485.4, \\
 e &= 90^\circ - 23^\circ 30' \\
 &= 66^\circ 30'.
 \end{aligned}$$

$$\text{By Eqn. 36a, } c = 36^\circ 29'.$$

$$\text{By Eqn. 37a, } a = 12^\circ 59'.$$

$$\text{By Eqn. 38a, } b = 2^\circ 50'.$$

$$\text{By Eqn. 39, } LM = 156.1.$$

### 16. To Relocate a Curve so the *E.C.* shall fall at a Given Point in a Given Parallel Tangent.

In Fig. 20 let  $ABC$  be the located curve, tapers omitted for clearness, and  $DEF$  the required curve ending at  $F$ .  $CG$  and  $GF$  are known.

By a solution of triangle  $KMI$ ,  $KF$  becomes known. The value of  $R_2$  now depends solely upon the taper chosen and its value of  $t_2$  and  $d_2$ , and may best be determined by trial, using the tables of functions of a one-degree curve, assuming at first a value of  $t_2$  somewhat larger, or smaller as the case may be, than  $t_1$ . It will usually be sufficient for the semi-tangent of the new curve *approximately* to equal  $KF$ .

*Example.* Assume curve  $ABC$  to be a  $6^\circ 00'$  curve, Taper 2, total angle  $36^\circ 14'$ .  $CG = 7.1$ ,  $GF = 42.4$ .

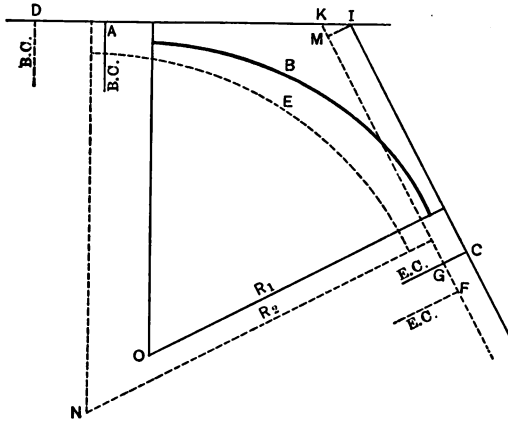


FIG. 20.

From  $\triangle KMI$ ,  $KM = 9.7$   
 and  $KI = 12.0$ .  
 By Eqn. 7,  $IC = 387.88$   
 $+ KM \quad 9.7$   
 $+ GF \quad 42.4$   
 $KF = 440.0$ .

From Tables,  $1^\circ$  curve

$$T_{36^\circ 14'} = 1874.7.$$

If the new curve were untapered,

$$M = \frac{1874.7}{440.0} = 4.26^\circ.$$

If Taper 2 be used on the new curve, then

$M$	$\frac{1847.7}{M}$	$\frac{1}{2}l$	Approx. $T$ .
$4^\circ 45'$	394.7	56.2	450.9
$50'$	387.9	57.5	445.4
$55'$	381.3	58.7	440.0
$5^\circ 00'$	374.9	60.0	434.9

Assuming a  $4^{\circ} 55'$  curve, Taper 2, then  
by Eqn. 7,  $T_2 = 440.29$ .

In this particular case it is unnecessary to interpolate to obtain a more exact value for the semi-tangents, 0.29 ft. being sufficiently close. Linear interpolation between the intermediate values given in the tables would be quite accurate when necessary.

### 17. Intersection of a Line with a Curve.

In Fig. 21, given  $R$ ,  $d$ ,  $AB$  and angle  $b$ , to find  $BP$  and angle  $a$ .

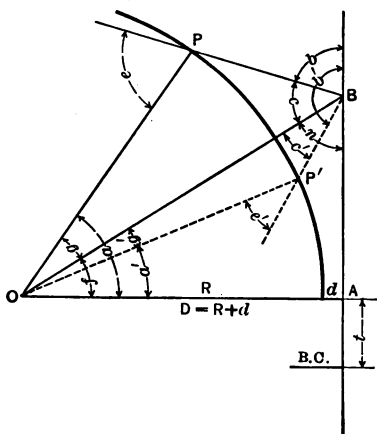


FIG. 21.

$$\tan n = \frac{D}{AB}, \quad (40)$$

$$c = 180^{\circ} - n - b, \quad (41)$$

$$c' = n + b' - 180^{\circ}, \quad (41a)$$

$$OB = \frac{D}{\sin n},$$

$$\sin e = \frac{OB}{R} \sin c$$

$$= \frac{D \sin c}{R \sin n}, \quad (42)$$

$$BP = \frac{R \sin (e - c)}{\sin c}, \quad (43)$$

$$\begin{aligned} a &= f + g \\ &= 90^\circ - n + e - c, \end{aligned} \quad (44)$$

$$\begin{aligned} a' &= f - g' \\ &= 90^\circ - n + c' - e'. \end{aligned} \quad (44a)$$

In equations 42 and 43,  $c'$  may be substituted for  $c$  with no other changes.

*Example.* Given a  $4^\circ 00'$  curve, Taper  $1\frac{1}{2}$ ,  $AB = 195.9$  ft.,  $b = 67^\circ 07'$ .

$$\text{By Eqn. 40,} \quad n = 82^\circ 13'.$$

$$\text{By Eqn. 41,} \quad c = 30^\circ 40'.$$

$$\text{By Eqn. 42,} \quad e = 31^\circ 00'.$$

$$\text{By Eqn. 43,} \quad BP = 16.34.$$

$$\text{By Eqn. 44,} \quad a = 8^\circ 07'.$$

## COMPOUND CURVES

**18. A Taper between the Branches of a Compound Curve** is often more necessary than between curves and tangents, as the change in curvature is often greater. *Only that portion* of the complete taper required to gradually increase the curvature as desired, is used.

*Example.* Taper 2 from tangent to a  $6^\circ 00'$  curve is built up from 30 ft. of  $1^\circ$ , 30 ft. of  $2^\circ$ , 30 ft. of  $3^\circ$ , 30 ft. of  $4^\circ$  and 30 ft. of  $5^\circ$  curves, but in compounding from a  $2^\circ$  to a  $6^\circ$  curve with Taper 2, the first 60 ft. is dropped off, the deflection tables being used as if the transit were at  $l = 60$ , the length of taper to fit a curve of  $M^\circ = M_1 + \Delta$ , where  $M_1$  is the degree of the lighter branch, and  $\Delta$  the curvature increment in degrees for the taper used.

**19. Taper Functions of the Partial Taper.**

From the method of developing the taper, the length of any taper from tangent is,

$$l = \frac{30}{\Delta} (M - \Delta). \quad *(45)$$

Then the entire taper from tangent to fit the branch of the compound curve of greater curvature is

$$l_2 = \frac{30}{\Delta} (M_2 - \Delta), \quad *(46)$$

and the length replaced by the branch of lesser curvature is that needed to fit a curve of  $M^\circ = M_1 + \Delta$  degree, or

$$\begin{aligned} l_1 &= \frac{30}{\Delta} (M_1 + \Delta - \Delta), \\ &= \frac{30 M_1}{\Delta}. \end{aligned} \quad *(47)$$

Then the partial taper retained between the branches of the compound has a length of

$$\begin{aligned} l_c &= l_2 - l_1 \\ &= \frac{30}{\Delta} (M_2 - M_1 - \Delta). \end{aligned} \quad *(48)$$

In Fig. 22,  $M_1$  is the curve of lesser degree,  $M_2$  the curve of greater degree, and  $ABC$  the taper joining the two curves, the tapers at the beginning and end of the compound curve being omitted for clearness of diagram.

The two curves are offset from each other to make room for the taper an amount  $KF = d_r$ , radially to both curves,

\* Equations 45, 46, 47, 48, 50, 51a, 56 and 57 are empirical equations derived from the tables, and cannot be used with other transition curves. When the taper functions of  $M_1$  and  $M_2$  are given in the tables these equations are not needed. When needed for other transition curves, somewhat similar equations, but with other constants, must be derived.

the curve of greater curvature lying within the one of lesser curvature.

$$d_r = d \text{ for } M = M_2 - M_1 \quad (49)$$

to be taken from the tables.

The central angle of the partial taper is

$$o_c = \frac{9(M_2 + M_1)(M_2 - M_1 - \Delta)}{\Delta}, \quad *(50)$$

or  $o_c$  may be taken from the tables, being the difference between  $o$  for  $l_2$  and for  $l_1$ .

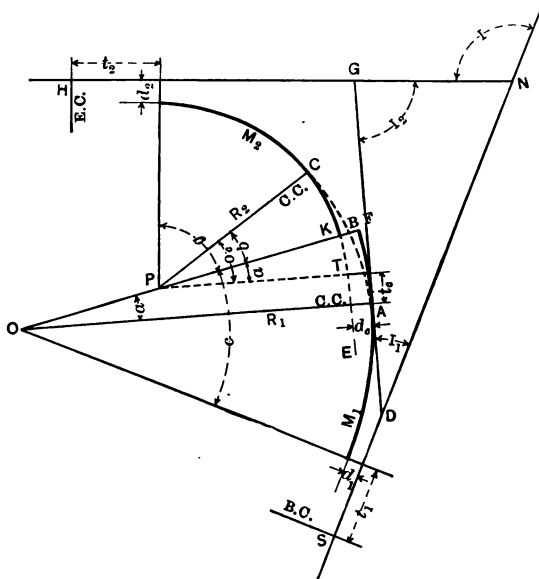


FIG. 22.

The common radial line,  $OF$ , divides this angle,  $o_c$ , proportionally to the degrees of curve of the two branches of the compound curve.

\* See footnote, page 28.



$$a = \frac{M_1}{M_1 + M_2} o_c \quad (51)$$

$$= \frac{9 M_1 (M_2 - M_1 - \Delta)}{\Delta} \quad *(51a)$$

Let  $DA$  be tangent to the curve of lesser degree at the beginning of the partial taper, and let the curve of greater degree be backed up through angle  $o_c$ , so that its tangent,  $ET$ , shall be parallel to  $DA$ , then

$$t_c = (R_1 - R_2 - d_r) \sin a, \quad (52)$$

$$d_c = R_1 - R_2 - t_c \cot a, \quad (53)$$

or 
$$= (R_1 - R_2) \text{ vers } a + d_r \cos a. \quad (53a)$$

From Eqn. 4,  $y_c = t_c + R_2 \sin o_c. \quad (54)$

From Eqn. 5,  $x_c = d_c + R_2 \text{ vers } o_c. \quad (55)$

Using the method of second differences with the tables, the deflection to the end of the taper, from tangent at the beginning of the partial taper, is

$$f_c = \frac{(3 l_1 + l_c + 45) l_c + 450}{\frac{300}{\Delta}} \quad *(56)$$

$$= \frac{3}{2} \left[ \frac{(4 M_1 + 2 M_2 + \Delta) (M_2 - M_1 - \Delta)}{\Delta} + \Delta \right]. \quad *(57)$$

Equation 56 may be used for obtaining all the deflections from tangent at  $A$ , the beginning of the partial taper, to points on the taper, using for  $l_c$  the distance of the point beyond the beginning of the partial taper,  $A$ ,  $l_1$  remaining constant from equation 45.

Where  $M_1$  is a multiple of  $\Delta$ , the deflections to points on the partial taper may be taken directly from the tables, transit at  $l = l_1$ , deflection to  $l = l_1 + l_c$ , using for  $l_c$  the distance of the point beyond the beginning of the partial taper,  $A$ .

\* See footnote, page 28.

The angle of backsight to the beginning of the partial taper, from tangent at the end of the taper, is

$$bs = o_c - f_c. \quad (58)$$

The long chord of the partial taper is, from Eqn. 2,

$$lc_c = y_c \sec f_c. \quad (59)$$

**20. The Semi-tangents of the Compound Curve.**

From Fig. 22  $I_1 = c - a,$  (60)

$$I_2 = g + a. \quad (61)$$

By Eqn. 8,  $SD = t_1 + D_1 \tan \frac{1}{2} I_1 - d_1 \csc I_1.$  (62)

By Eqn. 9,  $DA = R_1 \tan \frac{1}{2} I_1 + d_1 \csc I_1.$  (63)

By Eqn. 10

$$AG = t_c + *D_c \tan \frac{1}{2} I_2 - (d_c - d_2) \csc I_2. \quad (64)$$

By Eqn. 11,

$$GH = t_2 + D_2 \tan \frac{1}{2} I_2 - (d_2 - d_c) \csc I_2, \quad (65)$$

$$DG = DA + AG. \quad (66)$$

Solving triangle *DNG* gives values for *DN* and *NG*.

Then  $SN = SD + DN,$  (67)

$$NH = NG + GH. \quad (68)$$

Where it is desirable to obtain the semi-tangents of the compound curve without first finding the taper functions of the partial taper, *DG* may be drawn tangent to *M*<sub>1</sub> at *F* and equations 62 to 68 become as follows:

$$SD = t_1 + D_1 \tan \frac{1}{2} c - d_1 \csc c, \quad (62a)$$

$$DF = R_1 \tan \frac{1}{2} c + d_1 \csc c, \quad (63a)$$

$$FG = †D_r \tan \frac{1}{2} g - (d_r - d_2) \csc g, \quad (64a)$$

$$GH = t_2 + D_2 \tan \frac{1}{2} g - (d_2 - d_r) \csc g, \quad (65a)$$

$$DG = DF + FG, \quad (66a)$$

$$SN = SD + DN, \quad (67)$$

$$NH = NG + GH. \quad (68)$$

*Example.* Given *I* = 114° 24', *c* = 34° 40', *g* = 79° 44', *M*<sub>1</sub> = 3° 00', *M*<sub>2</sub> = 8° 00'. Use Taper 1 between tangent

$$* D_c = R_2 + d_c.$$

$$† D_r = R_2 + d_r.$$

and  $3^{\circ} 00'$  curve, Taper 2 between  $3^{\circ} 00'$  and  $8^{\circ} 00'$  curves and Taper  $2\frac{1}{2}$  between the  $8^{\circ} 00'$  curve and tangent Find the semi-tangents.

$$\begin{aligned} \text{By Eqn. 48, } l_c &= \frac{30}{1}(8 - 3 - 1) \\ &= 120. \end{aligned}$$

$$\begin{aligned} \text{By Eqn. 49, and the tables,} \\ d_r &= 0.79. \end{aligned}$$

$$\begin{aligned} \text{By Eqn. 50, } o_c &= \frac{9(8 + 3)(8 - 3 - 1)}{1} \\ &= 396', \\ &= 6^{\circ} 36'. \end{aligned}$$

$$\begin{aligned} \text{By Eqn. 51a, } a &= \frac{9 \times 3(8 - 3 - 1)}{1} \\ &= 108' \\ &= 1^{\circ} 48'. \end{aligned}$$

$$\text{By Eqn. 52, } t_c = 37.47.$$

$$\text{By Eqn. 53, } d_c = 1.38.$$

$$\text{By Eqn. 54, } y_c = 119.80.$$

$$\text{By Eqn. 55, } x_c = 6.13.$$

$$\text{By Eqn. 57, } f_c = 175\frac{1}{2}' = 2^{\circ} 55\frac{1}{2}'.$$

$$\text{By Eqn. 58, } bs = 3^{\circ} 40\frac{1}{2}'.$$

$$\text{By Eqn. 59, } lc_c = 119.96.$$

$$\text{By Eqn. 60, } I_1 = 32^{\circ} 52'.$$

$$\text{By Eqn. 61, } I_2 = 81^{\circ} 32'.$$

$$\text{By Eqn. 62, } SD = 637.26.$$

$$\text{By Eqn. 63, } DA = 564.59.$$

$$\text{By Eqn. 64, } AG = 656.32.$$

$$\text{By Eqn. 65, } GH = 683.74.$$

$$\text{By Eqn. 66, } DG = 1220.91.$$

$$\text{From } \triangle DGN, \quad NG = 727.57,$$

$$\text{and } \quad DN = 1326.06.$$

$$\text{By Eqn. 67, } SN = 1963.32.$$

$$\text{By Eqn. 68, } NH = 1411.31.$$

21. Given a Located Curve, to Compound with Curve of Given Radius so as to End on a Given Parallel Tangent, using Three Tapers.

In Fig. 23, given located curve *SAFV* of radius  $R_1$ , parallel tangent *NH* distant  $p$  from the original tangent *WV*,  $R_2$ ,  $d_1$ ,  $d_2$ ,  $d_r$ ,  $t_1$  and  $t_2$ , to find  $I_1$ ,  $I_2$  and *NH*.

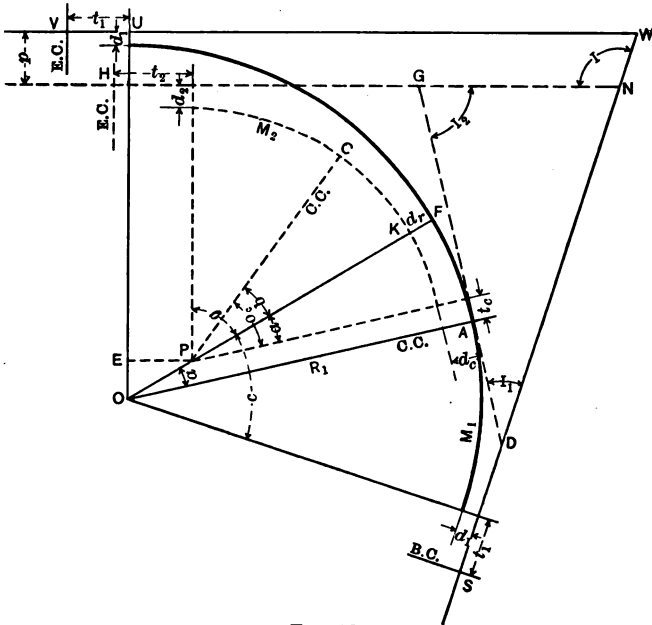


FIG. 23.

$$\begin{aligned}
 OE &= D_1 - p - D_2, \\
 OP &= R_1 - d_r - R_2, \\
 \cos g &= \frac{OE}{OP} \\
 &= \frac{R_1 - R_2 + d_1 - d_2 - p}{R_1 - R_2 - d_r} \qquad \qquad \qquad *(69) \\
 c &= I - g. \qquad \qquad \qquad (70)
 \end{aligned}$$

\* Where the new tangent is beyond the original tangent, requiring  $R_2$  to be greater than  $R_1$ ,  $p$  and  $d_r$  in equations 69, 71 and 72 change sign. For  $d$ , see Eqn. 49.

The new semi-tangents may now be determined by the methods of the preceding problem. If the semi-tangents of the two parts of the curve, very useful in running in the curve, are not needed, the semi-tangents of the entire curve may be obtained more easily as follows:

$$SN = (R_1 + d_1) \tan \frac{1}{2} I - p \csc I + t_1, \quad *(71)$$

$$NH = (R_1 + d_1) \tan \frac{1}{2} I - (R_1 - R_2 - d_r) \sin g + p \cot I + t_2. \quad *†(72)$$

*Example.* Given a located  $4^\circ 30'$  curve, Taper  $1\frac{1}{2}$ , intersection angle  $82^\circ 14'$ , to compound onto a parallel tangent 71 ft. beyond the original tangent, using a  $2^\circ 45'$  curve, Taper 1, with Taper 1 between the two curves.

$$\text{By Eqn. 69,} \quad \cos g = \frac{-738.71}{-810.13},$$

$$g = 24^\circ 14'.$$

$$\text{By Eqn. 70,} \quad c = 58^\circ 00'.$$

$$\text{By Eqn. 71,} \quad SN = 1258.99.$$

$$\text{By Eqn. 72,} \quad NH = 1502.68.$$

## 22. Given a Located Curve, to Compound onto a new Located Tangent, Point of Compound Approximately Fixed, full Tapered.

In Fig. 24,  $AN'$  is the located curve, to be compounded at about  $N'$  so as to unite with located tangent  $UF$ .

Run tangent to located curve at  $N'$ , intersecting located tangent. From Functions of a One-degree Curve determine degree of curve,  $M'$ , with which to compound if tapers were neglected. Then use such a degree of curve that

$$R_2 = R' - \frac{d_2 + d_r}{2}, \quad (73)$$

and the resulting  $g$  will be very nearly  $g'$ .

\* See footnote, page 33.

† Care should be taken to use a negative value for  $\cot I$  when  $I$  is greater than  $90^\circ$ .

$$\begin{aligned}
 OE &= OB + BF - FE \\
 &= R_1 \cos^2 g' + N'C \sin g' - (R_2 + d_2), \\
 OP &= R_1 - R_2 - d_r, \\
 \cos g &= \frac{OE}{OP} \\
 &= \frac{R_1 \cos^2 g' + N'C \sin g' - (R_2 + d_2)}{R_1 - R_2 - d_r}. \quad *(74)
 \end{aligned}$$

*Example.* Given located  $4^\circ 00'$  curve  $AN'$ , to compound at about  $N'$  ( $N'$  to be about the center of the taper between parts of the compound), so as to end on located tangent  $CF$ .  $N'C = 340.5$  ft.,  $g' = 42^\circ 12'$ , both measured on the ground.

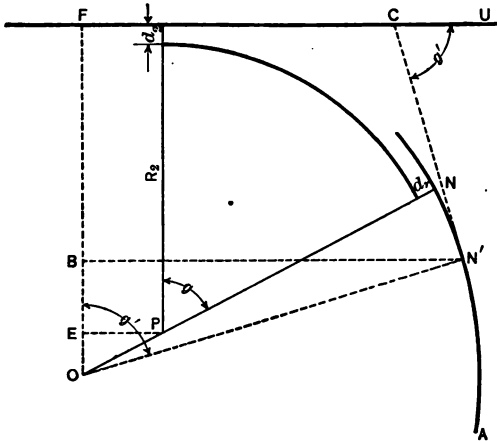


FIG. 24.

From Functions of a  $1^\circ$  Curve:

$$\begin{aligned}
 T \ 42^\circ 12' &= 2211.0, \\
 R' &= 5730 \times \frac{340.5}{2211} \\
 &= 882.4, \\
 M' &= 6^\circ 29' +.
 \end{aligned}$$

\* For  $d_r$ , see Eqn. 49.

By Eqn. 73,  $d_2 = 1.75$  for  $6^\circ 30'$  Tap. 2,  
 $d_r = 0.09$ .

$$\begin{aligned} \text{Approx. } R_2 &= 882.4 - \frac{1.75 + 0.09}{2} \\ &= 881.52, \\ R_{6^\circ 30'} &= 881.59. \end{aligned}$$

Use  $6^\circ 30'$  curve, Tap. 2.

By Eqn. 74,  $\cos g = \frac{406.53}{550.79}$   
 $g = 42^\circ 26'$ .

23. Given one of the Semi-tangents of a Compound Curve, the Intersection Angle, and both Radii, to find the two Central Angles and the other Semi-tangent.

In Fig. 25, given  $SN$ ,  $I$ ,  $R_1$  and  $R_2$ , to find  $c$ ,  $g$ , and  $NH$ .

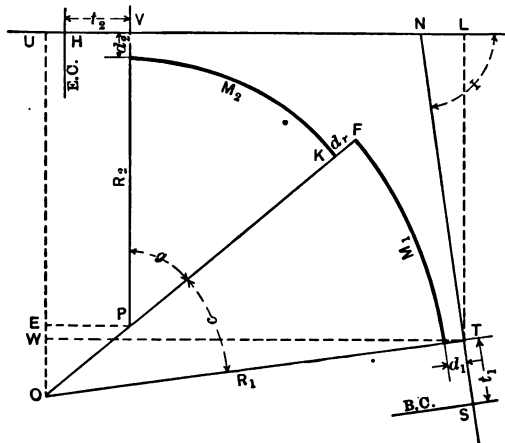


FIG. 25.

$$\begin{aligned} OE &= OW + WU - UE \\ &= (R_1 + d_1) \cos I + TN \sin I - (R_2 + d_2), \\ OP &= R_1 - R_2 - d_r, \\ \cos g &= \frac{OE}{OP} \end{aligned}$$

$$= \frac{(R_1 + d_1) \cos I + TN \sin I - (R_2 + d_2)}{R_1 - R_2 - *d_r}, \quad \dagger(75)$$

$$\begin{aligned} NH &= LU - LN - UV + t_2 \\ &= (R_1 + d_1) \sin I - TN \cos I \\ &\quad - (R_1 - R_2 - *d_r) \sin g + t_2. \end{aligned} \quad \dagger(76)$$

*Example.* Given semi-tangent  $SN = 1963.32$ ,  $M_1 = 3^\circ 00'$  Tap. 1,  $M_2 = 8^\circ 00'$  Tap.  $2\frac{1}{2}$ , and Tap. 2 between  $M_1$  and  $M_2$ ,  $I = 114^\circ 24'$ , to find  $c$ ,  $g$  and  $NH$ .

$$\text{By Eqn. 75,} \quad \cos g = \frac{212.62}{1192.78'}$$

$$g = 79^\circ 44'.$$

$$\text{By Eqn. 76,} \quad NH = 1411.32.$$

#### TAPERS BEYOND THE FROG

**24. When the Track Beyond the Turnout** curves back parallel to the main line, there is seldom room and little need for a taper. When the track beyond the turnout curves almost immediately in the same direction as the turnout, the taper is of much use, both as to looks and from practical considerations.

It has been the practice on many roads to introduce a short tangent, of twenty to thirty feet, beyond the frog, before beginning the curve. This answers the double purpose of giving the trackman room for an approximate taper, and by removing the *B.C.* from the heel of the frog, prevents the kink that otherwise is very likely to occur there due to the rail joint on the outside rail. However, this presents the very bad appearance and gives the bad riding of the carefully avoided "broken-backed curve." If the curve begin at the heel of the frog with a taper of moderate length, both appearance and service are much improved.

\* For  $d_r$  see Eqn. 49.

† When  $R_2$  is greater than  $R_1$ ,  $d_r$  becomes negative. When  $I$  is greater than  $90^\circ$ ,  $\cos I$  becomes negative.



Considerable ease in location will often be obtained if the curve beyond the taper may be handled as a simple curve tangent to a parallel with the main line, instead of with the tangent through the frog.

In Fig. 26,  $f$  is the distance from frog angle point to actual point of frog, usually given by standard drawings. It is

$$f = \frac{1}{2} (g + v) \cot \frac{1}{2} F, \quad (77)$$

where  $g$  = gauge,  $v$  = thickness of frog point, usually one-half inch, and  $F$  = frog angle.  $m$  = length of frog from actual point to heel.

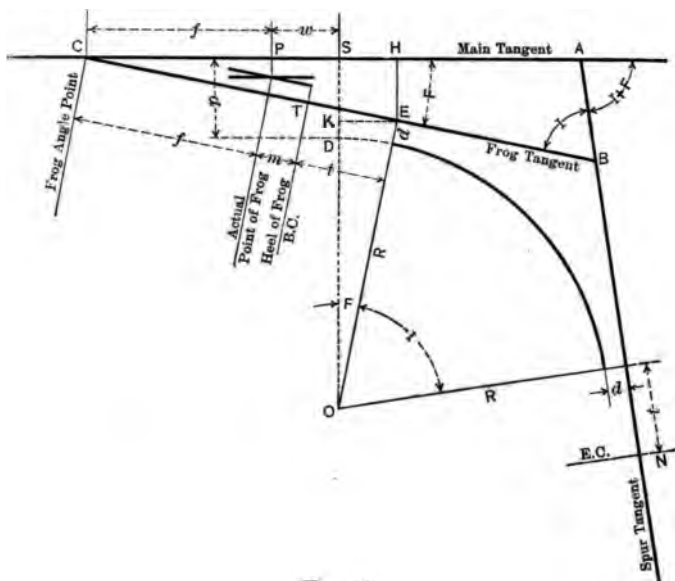


FIG. 26.

Then

$$\begin{aligned} p &= HE + KO - OD \\ &= (f + m + t) \sin F + (R + d) \cos F - R, \quad (78) \end{aligned}$$

$$\begin{aligned} w &= CH - SH - CP \\ &= (f + m + t) \cos F - (R + d) \sin F - f. \quad (79) \end{aligned}$$

From Eqn. 10,

$$AP = w + (R+p) \tan \frac{1}{2} (F+I) - (p-d) \csc (F+I). \quad (80)$$

From Eqn. 11,

$$AN = t + (R+d) \tan \frac{1}{2} (F+I) - (d-p) \csc (F+I), \quad (81)$$

$$AB = \frac{(AP+f) \sin F}{\sin I}. \quad (82)$$

The resulting calculations for the entire problem may be longer than if the semi-tangent  $BT$  be calculated by Eqn. 7,  $f + m$  added, and triangle  $ACB$  solved. However,  $p$  and  $w$  are very useful in a preliminary consideration of the location of the turnout.

*Example.* Given a No. 9 turnout from a side track to a branch line, with a  $6^\circ 00'$  curve, Tap.  $2\frac{1}{2}$ , intersection angle  $72^\circ 48'$ , beginning at the heel of the frog.  $g = 4' - 8\frac{1}{2}''$ ,  $v = \frac{1}{2}''$ ,  $m = 8' - 10''$ ,  $F = 6^\circ 22'$ .

$$\text{By Eqn. 77,} \quad f = 42.70.$$

$$\begin{aligned} \text{By Eqn. 78,} \quad p &= 10.70 + 949.72 - 955.04 \\ &= 5.38. \end{aligned}$$

$$\begin{aligned} \text{By Eqn. 79,} \quad w &= 95.92 - 105.97 - 42.70 \\ &= -52.75. \end{aligned}$$

The negative value of  $w$  means that  $S$  lies between  $P$  and  $C$ .

$$\begin{aligned} \text{By Eqn. 80,} \quad AP &= -52.75 + 794.08 - 4.88 \\ &= 736.45. \end{aligned}$$

$$\begin{aligned} \text{By Eqn. 81,} \quad AN &= 44.99 + 790.10 + 4.88 \\ &= 839.97. \end{aligned}$$

$$\text{By Eqn. 82,} \quad AB = 90.45.$$

## CHAPTER III

### FIELD WORK

#### SELECTION OF THE TAPER

**25. The Selection of the Proper Taper** for use on each curve is an important function of the engineer. As suggested elsewhere, the proper length of taper to use is one on which the super-elevation of rails given the main curve may be run off on the taper at from one-half to one inch per rail length. This will suggest the use of Taper 1,  $1\frac{1}{2}$  or 2, for curves that do not limit the speed of trains, with a maximum length of about 360 ft., and thence gradually decreasing in length as velocity and super-elevation decrease, to a minimum of 90 ft. Although some very short tapers are given in the tables, they are for exceptional conditions. The Table of Comparative Values will aid in the selection of the taper.

A table of the theoretical elevation needed to counteract the centrifugal forces is included with the other tables, copied from the *Proceedings of the American Railway Engineering Association*, but as the super-elevation depends more upon the velocity of trains than upon the degree of curve, and as this velocity varies with trains, seasons and traffic, an arbitrary rule, usually a compromise, is in force on most roads.

The beginning and end of every taper should be clearly marked for the track foreman, so that he may know between what points he is to give the rails a gradually increasing super-elevation. The proper maintenance of this gradual increase, however, is no easy task, even when the points are well marked, and if the distance over which

it occurs be too great, and the increase in super-elevation be too gradual, it is very likely to become and remain very irregular, totally destroying the value of the taper. Therefore, though theoretically a curve tapered throughout might seem perfection, as maintained practically it would be a very poorly riding curve. Too long a taper is as bad as none.

The somewhat prevalent practice of fitting a circular curve to the ground, and tangents at some undetermined offset therefrom, then connecting the two by the necessary taper to suit the offset, has the support of a few eminent engineers, but should be condemned as slipshod work. It is rarely the case that more careful thought and investigation will fail to place some other curve or tangents in a different location, with a suitable taper which should be chosen for totally different reasons. The weight and velocity of trains, the weight and character of the engines and cars whose direction is to be changed, and the amount and quickness of the change, should alone govern the choice of taper.

If any additional cost of construction be involved in the proper choice of taper, which is doubtful with good choice of location, it would be justified by the resulting lessened operating costs. Most certainly the higher quality of locating ability required to properly place a line to suit economic conditions is well able to solve this lesser problem.

#### LAYING OUT A TAPERED CURVE

**26.** After the location of tangents and main curve has been decided upon and choice of taper made, the *B.C.* and *E.C.* should be set by measurement from the *P.I.* The taper at each end should then be run from the *B.C.* and *E.C.*, the *C.C.* to the main curve being set preferably by long chord from the *B.C.* and *E.C.*, and then the main curve should be run from *C.C.* to *C.C.* of tapers, or from

each *C.C.* to the middle of the curve if it is unusually long.

It is usual, especially for final track centers, to stake the taper every thirty feet from *B.C.* and *E.C.*, closing to the *C.C.* with a short chord where the length of taper,  $l$ , is not a multiple of 30 ft.; but on location, and especially for slope staking on construction, it is often desirable to stake the station and plus fifty points, which may be done by obtaining the deflections from Eqn. 107.

If the main curve is of moderate length, it is usual, with the transit at the *C.C.*, to turn the transit at the *B.C.* with the backsight deflection set on the reverse side of the vernier, thus bringing the instrument into tangent at the *C.C.* with the vernier at zero, and thence run in the main curve with foresight on the other *C.C.* If the main curve is unusually long, and the other *C.C.* not visible, this involves running a comparatively long curve from a short backsight, frequently resulting in poor closing. In this case a flag may be set at an offset from the initial tangent equal to  $x$  of the taper, preferably opposite the *P.I.*, but in any event as far from the *C.C.* as the curve to be run from it. With the vernier set at the total central angle of the taper,  $o$ , and the instrument directed at this flag, bringing it into a direction parallel to the initial tangent, the instrument will then be tangent to the taper at the *C.C.* when the vernier is brought to zero.

#### PASSING OBSTRUCTIONS ON THE TAPER

##### **27. Curve run from Main Curve Produced.**

It frequently happens that either the *B.C.* or *C.C.* of the taper is inaccessible, when it is often necessary to run the main curve from the offset *B.C.* of a simple curve, or from a point on the simple curve produced backward as far as necessary beyond the *B.C.* of the simple curve, such point being set by offset from the initial tangent.

In Fig. 27, point  $C$  is the  $B.C.$  of the simple curve,  $D$  the  $B.C.$  and  $B$  the  $C.C.$  of the taper. The central angle of the portion of the simple curve from  $C$  to  $B$  is the central angle of the taper,  $o$ . Point  $A$ , a distance back on the simple curve equal to  $CB$ , and about opposite the  $B.C.$  of the taper, is a point frequently chosen from which

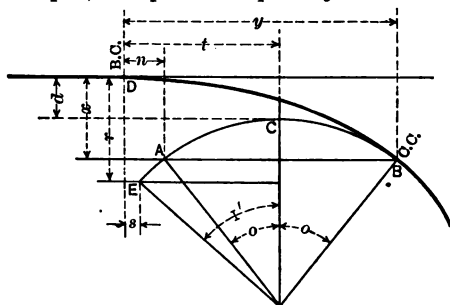


FIG. 27.

to run the main curve, because of the ease with which its position may be determined. Its offset from tangent is  $x$  of the taper, and its distance along the tangent from the  $B.C.$  of the taper is

$$n = y - 2R \sin o.$$

From Eqn. 4,  $R \sin o = y - t$ ,

then  $n = 2t - y.$  (83)

Any other point,  $E$ , may be chosen, its offset from tangent being,

$$r = d + R \text{vers } I',$$
 (84)

where  $I'$  is the central angle of the curve back of the  $B.C.$  of the simple curve.

The distance along the tangent from the  $B.C.$  of the taper is

$$s = t - R \text{vers } I'. \quad (85)$$

This is merely equivalent to suggesting that the main curve may be run in beyond the  $C.C.$  from any point back of the  $C.C.$  by considering it a simple curve from a parallel tangent.

**28. Curve run from a Point Beyond the C.C.**

When on location the *C.C.* is in a bad position to occupy with the transit, a point may be set on the main curve beyond the *C.C.* from a point on the semi-tangent, by working the problem under paragraph 17 backwards. The plus of the point to be set is assumed, and from that angle  $a$ , Fig. 28, is known.  $D$  and  $AB$  are known. Then

$$\tan n = \frac{D}{AB}, \quad (86)$$

$$OB = \frac{AB}{\cos n}, \quad (87)$$

$$\begin{aligned} g &= a - (90^\circ - n) \\ &= a + n - 90^\circ. \end{aligned} \quad (88)$$

Solving triangle  $OBP$ , two sides and the included angle given,

$$\tan (c + \frac{1}{2} g) = \frac{OB + R}{OB - R} \tan \frac{1}{2} g, \quad (89)$$

$$b = 180^\circ - n - c, \quad (90)$$

$$BP = \frac{R \sin g}{\sin c}. \quad (91)$$

For point  $P'$ , equations 88 and 90 become

$$g' = 90^\circ - (a' + n), \quad (88a)$$

$$b' = 180^\circ - n + c', \quad (90a)$$

the other equations remaining the same.

*Example.* Given a  $4^\circ 00'$  curve, Taper  $1\frac{1}{2}$ , *C.C.* in a poor location for a transit set up, the second station beyond, 137.9 ft. from the *C.C.*, being a particularly good transit point. On the same ridge with this second station is a point on the semi-tangent,  $PoST$ , 260.89 ft. from the *B.C.* Determine the angle and distance from  $PoST$  to  $PoC$ .

$$\begin{aligned} a &= 4 \times 0.6' \times 137.9 + 2^\circ 36' \\ &= 8^\circ 07'. \end{aligned}$$

By Eqn. 86,

$$n = 82^\circ 13'.$$

By Eqn. 87,

$$OB = 1446.50.$$

By Eqn. 88,  $g = 0^\circ 20'$ .  
 By Eqn. 89,  $c + \frac{1}{2}g = 30^\circ 50'$ ,  
 $c = 30^\circ 40'$ .  
 By Eqn. 90,  $b = 67^\circ 07'$ .  
 By Eqn. 91,  $BP = 16.34$ .

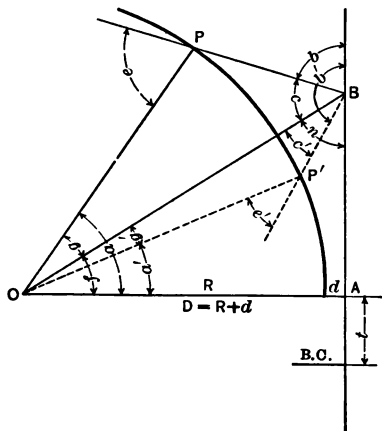


FIG. 28.

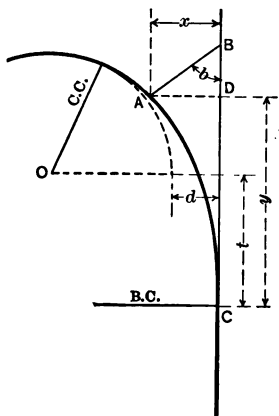


FIG. 29.

**29. Taper Points set by Offset.**

When both the *B.C.* and the *C.C.* are inconvenient to occupy with the transit, the taper points may be set by offset from the tangent, using  $x$  and  $y$ , or they may be set by offset from the tangent on the first half and from the curve on the second half. In the latter case the offset from the curve is the same as from tangent at equal distances from *B.C.* and *C.C.*

**30. Taper Points set from Point on Semi-tangent.**

A few or all of the taper points are occasionally set by measurement and angle from a point on the semi-tangent, *PoST*, by a solution of the triangle in Fig. 29.

$$\tan b = \frac{x}{CB - y}, \tag{92}$$

$$AB = \frac{CB - y}{\cos b}. \tag{93}$$



### 31. Curve Notes for the Field Book.

Assuming the *B.C.* at Sta. 489 + 15.2, the transit notes for a tapered curve would be as follows:

497					
⊙		+62.2	4° 41½'	2° 37½'	<i>E.C.</i>
		+32.2	4° 14½'		
496		+02.2	3° 41½'		
		+72.2	3° 02½'		
		+42.2	2° 17½'		
495		+12.2	1° 26½'		
		+82.2	0° 29½'		<i>l</i> = 195
⊙		+67.2	13° 23½'	13° 23½'	<i>C.C. Tap. 2</i>
			10° 52'		<i>o</i> = 7° 18½'
494	+50		8° 59½'		<i>TA</i> = 41° 24'
493	+50		7° 07'		<i>T</i> = 387.16
	+50		5° 14½'		<i>Exl.</i> = 55.64
492	+50		3° 22'		<i>R</i> = 764.08
	+50		1° 29½'		<i>L<sub>m</sub></i> = 357.0
⊙		+10.2	2° 37½'	4° 41½'	<i>C.C. 7° 30' R</i>
		+95.2	2° 16½'		
		+65.2	1° 39'		<i>t</i> = 97.41
		+35.2	1° 07½'		<i>d</i> = 2.71
490		+05.2	0° 42'		<i>x</i> = 8.93
		+75.2	0° 22½'		<i>lc</i> = 194.86
		+45.2	0° 09'		<i>l</i> = 195
⊙		+15.2	0° 00'		<i>B.C. Tap. 2</i>
					<i>o</i> = 7° 18½'
489					

In the above, the deflections for the taper at the *E.C.* are given from tangent at the *C.C.*, calculated from the equation

$$f' = \frac{(l + 2s + 45)(l - s) + 450}{\frac{300}{\Delta}}, \quad (94)$$

an empirical equation derived from the tables by the method of second differences, in which *l* is the distance from *B.C.* or *E.C.* to the point for which deflection is wanted, and *s* is the distance of the transit from *B.C.* or *E.C.* The equation gives the deflection in minutes, and is from tangent at the transit. The deflections from tangent at the *C.C.* given in the notes above are merely to make the notes complete. Usually both tapers are run from *B.C.* and *E.C.* towards the main curve, using the same set of deflections.

## CHAPTER IV

### OFFICE WORK

#### 32. Plotting a Tapered Curve.

In the plotting of tapered curves, it is customary, after plotting the tangents and locating the *B.C.* and *E.C.*, to draw the simple curve in its offset position, then draw a curve of radius twice that of the main curve extending from *B.C.* and *E.C.* a distance equal to  $l$ , the length of the taper, coinciding with the main curve at the *C.C.* The difference between such a curve and the exact taper is noticeable only if the drawing be on a very large scale.

#### 33. Paper Location with Tapers.

The usual method of paper location with tapers, as indeed frequently in location on the ground, is to offset the simple curve from its tangents an amount equal to  $d$  for the taper chosen. If curves predominate, they will be located first, and with parallel curves near their probable ends of radius greater by  $d$ , the tangents may be drawn in their offset position. If tangents predominate, they will be drawn first, with short parallel tangents near their probable ends, and the curves drawn tangent to these offset tangents.

After the location of the simple offset curves, and the tangents, the tapers may be drawn or merely indicated as desired, depending upon the scale of map used.

#### 34. Curve Compensation with Tapers.

It is a practice on some roads to use a compensation on the taper of half that on the main curve. An exactly equivalent result, with a simpler and more satisfactory grade line, is obtained if the change of grade from tangent

to curve be made at the point opposite the offset position of the *B.C.* of the simple curve, which is at the middle of the taper, and a suitable vertical curve inserted.

This brings correct theoretical and practical results, increasing the compensation in exact ratio with the curvature, and is well suited to location in rough country, where final consideration of the taper must be postponed until the location of curves and tangents.

### 35. Right of Way Descriptions with Tapered Curves.

A suitable description of right of way when the taper is used would be: “. . . , the center line of said railroad extending thence along a tangent  $N 1^{\circ} 14' W$  to station 4937 + 48.2, a distance of 465 ft., thence along a taper to the right of curvature increasing one degree every thirty feet to station 4938 + 98.2, a distance of 150 ft., thence along a  $6^{\circ} 00'$  curve to the right (radius 955.04) to station 4945 + 42.8, a distance of 644.6 ft., thence along a taper to the right of curvature decreasing one degree every thirty feet to station 4946 + 92.8, a distance of 150 ft., thence along a tangent  $N 46^{\circ} 26\frac{1}{2}' E$  to station 5052 + 47.1, a distance of 554.3 ft., . . . .”

## CHAPTER V

### TAPERING OLD TRACK

**36. The Tapering of Old Track**, located and constructed with circular curves only, calls for most careful analysis of the conditions encountered, and generally repays in results obtained a great deal of otherwise needless transit work. Although after long experience in this particular work one may decide almost offhand upon the taper to use and the changes to make in tangents and curves, the beginner must usually make more than one trial before arriving at the best results obtainable, which usually combines with the most satisfactory curve for operation the lowest cost in making the change in alignment. Such work is frequently complicated by bridges on the curves or tangents near the curves, limiting the amount track may be thrown, or by the slow, though frequently very decided, sliding of embankment on side hill work, distorting the original circular curve.

It will also frequently be found that the trackman has thrown the *B.C.* in towards the center of curvature, lining in an approximate taper, and if the curve be short, may have taken care of the additional curvature by throwing the middle of the curve out. If the curve be long, it will probably be found that a short portion beyond this approximate taper is of unduly heavy curvature. On the other hand, the passage of heavy engines of rigid wheel base has frequently thrown the curve out at the *B.C.* and *E.C.*, with which is coupled unduly heavy curvature just beyond. When allowed sufficient time, the engineer will rerun the original simple curve to determine just where the track is, before attempting to insert tapers. The

resulting transit notes, with measured offsets to the track as it is found, together with notes showing all bridges and openings, narrow embankments and cuts, and points where embankments and cuts may be cheaply widened and where not, will give the engineer the data for a careful office study of the conditions to be encountered. With an understanding of the various methods suggested below of inserting tapers, a tentative plan may be decided upon for each curve, subject to revision when running in the curves. Since the method involving the lowest maximum shift of track is the shifting of both curve and tangents, which will then influence the next curve in each direction, the entire series of curves and tangents must be studied as a whole.

The insertion of tapers in old circular track will generally be accompanied by a resurfacing out of face of the entire portion of the line involved, so that usually there is no need to confine the shifting of track to the curves, if the shifting of tangents also will improve results. If the track may be ballasted at the same time the cost of inserting tapers is practically eliminated.

**37.** Although, unfortunately, in the insertion of tapers in old circular curve alignment, the physical conditions encountered must very largely influence the choice of taper, frequently necessitating the use of short tapers, the operating conditions due to amount and direction of grade, velocity, weight and character of trains, amount of traffic, direction of heaviest tonnage, etc., must not be lost sight of, but must, as largely as possible, influence the choice of taper.

#### METHODS OF INSERTING TAPERS IN CIRCULAR TRACK. SIMPLE CURVES

**38. Shifting the Curve.** The simplest, though usually the least desirable, method of making room for the taper is by shifting the curve radially inward, the degree of

OG. VERSED SINES AND EXTERNAL SECANTS 199

68°

69°

ers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	'	P. P.
315	18	10.22258	50	9.80728	18	10.25295	51	0	
334	19	.22308	50	.80747	18	.25347	51	1	6 5.3 5.2
353	18	.22358	50	.80765	18	.25398	51	2	.7 6.2 6.1
371	18	.22408	50	.80783	18	.25449	51	3	8 7.0 7.0
390	18	.22458	50	.80802	18	.25501	51	4	9 7.9 7.9
709	19	10.22508	50	9.80820	18	10.25552	51	5	10 8.8 8.7
727	18	.22558	50	.80839	18	.25604	51	6	20 17.8 17.5
746	18	.22608	50	.80857	18	.25655	51	7	30 26.6 26.2
765	18	.22658	50	.80875	18	.25707	51	8	40 35.3 35.0
783	18	.22708	50	.80894	18	.25758	51	9	50 44.1 43.7
802	19	10.22759	50	9.80912	18	10.25810	51	10	
821	18	.22809	50	.80930	18	.25861	51	11	6 5.2 5.1
839	18	.22859	50	.80949	18	.25913	51	12	7 6.0 6.0
858	19	.22909	50	.80967	18	.25964	51	13	8 6.9 6.8
877	18	.22960	50	.80985	18	.26016	51	14	9 7.8 7.7
895	18	10.23010	50	9.81003	18	10.26067	52	15	10 8.6 8.6
914	18	.23060	50	.81022	18	.26119	51	16	20 17.3 17.1
933	18	.23110	50	.81040	18	.26171	51	17	30 26.0 25.7
951	18	.23161	50	.81058	18	.26222	51	18	40 34.6 34.3
970	18	.23211	50	.81077	18	.26274	52	19	50 43.3 42.9
988	18	10.23262	50	9.81095	18	10.26326	51	20	
1007	19	.23312	50	.81113	18	.26378	52	21	6 5.1 5.0
1026	18	.23362	50	.81131	18	.26429	52	22	7 5.9 5.9
1044	18	.23413	50	.81150	18	.26481	52	23	8 6.8 6.7
1063	18	.23463	50	.81168	18	.26533	52	24	9 7.6 7.6
1081	18	10.23514	50	9.81186	18	10.26585	52	25	10 8.5 8.4
1100	19	.23564	50	.81204	18	.26637	51	26	20 17.0 16.8
1119	18	.23615	50	.81223	18	.26689	52	27	30 25.5 25.2
1137	18	.23666	50	.81241	18	.26741	52	28	40 34.0 33.6
1156	18	.23716	50	.81259	18	.26793	52	29	50 42.5 42.1
1174	18	10.23767	50	9.81277	18	10.26845	52	30	
1193	18	.23817	50	.81295	18	.26897	52	31	6 5.0
1211	18	.23868	51	.81314	18	.26949	52	32	7 5.8
1230	18	.23919	50	.81332	18	.27001	52	33	8 6.6
1248	18	.23969	50	.81350	18	.27053	52	34	9 7.5
1267	19	10.24020	50	9.81368	18	10.27105	52	35	10 8.3
1286	18	.24071	51	.81386	18	.27157	52	36	20 16.6
1304	18	.24122	50	.81405	18	.27209	52	37	30 25.0
1323	18	.24173	50	.81423	18	.27261	52	38	40 33.3
1341	18	.24223	51	.81441	18	.27314	52	39	50 41.6
1360	18	10.24274	50	9.81459	18	10.27366	52	40	
1378	18	.24325	51	.81477	18	.27418	52	41	6 1.9 1.8
1397	18	.24376	51	.81495	18	.27470	52	42	7 2.2 2.1
1415	18	.24427	51	.81513	18	.27523	52	43	8 2.5 2.4
1434	18	.24478	51	.81532	18	.27575	52	44	9 2.8 2.8
1452	18	10.24529	51	9.81550	18	10.22627	52	45	10 3.1 3.1
1470	18	.24580	51	.81568	18	.27680	52	46	20 6.3 6.3
1489	18	.24631	51	.81586	18	.27732	52	47	30 9.5 9.5
1507	18	.24682	51	.81604	18	.27785	52	48	40 12.6 12.3
1526	18	.24733	51	.81622	18	.27837	52	49	50 15.8 15.4
1544	18	10.24784	51	9.81640	18	10.27890	52	50	
1563	18	.24835	51	.81658	18	.27942	52	51	6 1.8
1581	18	.24886	51	.81676	18	.27995	52	52	7 2.1
1599	18	.24937	51	.81695	18	.28047	52	53	8 2.4
1618	18	.24988	51	.81713	18	.28100	52	54	9 2.7
1636	18	10.25039	51	9.81731	18	10.28152	52	55	10 3.0
1655	18	.25090	51	.81749	18	.28205	52	56	20 6.0
1673	18	.25142	51	.81767	18	.28258	52	57	30 9.0
1692	18	.25193	51	.81785	18	.28310	52	58	40 12.0
1710	18	.25244	51	.81803	18	.28363	52	59	50 15.0
1728	18	10.25295	51	9.81821	18	10.28416	52	60	
ers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	'	P. P.

**39. Shifting the Tangents.** Where consecutive curves are of contrary flexure, and in a lesser degree where of similar flexure, shifting a short tangent, Fig. 31, forms a desirable method of making room for the taper. The tangent is shifted at its ends amounts approximately equal to  $d$  of the tapers adopted.

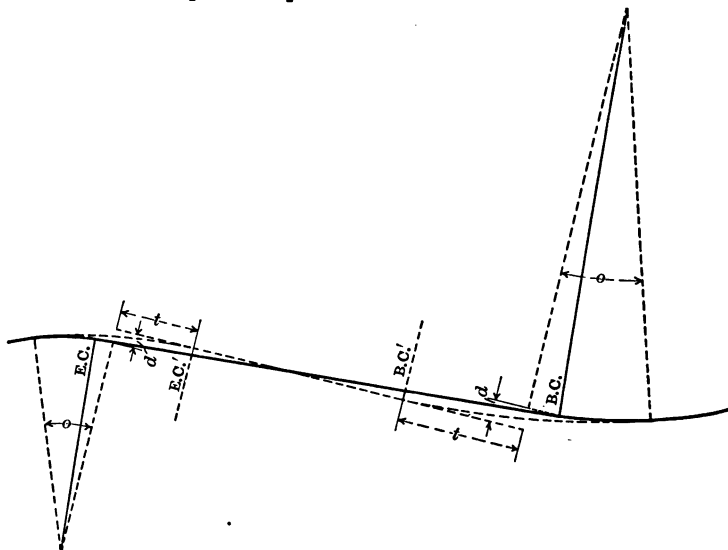


FIG. 31.

With this method it is usual first to fit the main portion of each curve as closely as desired by trial, not overlooking provision for inserting a proper taper at the other end of each curve, then connecting the two curves by a meander line, preferably the old tangent, and proceeding as in paragraph 15. Due to irregularities found in the track it is not likely that these curves, fitted to the track as found, will be exactly tangent to the old tangent, but this is immaterial.

With this method the length of track is slightly increased, but seldom enough to be objectionable.

**40. Shifting Curve and Tangents.** This method, Fig. 32, usually gives the most desirable rearrangement of alignment, involving the lowest maximum throw of track, and maintaining the length of line practically unchanged. To obtain this latter result the tangents should be thrown out about two-thirds of  $d$  of the taper opposite the old  $B.C.$  and  $E.C.$ , then run to an intersection and the curve run in. The new curve will cross the old one on the

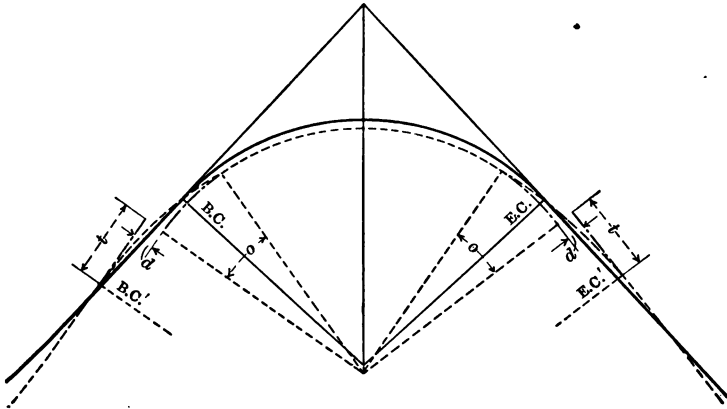


FIG. 32.

second half of the taper, the entire central portion of the new curve lying inside the old curve, about one-third  $d$  from it at the middle of the curve. These amounts will vary with the length of the tangents and their resulting angular shift.

**41. Increasing the Degree of Curve.** Where the preceding methods involve too great a throw of track with the taper desired, the curve may be sharpened, as in Fig. 33, enough to make room for the taper.

$$d = (R - R') \text{ vers } \frac{1}{2} I. \quad (97)$$

As the value of  $d$  depends upon both  $R'$  and the taper chosen, which latter itself is influenced by  $R'$ , trial solutions of the second half of this equation must be made



**39. Shifting the Tangents.** Where consecutive curves are of contrary flexure, and in a lesser degree where of similar flexure, shifting a short tangent, Fig. 31, forms a desirable method of making room for the taper. The tangent is shifted at its ends amounts approximately equal to  $d$  of the tapers adopted.

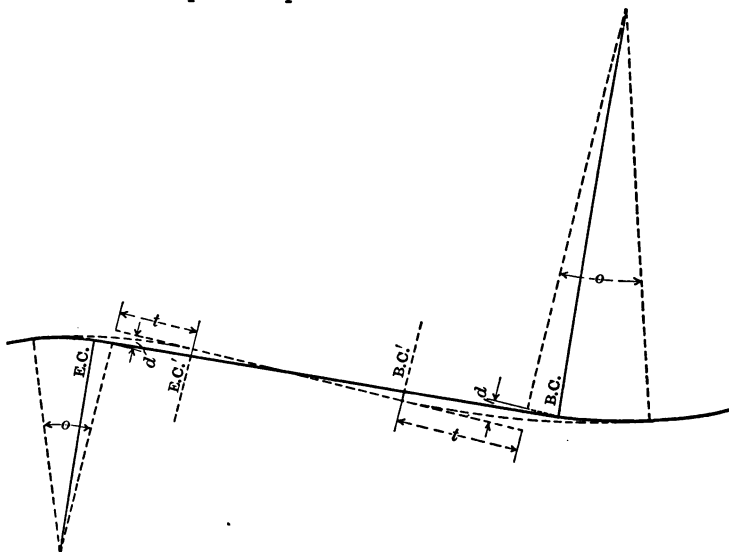


FIG. 31.

With this method it is usual first to fit the main portion of each curve as closely as desired by trial, not overlooking provision for inserting a proper taper at the other end of each curve, then connecting the two curves by a meander line, preferably the old tangent, and proceeding as in paragraph 15. Due to irregularities found in the track it is not likely that these curves, fitted to the track as found, will be exactly tangent to the old tangent, but this is immaterial.

With this method the length of track is slightly increased, but seldom enough to be objectionable.

For preliminary study, where  $I$  is not large, the factor  $\sec \frac{1}{2} I$  may be disregarded as insignificant. The new curve will now lie within the old throughout the tapers

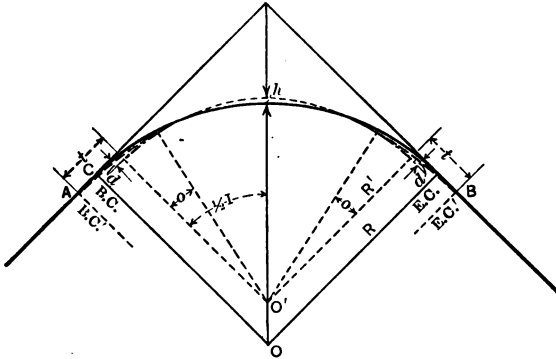


FIG. 34.

and a portion of the main curve, and outside the old curve on the middle portion of the main curve, a very desirable rearrangement. The best balance is obtained by making  $h$  equal about one-third  $d$ , when the maximum throw of track at the three points of greatest divergence will be about equal.

**43. Maintaining Length of Line Unchanged.** With the proper value of  $h$ , Eqn. 99,  $R'$  may be assumed such as to leave the length of line unchanged.

The length of line from  $A$  to  $B$ , Fig. 34, by the new alignment is

$$L' = l + \frac{100 I}{M'}. \tag{100}$$

The length of line from  $A$  to  $B$  by the old alignment is

$$\begin{aligned} L &= 2 AC + \frac{100 I}{M}, \\ &= 2t - 2(R - D') \tan \frac{1}{2} I + \frac{100 I}{M}. \end{aligned} \tag{101}$$

The table on page 115 gives the values of  $M'$ ,  $l$  and  $h$  for a large range of  $M$  and  $I$  with the more important tapers. Where curves are sharper than ten-degree, tangents will be short, and paragraphs 39 and 40 will give better results. Where  $I$  is greater than given in the tables, paragraph 46 will usually give better results unless curves of fractional minutes curvature are used.

When the value of  $M$  or  $I$  lies between those given in the table,  $M'$  may be interpolated and then checked by equations 100 and 101, recalculating when necessary. If on the first trial  $L' - L$  is too great, decrease  $M'$ . The irregularity of  $h$  in the table is due to using the nearest minute for  $M'$ .

Equations 100 and 101 are based upon fifty-foot chord measurement of both old and new curves, but any discrepancy over arc measurement introduced is small and may usually be neglected. With both curves based upon a fifty-foot chord, increasing a  $5^\circ 00'$  curve to a  $5^\circ 15'$  curve introduces a discrepancy due to arc excess of only 0.0002 ft. per hundred feet. With the old curve based upon a hundred-foot chord and the new curve based upon a fifty-foot chord the difference in arc excess is quite large, especially with the higher degrees of curve, but this is almost exactly balanced by the decreased value of  $AC$ , equation 101, over that assumed for the table, due to the increased value of  $R$ .

For arc measurement equations 100 and 101 become

$$L'(\text{arc}) = l + \frac{R'I\pi}{180}, \quad (100a)$$

$$L(\text{arc}) = 2t - 2(R - D') \tan \frac{1}{2}I + \frac{RI\pi}{180}. \quad (101a)$$

Using these equations, if a  $10^\circ 00'$  curve,  $I = 50^\circ 00'$ , be sharpened to a  $10^\circ 17'$  curve, Tap. 3, as given in the table, the new alignment would be 0.04 ft. longer than the old. The curve would have to be sharpened to a  $10^\circ 16'$  curve, Tap. 3, to maintain the length unchanged.

The length of line may be maintained unchanged with many of the other problems in this chapter by arranging by the manner of shifting curves and tangents that approximately half the new alignment lie within and half without the old.

**44. Increasing Degree and Shifting Curve and Tangents.** Where  $I$  is large the smallest increase of curvature avoiding odd minutes will frequently give too large a value

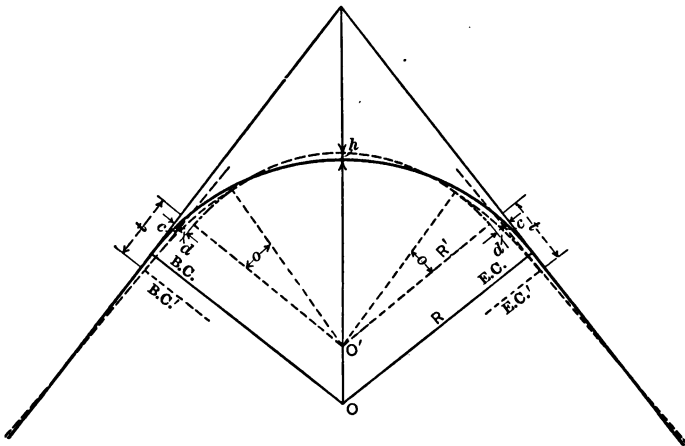


FIG. 35.

for  $h$  of equation 99, when to avoid throwing the curve out too much at the middle the tangents may be thrown in at the  $B.C.$  and  $C.C.$  of the old curve, as in Fig. 35.

$$c + h = (R - R') \text{ vers } \frac{1}{2} I - d \text{ (approx.)}. \quad (102)$$

For the best balance of track  $h$  should about equal  $c$ . The new tangents may be run to an intersection, new external calculated and  $h$  checked on the ground, and if satisfactory the curve run in.

**45.** Any of the preceding methods may be combined in any one curve, by shifting the tangent at one end only

The table on page 115 gives the values of  $M'$ ,  $l$  and  $h$  for a large range of  $M$  and  $I$  with the more important tapers. Where curves are sharper than ten-degree, tangents will be short, and paragraphs 39 and 40 will give better results. Where  $I$  is greater than given in the tables, paragraph 46 will usually give better results unless curves of fractional minutes curvature are used.

When the value of  $M$  or  $I$  lies between those given in the table,  $M'$  may be interpolated and then checked by equations 100 and 101, recalculating when necessary. If on the first trial  $L' - L$  is too great, decrease  $M'$ . The irregularity of  $h$  in the table is due to using the nearest minute for  $M'$ .

Equations 100 and 101 are based upon fifty-foot chord measurement of both old and new curves, but any discrepancy over arc measurement introduced is small and may usually be neglected. With both curves based upon a fifty-foot chord, increasing a  $5^\circ 00'$  curve to a  $5^\circ 15'$  curve introduces a discrepancy due to arc excess of only 0.0002 ft. per hundred feet. With the old curve based upon a hundred-foot chord and the new curve based upon a fifty-foot chord the difference in arc excess is quite large, especially with the higher degrees of curve, but this is almost exactly balanced by the decreased value of  $AC$ , equation 101, over that assumed for the table, due to the increased value of  $R$ .

For arc measurement equations 100 and 101 become

$$L'(\text{arc}) = l + \frac{R'I\pi}{180}, \quad (100a)$$

$$L(\text{arc}) = 2t - 2(R - D') \tan \frac{1}{2} I + \frac{RI\pi}{180}. \quad (101a)$$

Using these equations, if a  $10^\circ 00'$  curve,  $I = 50^\circ 00'$ , be sharpened to a  $10^\circ 17'$  curve, Tap. 3, as given in the *table*, the new alignment would be 0.04 ft. longer than the *old*. The curve would have to be sharpened to a  $10^\circ 16'$  curve, Tap. 3, to maintain the length unchanged.

either the full or partial amount of  $d$ , and the curve at the other end, or the tangents may be shifted different amounts at the two ends of the curve, thus taking advantage of different widths of roadbed available at different points.

On heavy grades a shorter taper may be used at the lower end of the curve when room is limited, due to the lower speed of ascending trains.

**46. Increasing Degree of Portion of Curve.** Where  $I$  is too great to sharpen the entire curve, and the tangents too long to be shifted advantageously, a portion only of the curve may be sharpened to make room for the taper, as in Fig. 36. The difference between the degree of the old curve and the portion sharpened should preferably not be greater than the curvature increment of the taper to be used, and may often be less.

$$\text{vers } I' = \frac{d}{R - R'} \quad (103)$$

$I'$  must of course be larger than the central angle of the taper, or the increase in curvature to provide the offset has been too great.  $I'$  should not be less than twice  $\alpha$ , and may usually be as much as three times  $\alpha$ .

### COMPOUND CURVES

**47.** Any combination of the preceding problems of this chapter may be used in inserting tapers at the ends or between the branches of old compound curves. A few of the possible combinations follow.

**48. Shifting the Curves.** In Fig. 37 the relative values of the various  $d$ 's are exaggerated, increasing the angular change in the position of the point of compounding. However, this arrangement disturbs the branch of sharper curvature disproportionately, which may be modified as in Fig. 38 by shifting the branch of lighter curvature for the entire amount of  $d_r$ .

**49. Shifting Curves and Tangents.** Where both the curves and tangents may be shifted, as in Fig. 39, the

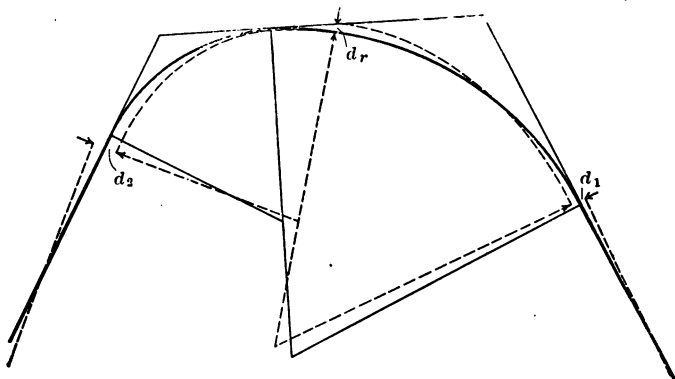


FIG. 39.

maximum throw of track may be much reduced. This aids particularly with the branch of sharper curvature.

**50. Shifting the Lighter Branch, and Increasing the Curvature of the Sharper Branch.** This change of align-

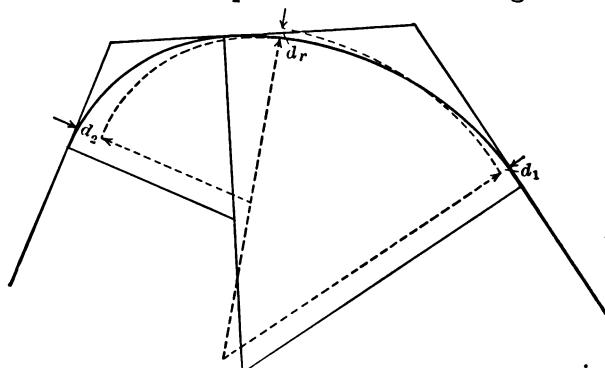


FIG. 40.

ment is shown in Fig. 40. With this may of course be combined the shifting of the end of the sharper branch to avoid curvature of odd minutes, as in paragraph 42, or also the shifting of one or both tangents as in paragraph 44.

FIELD WORK

51. The principal objection to compound curve alignment is the difficulty trackmen find in maintaining it to proper curvature. It follows that in inserting tapers in compound curves it is seldom profitable to make any lengthy calculations based upon the theoretical location of the curves. They will be somewhere else.

The best method of procedure is to pick out portions of the curves of apparently fairly uniform curvature, which can be tested with the mid-ordinate to a hundred-foot tape held against the rail at the ends of the tape, set up the transit on these portions, extend them as far in each direction as they fit the track fairly well, then turn tangents and intersect as in Fig. 41. It will usually be found that these

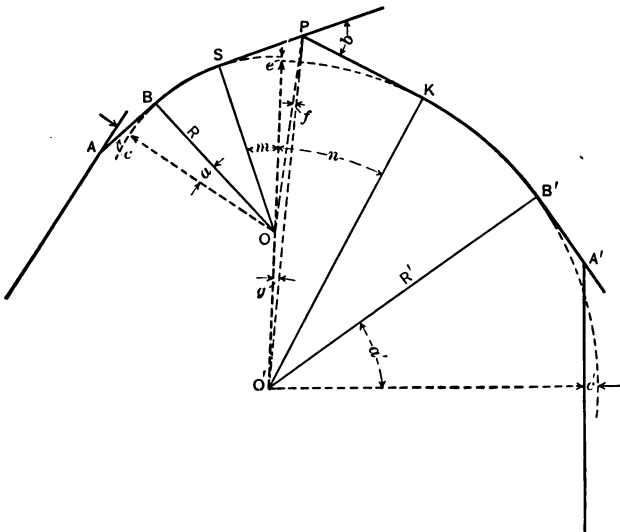


FIG. 41.

curves, fitted to the track, are not tangent to each other nor to the original tangents, the offsets from which may or may not be in a direction to facilitate the insertion of tapers.



**49. Shifting Curves and Tangents.** Where both the curves and tangents may be shifted, as in Fig. 39, the

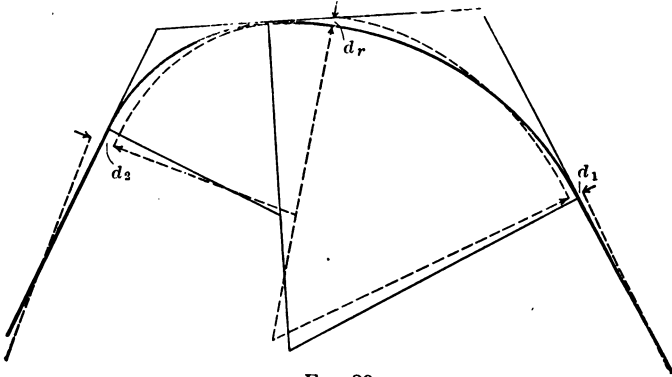


FIG. 39.

maximum throw of track may be much reduced. This aids particularly with the branch of sharper curvature.

**50. Shifting the Lighter Branch, and Increasing the Curvature of the Sharper Branch.** This change of align-

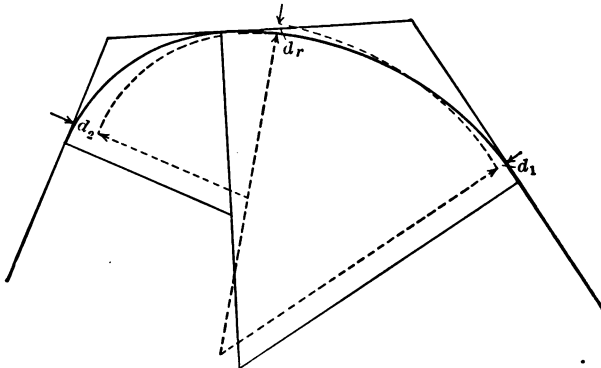


FIG. 40.

ment is shown in Fig. 40. With this may of course be combined the shifting of the end of the sharper branch to avoid curvature of odd minutes, as in paragraph 42, or also the shifting of one or both tangents as in paragraph 44.

RADII

$$R = \frac{25}{\sin \frac{M}{4}}$$

Deg.	Radius.	Log rad.	Deg.	Radius.	Log. rad.	Deg.	Radius.	Log. rad.
0° 00'	Infinite		1° 00'	5729.60	3.75812	2° 00'	2864.82	3.45710
1	343775.76	5.53627	1	5635.67	3.75095	1	2841.15	3.45340
2	171887.41	5.23524	2	5544.77	3.74388	2	2817.86	3.44962
3	114591.60	5.05915	3	5456.76	3.73693	3	2794.95	3.44637
4	85943.67	4.83421	4	5371.50	3.73010	4	2772.41	3.44286
5	68754.94	4.83730	5	5288.86	3.72336	5	2750.23	3.43937
6	57295.78	4.75812	6	5208.73	3.71673	6	2728.41	3.43591
7	49110.67	4.69118	7	5130.99	3.71020	7	2706.93	3.43248
8	42971.83	4.63318	8	5055.53	3.70377	8	2685.78	3.42907
9	37197.19	4.58203	9	4982.26	3.69743	9	2664.96	3.42569
10	34377.47	4.53627	10	4911.09	3.69118	10	2644.46	3.42234
11	31252.24	4.49488	11	4841.92	3.68502	11	2624.27	3.41901
12	28647.89	4.45709	12	4774.67	3.67895	12	2604.39	3.41571
13	26444.80	4.42234	13	4709.26	3.67295	13	2584.81	3.41243
14	24555.34	4.39016	14	4645.63	3.66704	14	2565.52	3.40918
15	22918.30	4.36018	15	4583.69	3.66121	15	2546.52	3.40595
16	21485.92	4.33215	16	4523.37	3.65546	16	2527.79	3.40274
17	20222.04	4.30583	17	4464.63	3.64979	17	2509.35	3.39956
18	19098.60	4.28100	18	4407.39	3.64418	18	2491.16	3.39640
19	18063.80	4.25753	19	4351.60	3.63865	19	2473.24	3.39327
20	17188.74	4.23524	20	4297.21	3.63319	20	2455.57	3.39015
21	16370.20	4.21405	21	4244.16	3.62779	21	2438.16	3.38706
22	15626.13	4.19385	22	4192.40	3.62246	22	2420.99	3.38399
23	14946.70	4.17555	23	4141.87	3.61720	23	2404.06	3.38095
24	14323.89	4.15866	24	4092.58	3.61200	24	2387.36	3.37792
25	13750.99	4.13833	25	4044.43	3.60686	25	2370.90	3.37491
26	13222.11	4.12130	26	3997.39	3.60177	26	2354.67	3.37193
27	12732.40	4.10491	27	3951.46	3.59676	27	2338.65	3.36896
28	12277.67	4.08912	28	3906.56	3.59179	28	2322.85	3.36602
29	11854.34	4.07388	29	3862.66	3.58689	29	2307.26	3.36310
30	11459.17	4.05915	30	3819.75	3.58203	30	2291.88	3.36019
31	11089.52	4.04491	31	3777.77	3.57724	31	2276.70	3.35731
32	10742.97	4.03112	32	3736.71	3.57249	32	2261.72	3.35444
33	10417.66	4.01777	33	3696.53	3.56779	33	2246.94	3.35159
34	10111.03	4.00480	34	3657.21	3.56315	34	2232.35	3.34876
35	9822.15	3.99221	35	3618.71	3.55855	35	2217.95	3.34595
36	9549.31	3.97997	36	3581.02	3.55401	36	2203.73	3.34316
37	9291.65	3.96809	37	3544.10	3.54951	37	2189.70	3.34038
38	9046.71	3.95649	38	3507.93	3.54505	38	2175.84	3.33763
39	8814.75	3.94521	39	3472.50	3.54064	39	2162.15	3.33489
40	8594.38	3.93421	40	3437.78	3.53628	40	2148.64	3.33216
41	8384.76	3.92341	41	3403.74	3.53196	41	2135.29	3.32946
42	8185.12	3.91303	42	3370.37	3.52768	42	2122.12	3.32677
43	7994.77	3.90281	43	3337.65	3.52344	43	2109.09	3.32410
44	7813.13	3.89282	44	3305.56	3.51924	44	2096.24	3.32144
45	7639.45	3.88306	45	3274.08	3.51509	45	2083.53	3.31880
46	7473.38	3.87352	46	3243.19	3.51097	46	2070.98	3.31618
47	7314.37	3.86418	47	3212.88	3.50689	47	2058.56	3.31357
48	7161.99	3.85503	48	3183.13	3.50285	48	2046.33	3.31098
49	7015.82	3.84608	49	3153.93	3.49885	49	2034.22	3.30840
50	6875.51	3.83730	50	3125.26	3.49489	50	2022.26	3.30584
51	6740.70	3.82870	51	3097.10	3.49096	51	2010.43	3.30329
52	6611.09	3.82027	52	3069.45	3.48706	52	1998.74	3.30076
53	6486.33	3.81200	53	3042.29	3.48320	53	1987.19	3.29824
54	6366.22	3.80388	54	3015.60	3.47937	54	1975.77	3.29574
55	6250.46	3.79591	55	2989.38	3.47558	55	1964.48	3.29325
56	6138.85	3.78809	56	2963.61	3.47182	56	1953.32	3.29077
57	6031.15	3.78040	57	2938.28	3.46809	57	1942.28	3.28831
58	5927.17	3.77285	58	2913.38	3.46440	58	1931.37	3.28587
59	5826.71	3.76542	59	2888.89	3.46073	59	1920.58	3.28343

## RADII — (Continued)

Deg.	Radius.	Log. rad.	Deg.	Radius.	Log. rad.	Deg.	Radius.	Log. rad.
3° 00'	1909.91	3.28101	4° 00'	1432.47	3.15608	5° 00'	1146.01	3.05919
1	1899.36	3.27861	1	1426.52	3.15430	1	1142.20	3.05774
2	1888.03	3.27622	2	1420.63	3.15248	2	1138.42	3.05630
3	1878.61	3.27384	3	1414.78	3.15069	3	1134.66	3.05487
4	1868.40	3.27147	4	1408.99	3.14891	4	1130.93	3.05344
5	1858.30	3.26912	5	1403.24	3.14713	5	1127.20	3.05201
6	1848.31	3.26677	6	1397.53	3.14536	6	1123.54	3.05059
7	1838.42	3.26445	7	1391.88	3.14360	7	1119.88	3.04917
8	1828.65	3.26213	8	1386.26	3.14185	8	1116.24	3.04776
9	1818.97	3.25983	9	1380.70	3.14010	9	1112.63	3.04635
10	1809.40	3.25753	10	1375.17	3.13836	10	1109.04	3.04495
11	1799.93	3.25525	11	1369.70	3.13662	11	1105.48	3.04355
12	1790.56	3.25299	12	1364.26	3.13490	12	1101.94	3.04216
13	1781.27	3.25073	13	1358.87	3.13318	13	1098.42	3.04077
14	1772.09	3.24849	14	1353.53	3.13146	14	1094.92	3.03938
15	1763.01	3.24625	15	1348.21	3.12976	15	1091.44	3.03800
16	1754.01	3.24403	16	1342.95	3.12806	16	1087.99	3.03662
17	1745.11	3.24182	17	1337.72	3.12637	17	1084.56	3.03525
18	1736.30	3.23962	18	1332.54	3.12468	18	1081.15	3.03389
19	1727.57	3.23744	19	1327.39	3.12300	19	1077.76	3.03252
20	1718.93	3.23526	20	1322.29	3.12133	20	1074.39	3.03116
21	1710.38	3.23309	21	1317.22	3.11966	21	1071.05	3.02981
22	1701.92	3.23094	22	1312.19	3.11800	22	1067.72	3.02846
23	1693.53	3.22879	23	1307.21	3.11634	23	1064.42	3.02711
24	1685.23	3.22666	24	1302.26	3.11470	24	1061.13	3.02577
25	1677.01	3.22454	25	1297.34	3.11305	25	1057.87	3.02443
26	1668.87	3.22242	26	1292.47	3.11142	26	1054.62	3.02310
27	1660.81	3.22032	27	1287.63	3.10979	27	1051.40	3.02177
28	1652.83	3.21823	28	1282.82	3.10817	28	1048.19	3.02044
29	1644.92	3.21614	29	1278.05	3.10655	29	1045.01	3.01912
30	1637.09	3.21407	30	1273.32	3.10494	30	1041.84	3.01780
31	1629.33	3.21201	31	1268.62	3.10333	31	1038.69	3.01649
32	1621.64	3.20996	32	1263.96	3.10173	32	1035.57	3.01518
33	1614.03	3.20791	33	1259.33	3.10014	33	1032.46	3.01387
34	1606.49	3.20588	34	1254.73	3.09855	34	1029.37	3.01257
35	1599.02	3.20385	35	1250.17	3.09697	35	1026.29	3.01127
36	1591.62	3.20184	36	1245.64	3.09539	36	1023.24	3.00998
37	1584.28	3.19983	37	1241.15	3.09382	37	1020.20	3.00869
38	1577.01	3.19784	38	1236.68	3.09226	38	1017.19	3.00740
39	1569.81	3.19585	39	1232.25	3.09070	39	1014.19	3.00612
40	1562.68	3.19387	40	1227.85	3.08915	40	1011.20	3.00484
41	1555.61	3.19190	41	1223.48	3.08760	41	1008.24	3.00356
42	1548.60	3.18994	42	1219.14	3.08606	42	1005.29	3.00229
43	1541.66	3.18799	43	1214.84	3.08452	43	1002.36	3.00102
44	1534.78	3.18605	44	1210.56	3.08299	44	999.45	2.99976
45	1527.96	3.18411	45	1206.31	3.08146	45	996.55	2.99850
46	1521.19	3.18218	46	1202.10	3.07994	46	993.67	2.99724
47	1514.49	3.18027	47	1197.91	3.07842	47	990.81	2.99599
48	1507.85	3.17736	48	1193.75	3.07691	48	987.96	2.99474
49	1501.27	3.17546	49	1189.62	3.07541	49	985.13	2.99350
50	1494.74	3.17357	50	1185.51	3.07391	50	982.32	2.99225
51	1488.27	3.17268	51	1181.44	3.07241	51	979.52	2.99101
52	1481.86	3.17081	52	1177.40	3.07092	52	976.74	2.98978
53	1475.50	3.16894	53	1173.38	3.06944	53	973.97	2.98855
54	1469.19	3.16708	54	1169.39	3.06796	54	971.22	2.98732
55	1462.94	3.16523	55	1165.43	3.06649	55	968.48	2.98609
56	1456.75	3.16338	56	1161.49	3.06502	56	965.76	2.98487
57	1450.60	3.16155	57	1157.58	3.06355	57	963.06	2.98365
58	1444.50	3.15972	58	1153.70	3.06209	58	960.37	2.98244
59	1438.46	3.15790	59	1149.84	3.06064	59	957.70	2.98123

RADII — (Continued)

Deg.	Radius.	Log. rad.	Deg.	Radius.	Log. rad.	Deg.	Radius.	Log. rad.
6° 00'	955.04	2.98002	7° 00'	818.64	2.91309	8° 00'	716.34	2.85512
1	952.39	2.97882	1	816.69	2.91206	1	714.85	2.85422
2	949.76	2.97762	2	814.76	2.91103	2	713.37	2.85332
3	947.15	2.97642	3	812.83	2.91000	3	711.90	2.85242
4	944.55	2.97522	4	810.92	2.90898	4	710.43	2.85152
5	941.96	2.97403	5	809.01	2.90795	5	708.96	2.85062
6	939.39	2.97284	6	807.11	2.90693	6	707.50	2.84973
7	936.83	2.97166	7	805.22	2.90592	7	706.05	2.84884
8	934.28	2.97048	8	803.34	2.90490	8	704.60	2.84795
9	931.75	2.96930	9	801.47	2.90389	9	703.16	2.84706
10	929.23	2.96812	10	799.61	2.90288	10	701.73	2.84617
11	926.73	2.96695	11	797.75	2.90187	11	700.30	2.84528
12	924.24	2.96578	12	795.91	2.90086	12	698.88	2.84440
13	921.76	2.96462	13	794.07	2.89986	13	697.46	2.84352
14	919.29	2.96346	14	792.24	2.89886	14	696.05	2.84264
15	916.84	2.96230	15	790.42	2.89786	15	694.64	2.84176
16	914.41	2.96114	16	788.61	2.89686	16	693.24	2.84089
17	911.98	2.95999	17	786.80	2.89587	17	691.85	2.84001
18	909.57	2.95884	18	785.01	2.89487	18	690.46	2.83914
19	907.17	2.95769	19	783.22	2.89388	19	689.08	2.83827
20	904.78	2.95655	20	781.44	2.89290	20	687.70	2.83740
21	902.41	2.95540	21	779.67	2.89191	21	686.33	2.83653
22	900.05	2.95427	22	777.91	2.89093	22	684.96	2.83567
23	897.70	2.95313	23	776.15	2.88995	23	683.60	2.83480
24	895.36	2.95200	24	774.40	2.88897	24	682.25	2.83394
25	893.04	2.95087	25	772.66	2.88799	25	680.90	2.83308
26	890.72	2.94974	26	770.93	2.88702	26	679.55	2.83222
27	888.42	2.94862	27	769.21	2.88604	27	678.21	2.83136
28	886.13	2.94750	28	767.49	2.88507	28	676.88	2.83051
29	883.86	2.94638	29	765.78	2.88410	29	675.55	2.82966
30	881.59	2.94527	30	764.08	2.88314	30	674.22	2.82880
31	879.34	2.94416	31	762.39	2.88218	31	672.90	2.82795
32	877.09	2.94305	32	760.70	2.88121	32	671.59	2.82710
33	874.86	2.94194	33	759.02	2.88025	33	670.28	2.82626
34	872.64	2.94084	34	757.35	2.87930	34	668.98	2.82541
35	870.44	2.93974	35	755.69	2.87834	35	667.68	2.82457
36	868.24	2.93864	36	754.03	2.87739	36	666.39	2.82373
37	866.05	2.93754	37	752.38	2.87644	37	665.10	2.82289
38	863.88	2.93645	38	750.74	2.87549	38	663.81	2.82205
39	861.71	2.93536	39	749.10	2.87454	39	662.54	2.82121
40	859.56	2.93428	40	747.48	2.87360	40	661.26	2.82037
41	857.42	2.93319	41	745.85	2.87265	41	659.99	2.81954
42	855.28	2.93211	42	744.24	2.87171	42	658.73	2.81871
43	853.16	2.93103	43	742.63	2.87077	43	657.47	2.81788
44	851.05	2.92996	44	741.03	2.86984	44	656.22	2.81705
45	848.95	2.92888	45	739.44	2.86890	45	654.97	2.81622
46	846.86	2.92781	46	737.86	2.86797	46	653.72	2.81539
47	844.78	2.92674	47	736.28	2.86704	47	652.48	2.81457
48	842.71	2.92568	48	734.70	2.86611	48	651.25	2.81375
49	840.65	2.92461	49	733.14	2.86519	49	650.02	2.81293
50	838.60	2.92355	50	731.58	2.86426	50	648.79	2.81211
51	836.56	2.92250	51	730.03	2.86334	51	647.57	2.81129
52	834.53	2.92144	52	728.48	2.86242	52	646.35	2.81047
53	832.51	2.92039	53	726.94	2.86150	53	645.14	2.80966
54	830.50	2.91934	54	725.41	2.86058	54	643.93	2.80884
55	828.50	2.91829	55	723.88	2.85967	55	642.73	2.80803
56	826.51	2.91725	56	722.36	2.85875	56	641.53	2.80722
57	824.53	2.91620	57	720.85	2.85784	57	640.34	2.80641
58	822.55	2.91516	58	719.34	2.85693	58	639.15	2.80560
59	820.59	2.91413	59	717.84	2.85603	59	637.96	2.80480

## RADII — (Continued)

Deg.	Radius.	Log. rad.	Deg.	Radius.	Log. rad.	Deg.	Radius.	Log. rad.
9° 00'	636.78	2.80399	10° 00'	573.14	2.75826	11° 00'	521.07	2.71690
1	635.60	2.80319	1	572.19	2.75754	1	520.28	2.71624
2	634.43	2.80239	2	571.24	2.75682	2	519.50	2.71558
3	633.27	2.80159	3	570.29	2.75610	3	518.71	2.71493
4	632.10	2.80080	4	569.35	2.75538	4	517.93	2.71427
5	630.94	2.79999	5	568.41	2.75466	5	517.16	2.71362
6	629.79	2.79920	6	567.47	2.75394	6	516.38	2.71297
7	628.64	2.79840	7	566.53	2.75323	7	515.61	2.71232
8	627.49	2.79761	8	565.60	2.75251	8	514.84	2.71167
9	626.35	2.79682	9	564.67	2.75180	9	514.07	2.71102
10	625.21	2.79603	10	563.75	2.75109	10	513.30	2.71037
11	624.08	2.79524	11	562.83	2.75038	11	512.54	2.70972
12	622.95	2.79445	12	561.91	2.74967	12	511.77	2.70908
13	621.82	2.79367	13	560.99	2.74896	13	511.02	2.70843
14	620.70	2.79288	14	560.08	2.74825	14	510.26	2.70779
15	619.58	2.79210	15	559.17	2.74754	15	509.50	2.70714
16	618.47	2.79132	16	558.26	2.74684	16	508.75	2.70650
17	617.36	2.79054	17	557.36	2.74613	17	508.00	2.70586
18	616.25	2.78976	18	556.46	2.74543	18	507.25	2.70522
19	615.15	2.78898	19	555.56	2.74473	19	506.50	2.70458
20	614.05	2.78821	20	554.66	2.74403	20	505.76	2.70394
21	612.96	2.78743	21	553.77	2.74333	21	505.02	2.70330
22	611.87	2.78666	22	552.88	2.74263	22	504.28	2.70267
23	610.78	2.78589	23	551.99	2.74193	23	503.54	2.70203
24	609.70	2.78512	24	551.11	2.74124	24	502.80	2.70140
25	608.62	2.78435	25	550.23	2.74054	25	502.06	2.70076
26	607.55	2.78358	26	549.35	2.73985	26	501.33	2.70013
27	606.48	2.78281	27	548.47	2.73916	27	500.60	2.69950
28	605.41	2.78205	28	547.60	2.73847	28	499.88	2.69887
29	604.35	2.78129	29	546.73	2.73777	29	499.16	2.69824
30	603.29	2.78052	30	545.87	2.73709	30	498.43	2.69761
31	602.23	2.77976	31	545.00	2.73640	31	497.72	2.69698
32	601.18	2.77900	32	544.14	2.73571	32	497.00	2.69635
33	600.13	2.77824	33	543.28	2.73502	33	496.28	2.69572
34	599.08	2.77749	34	542.42	2.73434	34	495.56	2.69510
35	598.04	2.77673	35	541.57	2.73365	35	494.85	2.69447
36	597.00	2.77598	36	540.72	2.73297	36	494.14	2.69385
37	595.97	2.77523	37	539.87	2.73229	37	493.43	2.69323
38	594.93	2.77447	38	539.03	2.73161	38	492.73	2.69261
39	593.91	2.77372	39	538.18	2.73093	39	492.02	2.69198
40	592.89	2.77297	40	537.34	2.73025	40	491.32	2.69136
41	591.87	2.77223	41	536.51	2.72957	41	490.62	2.69074
42	590.85	2.77148	42	535.67	2.72890	42	489.92	2.69013
43	589.84	2.77074	43	534.84	2.72822	43	489.22	2.68951
44	588.83	2.76997	44	534.01	2.72755	44	488.53	2.68889
45	587.83	2.76925	45	533.18	2.72687	45	487.84	2.68828
46	586.82	2.76851	46	532.35	2.72620	46	487.15	2.68766
47	585.82	2.76777	47	531.53	2.72553	47	486.46	2.68705
48	584.83	2.76703	48	530.71	2.72486	48	485.77	2.68643
49	583.84	2.76629	49	529.90	2.72419	49	485.09	2.68582
50	582.85	2.76556	50	529.08	2.72352	50	484.40	2.68521
51	581.86	2.76482	51	528.27	2.72286	51	483.72	2.68460
52	580.88	2.76409	52	527.46	2.72219	52	483.04	2.68400
53	579.90	2.76335	53	526.65	2.72152	53	482.37	2.68338
54	578.93	2.76262	54	525.85	2.72086	54	481.69	2.68277
55	577.95	2.76189	55	525.05	2.72020	55	481.02	2.68216
56	576.98	2.76116	56	524.25	2.71953	56	480.35	2.68156
57	576.02	2.76044	57	523.45	2.71887	57	479.68	2.68095
58	575.05	2.75971	58	522.65	2.71821	58	479.01	2.68035
59	574.10	2.75899	59	521.86	2.71755	59	478.35	2.67974

RADII — (Continued)

Deg.	Radius.	Log. rad.	Deg.	Radius.	Log. rad.	Deg.	Radius.	Log. rad.
12° 00'	477.68	2.67914	13° 00'	440.97	2.64441	14° 00'	409.51	2.61226
1	477.02	2.67854	1	440.41	2.64386	1	409.02	2.61175
2	476.36	2.67794	2	439.85	2.64330	2	408.54	2.61123
3	475.70	2.67734	3	439.29	2.64275	3	408.05	2.61072
4	475.05	2.67674	4	438.73	2.64219	4	407.57	2.61020
5	474.39	2.67614	5	438.17	2.64164	5	407.09	2.60969
6	473.74	2.67554	6	437.61	2.64109	6	406.61	2.60918
7	473.09	2.67494	7	437.05	2.64054	7	406.13	2.60867
8	472.44	2.67435	8	436.50	2.63999	8	405.66	2.60816
9	471.79	2.67375	9	435.95	2.63944	9	405.18	2.60764
10	471.15	2.67316	10	435.40	2.63889	10	404.70	2.60713
11	470.50	2.67256	11	434.85	2.63834	11	404.22	2.60662
12	469.86	2.67197	12	434.30	2.63779	12	403.75	2.60611
13	469.22	2.67138	13	433.75	2.63724	13	403.28	2.60560
14	468.58	2.67078	14	433.21	2.63669	14	402.81	2.60510
15	467.94	2.67019	15	432.66	2.63615	15	402.33	2.60459
16	467.31	2.66960	16	432.12	2.63560	16	401.87	2.60408
17	466.68	2.66901	17	431.58	2.63506	17	401.40	2.60357
18	466.04	2.66843	18	431.04	2.63451	18	400.93	2.60307
19	465.41	2.66784	19	430.50	2.63397	19	400.46	2.60256
20	464.79	2.66725	20	429.96	2.63343	20	400.00	2.60206
21	464.16	2.66667	21	429.42	2.63289	21	399.53	2.60155
22	463.53	2.66608	22	428.89	2.63235	22	399.07	2.60105
23	462.91	2.66550	23	428.36	2.63181	23	398.61	2.60055
24	462.29	2.66491	24	427.82	2.63127	24	398.15	2.60005
25	461.67	2.66433	25	427.29	2.63073	25	397.69	2.59954
26	461.05	2.66375	26	426.76	2.63019	26	397.23	2.59904
27	460.43	2.66317	27	426.23	2.62965	27	396.77	2.59854
28	459.82	2.66259	28	425.71	2.62911	28	396.32	2.59804
29	459.20	2.66201	29	425.18	2.62858	29	395.86	2.59754
30	458.59	2.66143	30	424.66	2.62804	30	395.41	2.59704
31	457.98	2.66085	31	424.14	2.62750	31	394.95	2.59655
32	457.37	2.66027	32	423.62	2.62697	32	394.50	2.59605
33	456.77	2.65970	33	423.09	2.62644	33	394.05	2.59555
34	456.16	2.65912	34	422.57	2.62590	34	393.60	2.59505
35	455.56	2.65855	35	422.06	2.62537	35	393.15	2.59456
36	454.96	2.65797	36	421.54	2.62484	36	392.70	2.59406
37	454.36	2.65740	37	421.02	2.62431	37	392.26	2.59357
38	453.76	2.65682	38	420.51	2.62378	38	391.81	2.59307
39	453.16	2.65625	39	420.00	2.62325	39	391.36	2.59258
40	452.57	2.65568	40	419.49	2.62272	40	390.91	2.59209
41	451.97	2.65511	41	418.98	2.62219	41	390.48	2.59160
42	451.38	2.65454	42	418.47	2.62166	42	390.04	2.59110
43	450.79	2.65397	43	417.96	2.62113	43	389.60	2.59061
44	450.20	2.65340	44	417.45	2.62061	44	389.16	2.59012
45	449.61	2.65284	45	416.95	2.62008	45	388.72	2.58963
46	449.02	2.65227	46	416.44	2.61955	46	388.28	2.58914
47	448.44	2.65170	47	415.94	2.61903	47	387.84	2.58865
48	447.86	2.65114	48	415.44	2.61851	48	387.40	2.58816
49	447.28	2.65057	49	414.94	2.61798	49	386.97	2.58767
50	446.70	2.65001	50	414.44	2.61746	50	386.53	2.58719
51	446.12	2.64945	51	413.94	2.61694	51	386.10	2.58670
52	445.54	2.64889	52	413.44	2.61642	52	385.67	2.58621
53	444.96	2.64832	53	412.95	2.61589	53	385.24	2.58573
54	444.39	2.64776	54	412.45	2.61537	54	384.81	2.58524
55	443.82	2.64720	55	411.96	2.61485	55	384.38	2.58476
56	443.25	2.64664	56	411.47	2.61434	56	383.95	2.58427
57	442.67	2.64608	57	410.98	2.61382	57	383.52	2.58379
58	442.11	2.64553	58	410.49	2.61330	58	383.09	2.58331
59	441.54	2.64497	59	410.00	2.61278	59	382.67	2.58282

## RADII — (Continued)

Deg.	Radius.	Log. rad.	Deg.	Radius.	Log. rad.	Deg.	Radius.	Log. rad.
15° 00'	382.25	2.58234	19° 00'	301.91	2.47988	23° 00'	249.53	2.39712
05	380.14	2.57994	05	300.59	2.47797	15	246.86	2.39245
10	378.05	2.57755	10	299.28	2.47608	30	244.24	2.38782
15	375.99	2.57518	15	297.99	2.47420	45	241.68	2.38324
20	373.95	2.57281	20	296.71	2.47233			
25	371.93	2.57046	25	295.44	2.47047	24° 00'	239.17	2.37871
30	369.93	2.56812	30	294.18	2.46861	15	236.71	2.37422
35	367.96	2.56580	35	292.94	2.46678	30	234.30	2.36978
40	366.00	2.56348	40	291.69	2.46492	45	231.95	2.36539
45	364.07	2.56118	45	290.46	2.46309			
50	362.16	2.55890	50	289.25	2.46127	25° 00'	229.64	2.36104
55	360.26	2.55662	55	288.04	2.45945	15	227.37	2.35673
						30	225.15	2.35248
16° 00'	358.39	2.55436	20° 00'	286.84	2.45764	45	222.98	2.34827
05	356.54	2.55211	05	285.66	2.45585			
10	354.70	2.54986	10	284.48	2.45405	26° 00'	220.84	2.34406
15	352.88	2.54763	15	283.31	2.45226	15	218.75	2.33995
20	351.09	2.54542	20	282.15	2.45048	30	216.69	2.33584
25	349.31	2.54321	25	281.00	2.44871	45	214.68	2.33179
30	347.55	2.54101	30	279.86	2.44695			
35	345.80	2.53883	35	278.73	2.44518	27° 00'	212.70	2.32776
40	344.08	2.53666	40	277.61	2.44344	15	210.76	2.32379
45	342.37	2.53450	45	276.50	2.44170	30	208.85	2.31983
50	340.68	2.53234	50	275.40	2.43996	45	206.98	2.31593
55	339.00	2.53020	55	274.30	2.43823			
17° 00'	337.34	2.52807	21° 00'	273.22	2.43651	28° 00'	205.14	2.31205
05	335.70	2.52595	05	272.14	2.43479	15	203.33	2.30820
10	334.07	2.52384	10	271.07	2.43309	30	201.56	2.30440
15	332.46	2.52174	15	270.01	2.43138	45	199.81	2.30062
20	330.87	2.51965	20	268.96	2.42969			
25	329.29	2.51758	25	267.91	2.42799	29° 00'	198.10	2.29688
30	327.72	2.51551	30	266.88	2.42632	15	196.42	2.29318
35	326.17	2.51344	35	265.86	2.42465	30	194.76	2.28950
40	324.64	2.51140	40	264.83	2.42298	45	193.13	2.28585
45	323.12	2.50936	45	263.82	2.42131	30° 00'	191.53	2.28224
50	321.61	2.50733	50	262.83	2.41966			
55	320.12	2.50531	55	261.82	2.41800			
18° 00'	318.64	2.50330	22° 00'	260.83	2.41637			
05	317.17	2.50129	05	259.85	2.41472			
10	315.72	2.49930	10	258.88	2.41310			
15	314.28	2.49732	15	257.91	2.41147			
20	312.86	2.49534	20	256.95	2.40986			
25	311.44	2.49337	25	256.00	2.40824			
30	310.04	2.49142	30	255.05	2.40664			
35	308.66	2.48948	35	254.12	2.40504			
40	307.28	2.48754	40	253.19	2.40344			
45	305.92	2.48561	45	252.26	2.40185			
50	304.57	2.48368	50	251.35	2.40027			
55	303.23	2.48177	55	250.44	2.39870			

## NOTATION

- $\Delta$  = Curvature increment of taper per 30 ft. of taper.  
 $M$  = Degree of main circular curve.  
 $l$  = Length of taper from the B.C. of the taper.  
 $f$  = Deflection from tangent at the B.C. of the taper.  
 $f', f_1, f_2$ , etc. = Deflection from tangent at some point on the taper.  
 $b$  = Deflection from tangent at the end of the taper, C.C. of main curve, to the B.C. of the taper.  
 $o$  = Central angle of the taper at each end of the curve.  
 $d$  = Circular curve offset from tangent to provide room for the taper.  
 $t$  = Distance along the tangent, from opposite the offset position of the B.C. of the simple curve to the B.C. of the taper.  
 $D = R + d$ , where  $R$  is the radius of the main circular curve.  
 $x$  and  $y$  are co-ordinates of points on the taper, referred to the tangent at the B.C. of the taper as meridian, and to a radial line at the B.C. of the taper as base.  
 $lc$  = Long chord of the taper, from the B.C. of the Taper to points on the taper.  
 $s$  = Distance along the taper, from the B.C. of the taper to the transit, when an intermediate set-up is necessary.  
 $T$  = Semi-tangent of the entire tapered curve, from P.I. to B.C. or E.C.  
 $E$  = External, the distance from the P.I. to a point on the curve radially opposite.

## EQUATIONS

- |  | Eqn. No.                                       |
|--|--|
| $T = t + D \tan \frac{1}{2} I.$                            | (7) Both ends, the same taper.                 |
| $T_t = t + D \tan \frac{1}{2} I - d \csc I.$               | (8) Tapered end — other end not tapered.       |
| $T_n = R \tan \frac{1}{2} I + d \csc I.$                   | (9) Untapered end — other end tapered.         |
| $T_1 = t_1 + D_1 \tan \frac{1}{2} I - (d_1 - d_2) \csc I.$ | (10) Both ends tapered with different tapers.  |
| $T_2 = t_2 + D_2 \tan \frac{1}{2} I - (d_2 - d_1) \csc I.$ | (11) Both ends tapered, with different tapers. |
| $E = D \sec \frac{1}{2} I - R.$                            | (12) Both ends the same taper.                 |



EMPIRICAL EQUATIONS DERIVED FROM THE  
TABLES

$$l = \frac{30}{\Delta} (M - \Delta). \quad (45)$$

$$f = \frac{(l + 15)(l + 30)}{\frac{300}{\Delta}}. \quad (107)$$

$$f' = \frac{(l + 2s + 45)(l - s) + 450}{\frac{300}{\Delta}}. \quad (94)$$

$$o = \frac{l(l + 30)}{\frac{300}{\Delta}}. \quad (108)$$

TAPER  $\frac{1}{2}$ . INTERMEDIATE VALUES

$\Delta = \frac{1}{4}$

<i>M</i>	<i>l</i>	<i>f</i>	<i>b</i>	<i>o</i>	<i>D</i>	<i>log D</i>	<i>d</i>	<i>t</i>	<i>z</i>	<i>y</i>	<i>lc</i>
0 30	30.00	0 02 $\frac{1}{2}$	0 02 $\frac{1}{2}$	0 04 $\frac{1}{2}$	11459.18	4.05915	0.01	15.00	0.02	30.00	30.00
35	40.00	0 03 $\frac{1}{2}$	0 03 $\frac{1}{2}$	0 07	9822.17	3.99221	0.02	20.00	0.04	40.00	40.00
40	50.00	0 04 $\frac{1}{2}$	0 05 $\frac{1}{2}$	0 10	8594.41	3.93422	0.03	25.00	0.06	50.00	50.00
45	60.00	0 05 $\frac{1}{2}$	0 08	0 13 $\frac{1}{2}$	7639.49	3.88306	0.04	30.00	0.10	60.00	60.00
50	70.00	0 07	0 10 $\frac{1}{2}$	0 17 $\frac{1}{2}$	6875.56	3.83731	0.05	35.00	0.14	70.00	70.00
55	80.00	0 08 $\frac{1}{2}$	0 13 $\frac{1}{2}$	0 22	6250.53	3.79592	0.07	40.00	0.20	80.00	80.00
1 00	90.00	0 10 $\frac{1}{2}$	0 16 $\frac{1}{2}$	0 27	5729.70	3.75813	0.10	45.00	0.27	90.00	90.00
05	100.00	0 12 $\frac{1}{2}$	0 20	0 32 $\frac{1}{2}$	5288.99	3.72337	0.13	50.00	0.36	100.00	100.00
10	110.00	0 14 $\frac{1}{2}$	0 24	0 38 $\frac{1}{2}$	4911.25	3.69119	0.16	55.00	0.47	110.00	110.00
15	120.00	0 16 $\frac{1}{2}$	0 28 $\frac{1}{2}$	0 45	4583.89	3.66123	0.20	60.00	0.59	120.00	120.00
20	130.00	0 19 $\frac{1}{2}$	0 32 $\frac{1}{2}$	0 52	4297.45	3.63321	0.24	65.00	0.73	130.00	130.00
25	140.00	0 22	0 37 $\frac{1}{2}$	0 59 $\frac{1}{2}$	4044.72	3.60689	0.29	70.00	0.89	140.00	140.00
30	150.00	0 24 $\frac{1}{2}$	0 42 $\frac{1}{2}$	1 07 $\frac{1}{2}$	3820.09	3.58207	0.34	75.00	1.08	149.99	150.00
35	160.00	0 27 $\frac{1}{2}$	0 48 $\frac{1}{2}$	1 16	3619.11	3.55860	0.40	80.00	1.29	159.99	160.00
40	170.00	0 30 $\frac{1}{2}$	0 54 $\frac{1}{2}$	1 25	3438.25	3.53634	0.47	85.00	1.52	169.99	170.00
45	180.00	0 34	1 00 $\frac{1}{2}$	1 34 $\frac{1}{2}$	3274.63	3.51516	0.55	90.00	1.79	179.98	179.99
50	190.00	0 37 $\frac{1}{2}$	1 07	1 44 $\frac{1}{2}$	3125.89	3.49497	0.63	94.99	2.08	189.98	189.99
55	200.00	0 41 $\frac{1}{2}$	1 13 $\frac{1}{2}$	1 55	2990.10	3.47569	0.72	99.99	2.40	199.98	199.99
2 00	210.00	0 45	1 21	2 06	2865.64	3.45722	0.82	104.99	2.75	209.97	209.99
05	220.00	0 49	1 28 $\frac{1}{2}$	2 17 $\frac{1}{2}$	2751.16	3.43952	0.93	109.99	3.13	219.96	219.98
10	230.00	0 53	1 36 $\frac{1}{2}$	2 29 $\frac{1}{2}$	2645.51	3.42251	1.05	114.99	3.55	229.95	229.98
15	240.00	0 57 $\frac{1}{2}$	1 44 $\frac{1}{2}$	2 42	2547.70	3.40615	1.18	119.99	4.00	239.94	239.97
20	250.00	1 01 $\frac{1}{2}$	1 53 $\frac{1}{2}$	2 55	2456.89	3.39039	1.32	124.98	4.49	249.93	249.97
25	260.00	1 06 $\frac{1}{2}$	2 02	3 08 $\frac{1}{2}$	2372.36	3.37518	1.46	129.98	5.02	259.92	259.97
30	270.00	1 11 $\frac{1}{2}$	2 11 $\frac{1}{2}$	3 22 $\frac{1}{2}$	2293.50	3.36050	1.62	134.98	5.59	269.90	269.96
35	280.00	1 16 $\frac{1}{2}$	2 20 $\frac{1}{2}$	3 37	2219.74	3.34630	1.79	139.97	6.20	279.88	279.95
40	290.00	1 21 $\frac{1}{2}$	2 30 $\frac{1}{2}$	3 52	2150.61	3.33256	1.97	144.97	6.86	289.86	289.94
45	300.00	1 26 $\frac{1}{2}$	2 41	4 07 $\frac{1}{2}$	2085.69	3.31925	2.16	149.96	7.56	299.84	299.94
50	310.00	1 32	2 51 $\frac{1}{2}$	4 23 $\frac{1}{2}$	2024.62	3.30634	2.36	154.96	8.30	309.81	309.93
55	320.00	1 37 $\frac{1}{2}$	3 02 $\frac{1}{2}$	4 40	1967.06	3.29382	2.58	159.95	9.09	319.78	319.91
3 00	330.00	1 43 $\frac{1}{2}$	3 13 $\frac{1}{2}$	4 57	1912.72	3.28165	2.81	164.94	9.93	329.74	329.89
05	340.00	1 49 $\frac{1}{2}$	3 25	5 14 $\frac{1}{2}$	1861.35	3.26983	3.05	169.93	10.82	339.70	339.87
10	350.00	1 55 $\frac{1}{2}$	3 37	5 32 $\frac{1}{2}$	1812.70	3.25833	3.30	174.93	11.76	349.66	349.85
15	360.00	2 01 $\frac{1}{2}$	3 49 $\frac{1}{2}$	5 51	1766.58	3.24713	3.57	179.92	12.75	359.61	359.83
20	370.00	2 08 $\frac{1}{2}$	4 01 $\frac{1}{2}$	6 10	1722.78	3.23623	3.85	184.90	13.80	369.55	369.81
25	380.00	2 15	4 14 $\frac{1}{2}$	6 29 $\frac{1}{2}$	1681.16	3.22561	4.15	189.89	14.90	379.49	379.78
30	390.00	2 21 $\frac{1}{2}$	4 27 $\frac{1}{2}$	6 49 $\frac{1}{2}$	1641.56	3.21526	4.47	194.88	16.07	389.42	389.75
35	400.00	2 28 $\frac{1}{2}$	4 41 $\frac{1}{2}$	7 10	1603.82	3.20516	4.80	199.86	17.29	399.35	399.72
40	410.00	2 35 $\frac{1}{2}$	4 55 $\frac{1}{2}$	7 31	1567.82	3.19530	5.14	204.85	18.57	409.27	409.69
45	420.00	2 43	5 09 $\frac{1}{2}$	7 52 $\frac{1}{2}$	1533.46	3.18567	5.50	209.83	19.91	419.18	419.65
50	430.00	2 50 $\frac{1}{2}$	5 24	8 14 $\frac{1}{2}$	1500.61	3.17627	5.87	214.81	21.31	429.08	429.61
55	440.00	2 58 $\frac{1}{2}$	5 38 $\frac{1}{2}$	8 37	1469.20	3.16708	6.26	219.79	22.78	438.97	439.56
4 00	450.00	3 06	5 54	9 00	1439.14	3.15810	6.67	224.77	24.31	448.85	449.51

TAPER  $\frac{1}{4}$ . CURVATURE INCREASING  $0^{\circ} 15'$  EVERY  $30$  FT.  $\Delta = 1$ 

Transit at	Deflections to															
	B.C. $0^{\circ} 15'$	C.C. $0^{\circ} 30'$	C.C. $0^{\circ} 45'$	C.C. $1^{\circ} 00'$	C.C. $1^{\circ} 15'$	C.C. $1^{\circ} 30'$	C.C. $1^{\circ} 45'$	C.C. $2^{\circ} 00'$	C.C. $2^{\circ} 15'$	C.C. $2^{\circ} 30'$	C.C. $2^{\circ} 45'$	C.C. $3^{\circ} 00'$	C.C. $3^{\circ} 15'$	C.C. $3^{\circ} 30'$	C.C. $3^{\circ} 45'$	C.C. $4^{\circ} 00'$
$l$	0	30	60	90	120	150	180	210	240	270	300	330	360	390	420	450
0	..	0 02 $\frac{1}{2}$	0 05 $\frac{1}{2}$	0 10 $\frac{1}{2}$	0 16 $\frac{1}{2}$	0 24 $\frac{1}{2}$	0 34 $\frac{1}{2}$	0 45 $\frac{1}{2}$	0 57 $\frac{1}{2}$	1 11 $\frac{1}{2}$	1 26 $\frac{1}{2}$	1 43 $\frac{1}{2}$	2 01 $\frac{1}{2}$	2 21 $\frac{1}{2}$	2 43	3 06
30	0 02 $\frac{1}{2}$	..	0 04 $\frac{1}{2}$	0 10 $\frac{1}{2}$	0 17 $\frac{1}{2}$	0 25 $\frac{1}{2}$	0 36 $\frac{1}{2}$	0 47 $\frac{1}{2}$	1 00 $\frac{1}{2}$	1 15 $\frac{1}{2}$	1 31 $\frac{1}{2}$	1 49	2 08 $\frac{1}{2}$	2 28 $\frac{1}{2}$	2 51	3 14 $\frac{1}{2}$
60	0 07 $\frac{1}{2}$	0 04 $\frac{1}{2}$	..	0 06 $\frac{1}{2}$	0 14 $\frac{1}{2}$	0 24 $\frac{1}{2}$	0 34 $\frac{1}{2}$	0 47 $\frac{1}{2}$	1 01 $\frac{1}{2}$	1 16 $\frac{1}{2}$	1 33 $\frac{1}{2}$	1 51 $\frac{1}{2}$	2 11 $\frac{1}{2}$	2 33	2 56 $\frac{1}{2}$	3 20 $\frac{1}{2}$
90	0 16 $\frac{1}{2}$	0 12 $\frac{1}{2}$	0 06 $\frac{1}{2}$	..	0 09	0 19 $\frac{1}{2}$	0 30 $\frac{1}{2}$	0 43 $\frac{1}{2}$	0 58 $\frac{1}{2}$	1 14 $\frac{1}{2}$	1 32 $\frac{1}{2}$	1 51 $\frac{1}{2}$	2 12	2 34	2 57 $\frac{1}{2}$	3 22 $\frac{1}{2}$
120	0 28 $\frac{1}{2}$	0 23 $\frac{1}{2}$	0 16 $\frac{1}{2}$	0 09	..	0 11 $\frac{1}{2}$	0 23 $\frac{1}{2}$	0 37 $\frac{1}{2}$	0 53	1 09 $\frac{1}{2}$	1 28	1 48	2 09 $\frac{1}{2}$	2 32 $\frac{1}{2}$	2 56 $\frac{1}{2}$	3 22 $\frac{1}{2}$
150	0 42 $\frac{1}{2}$	0 37 $\frac{1}{2}$	0 30	0 21 $\frac{1}{2}$	0 11 $\frac{1}{2}$	..	0 13 $\frac{1}{2}$	0 28 $\frac{1}{2}$	0 44 $\frac{1}{2}$	1 02	1 21	1 41	2 03 $\frac{1}{2}$	2 27 $\frac{1}{2}$	2 52 $\frac{1}{2}$	3 19
180	1 00 $\frac{1}{2}$	0 54	0 46	0 36 $\frac{1}{2}$	0 26	0 13 $\frac{1}{2}$	..	0 15 $\frac{1}{2}$	0 32 $\frac{1}{2}$	0 51	1 11	1 32 $\frac{1}{2}$	1 55	2 19 $\frac{1}{2}$	2 45 $\frac{1}{2}$	3 12 $\frac{1}{2}$
210	1 21	1 14	1 05 $\frac{1}{2}$	0 55 $\frac{1}{2}$	0 43 $\frac{1}{2}$	0 30 $\frac{1}{2}$	0 13 $\frac{1}{2}$	0 15 $\frac{1}{2}$	0 32 $\frac{1}{2}$	0 51	1 11	1 32 $\frac{1}{2}$	1 55	2 19 $\frac{1}{2}$	2 45 $\frac{1}{2}$	3 12 $\frac{1}{2}$
240	1 44 $\frac{1}{2}$	1 36 $\frac{1}{2}$	1 27 $\frac{1}{2}$	1 16 $\frac{1}{2}$	1 04	0 50 $\frac{1}{2}$	0 34 $\frac{1}{2}$	0 18	0 37 $\frac{1}{2}$	0 57 $\frac{1}{2}$	1 11	1 32 $\frac{1}{2}$	1 55	2 19 $\frac{1}{2}$	2 45 $\frac{1}{2}$	3 12 $\frac{1}{2}$
270	2 11 $\frac{1}{2}$	2 02 $\frac{1}{2}$	1 52 $\frac{1}{2}$	1 41	1 27 $\frac{1}{2}$	1 13	0 57	0 39 $\frac{1}{2}$	0 20 $\frac{1}{2}$	0 22 $\frac{1}{2}$	0 41 $\frac{1}{2}$	0 49 $\frac{1}{2}$	1 11 $\frac{1}{2}$	1 38	2 06	2 35 $\frac{1}{2}$
300	2 40 $\frac{1}{2}$	2 31 $\frac{1}{2}$	2 20 $\frac{1}{2}$	2 08 $\frac{1}{2}$	1 54 $\frac{1}{2}$	1 39	1 22	1 03 $\frac{1}{2}$	0 44	0 22 $\frac{1}{2}$	0 22 $\frac{1}{2}$	0 24 $\frac{1}{2}$	0 50 $\frac{1}{2}$	1 18	1 46 $\frac{1}{2}$	2 17 $\frac{1}{2}$
330	3 13 $\frac{1}{2}$	3 03 $\frac{1}{2}$	2 51 $\frac{1}{2}$	2 38 $\frac{1}{2}$	2 24	2 08	1 50 $\frac{1}{2}$	1 31	1 10 $\frac{1}{2}$	0 48 $\frac{1}{2}$	0 24 $\frac{1}{2}$	0 27	0 27	0 55	1 24 $\frac{1}{2}$	1 55 $\frac{1}{2}$
360	3 49 $\frac{1}{2}$	3 38 $\frac{1}{2}$	3 26	3 12	2 56 $\frac{1}{2}$	2 39 $\frac{1}{2}$	2 21 $\frac{1}{2}$	2 01 $\frac{1}{2}$	1 40	0 48 $\frac{1}{2}$	0 24 $\frac{1}{2}$	0 27	0 27	0 29 $\frac{1}{2}$	0 59 $\frac{1}{2}$	1 31 $\frac{1}{2}$
390	4 27 $\frac{1}{2}$	4 16 $\frac{1}{2}$	4 03	3 48 $\frac{1}{2}$	3 32 $\frac{1}{2}$	3 14 $\frac{1}{2}$	2 55 $\frac{1}{2}$	2 34 $\frac{1}{2}$	2 13 $\frac{1}{2}$	1 49 $\frac{1}{2}$	1 24	0 57	0 29 $\frac{1}{2}$	0 31 $\frac{1}{2}$	1 04	1 31 $\frac{1}{2}$
420	5 09 $\frac{1}{2}$	4 57	4 43 $\frac{1}{2}$	4 27 $\frac{1}{2}$	4 11	3 52 $\frac{1}{2}$	3 32 $\frac{1}{2}$	3 11 $\frac{1}{2}$	2 48 $\frac{1}{2}$	2 24	1 58 $\frac{1}{2}$	1 30 $\frac{1}{2}$	0 29 $\frac{1}{2}$	0 31 $\frac{1}{2}$	1 01 $\frac{1}{2}$	1 31 $\frac{1}{2}$
450	5 54	5 41	5 26 $\frac{1}{2}$	5 10 $\frac{1}{2}$	4 52 $\frac{1}{2}$	4 33 $\frac{1}{2}$	4 12 $\frac{1}{2}$	3 50 $\frac{1}{2}$	3 27	3 02	2 35 $\frac{1}{2}$	2 07 $\frac{1}{2}$	1 37 $\frac{1}{2}$	1 06 $\frac{1}{2}$	0 33 $\frac{1}{2}$	0 33 $\frac{1}{2}$

TABLES

TAPER 1/4. CURVATURE INCREASING 0° 15' EVERY 30 FT. — (Continued)  $\Delta = 1/4$

M	l	o	D	log D	d	t	z	v	lc
0 30	30	0 04½	11459.18	4.05915	0.01	15.00	0.02	30.00	30.00
0 45	60	0 13½	7639.49	3.88306	0.04	30.00	0.10	60.00	60.00
1 00	90	0 27	5729.70	3.75813	0.10	45.00	0.27	90.00	90.00
1 15	120	0 45	4583.89	3.66123	0.20	60.00	0.59	120.00	120.00
1 30	150	1 07½	3820.09	3.58207	0.34	75.00	1.08	149.99	150.00
1 45	180	1 34½	3274.63	3.51516	0.55	90.00	1.79	179.99	179.99
2 00	210	2 06	2865.64	3.45722	0.82	104.99	2.75	209.97	209.99
2 15	240	2 42	2547.70	3.40615	1.18	119.99	4.00	239.94	239.97
2 30	270	3 22½	2293.50	3.36050	1.62	134.98	5.59	269.90	269.96
2 45	300	4 07½	2085.69	3.31925	2.16	149.96	7.56	299.84	299.94
3 00	330	4 57	1912.72	3.28165	2.81	164.94	9.93	329.74	329.89
3 15	360	5 51	1766.58	3.24713	3.57	179.92	12.75	359.61	359.83
3 30	390	6 49½	1641.56	3.21526	4.47	194.88	16.07	389.43	389.75
3 45	420	7 52½	1533.46	3.18567	5.50	209.83	19.91	419.18	419.65
4 00	450	9 00	1439.14	3.15810	6.67	224.77	24.31	448.86	449.51

TAPER 1. CURVATURE INCREASING 0° 30' EVERY 30 FT.  $\Delta = \frac{1}{2}$

Deflections to

Transit at	B.C. 0° 30'	C.C. 1° 00'	C.C. 1° 30'	C.C. 2° 00'	C.C. 2° 30'	C.C. 3° 00'	C.C. 3° 30'	C.C. 4° 00'	C.C. 4° 30'	C.C. 5° 00'	C.C. 5° 30'	C.C. 6° 00'	C.C. 6° 30'	C.C. 7° 00'	C.C. 7° 30'
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0.04 $\frac{1}{2}$	0.09	0.11 $\frac{1}{2}$	0.21	0.33 $\frac{1}{2}$	0.49 $\frac{1}{2}$	1.08 $\frac{1}{2}$	1.30	1.54 $\frac{1}{2}$	2.22 $\frac{1}{2}$	2.53 $\frac{1}{2}$	3.27	4.03 $\frac{1}{2}$	4.43 $\frac{1}{2}$	5.26 $\frac{1}{2}$
60	0.15 $\frac{1}{2}$	0.24 $\frac{1}{2}$	0.33 $\frac{1}{2}$	0.51 $\frac{1}{2}$	0.84 $\frac{1}{2}$	1.12	1.12	1.35 $\frac{1}{2}$	2.01 $\frac{1}{2}$	2.30 $\frac{1}{2}$	3.03	3.38 $\frac{1}{2}$	4.16 $\frac{1}{2}$	4.57 $\frac{1}{2}$	5.42
90	0.33	0.46 $\frac{1}{2}$	0.61 $\frac{1}{2}$	0.91	1.31 $\frac{1}{2}$	1.81	1.09 $\frac{1}{2}$	1.34 $\frac{1}{2}$	2.02 $\frac{1}{2}$	2.33	3.06 $\frac{1}{2}$	3.43 $\frac{1}{2}$	4.23 $\frac{1}{2}$	5.06	5.51 $\frac{1}{2}$
120	0.56 $\frac{1}{2}$	0.83 $\frac{1}{2}$	1.16 $\frac{1}{2}$	1.71 $\frac{1}{2}$	2.51 $\frac{1}{2}$	3.51 $\frac{1}{2}$	1.01 $\frac{1}{2}$	1.27 $\frac{1}{2}$	1.57	2.29 $\frac{1}{2}$	3.04 $\frac{1}{2}$	3.42 $\frac{1}{2}$	4.24	5.08 $\frac{1}{2}$	5.55 $\frac{1}{2}$
150	1.25 $\frac{1}{2}$	1.81 $\frac{1}{2}$	2.51 $\frac{1}{2}$	3.51 $\frac{1}{2}$	5.01 $\frac{1}{2}$	7.01 $\frac{1}{2}$	0.47 $\frac{1}{2}$	1.15	1.45 $\frac{1}{2}$	2.19 $\frac{1}{2}$	2.56 $\frac{1}{2}$	3.36	4.18 $\frac{1}{2}$	5.04 $\frac{1}{2}$	5.53 $\frac{1}{2}$
180	2.00 $\frac{1}{2}$	2.81 $\frac{1}{2}$	3.81 $\frac{1}{2}$	5.11 $\frac{1}{2}$	7.01 $\frac{1}{2}$	9.51 $\frac{1}{2}$	0.27	0.56 $\frac{1}{2}$	1.28 $\frac{1}{2}$	2.03 $\frac{1}{2}$	2.42	3.23 $\frac{1}{2}$	4.07 $\frac{1}{2}$	4.54 $\frac{1}{2}$	5.45
210	3.29 $\frac{1}{2}$	4.41 $\frac{1}{2}$	5.81 $\frac{1}{2}$	7.81 $\frac{1}{2}$	10.51 $\frac{1}{2}$	14.01 $\frac{1}{2}$	0.31 $\frac{1}{2}$	0.31 $\frac{1}{2}$	1.05 $\frac{1}{2}$	1.42	2.21 $\frac{1}{2}$	3.04 $\frac{1}{2}$	3.50 $\frac{1}{2}$	4.39	5.30 $\frac{1}{2}$
240	4.22 $\frac{1}{2}$	5.41 $\frac{1}{2}$	6.81 $\frac{1}{2}$	8.81 $\frac{1}{2}$	11.51 $\frac{1}{2}$	15.01 $\frac{1}{2}$	0.36	0.36	0.36	0.40 $\frac{1}{2}$	1.55 $\frac{1}{2}$	2.39 $\frac{1}{2}$	3.27	4.17 $\frac{1}{2}$	5.10 $\frac{1}{2}$
270	5.21 $\frac{1}{2}$	6.41 $\frac{1}{2}$	7.81 $\frac{1}{2}$	9.81 $\frac{1}{2}$	12.51 $\frac{1}{2}$	16.01 $\frac{1}{2}$	1.54	1.18 $\frac{1}{2}$	0.40 $\frac{1}{2}$	0.45	1.55 $\frac{1}{2}$	2.09	2.57 $\frac{1}{2}$	3.49 $\frac{1}{2}$	4.44
300	6.27	7.41 $\frac{1}{2}$	8.81 $\frac{1}{2}$	10.81 $\frac{1}{2}$	13.51 $\frac{1}{2}$	17.01 $\frac{1}{2}$	2.44 $\frac{1}{2}$	2.07 $\frac{1}{2}$	1.27 $\frac{1}{2}$	0.45	0.45	0.49 $\frac{1}{2}$	1.41 $\frac{1}{2}$	2.36	3.33 $\frac{1}{2}$
330	7.38 $\frac{1}{2}$	8.51 $\frac{1}{2}$	9.81 $\frac{1}{2}$	11.81 $\frac{1}{2}$	14.51 $\frac{1}{2}$	18.01 $\frac{1}{2}$	3.40 $\frac{1}{2}$	3.02 $\frac{1}{2}$	2.21	1.36 $\frac{1}{2}$	0.49 $\frac{1}{2}$	0.54	0.54	1.50 $\frac{1}{2}$	2.49 $\frac{1}{2}$
360	8.55 $\frac{1}{2}$	9.81 $\frac{1}{2}$	11.16 $\frac{1}{2}$	13.16 $\frac{1}{2}$	15.51 $\frac{1}{2}$	19.01 $\frac{1}{2}$	4.42 $\frac{1}{2}$	4.03	3.20 $\frac{1}{2}$	2.34 $\frac{1}{2}$	1.45 $\frac{1}{2}$	1.54 $\frac{1}{2}$	0.58 $\frac{1}{2}$	1.50 $\frac{1}{2}$	1.59 $\frac{1}{2}$
390	10.18 $\frac{1}{2}$	11.51 $\frac{1}{2}$	13.01 $\frac{1}{2}$	14.51 $\frac{1}{2}$	16.51 $\frac{1}{2}$	20.01 $\frac{1}{2}$	5.51	5.09 $\frac{1}{2}$	4.25 $\frac{1}{2}$	3.38 $\frac{1}{2}$	2.48	1.54 $\frac{1}{2}$	0.58 $\frac{1}{2}$	0.58 $\frac{1}{2}$	1.03
420	10.18 $\frac{1}{2}$	11.51 $\frac{1}{2}$	13.01 $\frac{1}{2}$	14.51 $\frac{1}{2}$	16.51 $\frac{1}{2}$	20.01 $\frac{1}{2}$	7.06 $\frac{1}{2}$	6.22 $\frac{1}{2}$	5.36 $\frac{1}{2}$	4.48	3.56 $\frac{1}{2}$	3.01 $\frac{1}{2}$	2.03 $\frac{1}{2}$	1.03	0.00

TAPER 1. CURVATURE INCREASING 0° 30' EVERY 30 FT. — (Continued)  $\Delta = \frac{1}{2}$

M	t	o	D	log D	d	t	z	y	lc
1 00	30	0 09	5729.62	3.75813	0.02	15.00	0.04	30.00	30.00
1 30	60	0 27	3819.83	3.58204	0.08	30.00	0.20	60.00	60.00
2 00	90	0 54	2865.02	3.45713	0.20	45.00	0.55	90.00	90.00
2 30	120	1 30	2292.27	3.36027	0.39	60.00	1.18	119.99	120.00
3 00	150	2 15	1910.60	3.28117	0.69	74.99	2.16	149.97	149.99
3 30	180	3 09	1638.19	3.21436	1.10	89.98	3.57	179.94	179.98
4 00	210	4 12	1434.12	3.15659	1.65	104.97	5.50	209.88	209.95
4 30	240	5 24	1275.68	3.10574	2.36	119.94	8.01	239.77	239.91
5 00	270	6 45	1149.25	3.06041	3.24	134.91	11.18	269.61	269.84
5 30	300	8 15	1046.16	3.01960	4.32	149.85	15.10	299.35	299.73
6 00	330	9 54	960.65	2.98257	5.61	164.77	19.83	328.97	329.57
6 30	360	11 42	888.73	2.94877	7.14	179.67	25.46	358.44	359.34
7 00	390	13 39	817.56	2.91780	8.92	194.52	32.05	387.71	389.03
7 30	420	15 45	775.06	2.88933	10.98	209.33	39.67	416.73	418.62

## TAPER 1. INTERMEDIATE VALUES

 $\Delta = \frac{1}{2}$ 

<i>M</i>	<i>l</i>	<i>f</i>	<i>b</i>	<i>o</i>	<i>D</i>	log <i>D</i>	<i>d</i>	<i>t</i>	<i>z</i>	<i>y</i>	<i>lc</i>
1 00	30.00	0 04½	0 04½	0 09	5729.62	3.75813	0.02	15.00	0.04	30.00	30.00
05	35.00	0 05½	0 06	0 11½	5288.89	3.72336	0.03	17.50	0.06	35.00	35.00
10	40.00	0 06½	0 07½	0 14	4911.12	3.69118	0.03	20.00	0.08	40.00	40.00
15	45.00	0 07½	0 09½	0 16½	4583.73	3.66122	0.04	22.50	0.10	45.00	45.00
20	50.00	0 08½	0 11½	0 20	4297.26	3.63319	0.05	25.00	0.13	50.00	50.00
25	55.00	0 10	0 13½	0 23½	4044.49	3.60686	0.06	27.50	0.16	55.00	55.00
30	60.00	0 11½	0 15½	0 27	3819.83	3.58204	0.08	30.00	0.20	60.00	60.00
35	65.00	0 12½	0 18	0 30½	3618.80	3.55856	0.09	32.50	0.24	65.00	65.00
40	70.00	0 14½	0 20½	0 35	3437.89	3.53629	0.11	35.00	0.29	70.00	70.00
45	75.00	0 15½	0 23½	0 39½	3274.21	3.51511	0.13	37.50	0.35	75.00	75.00
50	80.00	0 17½	0 26½	0 44	3125.41	3.49491	0.15	40.00	0.41	80.00	80.00
55	85.00	0 19½	0 29½	0 48½	2989.55	3.47561	0.17	42.50	0.47	85.00	85.00
2 00	90.00	0 21	0 33	0 54	2865.02	3.45713	0.20	45.00	0.55	90.00	90.00
05	95.00	0 23	0 36½	0 59½	2750.45	3.43940	0.22	47.50	0.63	95.00	95.00
10	100.00	0 25	0 40	1 05	2644.71	3.42238	0.25	50.00	0.72	100.00	100.00
15	105.00	0 27	0 43½	1 10½	2546.80	3.40599	0.28	52.50	0.82	105.00	105.00
20	110.00	0 29½	0 47½	1 17	2455.89	3.39021	0.32	55.00	0.93	109.99	110.00
25	115.00	0 31½	0 52	1 23½	2371.25	3.37498	0.35	57.50	1.05	114.99	115.00
30	120.00	0 33½	0 56½	1 30	2292.27	3.36027	0.39	60.00	1.18	119.99	120.00
35	125.00	0 36½	1 00½	1 36½	2218.39	3.34604	0.44	62.50	1.31	124.99	125.00
40	130.00	0 38½	1 05½	1 44	2149.12	3.33226	0.48	65.00	1.46	129.99	130.00
45	135.00	0 41½	1 10½	1 51½	2084.06	3.31891	0.53	67.49	1.62	134.98	134.99
50	140.00	0 44	1 15	1 59	2022.84	3.30596	0.58	69.99	1.79	139.98	139.99
55	145.00	0 46½	1 20	2 06½	1965.11	3.29339	0.63	72.49	1.97	144.98	144.99
3 00	150.00	0 49½	1 25½	2 15	1910.60	3.28117	0.69	74.99	2.16	149.97	149.99
05	155.00	0 52½	1 31	2 23½	1859.05	3.26929	0.75	77.49	2.36	154.97	154.99
10	160.00	0 55½	1 36½	2 32	1810.21	3.25773	0.81	79.99	2.57	159.97	159.99
15	165.00	0 58½	1 42½	2 40½	1763.89	3.24647	0.88	82.49	2.80	164.96	164.98
20	170.00	1 01½	1 48½	2 50	1719.88	3.23550	0.95	84.99	3.05	169.96	169.98
25	175.00	1 05	1 53½	2 59½	1678.03	3.22480	1.02	87.49	3.30	174.95	174.98
30	180.00	1 08½	2 00½	3 09	1638.19	3.21436	1.10	89.98	3.57	179.94	179.98
35	185.00	1 11½	2 07	3 18½	1600.20	3.20417	1.18	92.48	3.86	184.93	184.97
40	190.00	1 15½	2 13½	3 29	1563.95	3.19422	1.27	94.98	4.16	189.92	189.97
45	195.00	1 18½	2 20½	3 39½	1529.32	3.18450	1.36	97.48	4.47	194.91	194.96
50	200.00	1 22½	2 27½	3 50	1496.19	3.17499	1.45	99.97	4.80	199.90	199.96
55	205.00	1 26½	2 34½	4 00½	1464.49	3.16569	1.55	102.47	5.14	204.89	204.95

TAPER 1. INTERMEDIATE VALUES — (Continued)  $\Delta = \frac{1}{2}$ 

<i>M</i>	<i>l</i>	<i>f</i>	<i>b</i>	<i>o</i>	<i>D</i>	log <i>D</i>	<i>d</i>	<i>t</i>	<i>z</i>	<i>y</i>	<i>lc</i>
4 00	210.00	1 30	2 42	4 12	1434.12	3.15659	1.65	104.97	5.50	209.88	209.95
05	215.00	1 34	2 49½	4 23½	1405.00	3.14768	1.76	107.47	5.87	214.87	214.95
10	220.00	1 38	2 57	4 35	1377.04	3.13895	1.87	109.96	6.26	219.85	219.94
15	225.00	1 42	3 04½	4 46½	1350.19	3.13039	1.98	112.46	6.67	224.83	224.93
20	230.00	1 46½	3 12½	4 59	1324.39	3.12201	2.10	114.95	7.10	229.82	229.93
25	235.00	1 50½	3 21	5 11½	1299.57	3.11380	2.23	117.45	7.54	234.80	234.92
30	240.00	1 54½	3 29½	5 24	1275.68	3.10574	2.36	119.94	8.01	239.77	239.91
35	245.00	1 59½	3 37½	5 36½	1252.66	3.09783	2.49	122.44	8.49	244.75	244.90
40	250.00	2 03½	3 46½	5 50	1230.48	3.09007	2.63	124.93	8.99	249.73	249.89
45	255.00	2 08½	3 55½	6 03½	1209.08	3.08246	2.77	127.43	9.51	254.70	254.88
50	260.00	2 13	4 04	6 17	1188.43	3.07497	2.92	129.92	10.05	259.67	259.87
55	265.00	2 17½	4 13	6 30½	1168.51	3.06763	3.08	132.41	10.60	264.64	264.85
5 00	270.00	2 22½	4 22½	6 45	1149.25	3.06041	3.24	134.91	11.18	269.61	269.84
05	275.00	2 27½	4 32	6 59½	1130.60	3.05331	3.40	137.40	11.78	274.57	274.82
10	280.00	2 32½	4 41½	7 14	1112.61	3.04634	3.57	139.89	12.40	279.53	279.81
15	285.00	2 37½	4 50½	7 28½	1095.19	3.03949	3.75	142.38	13.04	284.49	284.80
20	290.00	2 42½	5 01½	7 44	1078.33	3.03275	3.94	144.87	13.71	289.45	289.78
25	295.00	2 48	5 11½	7 59½	1062.00	3.02612	4.13	147.36	14.39	294.40	294.76
30	300.00	2 53½	5 21½	8 15	1046.16	3.01960	4.32	149.85	15.10	299.35	299.73
35	305.00	2 58½	5 32	8 30½	1030.81	3.01318	4.52	152.34	15.83	304.30	304.71
40	310.00	3 04½	5 42½	8 47	1015.93	3.00686	4.73	154.83	16.58	309.24	309.69
45	315.00	3 09½	5 53½	9 03½	1001.49	3.00065	4.94	157.32	17.36	314.18	314.66
50	320.00	3 15½	6 04½	9 20	987.48	2.99453	5.16	159.81	18.16	319.12	319.63
55	325.00	3 21½	6 15½	9 36½	973.86	2.98850	5.38	162.30	18.98	324.06	324.61
6 00	330.00	3 27	6 27	9 54	960.65	2.98257	5.61	164.77	19.83	328.97	329.57
15	345.00	3 45	7 01½	10 46½	923.18	2.96529	6.34	172.22	22.53	343.73	344.47
30	360.00	4 03½	7 38½	11 42	888.73	2.94877	7.14	179.67	25.46	358.44	359.34
45	375.00	4 23½	8 16½	12 39½	856.95	2.93296	8.00	187.10	28.63	373.10	374.20
7 00	390.00	4 43½	8 55½	13 39	827.56	2.91780	8.92	194.52	32.05	387.71	389.03
15	405.00	5 04½	9 36½	14 40½	800.33	2.90327	9.91	201.93	35.73	402.25	403.84
30	420.00	5 26½	10 18½	15 45	775.05	2.88933	10.97	209.33	39.67	416.73	418.62



THE RAILROAD TAPER

TAPER 1 $\frac{1}{2}$ . CURVATURE INCREASING 0° 45' EVERY 30 FT.  $\Delta = \frac{1}{2}$

Transit at	Deflections to													
	B.C. 0° 45'	C.C. 1° 30'	C.C. 2° 15'	C.C. 3° 00'	C.C. 3° 45'	C.C. 4° 30'	C.C. 5° 15'	C.C. 6° 00'	C.C. 6° 45'	C.C. 7° 30'	C.C. 8° 15'	C.C. 9° 00'	C.C. 9° 45'	C.C. 10° 30'
l	0	30	60	90	120	150	180	210	240	270	300	330	360	390
0	0	0 06 $\frac{1}{2}$	0 17	0 31 $\frac{1}{2}$	0 50 $\frac{1}{2}$	1 14 $\frac{1}{2}$	1 42 $\frac{1}{2}$	2 15	2 52	3 33 $\frac{1}{2}$	4 20	5 10 $\frac{1}{2}$	6 05 $\frac{1}{2}$	7 05 $\frac{1}{2}$
30	0 06 $\frac{1}{2}$	0 13 $\frac{1}{2}$	0 30 $\frac{1}{2}$	0 30 $\frac{1}{2}$	0 51 $\frac{1}{2}$	1 17 $\frac{1}{2}$	1 48	2 23	3 02 $\frac{1}{2}$	3 46	4 34 $\frac{1}{2}$	5 27 $\frac{1}{2}$	6 24 $\frac{1}{2}$	7 29 $\frac{1}{2}$
60	0 23 $\frac{1}{2}$	0 27	0 49 $\frac{1}{2}$	0 20 $\frac{1}{2}$	0 44	1 12	1 44 $\frac{1}{2}$	2 21 $\frac{1}{2}$	3 03 $\frac{1}{2}$	3 49 $\frac{1}{2}$	4 40	5 35 $\frac{1}{2}$	6 35	7 39
90	0 49 $\frac{1}{2}$	0 37	0 20 $\frac{1}{2}$	0 27	0 57 $\frac{1}{2}$	1 32 $\frac{1}{2}$	1 32 $\frac{1}{2}$	2 11 $\frac{1}{2}$	2 55 $\frac{1}{2}$	3 44	4 36 $\frac{1}{2}$	5 34	6 36	7 42 $\frac{1}{2}$
120	1 24 $\frac{1}{2}$	1 09 $\frac{1}{2}$	0 50 $\frac{1}{2}$	0 27	0 33 $\frac{1}{2}$	1 11	1 11	1 52 $\frac{1}{2}$	2 38 $\frac{1}{2}$	3 29 $\frac{1}{2}$	4 24 $\frac{1}{2}$	5 24	6 28	7 36 $\frac{1}{2}$
150	2 08 $\frac{1}{2}$	1 51 $\frac{1}{2}$	1 30	1 04	0 33 $\frac{1}{2}$	0 40 $\frac{1}{2}$	0 40 $\frac{1}{2}$	1 24 $\frac{1}{2}$	2 12 $\frac{1}{2}$	3 05 $\frac{1}{2}$	4 03	5 05	6 11 $\frac{1}{2}$	7 22
180	3 01	2 42	2 18 $\frac{1}{2}$	1 50 $\frac{1}{2}$	1 17 $\frac{1}{2}$	0 40 $\frac{1}{2}$	0 47 $\frac{1}{2}$	0 47 $\frac{1}{2}$	1 38	2 33	3 32 $\frac{1}{2}$	4 36 $\frac{1}{2}$	5 45 $\frac{1}{2}$	6 58 $\frac{1}{2}$
210	4 03	3 41 $\frac{1}{2}$	3 15 $\frac{1}{2}$	2 45 $\frac{1}{2}$	2 10 $\frac{1}{2}$	1 31	1 44 $\frac{1}{2}$	0 54	0 54	1 51 $\frac{1}{2}$	2 53 $\frac{1}{2}$	3 59 $\frac{1}{2}$	5 10 $\frac{1}{2}$	6 26
240	5 14	4 50 $\frac{1}{2}$	4 22	3 49 $\frac{1}{2}$	3 12 $\frac{1}{2}$	2 30 $\frac{1}{2}$	1 44 $\frac{1}{2}$	1 58	1 00 $\frac{1}{2}$	2 33	2 05	3 13 $\frac{1}{2}$	4 26 $\frac{1}{2}$	5 44 $\frac{1}{2}$
270	6 33 $\frac{1}{2}$	6 08	5 37 $\frac{1}{2}$	5 02 $\frac{1}{2}$	4 23 $\frac{1}{2}$	3 39 $\frac{1}{2}$	4 06 $\frac{1}{2}$	3 11 $\frac{1}{2}$	2 11 $\frac{1}{2}$	1 07 $\frac{1}{2}$	1 07 $\frac{1}{2}$	2 18 $\frac{1}{2}$	3 33 $\frac{1}{2}$	4 53 $\frac{1}{2}$
300	8 02 $\frac{1}{2}$	7 34 $\frac{1}{2}$	6 08	6 24 $\frac{1}{2}$	5 43	4 57	4 06 $\frac{1}{2}$	4 33 $\frac{1}{2}$	3 31 $\frac{1}{2}$	1 14 $\frac{1}{2}$	1 14 $\frac{1}{2}$	2 32	3 54 $\frac{1}{2}$	5 21 $\frac{1}{2}$
330	9 40 $\frac{1}{2}$	9 10	8 35 $\frac{1}{2}$	7 56	7 12	6 23 $\frac{1}{2}$	5 30 $\frac{1}{2}$	4 33 $\frac{1}{2}$	3 31 $\frac{1}{2}$	2 25	2 05	3 21 $\frac{1}{2}$	4 45 $\frac{1}{2}$	6 24 $\frac{1}{2}$
360	11 27 $\frac{1}{2}$	10 54 $\frac{1}{2}$	10 17 $\frac{1}{2}$	9 36	8 50	7 59 $\frac{1}{2}$	7 04	6 04 $\frac{1}{2}$	5 00 $\frac{1}{2}$	3 51 $\frac{1}{2}$	2 38 $\frac{1}{2}$	1 21	2 45 $\frac{1}{2}$	4 35 $\frac{1}{2}$
390	13 23 $\frac{1}{2}$	12 48 $\frac{1}{2}$	12 09	11 25	10 36 $\frac{1}{2}$	9 44	8 46 $\frac{1}{2}$	7 44 $\frac{1}{2}$	6 38 $\frac{1}{2}$	5 27 $\frac{1}{2}$	4 12	2 52	1 27 $\frac{1}{2}$	3 11 $\frac{1}{2}$

TABLES

TAPER 1½. CURVATURE INCREASING 0° 45' EVERY 30 FT. — (Continued)  $\Delta = \frac{1}{4}$

M	l	o	D	log D	d	t	z	y	lc
1 30	30	0 13½	3819.78	3.58204	0.03	15.00	0.06	30.00	30.00
2 15	60	0 40½	2546.64	3.40597	0.12	30.00	0.29	60.00	60.00
3 00	90	1 21	1910.20	3.28108	0.29	45.00	0.82	89.99	89.99
3 45	120	2 15	1528.55	3.18428	0.59	59.99	1.77	119.98	119.99
4 30	150	3 22½	1274.35	3.10529	1.03	74.98	3.24	149.94	149.98
5 15	180	4 43½	1093.09	3.03865	1.65	89.96	5.36	179.87	179.95
6 00	210	6 18	957.51	2.98114	2.47	104.93	8.24	209.73	209.89
6 45	240	8 06	852.48	2.93068	3.53	119.88	12.00	239.49	239.79
7 30	270	10 07½	768.94	2.88589	4.86	134.79	16.75	269.11	269.64
8 15	300	12 22½	701.12	2.84579	6.47	149.67	22.61	298.54	299.40
9 00	330	14 51	645.19	2.80969	8.41	164.49	29.08	327.70	329.04
9 45	360	17 33	598.53	2.77709	10.70	179.25	38.06	356.50	358.54
10 30	390	20 28½	559.24	2.74760	13.37	193.92	47.85	384.87	387.82

THE RAILROAD TAPER

TAPER 1½. CURVATURE INCREASING 0° 45' EVERY 30 FT. Δ = ½

Transit at	Deflections to													
	B.C. 0° 45'	C.C. 1° 30'	C.C. 2° 15'	C.C. 3° 00'	C.C. 3° 45'	C.C. 4° 30'	C.C. 5° 15'	C.C. 6° 00'	C.C. 6° 45'	C.C. 7° 30'	C.C. 8° 15'	C.C. 9° 00'	C.C. 9° 45'	C.C. 10° 30'
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0 06½	0 17	0 31½	0 46	0 59½	1 14½	1 42½	2 15	2 52	3 33½	4 20	5 10½	6 05½	7 05½
60	0 13	0 33	0 51	0 72	0 96	1 17½	1 48	2 23	3 02½	3 46	4 34½	5 27½	6 24½	7 26½
90	0 49½	0 37	0 20½	0 27	0 44	0 57	1 44½	2 21½	3 03½	3 49½	4 40	5 35½	6 35	7 39
120	1 24½	1 09½	0 50½	0 27	0 33½	0 33½	1 32½	2 11½	2 55½	3 44	4 36½	5 34	6 36	7 42½
150	2 08½	1 51½	1 30	1 04	0 33½	0 33½	1 11	1 52½	2 38½	3 29½	4 24½	5 24	6 28	7 36½
180	3 01	2 42	2 18½	1 50½	1 17½	0 40½	0 40½	0 47½	1 38	2 33	4 03	5 05	6 11½	7 22
210	4 03	3 41½	3 15½	2 45½	2 10½	1 31	0 47½	0 54	1 38	2 33	3 32½	4 36½	5 45½	6 58½
240	5 14	4 50½	4 22	3 49½	3 12½	2 30½	1 44½	0 54	1 38	2 33	3 32½	4 36½	5 45½	6 58½
270	6 33½	6 08	5 37½	5 02½	4 23½	3 39½	2 51	1 58	0 54	1 00½	2 05	3 13½	4 26½	5 44½
300	8 02½	7 34½	7 02	6 24½	5 43	4 57	4 06½	3 11½	1 00½	1 07½	1 07½	2 18½	3 33½	4 53½
330	9 40½	9 10	8 35½	7 56	7 12	6 23½	5 30½	4 33½	3 31½	1 07½	1 14½	1 14½	2 32	3 54
360	11 27½	10 54½	10 17½	9 36	8 50	7 59½	7 04	6 04½	5 00½	3 51½	2 38½	1 21	1 21	2 45½
390	13 23½	12 48½	12 09	11 25	10 36½	9 44	8 46½	7 44½	6 38½	5 27½	4 12	2 52	1 27½	1 27½

TAPER  $1\frac{1}{2}$ . INTERMEDIATE VALUES — (Continued)  $\Delta = \frac{1}{2}$

<i>M</i>	<i>l</i>	<i>f</i>	<i>b</i>	<i>o</i>	<i>D</i>	log <i>D</i>	<i>d</i>	<i>t</i>	<i>z</i>	<i>y</i>	<i>lc</i>
4 30	150.00	1 14 $\frac{1}{2}$	2 08 $\frac{1}{2}$	3 22 $\frac{1}{2}$	1274.35	3.10529	1.03	74.98	3.24	149.94	149.98
35	153.33	1 17 $\frac{1}{2}$	2 12 $\frac{1}{2}$	3 30 $\frac{1}{2}$	1251.26	3.09735	1.09	76.65	3.44	153.27	153.31
40	156.67	1 20 $\frac{1}{2}$	2 19	3 39 $\frac{1}{2}$	1229.00	3.08955	1.15	78.31	3.65	156.60	156.64
45	160.00	1 23 $\frac{1}{2}$	2 24 $\frac{1}{2}$	3 48	1207.52	3.08189	1.21	79.98	3.87	159.92	159.97
50	163.33	1 26 $\frac{1}{2}$	2 30 $\frac{1}{2}$	3 56 $\frac{1}{2}$	1186.79	3.07437	1.28	81.64	4.10	163.25	163.30
55	166.67	1 29 $\frac{1}{2}$	2 36 $\frac{1}{2}$	4 05 $\frac{1}{2}$	1166.78	3.06699	1.35	83.31	4.33	166.58	166.63
5 00	170.00	1 32 $\frac{1}{2}$	2 42 $\frac{1}{2}$	4 15	1147.43	3.05973	1.42	84.97	4.57	169.90	169.96
05	173.33	1 35 $\frac{1}{2}$	2 48 $\frac{1}{2}$	4 24 $\frac{1}{2}$	1128.69	3.05257	1.49	86.64	4.83	173.22	173.29
10	176.67	1 39	2 54 $\frac{1}{2}$	4 33 $\frac{1}{2}$	1110.61	3.04556	1.57	88.30	5.09	176.55	176.62
15	180.00	1 42 $\frac{1}{2}$	3 01 $\frac{1}{2}$	4 43 $\frac{1}{2}$	1093.09	3.03865	1.65	89.96	5.36	179.87	179.95
20	183.33	1 45 $\frac{1}{2}$	3 07 $\frac{1}{2}$	4 53 $\frac{1}{2}$	1076.12	3.03186	1.73	91.63	5.64	183.19	183.28
25	186.67	1 49 $\frac{1}{2}$	3 14	5 03 $\frac{1}{2}$	1059.68	3.02517	1.81	93.29	5.93	186.51	186.60
30	190.00	1 52 $\frac{1}{2}$	3 19 $\frac{1}{2}$	5 13 $\frac{1}{2}$	1043.74	3.01859	1.90	94.95	6.23	189.83	189.93
35	193.33	1 56 $\frac{1}{2}$	3 27 $\frac{1}{2}$	5 23 $\frac{1}{2}$	1028.28	3.01211	1.99	96.62	6.54	193.15	193.25
40	196.67	2 00	3 34 $\frac{1}{2}$	5 34 $\frac{1}{2}$	1013.28	3.00573	2.08	98.28	6.86	196.47	196.59
45	200.00	2 03 $\frac{1}{2}$	3 41 $\frac{1}{2}$	5 45	998.72	2.99944	2.17	99.94	7.19	199.79	199.71
50	203.33	2 07 $\frac{1}{2}$	3 48 $\frac{1}{2}$	5 55 $\frac{1}{2}$	984.59	2.99326	2.27	101.61	7.53	203.10	203.24
55	206.67	2 11 $\frac{1}{2}$	3 55 $\frac{1}{2}$	6 06 $\frac{1}{2}$	970.85	2.98715	2.37	103.27	7.88	206.42	206.57
6 00	210.00	2 15	4 03	6 18	957.51	2.98114	2.47	104.93	8.24	209.73	209.89
15	220.00	2 26 $\frac{1}{2}$	4 25 $\frac{1}{2}$	6 52 $\frac{1}{2}$	919.64	2.96362	2.80	109.92	9.39	219.66	219.86
30	230.00	2 39 $\frac{1}{2}$	4 49 $\frac{1}{2}$	7 28 $\frac{1}{2}$	884.74	2.94682	3.15	114.90	10.64	229.58	229.83
45	240.00	2 52 $\frac{1}{2}$	5 13 $\frac{1}{2}$	8 06	852.48	2.93068	3.53	119.88	12.00	239.49	239.79
7 00	250.00	3 05 $\frac{1}{2}$	5 39 $\frac{1}{2}$	8 45	822.58	2.91518	3.94	124.85	13.47	249.38	249.75
15	260.00	3 19 $\frac{1}{2}$	6 06	9 25 $\frac{1}{2}$	794.80	2.90026	4.38	129.82	15.05	259.26	259.70
30	270.00	3 33 $\frac{1}{2}$	6 33 $\frac{1}{2}$	10 07 $\frac{1}{2}$	768.93	2.88589	4.85	134.79	16.70	269.12	269.64
45	280.00	3 48 $\frac{1}{2}$	7 02 $\frac{1}{2}$	10 51	744.80	2.87204	5.36	139.76	18.58	278.95	279.57
8 00	290.00	4 04	7 32	11 36	722.24	2.85868	5.90	144.72	20.53	288.76	289.49
15	300.00	4 20	8 02 $\frac{1}{2}$	12 22 $\frac{1}{2}$	701.11	2.84579	6.47	149.67	22.61	298.54	299.40
30	310.00	4 36 $\frac{1}{2}$	8 34 $\frac{1}{2}$	13 10 $\frac{1}{2}$	681.30	2.83334	7.08	154.62	24.83	308.29	309.29
45	320.00	4 53	9 07	14 00	662.70	2.82132	7.73	159.56	27.18	318.02	319.17
9 00	330.00	5 10 $\frac{1}{2}$	9 40 $\frac{1}{2}$	14 51	645.20	2.80969	8.42	164.49	29.68	327.70	329.04
15	340.00	5 28 $\frac{1}{2}$	10 15	15 43 $\frac{1}{2}$	628.72	2.79846	9.14	169.42	32.32	337.34	338.88
30	350.00	5 46 $\frac{1}{2}$	10 50 $\frac{1}{2}$	16 37 $\frac{1}{2}$	613.19	2.78760	9.90	174.34	35.11	346.94	348.72
45	360.00	6 05 $\frac{1}{2}$	11 27 $\frac{1}{2}$	17 33	598.53	2.77709	10.70	179.25	38.06	356.50	358.54
10 00	370.00	6 25	12 05	18 30	584.69	2.76693	11.55	184.15	41.16	366.01	368.33
15	380.00	6 45 $\frac{1}{2}$	12 42 $\frac{1}{2}$	19 28 $\frac{1}{2}$	571.61	2.75710	12.44	189.04	44.43	375.47	378.09
30	390.00	7 05 $\frac{1}{2}$	13 22 $\frac{1}{2}$	20 28 $\frac{1}{2}$	559.24	2.74760	13.37	193.92	47.85	384.87	387.82

THE RAILROAD TAPER

Δ=1

TAPER 2. CURVATURE INCREASING 1° 00' EVERY 30 FT.

Deflections to

Transit at	B.C. 1° 00'	C.C. 2° 00'	C.C. 3° 00'	C.C. 4° 00'	C.C. 5° 00'	C.C. 6° 00'	C.C. 7° 00'	C.C. 8° 00'	C.C. 9° 00'	C.C. 10° 00'	C.C. 11° 00'	C.C. 12° 00'	C.C. 13° 00'
l	0	30	60	90	120	150	180	210	240	270	300	330	360
0	0 09	0 09	0 22½	0 42	1 07½	1 39	2 16½	3 00	3 49½	4 45	5 46½	6 54	8 07½
30	0 31½	0 18	0 18	0 40½	1 09	1 43½	2 24	3 10½	4 03	5 01½	6 06	7 16½	8 33
60	0 106	0 49½	0 27	0 58½	1 36	2 19½	3 09	4 04½	5 06	6 13½	7 27	8 46½	9 74
90	1 52½	1 33	1 07½	0 36	0 45	1 16½	2 03	2 55½	3 54	4 58½	6 09	7 25½	8 48
120	2 51	2 28½	2 00	0 36	0 45	1 34½	2 30	3 31½	4 39	5 52½	7 12	8 37½	9 64
150	4 01½	3 36	3 04½	1 25½	0 45	0 54	1 52½	2 57	4 07½	5 24	6 46½	8 15	9 48
180	5 24	4 55½	4 21	2 27	1 43½	1 03	2 10½	3 24	4 43½	6 09	7 40½	9 18	10 54
210	6 58½	6 27	5 49½	3 40½	2 54	2 01½	3 19½	4 43½	6 12	7 51	9 30	11 18	13 06
240	8 45	8 10	7 30	5 06	4 16½	3 21	4 48	6 27	8 12	10 03	11 51	13 45	15 39
270	10 43½	10 06	9 22½	6 43½	5 51	4 52½	6 28½	8 15	10 06	12 03	14 06	16 15	18 24
300	12 54	12 13½	11 27	8 33	7 37½	6 36	8 28½	10 21	12 18	14 21	16 30	18 45	21 06
330	15 16½	14 33	13 43½	10 34½	9 36	8 31½	10 33	12 36	14 42	16 51	19 06	21 27	23 54
360				12 48	11 46½	10 39	9 25½	8 06	6 40½	5 09	3 31½	1 48	0 00

TABLES

TAPER 2. CURVATURE INCREASING 1° 00' EVERY 30 FT. — (Continued)  $\Delta = 1$

$M$ °	$l$	$\phi$ °	$D$	$\log D$	$d$	$t$	$z$	$y$	$lc$
2 00	30	0 18	2864.86	3.45710	0.04	15.00	0.08	30.00	30.00
3 00	60	0 54	1910.07	3.28105	0.16	30.00	0.39	60.00	60.00
4 00	90	1 48	1432.86	3.15620	0.39	45.00	1.10	89.99	90.00
5 00	120	3 00	1146.80	3.05949	0.79	59.99	2.36	119.96	119.99
6 00	150	4 30	956.41	2.98064	1.37	74.97	4.32	149.90	149.97
7 00	180	6 18	820.84	2.91426	2.20	89.93	7.14	179.77	179.92
8 00	210	8 24	719.64	2.85711	3.30	104.87	10.98	209.52	209.81
9 00	240	10 48	641.49	2.80719	4.71	119.78	15.99	239.10	239.63
10 00	270	13 30	579.61	2.76314	6.47	134.63	22.30	268.43	269.36
11 00	300	16 30	529.69	2.72402	8.62	149.41	30.08	297.41	298.92
12 00	330	19 48	488.88	2.68920	11.20	164.10	39.44	325.91	328.29
13 00	360	23 24	455.21	2.65822	14.24	178.68	50.51	353.81	357.40

## TAPER 2. INTERMEDIATE VALUES

 $\Delta = 1$ 

<i>M</i>	<i>l</i>	<i>f</i>	<i>b</i>	<i>o</i>	<i>D</i>	log <i>D</i>	<i>d</i>	<i>t</i>	<i>z</i>	<i>y</i>	<i>lc</i>
2 00	30.00	0 09	0 09	0 18	2864.86	3.45710	0.04	15.00	0.08	30.00	30.00
05	32.50	0 10	0 10½	0 20½	2750.28	3.43938	0.05	16.25	0.09	32.50	32.50
10	35.00	0 10½	0 12	0 22½	2644.51	3.42234	0.05	17.50	0.11	35.00	35.00
15	37.50	0 11½	0 13½	0 25½	2546.58	3.40596	0.06	18.75	0.13	37.50	37.50
20	40.00	0 12½	0 15½	0 28	2455.64	3.39016	0.07	20.00	0.15	40.00	40.00
25	42.50	0 14	0 16½	0 30½	2370.98	3.37493	0.08	21.25	0.17	42.50	42.50
30	45.00	0 15	0 18½	0 33½	2291.97	3.36021	0.09	22.50	0.20	45.00	45.00
35	47.50	0 16½	0 20½	0 36½	2218.05	3.34597	0.10	23.75	0.22	47.50	47.50
40	50.00	0 17½	0 22½	0 40	2148.75	3.33219	0.11	25.00	0.25	50.00	50.00
45	52.50	0 18½	0 24½	0 43½	2083.65	3.31882	0.12	26.25	0.28	52.50	52.50
50	55.00	0 19½	0 27	0 46½	2022.39	3.30586	0.13	27.50	0.32	55.00	55.00
55	57.50	0 21½	0 29	0 50½	1964.52	3.29326	0.14	28.75	0.35	57.50	57.50
3 00	60.00	0 22½	0 31½	0 54	1910.07	3.28105	0.16	30.00	0.39	60.00	60.00
05	62.50	0 24	0 33½	0 57½	1858.47	3.26916	0.17	31.25	0.43	62.50	62.50
10	65.00	0 25½	0 36½	1 01½	1809.59	3.25758	0.19	32.50	0.48	65.00	65.00
15	67.50	0 26½	0 39	1 05½	1763.21	3.24630	0.20	33.75	0.53	67.50	67.50
20	70.00	0 28½	0 41½	1 10	1719.15	3.23531	0.22	35.00	0.58	70.00	70.00
25	72.50	0 30	0 44½	1 14½	1677.25	3.22460	0.24	36.25	0.63	72.50	72.50
30	75.00	0 31½	0 47½	1 18½	1637.35	3.21414	0.26	37.50	0.69	75.00	75.00
35	77.50	0 33½	0 50	1 23½	1599.30	3.20393	0.28	38.75	0.75	77.50	77.50
40	80.00	0 34½	0 53½	1 28	1562.98	3.19395	0.30	40.00	0.81	79.99	80.00
45	82.50	0 36½	0 56½	1 32½	1528.28	3.18420	0.32	41.25	0.88	82.49	82.50
50	85.00	0 38½	0 59½	1 37½	1495.08	3.17437	0.34	42.50	0.95	84.99	85.00
55	87.50	0 40½	1 02½	1 42½	1463.31	3.16534	0.37	43.75	1.02	87.49	87.50
4 00	90.00	0 42	1 04	1 48	1432.86	3.15620	0.39	45.00	1.10	89.99	90.00
05	92.50	0 44	1 09½	1 53½	1403.66	3.14726	0.42	46.24	1.18	92.49	92.50
10	95.00	0 45½	1 13	1 58½	1375.62	3.13850	0.45	47.49	1.27	95.99	95.00
15	97.50	0 47½	1 16½	2 04½	1348.69	3.12991	0.48	48.74	1.36	97.49	97.50
20	100.00	0 49½	1 20½	2 10	1322.80	3.12149	0.51	49.99	1.45	99.98	99.99
25	102.50	0 52	1 23½	2 15½	1297.87	3.11323	0.54	51.24	1.55	102.48	102.49
30	105.00	0 54	1 27½	2 21½	1273.89	3.10513	0.57	52.49	1.65	104.98	104.99
35	107.50	0 56½	1 31½	2 27½	1250.77	3.09718	0.60	53.74	1.76	107.48	107.49
40	110.00	0 58½	1 35½	2 34	1228.48	3.08937	0.63	54.99	1.87	109.98	109.99
45	112.50	1 00½	1 39½	2 40½	1206.98	3.08170	0.67	56.24	1.98	112.47	112.49
50	115.00	1 02½	1 44	2 46½	1186.22	3.07416	0.71	57.49	2.10	114.97	114.99
55	117.50	1 05½	1 48	2 53½	1166.18	3.06677	0.75	58.74	2.23	117.47	117.49
5 00	120.00	1 07½	1 52½	3 00	1146.80	3.05949	0.79	59.99	2.36	119.96	119.99
05	122.50	1 10	1 56½	3 06½	1128.03	3.05232	0.83	61.24	2.49	122.46	122.49
10	125.00	1 12½	2 01½	3 13½	1109.91	3.04520	0.87	62.48	2.63	124.96	124.99

TAPER 2. INTERMEDIATE VALUES— (Continued)  $\Delta = 1$

<i>M</i>	<i>t</i>	<i>f</i>	<i>b</i>	<i>ó</i>	<i>D</i>	log <i>D</i>	<i>d</i>	<i>t</i>	<i>z</i>	<i>y</i>	<i>lc</i>
5 15	127.50	1 14½	2 06	3 20½	1092.35	3.03836	0.91	63.73	2.77	127.45	127.49
20	130.00	1 17½	2 10½	3 28	1075.35	3.03155	0.96	64.98	2.92	129.95	129.98
25	132.50	1 20	2 15½	3 35½	1058.87	3.02484	1.00	66.23	3.08	132.44	132.48
30	135.00	1 22½	2 20½	3 42½	1042.89	3.01823	1.05	67.48	3.24	134.94	134.98
35	137.50	1 25½	2 25	3 50½	1027.39	3.01174	1.10	68.73	3.41	137.44	137.48
40	140.00	1 27½	2 30½	3 58	1012.35	3.00490	1.15	69.98	3.58	139.93	139.98
45	142.50	1 30½	2 35½	4 05½	997.76	2.99903	1.21	71.22	3.75	142.42	142.48
50	145.00	1 33½	2 40½	4 13½	983.58	2.99281	1.26	72.47	3.93	144.92	144.97
55	147.50	1 36½	2 45½	4 21½	969.80	2.98668	1.32	73.72	4.12	147.41	147.47
6 00	150.00	1 39	2 51	4 30	956.41	2.98064	1.37	74.97	4.32	149.90	149.97
15	157.50	1 47½	3 07½	4 55½	918.39	2.96303	1.55	78.71	4.94	157.37	157.47
30	165.00	1 57	3 24½	5 21½	883.34	2.94613	1.75	82.45	5.61	164.84	164.96
45	172.50	2 06½	3 42½	5 49½	850.92	2.92989	1.97	86.19	6.34	172.32	172.44
7 00	180.00	2 16½	4 01½	6 18	820.84	2.91426	2.20	89.93	7.14	179.77	179.92
15	187.50	2 26½	4 21	6 47½	792.86	2.89920	2.44	93.67	8.00	187.22	187.39
30	195.00	2 37½	4 41½	7 18½	766.79	2.88468	2.71	97.41	8.93	194.66	194.86
45	202.50	2 48½	5 02½	7 50½	742.43	2.87066	2.99	101.14	9.92	202.10	202.34
8 00	210.00	3 00	5 24	8 24	719.63	2.85711	3.29	104.87	10.98	209.52	209.81
15	217.50	3 11½	5 46½	8 58½	698.26	2.84402	3.62	108.60	12.12	216.93	217.26
30	225.00	3 24	6 09½	9 33½	678.18	2.83134	3.96	112.33	13.33	224.33	224.72
45	232.50	3 36½	6 33½	10 10½	659.29	2.81908	4.32	116.05	14.62	231.72	232.18
9 00	240.00	3 49½	6 58½	10 48	641.49	2.80719	4.71	119.78	15.99	239.10	239.63
15	247.50	4 02½	7 24	11 26½	624.69	2.79566	5.11	123.49	17.44	246.46	247.07
30	255.00	4 16½	7 50½	12 06½	608.83	2.78450	5.54	127.21	18.97	253.80	254.51
45	262.50	4 30½	8 17½	12 47½	593.82	2.77365	5.99	130.92	20.59	261.12	261.92
10 00	270.00	4 45	8 45	13 30	579.61	2.76314	6.47	134.63	22.30	268.42	269.36
15	277.50	4 59½	9 13½	14 13½	566.14	2.75292	6.97	138.33	24.11	275.71	276.76
30	285.00	5 15	9 42½	14 57½	553.36	2.74301	7.49	142.03	26.00	282.96	284.16
45	292.50	5 30½	10 12½	15 43½	541.22	2.73337	8.04	145.72	27.99	290.20	291.54
11 00	300.00	5 46½	10 43½	16 30	529.69	2.72402	8.62	149.41	30.08	297.40	298.92
15	307.50	6 02½	11 15	17 17½	518.73	2.71494	9.23	153.09	32.26	304.58	306.28
30	315.00	6 19½	11 47½	18 06½	508.29	2.70611	9.86	156.77	34.55	311.72	313.64
45	322.50	6 36½	12 20½	18 56½	498.36	2.69754	10.52	160.44	36.94	318.84	319.50
12 00	330.00	6 54	12 54	19 48	488.88	2.68920	11.20	164.10	39.44	325.91	328.29
15	337.50	7 11½	13 28½	20 40½	479.86	2.68111	11.92	167.76	42.04	332.95	335.59
30	345.00	7 30	14 03½	21 33½	471.25	2.67325	12.66	171.41	44.76	339.95	342.88
45	352.50	7 48½	14 39½	22 28½	463.05	2.66563	13.44	175.05	47.59	346.90	350.15
13 00	360.00	8 07½	15 16½	23 24	455.22	2.65822	14.25	178.68	50.51	353.81	357.40



THE RAILROAD TAPER

TAPER 24. CURVATURE INCREASING 1° 15' EVERY 30 FT. Δ=14

Transit at	Deflections to											
	B.C. 1° 15'	C.C. 2° 30'	C.C. 3° 45'	C.C. 5° 00'	C.C. 6° 15'	C.C. 7° 30'	C.C. 8° 45'	C.C. 10° 00'	C.C. 11° 15'	C.C. 12° 30'	C.C. 13° 45'	C.C. 15° 00'
l	0	30	60	90	120	150	180	210	240	270	300	330
0	0	0 11½	0 28	0 52½	1 24½	2 03½	2 50½	3 45	4 47	5 56½	7 13	8 37½
30	0 11½	0 22½	0 22½	0 50½	1 26½	2 09½	3 00	3 58	5 03½	6 17	7 37½	9 05½
60	0 39½	0 33½	0 33½	0 33½	1 13	2 00	2 54½	3 56½	5 05½	6 22½	7 47	9 18½
90	1 22½	1 02	0 33½	0 45	1 35½	1 35½	2 33½	3 39½	4 52½	6 13	7 41½	9 17
120	2 20½	1 56½	1 24½	0 45	0 56½	0 56½	1 58	3 07½	4 24½	5 48½	7 20½	9 00
150	3 33½	3 05½	2 30	1 47	0 56½	1 07½	1 07½	2 20½	3 41½	5 09½	6 45	8 28
180	5 02	4 30	3 50½	3 03½	2 09½	1 07½	1 18½	1 18½	2 43	4 15	5 54½	7 41½
210	6 45	6 09½	5 26½	4 35½	3 37½	2 32	1 18½	1 30	3 05½	4 48½	6 39½	8 30½
240	8 43	8 03½	7 17	6 22½	5 20½	4 11½	2 54½	1 30	3 05½	4 48½	6 39½	8 30½
270	10 56½	10 13	9 22½	8 24½	7 18½	6 05½	4 45	1 30	1 41½	1 41½	1 52½	2 03½
300	13 24½	12 37½	11 43	10 41½	9 32	8 15	6 50½	5 18½	3 89½	1 52½	1 52½	2 03½
330	16 07½	15 17	14 18½	13 13	12 00	10 39½	9 11½	7 35½	5 52½	4 02	2 03½	2 03½

TAPER 2½. CURVATURE INCREASING 1° 15' EVERY 30 FT. — (Continued) Δ=1½

$M$	$l$	$\phi$	$D$	$\log D$	$d$	$t$	$z$	$v$	$lc$
2 30	30	0 22½	2291.93	3.36020	0.05	15.00	0.10	30.00	30.00
3 45	60	1 07½	1528.16	3.18417	0.20	30.00	0.49	60.00	60.00
5 00	90	2 15	1146.50	3.05937	0.49	44.99	1.37	89.98	90.00
6 15	120	3 45	917.82	2.96276	0.98	59.98	2.94	119.94	119.98
7 30	150	5 37½	765.80	2.88412	1.72	74.95	5.40	149.84	149.94
8 45	180	7 52½	657.72	2.81803	2.75	89.90	8.92	179.63	179.86
10 00	210	10 30	577.26	2.76137	4.12	104.80	13.71	209.25	209.70
11 15	240	13 30	515.38	2.71213	5.88	119.65	19.96	238.59	239.42
12 30	270	16 52½	466.67	2.66901	8.08	134.42	27.83	267.55	268.98
13 45	300	20 37½	427.71	2.63115	10.76	149.08	37.49	295.95	298.32
15 00	330	24 45	396.23	2.59795	13.98	163.60	49.09	323.63	327.33

## TAPER 2½. INTERMEDIATE VALUES Δ=1½

<i>M</i>	<i>l</i>	<i>f</i>	<i>b</i>	<i>o</i>	<i>D</i>	log <i>D</i>	<i>d</i>	<i>t</i>	<i>x</i>	<i>y</i>	<i>lc</i>
2 30	30.00	0 11½	0 11½	0 22½	2291.93	3.36020	0.05	15.00	0.10	30.00	30.00
35	32.00	0 12	0 12½	0 24½	2218.01	3.34596	0.06	16.00	0.11	32.00	32.00
40	34.00	0 13	0 14½	0 27½	2148.70	3.33218	0.06	17.00	0.13	34.00	34.00
45	36.00	0 14	0 15½	0 29½	2083.60	3.31881	0.07	18.00	0.15	36.00	36.00
50	38.00	0 15	0 17½	0 32½	2022.34	3.30585	0.08	19.00	0.17	38.00	38.00
55	40.00	0 16	0 19	0 35	1964.57	3.29327	0.09	20.00	0.19	40.00	40.00
3 00	42.00	0 17	0 20½	0 37½	1910.00	3.28103	0.09	21.00	0.21	42.00	42.00
05	44.00	0 18½	0 22½	0 40½	1858.40	3.26914	0.10	22.00	0.23	44.00	44.00
10	46.00	0 19½	0 24½	0 43½	1809.51	3.25756	0.11	23.00	0.26	46.00	46.00
15	48.00	0 20½	0 26½	0 46½	1763.13	3.24628	0.12	24.00	0.29	48.00	48.00
20	50.00	0 21½	0 28½	0 50	1719.06	3.23529	0.13	25.00	0.32	50.00	50.00
25	52.00	0 23	0 30½	0 53½	1677.16	3.22457	0.15	26.00	0.35	52.00	52.00
30	54.00	0 24½	0 32½	0 56½	1637.25	3.21411	0.16	27.00	0.38	54.00	54.00
35	56.00	0 25½	0 34½	1 00½	1599.19	3.20390	0.17	28.00	0.41	56.00	56.00
40	58.00	0 26½	0 37	1 03½	1562.86	3.19392	0.18	29.00	0.45	58.00	58.00
45	60.00	0 28	0 39½	1 07½	1528.16	3.18417	0.20	30.00	0.49	60.00	60.00
50	62.00	0 29½	0 41½	1 11½	1494.95	3.17463	0.21	31.00	0.53	62.00	62.00
55	64.00	0 31	0 44½	1 15½	1463.17	3.16529	0.23	32.00	0.57	64.00	64.00
4 00	66.00	0 32½	0 46½	1 19½	1432.71	3.15616	0.24	33.00	0.62	66.00	66.00
05	68.00	0 34	0 49½	1 23½	1403.50	3.14721	0.26	34.00	0.67	68.00	68.00
10	70.00	0 35½	0 52	1 27½	1375.45	3.13844	0.28	35.00	0.72	69.99	70.00
15	72.00	0 37	0 54½	1 31½	1348.50	3.12985	0.29	36.00	0.77	71.99	72.00
20	74.00	0 38½	0 57½	1 36½	1322.60	3.12143	0.31	37.00	0.83	73.99	74.00
25	76.00	0 40½	1 00½	1 40½	1297.67	3.11316	0.33	38.00	0.89	75.99	76.00
30	78.00	0 41½	1 03½	1 45½	1273.67	3.10506	0.35	39.00	0.95	77.99	78.00
35	80.00	0 43½	1 06½	1 50	1250.54	3.09710	0.37	40.00	1.01	79.99	80.00
40	82.00	0 45½	1 09½	1 54½	1228.25	3.08929	0.40	40.99	1.08	81.99	82.00
45	84.00	0 47	1 12½	1 59½	1206.73	3.08161	0.42	41.99	1.15	83.99	84.00
50	86.00	0 48½	1 16	2 04½	1185.95	3.07407	0.44	42.99	1.22	85.99	86.00
55	88.00	0 50½	1 19½	2 09½	1165.90	3.06666	0.47	43.99	1.30	87.99	88.00
5 00	90.00	0 52½	1 22½	2 15	1146.50	3.05937	0.49	44.99	1.37	89.98	90.00
05	92.00	0 54½	1 25½	2 20½	1127.72	3.05220	0.52	45.99	1.45	91.98	91.99
10	94.00	0 56½	1 29½	2 25½	1109.58	3.04516	0.54	46.99	1.54	93.98	93.99
15	96.00	0 58½	1 33	2 31½	1092.01	3.03823	0.57	47.99	1.63	95.98	95.99
20	98.00	1 00½	1 36½	2 36½	1074.99	3.03140	0.60	48.99	1.72	97.98	97.99
25	100.00	1 02½	1 40½	2 42½	1058.50	3.02469	0.63	49.99	1.81	99.98	99.99
30	102.00	1 04½	1 44	2 48½	1042.50	3.01808	0.66	50.99	1.91	101.97	101.99
35	104.00	1 06½	1 47½	2 54½	1026.98	3.01156	0.69	51.99	2.01	103.97	103.99
40	106.00	1 08½	1 51½	3 00½	1011.92	3.00515	0.72	52.99	2.11	105.97	105.99

TAPER  $2\frac{1}{4}$ . INTERMEDIATE VALUES — (Continued)  $\Delta = 1\frac{1}{4}$ 

<i>M</i>	<i>l</i>	<i>f</i>	<i>b</i>	<i>o</i>	<i>D</i>	log <i>D</i>	<i>d</i>	<i>t</i>	<i>z</i>	<i>y</i>	<i>lc</i>
5 45	108.00	1 10½	1 55½	3 06½	997.31	2.99883	0.76	53.99	2.22	107.97	107.99
50	110.00	1 13	1 59½	3 12½	983.11	2.99260	0.79	54.98	2.33	109.96	109.99
55	112.00	1 15½	2 03½	3 18½	969.31	2.98646	0.83	55.98	2.45	111.96	111.99
6 00	114.00	1 17½	2 07½	3 25½	955.90	2.98041	0.86	56.98	2.57	113.95	113.98
15	120.00	1 24½	2 20½	3 45	917.82	2.96276	0.98	59.98	2.95	119.94	119.98
30	126.00	1 31½	2 34	4 05½	882.70	2.94581	1.11	62.97	3.36	125.93	125.97
45	132.00	1 39½	2 48	4 27½	850.19	2.92952	1.24	65.97	3.81	131.91	131.97
7 00	138.00	1 47	3 02½	4 49½	820.03	2.91383	1.39	68.96	4.30	137.89	137.96
15	144.00	1 55½	3 18	5 13½	791.97	2.89871	1.55	71.96	4.83	143.87	143.95
30	150.00	2 03½	3 33½	5 37½	765.80	2.88412	1.72	74.95	5.40	149.84	149.94
45	156.00	2 12½	3 50½	6 02½	741.34	2.87002	1.90	77.94	6.01	155.81	155.93
8 00	162.00	2 21	4 07½	6 28½	718.43	2.85638	2.09	80.93	6.67	161.78	161.91
15	168.00	2 31	4 24½	6 55½	696.93	2.84319	2.29	83.92	7.37	167.73	167.89
30	174.00	2 40½	4 43	7 23½	676.73	2.83042	2.51	86.91	8.12	173.69	173.88
45	180.00	2 50½	5 01½	7 52½	657.71	2.81803	2.74	89.90	8.92	179.63	179.86
9 00	186.00	3 01	5 21½	8 22½	639.77	2.80602	2.99	92.88	9.77	185.57	185.84
15	192.00	3 11½	5 41½	8 52½	622.83	2.79437	3.25	95.86	10.68	191.51	191.82
30	198.00	3 22½	6 02	9 24½	606.81	2.78305	3.52	98.84	11.64	197.43	197.79
45	204.00	3 33½	6 23½	9 56½	591.64	2.77206	3.81	101.82	12.65	203.34	203.75
10 00	210.00	3 45	6 45	10 30	577.26	2.76137	4.12	104.80	13.71	209.25	209.70
15	216.00	3 56½	7 07½	11 04½	563.61	2.75098	4.44	107.78	14.84	215.14	215.65
30	222.00	4 08½	7 30½	11 39½	550.64	2.74087	4.77	110.75	16.03	221.02	221.60
45	228.00	4 21½	7 54	12 15½	538.30	2.73102	5.12	113.72	17.27	226.89	227.55
11 00	234.00	4 34	8 18½	12 52½	526.56	2.72145	5.49	116.69	18.58	232.74	233.49
15	240.00	4 47	8 43	13 30	515.38	2.71213	5.88	119.65	19.96	238.59	239.42
30	246.00	5 00½	9 08½	14 08½	504.71	2.70304	6.28	122.61	21.40	244.42	245.36
45	252.00	5 13½	9 34½	14 48½	494.54	2.69420	6.70	125.57	22.90	250.23	251.29
12 00	258.00	5 27½	10 01½	15 28½	484.82	2.68558	7.14	128.52	24.47	256.02	257.20
15	264.00	5 41½	10 28½	16 10½	475.54	2.67719	7.60	131.47	26.11	261.79	263.09
30	270.00	5 56½	10 56½	16 52½	466.67	2.66901	8.08	134.42	27.82	267.54	268.98
45	276.00	6 11	11 24½	17 35½	458.19	2.66105	8.58	137.36	29.61	273.27	274.87
13 00	282.00	6 26	11 53½	18 19½	450.06	2.65327	9.09	140.30	31.47	278.98	280.75
15	288.00	6 41½	12 23½	19 04½	442.29	2.64571	9.63	143.23	33.40	284.66	286.61
30	294.00	6 57½	12 53½	19 50½	434.85	2.63834	10.19	146.16	35.40	290.32	292.47
45	300.00	7 13½	13 24½	20 37½	427.71	2.63115	10.76	149.08	37.49	295.95	298.32
14 00	306.00	7 29½	13 55½	21 25½	420.87	2.62415	11.36	152.00	39.65	301.55	304.15
15	312.00	7 46	14 27½	22 13½	414.31	2.61733	11.98	154.91	41.89	307.12	309.96
30	318.00	8 02½	15 00½	23 03½	408.04	2.61070	12.63	157.81	44.21	312.66	315.76
45	324.00	8 20	15 23½	23 53½	402.01	2.60424	13.29	160.71	46.61	318.16	321.55
15 00	330.00	8 37½	16 07½	24 45	396.23	2.59795	13.98	163.60	49.09	323.63	327.33

THE RAILROAD TAPER

TAPER 2½. CURVATURE INCREASING 1° 30' EVERY 30 FT. Δ = 1½

Transit at	Deflections to										
	B.C. 1° 30'	C.C. 3° 00'	C.C. 4° 30'	C.C. 6° 00'	C.C. 7° 30'	C.C. 9° 00'	C.C. 10° 30'	C.C. 12° 00'	C.C. 13° 30'	C.C. 15° 00'	C.C. 16° 30'
l	0	30	60	90	120	150	180	210	240	270	300
0	0	0	0	0	0	0	0	0	0	0	0
30	0 13½	0 33½	1 03	1 41½	2 28½	3 24½	4 30	4 30	5 44½	7 07½	8 39½
60	0 47½	0 27	1 00½	1 43½	2 35½	3 36	4 45½	4 45½	6 04½	7 32½	9 09
90	1 39	0 40½	0 40½	1 27½	2 24	3 29½	4 43½	4 43½	6 06½	7 39	9 20½
120	2 48½	0 54	0 54	0 54	1 54½	3 04½	4 23½	4 23½	5 51	7 27½	9 13½
150	4 16½	1 41½	1 41½	1 07½	1 07½	2 21½	3 45	3 45	5 17½	6 55½	8 43½
180	6 02½	3 00	3 00	2 35½	1 21	1 21	2 48½	2 48½	4 25½	6 11½	8 06
210	8 06	5 24	4 36½	4 21	3 02½	1 21	1 34½	1 34½	3 15½	5 06	7 05½
240	10 27½	7 23½	6 31½	5 30½	4 21	3 02½	1 48	1 48	1 48	3 42½	5 40½
270	13 07½	11 15	8 44½	7 39	6 24½	5 01½	3 29½	3 29½	2 01½	2 01½	4 09½
300	16 05½	15 09	14 03½	12 49½	11 26½	9 54	8 12½	6 22½	4 23½	2 15	2 15

TAPER 2½. CURVATURE INCREASING 1° 30' EVERY 30 FT. — (Continued) Δ = 1½

<i>M</i>	<i>l</i>	<i>o</i>	<i>D</i>	log <i>D</i>	<i>d</i>	<i>t</i>	<i>z</i>	<i>v</i>	<i>lc</i>
3 00	30	0 27	1909.97	3.28103	0.06	15.00	0.12	30.00	30.00
4 30	60	1 21	1273.56	3.10502	0.24	30.00	0.59	60.00	60.00
6 00	90	2 42	955.63	2.98029	0.59	44.99	1.65	89.98	89.99
7 30	120	4 30	765.26	2.88381	1.18	59.97	3.53	119.92	119.97
9 00	150	6 45	638.84	2.80539	2.06	74.93	6.47	149.77	149.91
10 30	180	9 27	549.16	2.73970	3.29	89.85	10.70	179.47	179.79
12 00	210	12 36	482.62	2.68361	4.94	104.72	16.44	208.92	209.56
13 30	240	16 12	431.71	2.63519	7.05	119.50	23.91	237.98	239.17
15 00	270	20 15	391.93	2.59321	9.68	134.17	33.31	266.47	268.54
16 30	300	24 45	360.45	2.55684	12.90	148.68	44.82	294.19	297.58

TAPER  $2\frac{1}{2}$ . INTERMEDIATE VALUES  $\Delta = 1\frac{1}{2}$ 

<i>M</i>	<i>l</i>	<i>f</i>	<i>b</i>	<i>o</i>	<i>D</i>	$\log D$	<i>d</i>	<i>t</i>	<i>z</i>	<i>y</i>	<i>lc</i>
3 00	30.00	0 13 $\frac{1}{2}$	0 13 $\frac{1}{2}$	0 27	1909.97	3.28103	0.06	15.00	0.12	30.00	30.00
05	31.67	0 14 $\frac{1}{2}$	0 14 $\frac{1}{2}$	0 29 $\frac{1}{2}$	1858.37	3.26913	0.07	15.83	0.13	31.67	31.67
10	33.33	0 15 $\frac{1}{2}$	0 16 $\frac{1}{2}$	0 31 $\frac{1}{2}$	1809.47	3.25755	0.07	16.67	0.15	33.33	33.33
15	35.00	0 16 $\frac{1}{2}$	0 18 $\frac{1}{2}$	0 34 $\frac{1}{2}$	1763.09	3.24627	0.08	17.50	0.17	35.00	35.00
20	36.67	0 17 $\frac{1}{2}$	0 19 $\frac{1}{2}$	0 36 $\frac{1}{2}$	1719.02	3.23528	0.09	18.33	0.18	36.67	36.67
25	38.33	0 18 $\frac{1}{2}$	0 21	0 39 $\frac{1}{2}$	1677.10	3.22456	0.09	19.17	0.20	38.33	38.33
30	40.00	0 19 $\frac{1}{2}$	0 22 $\frac{1}{2}$	0 42	1637.19	3.21410	0.10	20.00	0.22	40.00	40.00
35	41.67	0 20 $\frac{1}{2}$	0 24 $\frac{1}{2}$	0 44 $\frac{1}{2}$	1599.13	3.20388	0.11	20.83	0.24	41.67	41.67
40	43.33	0 21 $\frac{1}{2}$	0 26 $\frac{1}{2}$	0 47 $\frac{1}{2}$	1562.80	3.19390	0.12	21.67	0.27	43.33	43.33
45	45.00	0 22 $\frac{1}{2}$	0 28 $\frac{1}{2}$	0 50 $\frac{1}{2}$	1528.09	3.18415	0.13	22.50	0.29	45.00	45.00
50	46.67	0 23 $\frac{1}{2}$	0 30	0 53 $\frac{1}{2}$	1494.88	3.17461	0.14	23.33	0.32	46.67	46.67
55	48.33	0 24 $\frac{1}{2}$	0 32	0 56 $\frac{1}{2}$	1463.09	3.16527	0.15	24.17	0.35	48.33	48.33
4 00	50.00	0 26	0 34	1 00	1432.63	3.15613	0.16	25.00	0.38	50.00	50.00
05	51.67	0 27 $\frac{1}{2}$	0 36	1 03 $\frac{1}{2}$	1403.41	3.14715	0.17	25.83	0.41	51.67	51.67
10	53.33	0 28 $\frac{1}{2}$	0 38 $\frac{1}{2}$	1 06 $\frac{1}{2}$	1375.35	3.13841	0.18	26.66	0.44	53.33	53.33
15	55.00	0 29 $\frac{1}{2}$	0 40 $\frac{1}{2}$	1 10 $\frac{1}{2}$	1348.41	3.12982	0.20	27.50	0.48	55.00	55.00
20	56.67	0 31	0 42 $\frac{1}{2}$	1 13 $\frac{1}{2}$	1322.50	3.12140	0.21	28.33	0.51	56.67	56.67
25	58.33	0 32 $\frac{1}{2}$	0 44 $\frac{1}{2}$	1 17 $\frac{1}{2}$	1297.56	3.11313	0.22	29.16	0.55	58.33	58.33
35	60.00	0 33 $\frac{1}{2}$	0 47 $\frac{1}{2}$	1 21	1273.56	3.10502	0.24	30.00	0.59	60.00	60.00
30	61.67	0 35 $\frac{1}{2}$	0 49 $\frac{1}{2}$	1 24 $\frac{1}{2}$	1250.42	3.09706	0.25	30.83	0.63	61.67	61.67
40	63.33	0 36 $\frac{1}{2}$	0 52 $\frac{1}{2}$	1 28 $\frac{1}{2}$	1228.12	3.08924	0.27	31.66	0.67	63.33	63.33
45	65.00	0 38	0 54 $\frac{1}{2}$	1 32 $\frac{1}{2}$	1206.59	3.08156	0.28	32.50	0.72	64.99	65.00
50	66.67	0 39 $\frac{1}{2}$	0 57 $\frac{1}{2}$	1 36 $\frac{1}{2}$	1185.81	3.07402	0.30	33.33	0.77	66.67	66.67
55	68.33	0 41	0 59 $\frac{1}{2}$	1 40 $\frac{1}{2}$	1165.74	3.06660	0.31	34.16	0.82	68.33	68.33
5 00	70.00	0 42 $\frac{1}{2}$	1 02 $\frac{1}{2}$	1 45	1146.34	3.05931	0.33	35.00	0.87	69.99	70.00
05	71.67	0 44	1 05 $\frac{1}{2}$	1 49 $\frac{1}{2}$	1127.55	3.05214	0.35	35.83	0.92	71.67	71.67
10	73.33	0 45 $\frac{1}{2}$	1 08	1 53 $\frac{1}{2}$	1109.41	3.04509	0.37	36.66	0.97	73.33	73.33
15	75.00	0 47 $\frac{1}{2}$	1 11	1 58 $\frac{1}{2}$	1091.83	3.03816	0.39	37.49	1.03	74.99	75.00
20	76.67	0 49	1 13 $\frac{1}{2}$	2 02 $\frac{1}{2}$	1074.80	3.03133	0.41	38.33	1.09	76.67	76.67
25	78.33	0 50 $\frac{1}{2}$	1 16 $\frac{1}{2}$	2 07 $\frac{1}{2}$	1058.30	3.02461	0.43	39.16	1.15	78.33	78.33
30	80.00	0 52 $\frac{1}{2}$	1 19 $\frac{1}{2}$	2 12	1042.29	3.01799	0.45	39.99	1.22	79.99	80.00
35	81.67	0 54	1 22 $\frac{1}{2}$	2 16 $\frac{1}{2}$	1026.76	3.01147	0.47	40.83	1.28	81.67	81.67
40	83.33	0 55 $\frac{1}{2}$	1 26	2 21 $\frac{1}{2}$	1011.69	3.00505	0.49	41.66	1.35	83.33	83.33
45	85.00	0 57 $\frac{1}{2}$	1 29 $\frac{1}{2}$	2 26 $\frac{1}{2}$	997.07	2.99873	0.52	42.49	1.42	84.98	84.99
50	87.67	0 59 $\frac{1}{2}$	1 32 $\frac{1}{2}$	2 31 $\frac{1}{2}$	982.86	2.99249	0.54	43.32	1.49	86.65	86.66
55	88.33	1 01 $\frac{1}{2}$	1 35 $\frac{1}{2}$	2 36 $\frac{1}{2}$	969.04	2.98634	0.56	44.16	1.57	88.31	88.33

TAPER  $2\frac{1}{2}$ . INTERMEDIATE VALUES — (Continued)  $\Delta = 1\frac{1}{2}$

<i>M</i>	<i>l</i>	<i>f</i>	<i>b</i>	<i>o</i>	<i>D</i>	log <i>D</i>	<i>d</i>	<i>t</i>	<i>x</i>	<i>y</i>	<i>lc</i>
6 00	90.00	1 03	1 39	2 42	955.63	2.98029	0.59	44.99	1.65	89.98	89.99
15	95.00	1 08½	1 49½	2 58½	917.51	2.96261	0.67	47.49	1.90	94.97	94.99
30	100.00	1 14½	2 00½	3 15	882.35	2.94564	0.76	49.98	2.18	99.96	99.99
45	105.00	1 21	2 11½	3 32½	849.80	2.92932	0.85	52.48	2.48	104.96	104.99
7 00	110.00	1 27½	2 23½	3 51	819.59	2.91360	0.95	54.98	2.80	109.95	109.98
15	115.00	1 34½	2 36	4 10½	791.48	2.89844	1.06	57.47	3.15	114.93	114.98
30	120.00	1 41½	2 48½	4 30	765.26	2.88381	1.18	59.97	3.53	119.92	119.97
45	125.00	1 48½	3 02½	4 50½	740.75	2.86967	1.31	62.46	3.94	124.90	124.96
8 00	130.00	1 56	3 16	5 12	717.78	2.85599	1.44	64.96	4.38	129.88	129.95
15	135.00	2 03½	3 30½	5 34½	696.22	2.84275	1.58	67.45	4.85	134.86	134.95
30	140.00	2 11½	3 45½	5 57	675.95	2.82991	1.73	69.94	5.36	139.84	139.94
45	145.00	2 20	4 00½	6 20½	656.86	2.81747	1.89	72.44	5.90	144.81	144.93
9 00	150.00	2 28½	4 16½	6 45	638.84	2.80539	2.06	74.93	6.47	149.77	149.91
15	155.00	2 37½	4 33	7 10½	621.82	2.79366	2.24	77.42	7.08	154.74	154.90
30	160.00	2 46½	4 49½	7 36	605.72	2.78227	2.43	79.91	7.73	159.70	159.88
45	165.00	2 55½	5 07½	8 02½	590.46	2.77119	2.63	82.39	8.42	164.65	164.86
10 00	170.00	3 05	5 25	8 30	575.98	2.76041	2.84	84.88	9.14	169.60	169.84
15	175.00	3 14½	5 43½	8 58½	562.23	2.74991	3.06	87.37	9.90	174.54	174.82
30	180.00	3 24½	6 02½	9 27	549.16	2.73970	3.29	89.85	10.70	179.47	179.79
45	185.00	3 35	6 21½	9 56½	536.71	2.72974	3.53	92.33	11.55	184.40	184.76
11 00	190.00	3 45½	6 41½	10 27	524.86	2.72004	3.79	94.81	12.44	189.32	189.73
15	195.00	3 56½	7 02	10 58½	513.56	2.71059	4.06	97.29	13.37	194.24	194.69
30	200.00	4 07½	7 22½	11 30	502.77	2.70137	4.34	99.77	14.35	199.14	199.65
45	205.00	4 18½	7 44½	12 02½	492.47	2.69238	4.63	102.24	15.37	204.03	204.61
12 00	210.00	4 30	8 06	12 36	482.62	2.68361	4.94	104.72	16.44	208.92	209.56
15	215.00	4 41½	8 28½	13 10½	473.20	2.67504	5.26	107.19	17.56	213.79	214.51
30	220.00	4 53½	8 51½	13 45	464.18	2.66669	5.59	109.65	18.73	218.65	219.46
45	225.00	5 06	9 14½	14 20½	455.54	2.65853	5.93	112.12	19.95	223.50	224.40
13 00	230.00	5 18½	9 38½	14 57	447.26	2.65056	6.29	114.58	21.22	228.34	229.33
15	235.00	5 31½	10 03	15 34½	439.32	2.64278	6.66	117.04	22.54	233.17	234.25
30	240.00	5 44½	10 27½	16 12	431.71	2.63519	7.05	119.50	23.91	237.98	239.17
45	245.00	5 57½	10 53½	16 50½	424.40	2.62778	7.45	121.95	25.34	242.77	244.08
14 00	250.00	6 11	11 19	17 30	417.38	2.62053	7.87	124.40	26.82	247.55	248.99
15	255.00	6 24½	11 45½	18 10½	410.63	2.61345	8.30	126.85	28.36	252.30	253.89
30	260.00	6 38½	12 12½	18 51	404.15	2.60654	8.74	129.29	29.95	257.04	258.78
45	265.00	6 53	12 39½	19 32½	397.92	2.59980	9.20	131.73	31.60	261.77	263.67
15 00	270.00	7 07½	13 07½	20 15	391.93	2.59321	9.68	134.17	33.31	266.47	268.54
30	280.00	7 37½	14 04½	21 42	380.62	2.58049	10.69	139.03	36.90	275.81	278.26
16 00	290.00	8 08	15 04	23 12	370.15	2.56838	11.76	143.87	40.74	285.05	287.94
30	300.00	8 39½	16 05½	24 45	360.45	2.55684	12.90	148.68	44.82	294.19	297.58



TAPER 2 $\frac{1}{4}$ . CURVATURE INCREASING 2° 00'  
EVERY 30 FT.

 $\Delta=2$ 

Transit at	Deflections to									
	B.C. 2° 00'	C.C. 4° 00'	C.C. 6° 00'	C.C. 8° 00'	C.C. 10° 00'	C.C. 12° 00'	C.C. 14° 00'	C.C. 16° 00'	C.C. 18° 00'	C.C. 20° 00'
<i>l</i>	0	30	60	90	120	150	180	210	240	270
0	0 1	0 1	0 1	0 1	0 1	0 1	0 1	0 1	0 1	0 1
30	0 18	0 18	0 45	1 24	2 15	3 18	4 33	6 00	7 39	9 30
60	1 03	0 36	0 36	1 21	2 18	3 27	4 48	6 21	8 06	10 03
90	2 12	1 39	0 54	0 54	1 12	2 33	4 06	5 51	7 48	9 57
120	3 45	3 06	2 15	1 12	1 12	1 30	3 09	5 00	7 03	9 18
150	5 42	4 57	4 00	2 51	1 30	1 30	1 48	3 45	5 54	8 15
180	8 03	7 12	6 09	4 54	3 27	1 48	1 48	2 06	4 21	6 48
210	10 48	9 51	8 42	7 21	5 48	4 03	2 06	2 06	2 24	4 57
240	13 57	12 54	11 39	10 12	8 33	6 42	4 39	2 24	2 24	2 42
270	17 30	16 21	15 00	13 27	11 42	9 45	7 36	5 15	2 42	.....

<i>M</i>	<i>l</i>	<i>o</i>	<i>D</i>	log <i>D</i>	<i>d</i>	<i>t</i>	<i>x</i>	<i>y</i>	<i>lc</i>
4 00	30	0 36	1432.55	3.15611	0.08	15.00	0.16	30.00	30.00
6 00	60	1 48	955.35	2.98016	0.31	29.99	0.79	59.99	60.00
8 00	90	3 36	717.12	2.85559	0.78	44.98	2.20	89.96	89.98
10 00	120	6 00	574.71	2.75945	1.57	59.95	4.70	119.85	119.95
12 00	150	9 00	480.42	2.68162	2.74	74.87	8.63	149.60	149.85
14 00	180	12 36	413.90	2.61690	4.39	89.73	14.25	179.07	179.64
16 00	210	16 48	364.96	2.56225	6.57	104.50	21.87	208.08	209.24
18 00	240	21 36	328.02	2.51590	9.38	119.12	31.77	236.44	238.54
20 00	270	27 00	299.71	2.47670	12.87	133.54	44.13	263.76	267.43

TAPER 2 $\frac{1}{2}$ . INTERMEDIATE VALUES $\Delta=2$ 

<i>M</i>	<i>l</i>	<i>f</i>	<i>b</i>	<i>o</i>	<i>D</i>	log <i>D</i>	<i>d</i>	<i>t</i>	<i>x</i>	<i>y</i>	<i>lc</i>
4 00	30.00	0 18	0 18	0 36	1432.55	3.15611	0.08	15.00	0.16	30.00	30.00
05	31.25	0 19	0 19 $\frac{1}{2}$	0 38 $\frac{1}{2}$	1403.33	3.14716	0.09	15.62	0.17	31.25	31.25
10	32.50	0 19 $\frac{1}{2}$	0 21	0 40 $\frac{1}{2}$	1375.26	3.13838	0.09	16.25	0.19	32.50	32.50
15	33.75	0 20 $\frac{1}{2}$	0 22 $\frac{1}{2}$	0 43	1348.31	3.12979	0.10	16.87	0.20	33.75	33.75
20	35.00	0 21 $\frac{1}{2}$	0 23 $\frac{1}{2}$	0 45 $\frac{1}{2}$	1322.40	3.12136	0.11	17.50	0.22	35.00	35.00
25	36.25	0 22 $\frac{1}{2}$	0 25 $\frac{1}{2}$	0 48	1297.45	3.11309	0.11	18.12	0.24	36.25	36.25
30	37.50	0 23 $\frac{1}{2}$	0 27	0 50 $\frac{1}{2}$	1273.44	3.10498	0.12	18.75	0.26	37.50	37.50
35	38.75	0 24 $\frac{1}{2}$	0 28 $\frac{1}{2}$	0 53 $\frac{1}{2}$	1250.30	3.09701	0.13	19.37	0.28	38.75	38.75
40	40.00	0 25 $\frac{1}{2}$	0 30 $\frac{1}{2}$	0 56	1227.99	3.08919	0.14	20.00	0.30	40.00	40.00
45	41.25	0 26 $\frac{1}{2}$	0 32	0 58 $\frac{1}{2}$	1206.46	3.08151	0.15	20.62	0.32	41.25	41.25
50	42.50	0 27 $\frac{1}{2}$	0 33 $\frac{1}{2}$	1 01 $\frac{1}{2}$	1185.66	3.07396	0.15	21.25	0.34	42.50	42.50
55	43.75	0 29	0 35 $\frac{1}{2}$	1 04 $\frac{1}{2}$	1165.59	3.06655	0.16	21.87	0.37	43.75	43.75
5 00	45.00	0 30	0 37 $\frac{1}{2}$	1 07 $\frac{1}{2}$	1146.18	3.05925	0.17	22.50	0.39	45.00	45.00
05	46.25	0 31 $\frac{1}{2}$	0 39 $\frac{1}{2}$	1 10 $\frac{1}{2}$	1127.38	3.05207	0.18	23.12	0.42	46.25	46.25
10	47.50	0 32 $\frac{1}{2}$	0 41 $\frac{1}{2}$	1 13 $\frac{1}{2}$	1109.23	3.04502	0.19	23.75	0.44	47.50	47.50
15	48.75	0 33 $\frac{1}{2}$	0 43 $\frac{1}{2}$	1 16 $\frac{1}{2}$	1091.64	3.03808	0.20	24.37	0.47	48.75	48.75
20	50.00	0 34 $\frac{1}{2}$	0 45 $\frac{1}{2}$	1 20	1074.60	3.03125	0.21	25.00	0.50	50.00	50.00
25	51.25	0 36	0 47 $\frac{1}{2}$	1 23 $\frac{1}{2}$	1058.09	3.02452	0.22	25.62	0.54	51.25	51.25
30	52.50	0 37	0 49 $\frac{1}{2}$	1 26 $\frac{1}{2}$	1042.08	3.01790	0.24	26.25	0.57	52.50	52.50
35	53.75	0 38 $\frac{1}{2}$	0 51 $\frac{1}{2}$	1 30	1026.54	3.01138	0.25	26.87	0.60	53.75	53.75
40	55.00	0 39 $\frac{1}{2}$	0 53 $\frac{1}{2}$	1 33 $\frac{1}{2}$	1011.46	3.00495	0.26	27.50	0.63	55.00	55.00
45	56.25	0 41	0 56	1 37	996.83	2.99862	0.28	28.12	0.67	56.25	56.25
50	57.50	0 42 $\frac{1}{2}$	0 58 $\frac{1}{2}$	1 40 $\frac{1}{2}$	982.61	2.99238	0.29	28.75	0.71	57.50	57.50
55	58.75	0 43 $\frac{1}{2}$	1 00 $\frac{1}{2}$	1 44 $\frac{1}{2}$	968.78	2.98623	0.30	29.37	0.75	58.75	58.75
6 00	60.00	0 45	1 03	1 48	955.35	2.98016	0.31	29.99	0.79	59.99	60.00
15	63.75	0 49 $\frac{1}{2}$	1 10 $\frac{1}{2}$	1 59 $\frac{1}{2}$	917.20	2.96246	0.36	31.87	0.91	63.74	63.75
30	67.50	0 53 $\frac{1}{2}$	1 18	2 11 $\frac{1}{2}$	882.00	2.94547	0.41	33.74	1.05	67.49	67.50
45	71.25	0 58 $\frac{1}{2}$	1 26	2 24 $\frac{1}{2}$	849.41	2.92912	0.46	35.62	1.21	71.24	71.25
7 00	75.00	1 03	1 34 $\frac{1}{2}$	2 37 $\frac{1}{2}$	819.15	2.91336	0.51	37.49	1.38	74.98	75.00
15	78.75	1 08	1 43 $\frac{1}{2}$	2 51 $\frac{1}{2}$	790.99	2.89817	0.57	39.36	1.56	78.73	78.74
30	82.50	1 13	1 52 $\frac{1}{2}$	3 05 $\frac{1}{2}$	764.72	2.88350	0.64	41.24	1.76	82.47	82.49
45	86.25	1 18 $\frac{1}{2}$	2 02	3 20 $\frac{1}{2}$	740.15	2.86932	0.71	43.11	1.97	86.22	86.24
8 00	90.00	1 24	2 12	3 36	717.12	2.85559	0.78	44.98	2.20	89.96	89.98
15	93.75	1 29 $\frac{1}{2}$	2 22 $\frac{1}{2}$	3 52	695.50	2.84230	0.86	46.85	2.45	93.70	93.73
30	97.50	1 35 $\frac{1}{2}$	2 33	4 08 $\frac{1}{2}$	675.17	2.82941	0.95	48.73	2.71	97.44	97.48
45	101.25	1 41 $\frac{1}{2}$	2 44	4 25 $\frac{1}{2}$	656.01	2.81691	1.04	50.60	2.99	101.18	101.23

TAPER 2 $\frac{1}{4}$ . INTERMEDIATE VALUES — (Continued)  $\Delta=2$ 

<i>M</i>	<i>l</i>	<i>f</i>	<i>b</i>	<i>o</i>	<i>D</i>	<i>log D</i>	<i>d</i>	<i>t</i>	<i>z</i>	<i>y</i>	<i>lc</i>
9 00	105.00	1 48	2 55 $\frac{1}{2}$	4 43 $\frac{1}{2}$	637.91	2.80476	1.13	52.47	3.30	104.92	104.97
15	108.75	1 54 $\frac{1}{2}$	3 07 $\frac{1}{2}$	5 01 $\frac{1}{2}$	620.81	2.79296	1.23	54.34	3.62	108.66	108.71
30	112.50	2 01	3 19 $\frac{1}{2}$	5 20 $\frac{1}{2}$	604.63	2.78149	1.34	56.21	3.96	112.39	112.46
45	116.25	2 08	3 32	5 40	589.28	2.77032	1.45	58.08	4.32	116.12	116.21
10 00	120.00	2 15	3 45	6 00	574.71	2.75945	1.57	59.95	4.70	119.85	119.95
15	123.75	2 22 $\frac{1}{2}$	3 58 $\frac{1}{2}$	6 20 $\frac{1}{2}$	560.86	2.74885	1.69	61.82	5.11	123.58	123.69
30	127.50	2 29 $\frac{1}{2}$	4 12	6 41 $\frac{1}{2}$	547.69	2.73853	1.82	63.68	5.54	127.31	127.43
45	131.25	2 37 $\frac{1}{2}$	4 26	7 03 $\frac{1}{2}$	535.14	2.72847	1.96	65.55	6.00	131.03	131.17
11 00	135.00	2 45	4 40 $\frac{1}{2}$	7 25 $\frac{1}{2}$	523.17	2.71864	2.10	67.42	6.48	134.75	134.91
15	138.75	2 53	4 55 $\frac{1}{2}$	7 48 $\frac{1}{2}$	511.75	2.70906	2.25	69.28	6.98	138.47	138.65
30	142.50	3 01	5 10 $\frac{1}{2}$	8 11 $\frac{1}{2}$	500.84	2.69970	2.41	71.15	7.51	142.18	142.39
45	146.25	3 09 $\frac{1}{2}$	5 26	8 35 $\frac{1}{2}$	490.41	2.69056	2.57	73.01	8.06	145.89	146.12
12 00	150.00	3 18	5 42	9 00	480.42	2.68162	2.74	74.87	8.63	149.60	149.85
15	153.75	3 26 $\frac{1}{2}$	5 58 $\frac{1}{2}$	9 25 $\frac{1}{2}$	470.86	2.67289	2.92	76.74	9.23	153.30	153.58
30	157.50	3 35 $\frac{1}{2}$	6 15	9 50 $\frac{1}{2}$	461.69	2.66435	3.10	78.60	9.86	157.00	157.31
45	161.25	3 44 $\frac{1}{2}$	6 32	10 16 $\frac{1}{2}$	452.91	2.65601	3.30	80.46	10.52	160.69	161.04
13 00	165.00	3 54	6 49 $\frac{1}{2}$	10 43 $\frac{1}{2}$	444.47	2.64784	3.50	82.32	11.20	164.37	164.76
15	168.75	4 03 $\frac{1}{2}$	7 07 $\frac{1}{2}$	11 10 $\frac{1}{2}$	436.37	2.63985	3.71	84.17	11.92	168.06	168.48
30	172.50	4 13	7 25 $\frac{1}{2}$	11 38 $\frac{1}{2}$	428.59	2.63204	3.93	86.03	12.67	171.74	172.20
45	176.25	4 23	7 44	12 07	421.10	2.62439	4.15	87.89	13.45	175.41	175.92
14 00	180.00	4 33	8 03	12 36	413.90	2.61690	4.39	89.73	14.25	179.07	179.64
15	183.75	4 43 $\frac{1}{2}$	8 22 $\frac{1}{2}$	13 05 $\frac{1}{2}$	406.96	2.60955	4.63	91.59	15.09	182.73	183.35
30	187.50	4 53 $\frac{1}{2}$	8 42	13 35 $\frac{1}{2}$	400.29	2.60237	4.88	93.44	15.96	186.38	187.06
45	191.25	5 04 $\frac{1}{2}$	9 02	14 06 $\frac{1}{2}$	393.86	2.59534	5.14	95.29	16.86	190.02	190.76
15 00	195.00	5 15	9 32 $\frac{1}{2}$	14 37 $\frac{1}{2}$	387.66	2.58845	5.41	97.14	17.79	193.65	194.46
30	202.50	5 37 $\frac{1}{2}$	10 04 $\frac{1}{2}$	15 41 $\frac{1}{2}$	375.90	2.57507	5.97	100.82	19.76	200.89	201.86
16 00	210.00	6 00	10 48	16 48	364.96	2.56225	6.57	104.50	21.87	208.08	209.24
30	217.50	6 23 $\frac{1}{2}$	11 33	17 56 $\frac{1}{2}$	354.76	2.54993	7.21	108.18	24.12	215.25	216.60
17 00	225.00	6 48	12 19 $\frac{1}{2}$	19 07 $\frac{1}{2}$	345.23	2.53811	7.89	111.85	26.52	222.37	223.94
30	232.50	7 13	13 07 $\frac{1}{2}$	20 20 $\frac{1}{2}$	336.33	2.52677	8.61	115.49	29.07	229.43	231.26
18 00	240.00	7 39	13 57	21 36	328.02	2.51590	9.38	119.12	31.77	236.44	238.54
30	247.50	8 05 $\frac{1}{2}$	14 48	22 53 $\frac{1}{2}$	320.22	2.50545	10.18	122.76	34.63	243.38	245.83
19 00	255.00	8 33	15 40 $\frac{1}{2}$	24 13 $\frac{1}{2}$	312.94	2.49546	11.03	126.38	37.64	250.26	253.07
30	262.50	9 01	16 34 $\frac{1}{2}$	25 35 $\frac{1}{2}$	306.10	2.48586	11.92	129.98	40.81	257.06	260.27
20 00	270.00	9 30	17 30	27 00	299.71	2.47670	12.87	133.54	44.13	263.76	267.43

TAPER 3. CURVATURE INCREASING 2° 30'  
EVERY 30 FT.

$\Delta = 2\frac{1}{2}$

Transit at	Deflections to									
	B.C. 2° 30'	C.C. 5° 00'	C.C. 7° 30'	C.C. 10° 00'	C.C. 12° 30'	C.C. 15° 00'	C.C. 17° 30'	C.C. 20° 00'	C.C. 22° 30'	
<i>l</i>	0	30	60	90	120	150	180	210	240	
0	.....	0 22½	0 56½	1 45	2 48½	4 07½	5 41½	7 30	9 33½	
30	0 22½	.....	0 45	1 41½	2 52½	4 18½	6 00	7 56½	10 07½	
60	1 18½	0 45	.....	1 07½	2 26½	4 00	5 48½	7 52½	10 11½	
90	2 45	2 03½	1 07½	.....	1 30	3 11½	5 07½	7 18½	9 45	
120	4 41½	3 52½	2 48½	1 30	.....	1 52½	3 56½	6 15	8 48½	
150	7 07½	6 11½	5 00	3 33½	1 52½	.....	2 15	4 41½	7 22½	
180	10 03½	9 00	7 41½	6 07½	4 18½	2 15	.....	2 37½	5 26½	
210	13 30	12 18½	10 52½	9 11½	7 15	5 03½	2 37½	.....	3 00	
240	17 26½	16 07½	14 33½	12 45	10 41½	8 22½	5 48½	3 00	.....	

<i>M</i>	<i>l</i>	<i>o</i>	<i>D</i>	log <i>D</i>	<i>d</i>	<i>t</i>	<i>z</i>	<i>y</i>	<i>lc</i>
5 00	30	0 45	1146.11	3.05923	0.10	15.00	0.20	30.00	30.00
7 30	60	2 15	764.47	2.88336	0.39	29.99	0.98	59.99	60.00
10 00	90	4 30	574.12	2.75900	0.98	44.97	2.75	89.94	89.98
12 30	120	7 30	460.55	2.66328	1.96	59.91	5.88	119.77	119.91
15 00	150	11 15	385.68	2.58623	3.43	74.80	10.77	149.37	149.76
17 30	180	15 45	333.21	2.52270	5.48	89.59	17.78	178.54	179.41
20 00	210	21 00	295.04	2.46988	8.20	104.22	27.25	207.01	208.78
22 30	240	27 00	266.74	2.42609	11.69	118.63	39.49	234.42	237.72

## TAPER 3. INTERMEDIATE VALUES

 $\Delta=2\frac{1}{2}$ 

<i>M</i>	<i>l</i>	<i>f</i>	<i>b</i>	<i>o</i>	<i>D</i>	log <i>D</i>	<i>d</i>	<i>t</i>	<i>z</i>	<i>y</i>	<i>lc</i>
5 00	30.00	0 22½	0 22½	0 45	1146.11	3.05923	0.10	15.00	0.20	30.00	30.00
05	31.00	0 23½	0 23½	0 47½	1127.30	3.05204	0.10	15.50	0.21	31.00	31.00
10	32.00	0 24½	0 25½	0 49½	1109.15	3.04499	0.11	16.00	0.22	32.00	32.00
15	33.00	0 25½	0 26½	0 52	1091.56	3.03805	0.12	16.50	0.24	33.00	33.00
20	34.00	0 26½	0 28½	0 54½	1074.51	3.03121	0.12	17.00	0.26	34.00	34.00
25	35.00	0 27	0 30	0 57	1058.00	3.02449	0.13	17.50	0.28	35.00	35.00
30	36.00	0 28	0 31½	0 59½	1041.98	3.01786	0.14	18.00	0.29	36.00	36.00
35	37.00	0 29	0 33	1 02	1026.44	3.01133	0.15	18.50	0.31	37.00	37.00
40	38.00	0 30	0 34½	1 04½	1011.35	3.00490	0.15	19.00	0.33	38.00	38.00
45	39.00	0 31	0 36½	1 07½	996.71	2.99857	0.16	19.50	0.35	39.00	39.00
50	40.00	0 32	0 38	1 10	982.49	2.99233	0.17	20.00	0.37	40.00	40.00
55	41.00	0 33½	0 39½	1 12½	968.66	2.98617	0.18	20.50	0.40	41.00	41.00
6 00	42.00	0 34½	0 41½	1 15½	955.23	2.98011	0.19	21.00	0.42	42.00	42.00
15	45.00	0 37½	0 46½	1 24½	917.05	2.96239	0.21	22.50	0.49	45.00	45.00
30	48.00	0 41	0 52½	1 33½	881.83	2.94538	0.24	24.00	0.57	48.00	48.00
45	51.00	0 44½	0 58½	1 43½	849.23	2.92903	0.28	25.50	0.66	51.00	51.00
7 00	54.00	0 48½	1 05½	1 53½	818.95	2.91326	0.31	26.99	0.76	53.99	54.00
15	57.00	0 52½	1 11½	2 04	790.77	2.89805	0.35	28.49	0.87	56.99	57.00
30	60.00	0 56½	1 18½	2 15	764.47	2.88336	0.39	29.99	0.98	59.99	60.00
45	63.00	1 00½	1 26	2 26½	739.88	2.86916	0.44	31.49	1.11	62.99	63.00
8 00	66.00	1 04½	1 33½	2 38½	716.82	2.85541	0.48	32.99	1.24	65.98	66.00
15	69.00	1 09½	1 41½	2 50½	695.17	2.84209	0.53	34.49	1.39	68.98	69.00
30	72.00	1 14	1 49½	3 03½	674.81	2.82918	0.59	35.99	1.55	71.98	71.99
45	75.00	1 18½	1 58	3 16½	655.61	2.81665	0.64	37.48	1.72	74.97	74.99
9 00	78.00	1 23½	2 06½	3 30½	637.48	2.80447	0.70	38.98	1.90	77.97	77.99
15	81.00	1 28½	2 16	3 44½	620.35	2.79264	0.77	40.48	2.09	80.96	80.99
30	84.00	1 34	2 25½	3 59½	604.13	2.78113	0.84	41.98	2.30	83.95	83.99
45	87.00	1 39½	2 35	4 14½	588.74	2.76992	0.91	43.47	2.52	86.95	86.98
10 00	90.00	1 45	2 45	4 30	574.12	2.75900	0.98	44.97	2.75	89.94	89.98
15	93.00	1 50½	2 55½	4 46	560.23	2.74837	1.06	46.47	2.99	92.93	92.98
30	96.00	1 56½	3 06	5 02½	547.01	2.73800	1.14	47.96	3.25	95.92	95.97
45	99.00	2 02½	3 16½	5 19½	534.41	2.72787	1.23	49.46	3.53	98.90	98.96
11 00	102.00	2 08½	3 27½	5 36½	522.39	2.71799	1.32	50.95	3.82	101.89	101.96
15	105.00	2 15	3 39½	5 54½	510.92	2.70835	1.42	52.45	4.12	104.87	104.95
30	108.00	2 21½	3 51	6 12½	499.95	2.69893	1.52	53.94	4.44	107.86	107.95
45	111.00	2 28	4 03½	6 31½	489.46	2.68972	1.62	55.44	4.78	110.84	110.94

TAPER 3. INTERMEDIATE VALUES — (Continued)  $\Delta = 2\frac{1}{2}$

<i>M</i>	<i>l</i>	<i>f</i>	<i>b</i>	<i>o</i>	<i>D</i>	log <i>D</i>	<i>d</i>	<i>t</i>	<i>x</i>	<i>y</i>	<i>lc</i>
12 00	114.00	2 34½	4 15½	6 50½	479.41	2.68071	1.73	56.93	5.13	113.82	113.93
15	117.00	2 41½	4 28½	7 10	469.78	2.67189	1.84	58.42	5.50	116.80	116.92
30	120.00	2 48½	4 41½	7 30	460.55	2.66328	1.96	59.91	5.88	119.77	119.91
45	123.00	2 56	4 54½	7 50½	451.69	2.65484	2.08	61.41	6.29	122.75	122.90
13 00	126.00	3 03½	5 08½	8 11½	443.18	2.64658	2.21	62.90	6.71	125.72	125.89
15	129.00	3 10½	5 22	8 32½	435.00	2.63849	2.34	64.39	7.15	128.69	128.88
30	132.00	3 18½	5 36	7 54½	427.14	2.63057	2.48	65.88	7.61	131.65	131.87
45	135.00	3 26½	5 50½	9 16½	419.58	2.62281	2.63	67.37	8.09	134.61	134.86
14 00	138.00	3 34½	6 05½	9 39½	412.29	2.61520	2.78	68.86	8.58	137.57	137.84
15	141.00	3 42½	6 20½	10 02½	405.26	2.60773	2.93	70.34	9.10	140.53	140.82
30	144.00	3 50½	6 36	10 26½	398.50	2.60043	3.09	71.83	9.64	143.48	143.80
45	147.00	3 59	6 51½	10 50½	391.98	2.59326	3.26	73.32	10.19	146.43	146.78
15 00	150.00	4 07½	7 07½	11 15	385.68	2.58623	3.43	74.80	10.77	149.37	149.76
30	156.00	4 25	7 40½	12 05½	373.72	2.57255	3.79	77.77	11.99	155.25	155.71
16 00	162.00	4 43½	8 14½	12 57½	362.56	2.55938	4.17	80.73	13.30	161.11	161.65
30	168.00	5 02	8 49½	13 51½	352.13	2.54670	4.58	83.69	14.70	166.94	167.58
17 00	174.00	5 21½	9 26½	14 47½	342.36	2.53448	5.02	86.64	16.19	172.75	173.50
30	180.00	5 41½	10 03½	15 45	333.20	2.52270	5.48	89.58	17.78	178.54	179.41
18 00	186.00	6 01½	10 42½	16 44½	324.61	2.51136	5.97	92.52	19.47	184.30	185.31
30	192.00	6 23	11 22½	17 45½	316.53	2.50041	6.49	95.46	21.26	190.03	191.20
19 00	198.00	6 44½	12 03½	18 48½	308.94	2.48987	7.03	98.39	23.15	195.73	197.07
30	204.00	7 07	12 46½	19 53½	301.78	2.47969	7.60	101.31	25.14	201.39	202.93
20 00	210.00	7 30	13 30	21 00	295.04	2.46988	8.20	104.22	27.25	207.01	208.78
30	216.00	7 53½	14 15	22 08½	288.69	2.46043	8.83	107.12	29.47	212.59	214.62
21 00	222.00	8 17½	15 00½	23 18½	282.72	2.45136	9.50	110.02	31.80	218.13	220.44
30	228.00	8 42½	15 48	24 30½	277.07	2.44259	10.19	112.90	34.25	223.62	226.23
22 00	234.00	9 07½	16 36½	25 44½	271.75	2.43417	10.92	115.77	36.81	229.05	231.99
30	240.00	9 33½	17 26½	27 00	266.74	2.42609	11.69	118.63	39.49	234.42	237.72

TAPER  $3\frac{1}{4}$ . CURVATURE INCREASING  $3^\circ 00'$   
EVERY 30 FT.

 $\Delta=3$ 

Transit at	Deflections to							
	B.C. $3^\circ 00'$	C.C. $6^\circ 00'$	C.C. $9^\circ 00'$	C.C. $12^\circ 00'$	C.C. $15^\circ 00'$	C.C. $18^\circ 00'$	C.C. $21^\circ 00'$	C.C. $24^\circ 00'$
<i>l</i>	0	30	60	90	120	150	180	210
	° /	° /	° /	° /	° /	° /	° /	° /
0	.....	0 27	1 07½	2 06	3 22½	4 57	6 49½	9 00
30	0 27	.....	0 54	2 01½	3 27	5 10½	7 12	9 31½
60	1 34½	0 54	.....	1 21	2 55½	4 48	6 58½	9 27
90	3 18	2 28½	1 21	.....	1 48	3 49½	6 09	8 46½
120	5 37½	4 39	3 22½	1 48	.....	2 15	4 43½	7 30
150	8 33	7 25½	6 00	4 16½	2 15	.....	2 42	5 37½
180	12 04½	10 48	9 13½	7 21	5 10½	2 42	.....	3 09
210	16 12	14 46½	13 03	11 01½	8 42	6 04½	3 09	.....

<i>M</i>	<i>l</i>	<i>o</i>	<i>D</i>	log <i>D</i>	<i>d</i>	<i>t</i>	<i>x</i>	<i>y</i>	<i>lc</i>
° /		° /							
6 00	30	0 54	955.16	2.98008	0.12	15.00	0.24	30.00	30.00
9 00	60	2 42	637.25	2.80431	0.47	29.99	1.18	59.98	60.00
12 00	90	5 24	478.84	2.68021	1.18	44.96	3.30	89.91	89.97
15 00	120	9 00	384.60	2.58501	2.35	59.88	7.06	119.67	119.88
18 00	150	13 30	322.75	2.50887	4.11	74.71	12.91	149.10	149.65
21 00	180	18 54	279.78	2.44682	6.56	89.40	21.29	177.91	179.17
24 00	210	25 12	248.99	2.39618	9.82	103.88	32.58	205.71	208.28

TAPER  $3\frac{1}{2}$ . INTERMEDIATE VALUES

$\Delta=3$

<i>M</i>	<i>l</i>	<i>f</i>	<i>b</i>	<i>o</i>	<i>D</i>	log <i>D</i>	<i>d</i>	<i>t</i>	<i>z</i>	<i>y</i>	<i>lc</i>
6 00	30.00	0 27	0 27	0 54	955.16	2.98008	0.12	15.00	0.24	30.00	30.00
15	32.50	0 29½	0 31½	1 01	916.98	2.96236	0.14	16.25	0.28	32.50	32.50
30	35.00	0 32½	0 35½	1 08½	881.75	2.94535	0.16	17.50	0.33	35.00	35.00
45	37.50	0 35½	0 40½	1 16	849.13	2.92897	0.18	18.75	0.39	37.50	37.50
7 00	40.00	0 38½	0 45½	1 24	818.84	2.91320	0.20	20.00	0.45	40.00	40.00
15	42.50	0 41½	0 50½	1 32½	790.65	2.89798	0.23	21.25	0.52	42.50	42.50
30	45.00	0 45	0 56½	1 41½	764.34	2.88329	0.26	22.49	0.59	45.00	45.00
45	47.50	0 48½	1 02	1 50½	739.73	2.86907	0.29	23.74	0.67	47.49	47.50
8 00	50.00	0 52	1 08	2 00	716.66	2.85531	0.32	24.99	0.76	49.99	50.00
15	52.50	0 55½	1 14½	2 10	694.99	2.84198	0.35	26.24	0.85	52.49	52.50
30	55.00	0 59½	1 20½	2 20½	674.61	2.82905	0.39	27.49	0.95	54.99	55.00
45	57.50	1 03½	1 27½	2 31	655.40	2.81651	0.43	28.74	1.06	57.49	57.50
9 00	60.00	1 07½	1 34½	2 42	637.25	2.80431	0.47	29.99	1.18	59.98	60.00
15	62.50	1 11½	1 41½	2 53½	620.09	2.79245	0.51	31.24	1.31	62.48	62.50
30	65.00	1 16	1 49½	3 05½	603.85	2.78093	0.56	32.48	1.44	64.98	64.99
45	67.50	1 20½	1 57	3 17½	588.44	2.76970	0.61	33.73	1.58	67.48	67.49
10 00	70.00	1 25	2 05	3 30	573.80	2.75876	0.66	34.98	1.73	69.97	69.99
15	72.50	1 29½	2 13½	3 43	559.88	2.74810	0.71	36.23	1.89	72.47	72.49
30	75.00	1 34½	2 21½	3 56½	546.64	2.73770	0.77	37.48	2.06	74.96	74.99
45	77.50	1 39½	2 30½	4 10	534.01	2.72755	0.83	38.73	2.24	77.45	77.49
11 00	80.00	1 44½	2 39½	4 24	521.96	2.71764	0.89	39.97	2.43	79.95	79.98
15	82.50	1 49½	2 48½	4 38½	510.46	2.70796	0.96	41.22	2.63	82.44	82.48
30	85.00	1 55	2 58½	4 53½	499.46	2.69850	1.03	42.46	2.84	84.93	84.98
45	87.50	2 00½	3 08	5 08½	488.94	2.68926	1.10	43.71	3.06	87.42	87.47
12 00	90.00	2 06	3 18	5 24	478.86	2.68021	1.18	44.96	3.29	89.91	89.97
15	92.50	2 11½	3 28½	5 40	469.20	2.67136	1.26	46.20	3.54	92.40	92.47
30	95.00	2 17½	3 38½	5 56½	459.93	2.66269	1.34	47.45	3.80	94.89	94.96
45	97.50	2 23½	3 49½	6 13	451.03	2.65421	1.42	48.69	4.07	97.37	97.46



TAPER  $3\frac{1}{4}$ . INTERMEDIATE VALUES — (Continued)  $\Delta=3$ 

<i>M</i>	<i>i</i>	<i>f</i>	<i>b</i>	<i>o</i>	<i>D</i>	log <i>D</i>	<i>d</i>	<i>t</i>	<i>x</i>	<i>y</i>	<i>lc</i>
13 00	100.00	2 29½	4 00½	6 30	442.48	2.64589	1.51	49.94	4.35	99.86	99.95
15	102.50	2 35½	4 11½	6 47½	434.26	2.63775	1.60	51.18	4.64	102.35	102.45
30	105.00	2 42	4 23½	7 05½	426.36	2.62978	1.70	52.42	4.94	104.82	104.94
45	107.50	2 48½	4 35	7 23½	418.75	2.62195	1.80	53.67	5.26	107.30	107.43
14 00	110.00	2 55	4 47	7 42	411.41	2.61427	1.90	54.91	5.59	109.78	109.92
15	112.50	3 01½	4 59½	8 01	404.34	2.60675	2.01	56.15	5.94	112.26	112.41
30	115.00	3 08½	5 11½	8 20½	397.53	2.59937	2.12	57.39	6.30	114.73	114.90
45	117.50	3 15½	5 24½	8 40	390.95	2.59212	2.23	58.64	6.67	117.20	117.39
15 00	120.00	3 22½	5 37½	9 00	384.60	2.58501	2.35	59.88	7.06	119.67	119.88
30	125.00	3 37	6 04½	9 41½	372.53	2.57116	2.60	62.36	7.88	124.61	124.85
16 00	130.00	3 52	6 32	10 24	361.26	2.55782	2.87	64.84	8.76	129.54	129.82
30	135.00	4 07½	7 00½	11 08½	350.70	2.54494	3.15	67.31	9.70	134.45	134.79
17 00	140.00	4 23½	7 30½	11 54	340.79	2.53249	3.45	69.78	10.70	139.34	139.75
30	145.00	4 40	8 01½	12 41½	331.49	2.52047	3.77	72.25	11.77	144.22	144.70
18 00	150.00	4 57	8 33	13 30	322.75	2.50887	4.11	74.71	12.91	149.10	149.65
30	155.00	5 14½	9 05½	14 20½	314.51	2.49763	4.47	77.17	14.12	153.96	154.59
19 00	160.00	5 32½	9 39½	15 12	306.75	2.48678	4.84	79.63	15.40	158.78	159.52
30	165.00	5 51	10 14½	16 05½	299.42	2.47628	5.24	82.08	16.76	163.59	164.44
20 00	170.00	6 10	10 50	17 00	292.50	2.46613	5.66	84.52	18.19	168.39	169.36
30	175.00	6 29½	11 26½	17 56½	285.96	2.45631	6.10	86.96	19.70	173.16	174.27
21 00	180.00	6 49½	12 04½	18 54	279.78	2.44682	6.56	89.40	21.29	177.91	179.17
30	185.00	7 10	12 43½	19 53½	273.92	2.43762	7.04	91.83	22.96	182.62	184.06
22 00	190.00	7 31	13 23	20 54	268.38	2.42875	7.55	94.25	24.71	187.30	188.93
30	195.00	7 52½	14 03½	21 56½	263.13	2.42017	8.08	96.67	26.55	191.95	193.79
23 00	200.00	8 14½	14 45½	23 00	258.17	2.41191	8.64	99.08	28.47	196.59	198.63
24 00	210.00	9 00	16 12	25 12	248.99	2.39618	9.82	103.88	32.58	206.71	208.28

TAPER 3½. CURVATURE INCREASING 4° 00'  
EVERY 30 FT.

Δ=4

Transit at	Deflections to						
	B.C. 4° 00'	C.C. 8° 00'	C.C. 12° 00'	C.C. 16° 00'	C.C. 20° 00'	C.C. 24° 00'	C.C. 28° 00'
<i>l</i>	0	30	60	90	120	150	180
0	.....	0 36	1 30	2 48	4 30	6 36	9 06
30	0 36	.....	1 12	2 42	4 36	6 54	9 36
60	2 06	1 12	.....	1 48	3 54	6 24	9 18
90	4 24	3 18	1 48	.....	2 24	5 06	8 12
120	7 30	6 12	4 30	2 24	.....	3 00	6 18
150	11 24	9 54	8 00	5 42	3 00	.....	3 36
180	16 06	14 24	12 18	9 48	6 54	3 36	.....

<i>M</i>	<i>l</i>	<i>o</i>	<i>D</i>	log <i>D</i>	<i>d</i>	<i>t</i>	<i>z</i>	<i>y</i>	<i>lc</i>
8 00	30	1 12	716.50	2.85522	0.16	15.00	0.31	30.00	30.00
12 00	60	3 36	478.31	2.67971	0.63	29.98	1.57	59.97	59.99
16 00	90	7 12	359.96	2.55625	1.57	44.92	4.39	89.84	89.95
20 00	120	12 00	289.97	2.46235	3.13	59.78	9.40	119.42	119.79
24 00	150	18 00	244.63	2.38851	5.46	74.49	17.17	148.40	149.39
28 00	180	25 12	213.85	2.33011	8.71	88.95	28.24	176.29	178.52

TAPER 3 $\frac{1}{2}$  INTERMEDIATE VALUES $\Delta=4$ 

<i>M</i>	<i>l</i>	<i>f</i>	<i>b</i>	<i>o</i>	<i>D</i>	<i>log D</i>	<i>d</i>	<i>t</i>	<i>x</i>	<i>y</i>	<i>lc</i>
8 00	30.00	0 36	0 36	1 12	716.50	2.85522	0.16	15.00	0.31	30.00	30.00
15	31.88	0 38 $\frac{1}{2}$	0 40	1 18 $\frac{1}{2}$	694.82	2.84187	0.18	15.93	0.36	31.87	31.87
30	33.75	0 41 $\frac{1}{2}$	0 44 $\frac{1}{2}$	1 26	674.42	2.82893	0.20	16.87	0.41	33.74	33.75
45	35.62	0 44 $\frac{1}{2}$	0 49 $\frac{1}{2}$	1 33 $\frac{1}{2}$	655.19	2.81637	0.22	17.81	0.46	35.62	35.62
9 00	37.50	0 47 $\frac{1}{2}$	0 54	1 41 $\frac{1}{2}$	637.02	2.80415	0.24	18.74	0.52	37.50	37.50
15	39.38	0 50 $\frac{1}{2}$	0 59	1 49 $\frac{1}{2}$	619.84	2.79228	0.26	19.68	0.58	39.37	39.37
30	41.25	0 53 $\frac{1}{2}$	1 04	1 57 $\frac{1}{2}$	603.58	2.78073	0.29	20.62	0.64	41.24	41.25
45	43.12	0 56 $\frac{1}{2}$	1 09 $\frac{1}{2}$	2 06 $\frac{1}{2}$	588.15	2.76949	0.32	21.55	0.71	43.12	43.12
10 00	45.00	1 00	1 15	2 15	573.49	2.75853	0.35	22.49	0.79	44.99	45.00
15	46.88	1 03 $\frac{1}{2}$	1 20 $\frac{1}{2}$	2 24 $\frac{1}{2}$	559.55	2.74784	0.38	23.43	0.87	46.87	46.87
30	48.75	1 07	1 26 $\frac{1}{2}$	2 33 $\frac{1}{2}$	546.28	2.73742	0.41	24.36	0.95	48.74	48.75
45	50.62	1 10 $\frac{1}{2}$	1 32 $\frac{1}{2}$	2 43 $\frac{1}{2}$	533.62	2.72723	0.44	25.30	1.04	50.61	50.62
11 00	52.50	1 14 $\frac{1}{2}$	1 39	2 53 $\frac{1}{2}$	521.54	2.71729	0.47	26.24	1.13	52.48	52.50
15	54.38	1 18	1 45 $\frac{1}{2}$	3 03 $\frac{1}{2}$	510.01	2.70758	0.51	27.17	1.23	54.35	54.37
30	56.25	1 22	1 52	3 14	498.98	2.69808	0.55	28.11	1.34	56.22	56.24
45	58.12	1 26	1 58 $\frac{1}{2}$	3 24 $\frac{1}{2}$	488.48	2.68880	0.59	29.04	1.45	58.10	58.12
12 00	60.00	1 30	2 06	3 36	478.31	2.67971	0.63	29.98	1.57	59.97	59.99
15	61.88	1 34 $\frac{1}{2}$	2 13 $\frac{1}{2}$	3 47 $\frac{1}{2}$	468.61	2.67081	0.67	30.91	1.69	61.84	61.87
30	63.75	1 38 $\frac{1}{2}$	2 20 $\frac{1}{2}$	3 59	459.31	2.66211	0.72	31.85	1.82	63.71	63.74
45	65.62	1 42 $\frac{1}{2}$	2 28 $\frac{1}{2}$	4 11	450.38	2.65358	0.77	32.79	1.96	65.59	65.62
13 00	67.50	1 47 $\frac{1}{2}$	2 36	4 23 $\frac{1}{2}$	441.79	2.64522	0.82	33.72	2.11	67.46	67.49
15	69.38	1 51 $\frac{1}{2}$	2 44	4 35 $\frac{1}{2}$	433.53	2.63702	0.87	34.65	2.26	69.33	69.36
30	71.25	1 56 $\frac{1}{2}$	2 52	4 48 $\frac{1}{2}$	425.58	2.62898	0.92	35.59	2.42	71.19	71.23
45	73.12	2 01 $\frac{1}{2}$	3 00 $\frac{1}{2}$	5 01 $\frac{1}{2}$	417.92	2.62109	0.97	36.52	2.58	73.06	73.11
14 00	75.00	2 06	3 09	5 15	410.54	2.61336	1.03	37.46	2.75	74.93	74.98
15	76.88	2 11	3 17 $\frac{1}{2}$	5 28 $\frac{1}{2}$	403.42	2.60576	1.09	38.39	2.93	76.79	76.85
30	78.75	2 16	3 26 $\frac{1}{2}$	5 42 $\frac{1}{2}$	396.56	2.59831	1.15	39.33	3.12	78.66	78.72
45	80.62	2 21	3 35 $\frac{1}{2}$	5 56 $\frac{1}{2}$	389.94	2.59100	1.22	40.26	3.31	80.53	80.59
15 00	82.50	2 26 $\frac{1}{2}$	3 45	6 11 $\frac{1}{2}$	383.53	2.58380	1.28	41.19	3.51	82.39	82.46
30	86.25	2 37	4 04	6 41	371.35	2.56978	1.42	43.06	3.93	86.12	86.21
16 00	90.00	2 48	4 24	7 12	359.96	2.55625	1.57	44.92	4.39	89.84	89.95
30	93.75	2 59 $\frac{1}{2}$	4 44 $\frac{1}{2}$	7 44	349.28	2.54317	1.73	46.79	4.89	93.56	93.69
17 00	97.50	3 11 $\frac{1}{2}$	5 06	8 17 $\frac{1}{2}$	339.23	2.53049	1.89	48.65	5.42	97.27	97.43
30	101.25	3 23 $\frac{1}{2}$	5 28	8 51 $\frac{1}{2}$	329.79	2.51824	2.07	50.51	5.98	100.98	101.16
18 00	105.00	3 36	5 51	9 27	320.90	2.50637	2.26	52.37	6.59	104.68	104.89
30	108.75	3 49	6 14 $\frac{1}{2}$	10 03 $\frac{1}{2}$	312.50	2.49485	2.46	54.22	7.23	108.38	108.62
19 00	112.50	4 02 $\frac{1}{2}$	6 39	10 41 $\frac{1}{2}$	304.58	2.48370	2.67	56.08	7.91	112.07	112.34
30	116.25	4 16	7 04	11 20	297.07	2.47286	2.89	57.93	8.63	115.75	116.07
20 00	120.00	4 30	7 30	12 00	289.97	2.46235	3.13	59.78	9.40	119.42	119.79
30	123.75	4 44 $\frac{1}{2}$	7 56 $\frac{1}{2}$	12 41	283.24	2.45215	3.38	61.63	10.21	123.08	123.51
21 00	127.50	4 59 $\frac{1}{2}$	8 24	13 23 $\frac{1}{2}$	276.86	2.44226	3.64	63.48	11.06	126.74	127.22
30	131.25	5 14 $\frac{1}{2}$	8 52	14 06 $\frac{1}{2}$	270.79	2.43263	3.91	65.32	11.96	130.38	130.93

TAPER 3½. INTERMEDIATE VALUES — (Continued) Δ=4

M	l	f	b	o	D	log D	d	t	x	y	lc
22 00	185.00	5 30	9 21	14 51	265.02	2.42328	4.19	67.16	12.90	134.01	134.63
30	138.75	5 46	9 50½	15 36½	259.53	2.41419	4.48	69.00	13.90	137.63	138.33
23 00	142.50	6 02½	10 21	16 23½	254.33	2.40540	4.80	70.83	14.94	141.23	142.02
24 00	150.00	6 36	11 24	18 00	244.63	2.38851	5.46	74.49	17.17	148.40	149.39
25 00	157.50	7 11½	12 30	19 41½	235.82	2.37258	6.18	78.14	19.61	155.50	156.73
26 00	165.00	7 48	13 39	21 27	227.81	2.35757	6.97	81.76	22.26	162.52	164.04
27 00	172.50	8 26½	14 51	23 17½	220.51	2.34343	7.81	85.37	25.14	169.45	171.31
28 00	180.00	9 06	16 06	25 12	213.85	2.33011	8.71	88.95	28.24	176.29	178.52

TAPER 3½. CURVATURE INCREASING 5° 00' EVERY 30 FT. Δ=5

Transit at	Deflections to					
	B.C. 5° 00'	C.C. 10° 00'	C.C. 15° 00'	C.C. 20° 00'	C.C. 25° 00'	C.C. 30° 00'
l	0	30	60	90	120	150
0	.....	0 45	1 52½	3 30	5 37½	8 15
30	0 45	.....	1 30	3 22½	5 45	8 37½
60	2 37½	1 30	.....	2 15	4 52½	8 00
90	5 30	4 07½	2 15	.....	3 00	6 22½
120	9 22½	7 45	5 37½	3 00	.....	3 45
150	14 15	12 22½	10 00	7 07½	3 45	.....

M	l	o	D	log D	d	t	x	y	lc
10 00	30	1 30	573.34	2.75841	0.20	14.99	0.39	30.00	30.00
15 00	60	4 30	383.13	2.58323	0.78	29.97	1.96	59.96	59.99
20 00	90	9 00	288.80	2.45939	1.96	44.88	5.49	89.75	89.92
25 00	120	15 00	233.54	2.36836	3.90	59.66	11.73	119.09	119.67
30 00	150	22 30	198.34	2.29741	6.81	74.21	21.39	147.50	149.04

TAPER  $3\frac{3}{4}$ . INTERMEDIATE VALUES $\Delta=5$ 

<i>M</i>	<i>l</i>	<i>f</i>	<i>b</i>	<i>o</i>	<i>D</i>	log <i>D</i>	<i>d</i>	<i>t</i>	<i>x</i>	<i>y</i>	<i>lc</i>
10 00	30.00	0 45	0 45	1 30	573.34	2.75841	0.20	14.99	0.39	30.00	30.00
15	31.50	0 47 $\frac{1}{2}$	0 49	1 36 $\frac{1}{2}$	559.38	2.74771	0.21	15.74	0.43	31.50	31.50
30	33.00	0 50 $\frac{1}{2}$	0 53 $\frac{1}{2}$	1 44	546.10	2.73727	0.23	16.49	0.48	33.00	33.00
45	34.50	0 53 $\frac{1}{2}$	0 58	1 51 $\frac{1}{2}$	533.43	2.72708	0.25	17.24	0.53	34.50	34.50
11 00	36.00	0 56	1 02 $\frac{1}{2}$	1 58 $\frac{1}{2}$	521.34	2.71712	0.27	17.99	0.59	36.00	36.00
15	37.50	0 59 $\frac{1}{2}$	1 07 $\frac{1}{2}$	2 06 $\frac{1}{2}$	509.79	2.70739	0.29	18.74	0.65	37.49	37.50
30	39.00	1 02	1 12 $\frac{1}{2}$	2 14 $\frac{1}{2}$	498.74	2.69787	0.31	19.49	0.71	38.99	39.00
45	40.50	1 05 $\frac{1}{2}$	1 17 $\frac{1}{2}$	2 22 $\frac{1}{2}$	488.18	2.68858	0.34	20.24	0.77	40.49	40.50
12 00	42.00	1 08 $\frac{1}{2}$	1 22 $\frac{1}{2}$	2 31 $\frac{1}{2}$	478.05	2.67947	0.37	20.99	0.84	41.99	42.00
15	43.50	1 11 $\frac{1}{2}$	1 28	2 39 $\frac{1}{2}$	468.34	2.67056	0.40	21.74	0.91	43.49	43.50
30	45.00	1 15	1 33 $\frac{1}{2}$	2 48 $\frac{1}{2}$	459.02	2.66183	0.43	22.49	0.98	44.99	45.00
45	46.50	1 18 $\frac{1}{2}$	1 39 $\frac{1}{2}$	2 57 $\frac{1}{2}$	450.07	2.65328	0.46	23.23	1.06	46.49	46.50
13 00	48.00	1 22	1 45 $\frac{1}{2}$	3 07 $\frac{1}{2}$	441.46	2.64489	0.49	23.98	1.14	47.98	48.00
15	49.50	1 25 $\frac{1}{2}$	1 51 $\frac{1}{2}$	3 16 $\frac{1}{2}$	433.18	2.63667	0.52	24.73	1.23	49.48	49.50
30	51.00	1 29	1 57 $\frac{1}{2}$	3 26 $\frac{1}{2}$	425.21	2.62860	0.55	25.48	1.32	50.98	51.00
45	52.50	1 32 $\frac{1}{2}$	2 03 $\frac{1}{2}$	3 36 $\frac{1}{2}$	417.53	2.62069	0.58	26.23	1.42	52.48	52.50
14 00	54.00	1 36 $\frac{1}{2}$	2 10 $\frac{1}{2}$	3 46 $\frac{1}{2}$	410.13	2.61292	0.62	26.98	1.52	53.97	53.99
15	55.50	1 40 $\frac{1}{2}$	2 16 $\frac{1}{2}$	3 57 $\frac{1}{2}$	402.99	2.60529	0.66	27.72	1.62	55.47	55.49
30	57.00	1 44 $\frac{1}{2}$	2 23 $\frac{1}{2}$	4 08	396.11	2.59782	0.70	28.47	1.73	56.97	56.99
45	58.50	1 48 $\frac{1}{2}$	2 30 $\frac{1}{2}$	4 18 $\frac{1}{2}$	389.46	2.59046	0.74	29.22	1.84	58.46	58.49
15 00	60.00	1 52 $\frac{1}{2}$	2 37 $\frac{1}{2}$	4 30	383.03	2.58323	0.78	29.97	1.96	59.96	59.99
30	63.00	2 01	2 52	4 53	370.80	2.56914	0.87	31.46	2.21	62.95	62.99

TAPER 3 $\frac{1}{2}$ . INTERMEDIATE VALUES — (Continued)  $\Delta=5$ 

<i>M</i>	<i>l</i>	<i>f</i>	<i>b</i>	<i>a</i>	<i>D</i>	log <i>D</i>	<i>d</i>	<i>t</i>	<i>z</i>	<i>y</i>	<i>lc</i>
16 00	66.00	2 09 $\frac{1}{2}$	3 07	5 16 $\frac{1}{2}$	359.35	2.55552	0.96	32.96	2.48	64.44	64.99
30	69.00	2 18 $\frac{1}{2}$	3 23	5 41 $\frac{1}{2}$	348.61	2.54234	1.06	34.45	2.77	68.92	68.98
17 00	72.00	2 27 $\frac{1}{2}$	3 39 $\frac{1}{2}$	6 07 $\frac{1}{2}$	338.51	2.52957	1.17	35.94	3.09	71.90	71.97
30	75.00	2 37 $\frac{1}{2}$	3 56 $\frac{1}{2}$	6 33 $\frac{1}{2}$	329.00	2.51720	1.28	37.44	3.43	74.88	74.97
18 00	78.00	2 47 $\frac{1}{2}$	4 13 $\frac{1}{2}$	7 01 $\frac{1}{2}$	320.04	2.50520	1.40	38.92	3.79	77.86	77.96
30	81.00	2 57 $\frac{1}{2}$	4 32	7 29 $\frac{1}{2}$	311.57	2.49356	1.53	40.41	4.18	80.84	80.95
19 00	84.00	3 08	4 50 $\frac{1}{2}$	7 58 $\frac{1}{2}$	303.58	2.48227	1.67	41.90	4.59	83.81	83.94
30	87.00	3 19	5 10	8 29	295.99	2.47128	1.81	43.39	5.03	86.78	86.93
20 00	90.00	3 30	5 30	9 00	288.80	2.46060	1.96	44.88	5.49	89.75	89.92
30	93.00	3 41 $\frac{1}{2}$	5 50 $\frac{1}{2}$	9 32	281.98	2.45022	2.12	46.36	5.98	92.71	92.91
21 00	96.00	3 53	6 11 $\frac{1}{2}$	10 04 $\frac{1}{2}$	275.50	2.44012	2.28	47.85	6.50	95.67	95.89
30	99.00	4 05	6 33 $\frac{1}{2}$	10 38 $\frac{1}{2}$	269.33	2.43028	2.45	49.33	7.05	98.62	98.87
22 00	102.00	4 17 $\frac{1}{2}$	6 55 $\frac{1}{2}$	11 13 $\frac{1}{2}$	263.46	2.42071	2.63	50.81	7.63	101.56	101.85
30	105.00	4 30	7 18 $\frac{1}{2}$	11 48 $\frac{1}{2}$	257.87	2.41140	2.82	52.29	8.23	104.50	104.82
23 00	108.00	4 43	7 42 $\frac{1}{2}$	12 25 $\frac{1}{2}$	252.55	2.40235	3.02	53.76	8.86	107.44	107.78
24 00	114.00	5 09 $\frac{1}{2}$	8 31 $\frac{1}{2}$	13 40 $\frac{1}{2}$	242.61	2.38491	3.44	56.72	10.23	113.28	113.73
25 00	120.00	5 37 $\frac{1}{2}$	9 22 $\frac{1}{2}$	15 00	233.54	2.36836	3.90	59.66	11.73	119.09	119.67
26 00	126.00	6 06 $\frac{1}{2}$	10 16 $\frac{1}{2}$	16 22 $\frac{1}{2}$	225.24	2.35265	4.40	62.59	13.37	124.87	125.59
27 00	132.00	6 37	11 12 $\frac{1}{2}$	17 49 $\frac{1}{2}$	217.64	2.33774	4.94	65.51	15.15	130.61	131.49
28 00	138.00	7 08 $\frac{1}{2}$	12 10 $\frac{1}{2}$	19 19 $\frac{1}{2}$	210.66	2.32358	5.52	68.42	17.07	136.29	137.36
29 00	144.00	7 41	13 11 $\frac{1}{2}$	20 52 $\frac{1}{2}$	204.24	2.31014	6.14	71.32	19.15	141.93	143.21
30 00	150.00	8 15	14 15	22 30	198.34	2.29741	6.81	74.21	21.39	147.50	149.04









COMPARATIVE VALUES — (Continued)

M	Δ	Taper	‡	‡	‡	‡	1‡	1‡	1‡	2‡	2‡	2‡	3‡	3‡	3‡	4‡	4‡	5‡
			‡	‡	‡	‡	1	2	2‡	3	3‡	3‡	3‡	3‡	3‡	3‡	3‡	3‡
11° 00'	l	.....	.....	.....	.....	.....	300.00	234.00	190.00	135.00	102.00	80.00	80.00	52.50	36.00			
	d	.....	.....	.....	.....	.....	8.62	5.49	3.79	2.10	1.32	0.89	0.89	0.47	0.27			
	o	.....	.....	.....	.....	.....	16° 30'	12° 52½'	10° 27'	7° 25½'	5° 36½'	4° 24'	4° 24'	2° 53½'	1° 58½'			
12° 00'	l	.....	.....	.....	.....	.....	330.00	258.00	210.00	150.00	114.00	90.00	90.00	60.00	42.00			
	d	.....	.....	.....	.....	.....	11.20	7.14	4.94	2.74	1.73	1.18	1.18	0.63	0.37			
	o	.....	.....	.....	.....	.....	19° 48'	15° 28½'	12° 36'	9° 00'	6° 50½'	5° 24'	5° 24'	3° 36'	2° 31½'			
13° 00'	l	.....	.....	.....	.....	.....	360.00	282.00	230.00	165.00	126.00	100.00	100.00	67.50	48.00			
	d	.....	.....	.....	.....	.....	14.25	9.09	6.29	3.50	2.21	1.51	1.51	0.82	0.49			
	o	.....	.....	.....	.....	.....	23° 24'	18° 19½'	14° 57'	10° 43½'	8° 11½'	6° 30'	6° 30'	4° 23½'	3° 07½'			
14° 00'	l	.....	.....	.....	.....	.....	.....	306.00	250.00	180.00	138.00	110.00	110.00	75.00	54.00			
	d	.....	.....	.....	.....	.....	.....	11.36	7.87	4.39	2.78	1.90	1.90	1.03	0.62			
	o	.....	.....	.....	.....	.....	.....	21° 25½'	17° 30'	12° 36'	9° 39½'	7° 42'	7° 42'	5° 15'	3° 46½'			
15° 00'	l	.....	.....	.....	.....	.....	.....	330.00	270.00	195.00	150.00	120.00	120.00	82.50	60.00			
	d	.....	.....	.....	.....	.....	.....	13.98	9.68	5.41	3.43	2.35	2.35	1.28	0.78			
	o	.....	.....	.....	.....	.....	.....	24° 45'	20° 15'	14° 37½'	11° 15'	9° 00'	9° 00'	6° 11½'	4° 30'			
16° 00'	l	.....	.....	.....	.....	.....	.....	.....	290.00	210.00	162.00	130.00	130.00	90.00	66.00			
	d	.....	.....	.....	.....	.....	.....	.....	11.76	6.57	4.17	2.87	2.87	1.57	0.96			
	o	.....	.....	.....	.....	.....	.....	.....	23° 12'	16° 48'	12° 57½'	10° 24'	10° 24'	7° 12'	5° 16½'			

COMPARATIVE VALUES — (Continued)

M	Taper	1		2		3		4		5	
		1	1½	2	2½	3	3½	4	4½	5	5½
7° 00'	l	390.00	250.00	180.00	138.00	110.00	75.00	54.00	40.00	30.00	20.00
	d	8.92	3.94	2.20	1.39	0.95	0.51	0.31	0.20	0.16	0.12
	o	13° 39'	8° 45'	6° 18'	4° 49½'	3° 51'	2° 37½'	1° 53½'	1° 24'	1° 00'	0° 45'
7° 30'	l	420.00	270.00	195.00	150.00	120.00	82.50	60.00	45.00	30.00	20.00
	d	10.97	4.85	2.71	1.72	1.18	0.64	0.39	0.26	0.20	0.15
	o	15° 45'	10° 07½'	7° 18½'	5° 37½'	4° 30'	3° 05½'	2° 15'	1° 41½'	1° 15'	0° 55'
8° 00'	l	450.00	290.00	210.00	162.00	130.00	90.00	66.00	50.00	30.00	20.00
	d	12.16	5.90	3.29	2.09	1.44	0.78	0.48	0.32	0.24	0.18
	o	17° 30'	11° 36'	8° 24'	6° 28½'	5° 12'	3° 36'	2° 38½'	2° 00'	1° 45'	1° 12'
8° 30'	l	480.00	310.00	225.00	174.00	140.00	97.50	72.00	55.00	33.75	20.00
	d	13.27	7.08	3.96	2.51	1.73	0.95	0.59	0.39	0.26	0.20
	o	19° 00'	13° 10½'	9° 33½'	7° 23½'	5° 57'	4° 08½'	3° 03½'	2° 20½'	1° 55'	1° 26'
9° 00'	l	510.00	330.00	240.00	186.00	150.00	105.00	78.00	60.00	37.50	20.00
	d	14.38	8.42	4.71	2.99	2.06	1.13	0.70	0.47	0.24	0.20
	o	20° 30'	14° 51'	10° 48'	8° 22½'	6° 45'	4° 43½'	3° 30½'	2° 42'	1° 41½'	1° 26'
10° 00'	l	540.00	370.00	270.00	210.00	170.00	120.00	90.00	70.00	45.00	30.00
	d	15.59	11.55	6.47	4.12	2.84	1.57	0.98	0.66	0.35	0.20
	o	22° 00'	18° 30'	13° 30'	10° 30'	8° 30'	6° 00'	4° 30'	3° 30'	2° 15'	1° 30'

COMPARATIVE VALUES — (Continued)

M	Δ	1		2		3		4		5	
		1	2	1	2	1	2	1	2	1	2
11° 00'	l	.....	300.00	234.00	190.00	135.00	102.00	80.00	52.50	36.00	
	d	.....	8.62	5.49	3.79	2.10	1.32	0.89	0.47	0.27	
	o	.....	16° 30'	12° 52½'	10° 27'	7° 25½'	5° 36½'	4° 24'	2° 53½'	1° 58½'	
12° 00'	l	.....	330.00	258.00	210.00	150.00	114.00	90.00	60.00	42.00	
	d	.....	11.20	7.14	4.94	2.74	1.73	1.18	0.63	0.37	
	o	.....	19° 48'	15° 28½'	12° 36'	9° 00'	6° 50½'	5° 24'	3° 36'	2° 31½'	
13° 00'	l	.....	360.00	282.00	230.00	165.00	126.00	100.00	67.50	48.00	
	d	.....	14.25	9.09	6.29	3.50	2.21	1.51	0.82	0.49	
	o	.....	23° 24'	18° 19½'	14° 57'	10° 43½'	8° 11½'	6° 30'	4° 23½'	3° 07½'	
14° 00'	l	.....	.....	306.00	250.00	180.00	138.00	110.00	75.00	54.00	
	d	.....	.....	11.36	7.87	4.39	2.78	1.90	1.03	0.62	
	o	.....	.....	21° 25½'	17° 30'	12° 36'	9° 39½'	7° 42'	5° 15'	3° 46½'	
15° 00'	l	.....	.....	330.00	270.00	195.00	150.00	120.00	82.50	60.00	
	d	.....	.....	13.98	9.68	5.41	3.43	2.35	1.28	0.78	
	o	.....	.....	24° 45'	20° 15'	14° 37½'	11° 15'	9° 00'	6° 11½'	4° 30'	
16° 00'	l	.....	.....	.....	290.00	210.00	162.00	130.00	90.00	66.00	
	d	.....	.....	.....	11.76	6.57	4.17	2.87	1.57	0.96	
	o	.....	.....	.....	23° 12'	16° 48'	12° 57½'	10° 24'	7° 12'	5° 16½'	

THE RAILROAD TAPER

COMPARATIVE VALUES — (Continued)

<i>M</i>	$\Delta$	$\frac{1}{2}$	$\frac{1}{3}$	1	$1\frac{1}{2}$	$2\frac{1}{2}$	$3\frac{1}{2}$	2	2 $\frac{1}{2}$	3	3 $\frac{1}{2}$	4	5
	Taper	$\frac{1}{2}$	$1\frac{1}{2}$	2	$2\frac{1}{2}$	$3\frac{1}{2}$	$4\frac{1}{2}$	$5\frac{1}{2}$	3	3 $\frac{1}{2}$	3 $\frac{1}{2}$	3 $\frac{1}{2}$	3 $\frac{1}{2}$
18° 00'	<i>l</i> <i>d</i> <i>o</i>	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	240.00 9.38 21° 36'	186.00 5.97 16° 44 $\frac{1}{2}$ '	150.00 4.11 13° 30'	105.00 2.26 9° 27'	78.00 1.40 7° 01 $\frac{1}{4}$ '	
20° 00'	<i>l</i> <i>d</i> <i>o</i>	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	270.00 12.87 27° 00'	210.00 8.20 21° 00'	170.00 5.66 17.00	120.00 3.13 12° 00'	90.00 1.96 9° 00'	
22° 30'	<i>l</i> <i>d</i> <i>o</i>	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	240.00 11.69 27° 00'	195.00 8.08 21° 56 $\frac{1}{2}$ '	138.75 4.48 15° 36 $\frac{1}{2}$ '	105.00 2.82 11° 48 $\frac{1}{2}$ '	
25° 00'	<i>l</i> <i>d</i> <i>o</i>	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	157.50 6.18 19° 41 $\frac{1}{2}$ '	120.00 3.90 15° 00'	
30° 00'	<i>l</i> <i>d</i> <i>o</i>	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	..... ..... .....	150.00 6.81 22° 30'	



## MAINTAINING LENGTH UNCHANGED — (Continued)

M				5° 00'											
Δ				½			1			1½			2		
Taper.				1			1½			2			2½		
I				l	h	M'	l	h	M'	l	h	M'	l	h	M'
15°	.....	.....	.....	.....	.....	.....	.....	.....	.....	154.00	0.35	6° 08'	102.00	0.25	5° 30'
20	.....	.....	.....	.....	.....	.....	.....	.....	.....	132.50	0.34	5° 25'	95.20	0.17	5° 13'
25	.....	.....	.....	.....	.....	.....	.....	.....	.....	127.00	0.32	5° 14'	93.20	0.18	5° 08'
30	349.00	1.64	6° 19'	182.67	0.64	5° 19'	124.50	0.29	5° 09'	124.50	0.29	5° 09'	92.00	0.13	5° 05'
40	296.00	1.43	5° 26'	176.67	0.70	5° 10'	122.50	0.32	5° 05'	122.50	0.32	5° 05'	91.20	0.19	5° 03'
50	285.00	1.50	5° 15'	174.00	0.66	5° 06'	121.50	0.28	5° 03'	.....	.....	.....	.....	.....	.....
60	280.00	1.60	5° 10'	172.67	0.62	5° 04'	.....	.....	.....	.....	.....	.....	.....	.....	.....
70	277.00	1.53	5° 07'	172.00	0.72	5° 03'	.....	.....	.....	.....	.....	.....	.....	.....	.....
80	275.00	1.31	5° 05'	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
90	274.00	1.48	5° 04'	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
M				6° 00'											
Δ				¾			1			1½			2		
Taper.				1½			2			2½			3		
I				l	h	M'	l	h	M'	l	h	M'	l	h	M'
15°	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	111.00	0.25	7° 03'
20	.....	.....	.....	.....	.....	.....	.....	.....	.....	131.60	0.35	6° 44'	98.33	0.22	6° 25'
25	.....	.....	.....	.....	.....	.....	.....	.....	.....	123.60	0.36	6° 24'	95.00	0.24	6° 15'
30	258.67	1.21	7° 13'	163.50	0.58	6° 27'	120.00	0.33	6° 15'	120.00	0.33	6° 15'	93.33	0.25	6° 10'
40	228.67	1.12	6° 28'	157.00	0.66	6° 14'	117.20	0.35	6° 08'	117.20	0.35	6° 08'	92.00	0.34	6° 06'
50	220.67	1.09	6° 16'	154.00	0.52	6° 08'	116.00	0.34	6° 05'	116.00	0.34	6° 05'	91.00	0.14	6° 03'
60	217.33	1.25	6° 11'	153.00	0.76	6° 06'	115.20	0.20	6° 03'	.....	.....	.....	.....	.....	.....
70	215.33	1.35	6° 08'	152.00	0.58	6° 04'	.....	.....	.....	.....	.....	.....	.....	.....	.....
80	214.00	1.39	6° 06'	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
90	212.67	0.72	6° 04'	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
M				8° 00'											
Δ				1			1½			2			3		
Taper.				2			2½			3			3½		
I				l	h	M'	l	h	M'	l	h	M'	l	h	M'
20°	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	112.25	0.43	9° 29'
25	.....	.....	.....	.....	.....	.....	.....	.....	.....	176.67	0.71	10° 20'	101.00	0.40	8° 44'
30	.....	.....	.....	.....	.....	.....	.....	.....	.....	150.00	0.67	9° 00'	97.00	0.43	8° 28'
40	258.50	1.61	9° 37'	179.60	0.96	8° 44'	139.00	0.64	8° 27'	139.00	0.64	8° 27'	93.25	0.31	8° 13'
50	232.50	1.58	8° 45'	172.00	1.08	8° 25'	135.33	0.63	8° 16'	135.33	0.63	8° 16'	92.00	0.31	8° 08'
60	224.00	1.57	8° 28'	168.40	0.92	8° 16'	133.67	0.70	8° 11'	133.67	0.70	8° 11'	91.50	0.43	8° 06'
70	219.50	1.48	8° 19'	166.40	0.81	8° 11'	132.67	0.75	8° 08'	132.67	0.75	8° 08'	91.00	0.33	8° 04'
80	217.00	1.50	8° 14'	165.60	1.14	8° 09'	132.00	0.74	8° 06'	.....	.....	.....	.....	.....	.....
90	215.50	1.65	8° 11'	164.80	1.18	8° 07'	131.67	0.95	8° 05'	.....	.....	.....	.....	.....	.....
M				10° 00'											
Δ				1½			2			3			4		
Taper.				2½			3			3½			4		
I				l	h	M'	l	h	M'	l	h	M'	l	h	M'
25°	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	112.00	0.45	11° 50'
30	.....	.....	.....	.....	.....	.....	.....	.....	.....	155.50	0.76	12° 22'	101.40	0.41	10° 57'
40	.....	.....	.....	.....	.....	.....	.....	.....	.....	132.50	0.69	10° 50'	95.40	0.39	10° 27'
50	258.00	1.99	12° 00'	190.67	1.32	11° 02'	127.00	0.65	10° 28'	127.00	0.65	10° 28'	93.40	0.45	10° 17'
60	234.80	1.90	11° 02'	182.67	1.33	10° 38'	124.75	0.73	10° 19'	124.75	0.73	10° 19'	92.20	0.39	10° 11'
70	226.40	1.95	10° 41'	178.67	1.31	10° 26'	123.25	0.64	10° 13'	123.25	0.64	10° 13'	91.60	0.42	10° 08'
80	221.60	1.86	10° 29'	176.33	1.30	10° 19'	122.50	0.71	10° 10'	122.50	0.71	10° 10'	91.20	0.41	10° 06'
90	218.80	1.90	10° 22'	175.00	1.46	10° 15'	122.00	0.82	10° 08'	122.00	0.82	10° 08'	91.00	0.53	10° 06'

N	0	1	2	3	4	5	6	7	8	9
<b>100</b>	00000	00043	00087	00130	00173	00217	00260	00303	00346	00389
1	0432	0475	0518	0561	0604	0647	0689	0732	0775	0817
2	0860	0903	0945	0988	1030	1072	1115	1157	1199	1242
3	1284	1326	1368	1410	1452	1494	1536	1578	1620	1662
4	1703	1745	1787	1828	1870	1912	1953	1995	2036	2078
5	2119	2160	2202	2243	2284	2325	2366	2407	2449	2490
6	2531	2572	2612	2653	2694	2735	2776	2816	2857	2898
7	2938	2979	3019	3060	3100	3141	3181	3222	3262	3302
8	3342	3383	3423	3463	3503	3543	3583	3623	3663	3703
9	3743	3782	3822	3862	3902	3941	3981	4021	4060	4100
<b>110</b>	04139	04179	04218	04258	04297	04336	04376	04415	04454	04493
1	4532	4571	4610	4650	4689	4727	4766	4805	4844	4883
2	4922	4961	4999	5038	5077	5115	5154	5192	5231	5269
3	5308	5346	5385	5423	5461	5500	5538	5576	5614	5652
4	5690	5729	5767	5805	5843	5881	5918	5956	5994	6032
5	6070	6108	6145	6183	6221	6258	6296	6333	6371	6408
6	6446	6483	6521	6558	6595	6633	6670	6707	6744	6781
7	6819	6856	6893	6930	6967	7004	7041	7078	7115	7151
8	7188	7225	7262	7298	7335	7372	7408	7445	7482	7518
9	7555	7591	7628	7664	7700	7737	7773	7809	7846	7882
<b>120</b>	07918	07954	07990	08027	08063	08099	08135	08171	08207	08243
1	8279	8314	8350	8386	8422	8458	8493	8529	8565	8600
2	8636	8672	8707	8743	8778	8814	8849	8884	8920	8955
3	8991	9026	9061	9096	9132	9167	9202	9237	9272	9307
4	9342	9377	9412	9447	9482	9517	9552	9587	9621	9656
5	9691	9726	9760	9795	9830	9864	9899	9934	9968	10003
6	10037	10072	10106	10140	10175	10209	10243	10278	10312	0346
7	0380	0415	0449	0483	0517	0551	0585	0619	0653	0687
8	0721	0755	0789	0823	0857	0890	0924	0958	0992	1025
9	1059	1093	1126	1160	1193	1227	1261	1294	1327	1361
<b>130</b>	11394	11428	11461	11494	11528	11561	11594	11628	11661	11694
1	1727	1760	1793	1826	1860	1893	1926	1959	1992	2024
2	2057	2090	2123	2156	2189	2222	2254	2287	2320	2352
3	2385	2418	2450	2483	2516	2548	2581	2613	2646	2678
4	2710	2743	2775	2808	2840	2872	2905	2937	2969	3001
5	3033	3066	3098	3130	3162	3194	3226	3258	3290	3322
6	3354	3386	3418	3450	3481	3513	3545	3577	3609	3640
7	3672	3704	3735	3767	3799	3830	3862	3893	3925	3956
8	3988	4019	4051	4082	4114	4145	4176	4208	4239	4270
9	4301	4333	4364	4395	4426	4457	4489	4520	4551	4582
<b>140</b>	14613	14644	14675	14706	14737	14768	14799	14829	14860	14891
1	4922	4953	4983	5014	5045	5076	5106	5137	5168	5198
2	5229	5259	5290	5320	5351	5381	5412	5442	5473	5503
3	5534	5564	5594	5625	5655	5685	5715	5746	5776	5806
4	5836	5866	5897	5927	5957	5987	6017	6047	6077	6107
5	6137	6167	6197	6227	6256	6286	6316	6346	6376	6406
6	6435	6465	6495	6524	6554	6584	6613	6643	6673	6702
7	6732	6761	6791	6820	6850	6879	6909	6938	6967	6997
8	7026	7056	7085	7114	7143	7173	7202	7231	7260	7289
9	7319	7348	7377	7406	7435	7464	7493	7522	7551	7580
<b>150</b>	17609	17638	17667	17696	17725	17754	17782	17811	17840	17869



N	0	1	2	3	4	5	6	7	8	9
<b>150</b>	17609	17638	17667	17696	17725	17754	17782	17811	17840	17869
<b>1</b>	7898	7926	7955	7984	8013	8041	8070	8099	8127	8156
<b>2</b>	8184	8213	8241	8270	8298	8327	8355	8384	8412	8441
<b>3</b>	8469	8498	8526	8554	8583	8611	8639	8667	8696	8724
<b>4</b>	8752	8780	8808	8837	8865	8893	8921	8949	8977	9005
<b>5</b>	9033	9061	9089	9117	9145	9173	9201	9229	9257	9285
<b>6</b>	9312	9340	9368	9396	9424	9451	9479	9507	9535	9562
<b>7</b>	9590	9618	9645	9673	9700	9728	9756	9783	9811	9838
<b>8</b>	9866	9893	9921	9948	9976	20003	20030	20058	20085	20112
<b>9</b>	20140	20167	20194	20222	20249	0276	0303	0330	0358	0385
<b>160</b>	20412	20439	20466	20493	20520	20548	20575	20602	20629	20656
<b>1</b>	0683	0710	0737	0763	0790	0817	0844	0871	0898	0925
<b>2</b>	0952	0978	1005	1032	1059	1085	1112	1139	1165	1192
<b>3</b>	1219	1245	1272	1299	1325	1352	1378	1405	1431	1458
<b>4</b>	1484	1511	1537	1564	1590	1617	1643	1669	1696	1722
<b>5</b>	1748	1775	1801	1827	1854	1880	1906	1932	1958	1985
<b>6</b>	2011	2037	2063	2089	2115	2141	2167	2194	2220	2246
<b>7</b>	2272	2298	2324	2350	2376	2401	2427	2453	2479	2505
<b>8</b>	2531	2557	2583	2608	2634	2660	2686	2712	2737	2763
<b>9</b>	2789	2814	2840	2866	2891	2917	2943	2968	2994	3019
<b>170</b>	23045	23070	23096	23121	23147	23172	23198	23223	23249	23274
<b>1</b>	3300	3325	3350	3376	3401	3426	3452	3477	3502	3528
<b>2</b>	3553	3578	3603	3629	3654	3679	3704	3729	3754	3779
<b>3</b>	3805	3830	3855	3880	3905	3930	3955	3980	4005	4030
<b>4</b>	4055	4080	4105	4130	4155	4180	4204	4229	4254	4279
<b>5</b>	4304	4329	4353	4378	4403	4428	4452	4477	4502	4527
<b>6</b>	4551	4576	4601	4625	4650	4674	4699	4724	4748	4773
<b>7</b>	4797	4822	4846	4871	4895	4920	4944	4969	4993	5018
<b>8</b>	5042	5066	5091	5115	5139	5164	5188	5212	5237	5261
<b>9</b>	5285	5310	5334	5358	5382	5406	5431	5455	5479	5503
<b>180</b>	25527	25551	25575	25600	25624	25648	25672	25696	25720	25744
<b>1</b>	5768	5792	5816	5840	5864	5888	5912	5935	5959	5983
<b>2</b>	6007	6031	6055	6079	6102	6126	6150	6174	6198	6221
<b>3</b>	6245	6269	6293	6316	6340	6364	6387	6411	6435	6458
<b>4</b>	6482	6505	6529	6553	6576	6600	6623	6647	6670	6694
<b>5</b>	6717	6741	6764	6788	6811	6834	6858	6881	6905	6928
<b>6</b>	6951	6975	6998	7021	7045	7068	7091	7114	7138	7161
<b>7</b>	7184	7207	7231	7254	7277	7300	7323	7346	7370	7393
<b>8</b>	7416	7439	7462	7485	7508	7531	7554	7577	7600	7623
<b>9</b>	7646	7669	7692	7715	7738	7761	7784	7807	7830	7852
<b>190</b>	27875	27898	27921	27944	27967	27989	28012	28035	28058	28081
<b>1</b>	8103	8126	8149	8171	8194	8217	8240	8262	8285	8307
<b>2</b>	8330	8353	8375	8398	8421	8443	8466	8488	8511	8533
<b>3</b>	8556	8578	8601	8623	8646	8668	8691	8713	8735	8758
<b>4</b>	8780	8803	8825	8847	8870	8892	8914	8937	8959	8981
<b>5</b>	9003	9026	9048	9070	9092	9115	9137	9159	9181	9203
<b>6</b>	9226	9248	9270	9292	9314	9336	9358	9380	9403	9425
<b>7</b>	9447	9469	9491	9513	9535	9557	9579	9601	9623	9645
<b>8</b>	9667	9688	9710	9732	9754	9776	9798	9820	9842	9863
<b>9</b>	9885	9907	9929	9951	9973	9994	30016	30038	30060	30081
<b>200</b>	30103	30125	30146	30168	30190	30211	30233	30255	30276	30298

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<b>200</b>	30103	30125	30146	30168	30190	30211	30233	30255	30276	30298
<b>1</b>	0320	0341	0363	0384	0406	0428	0449	0471	0492	0514
<b>2</b>	0535	0557	0578	0600	0621	0643	0664	0685	0707	0728
<b>3</b>	0750	0771	0792	0814	0835	0856	0878	0899	0920	0942
<b>4</b>	0963	0984	1006	1027	1048	1069	1091	1112	1133	1154
<b>5</b>	1175	1197	1218	1239	1260	1281	1302	1323	1345	1366
<b>6</b>	1387	1408	1429	1450	1471	1492	1513	1534	1555	1576
<b>7</b>	1597	1618	1639	1660	1681	1702	1723	1744	1765	1785
<b>8</b>	1806	1827	1848	1869	1890	1911	1931	1952	1973	1994
<b>9</b>	2015	2035	2056	2077	2098	2118	2139	2160	2181	2201
<b>210</b>	32222	32243	32263	32284	32305	32325	32346	32366	32387	32408
<b>1</b>	2428	2449	2469	2490	2510	2531	2552	2572	2593	2613
<b>2</b>	2634	2654	2675	2695	2715	2736	2756	2777	2797	2818
<b>3</b>	2838	2858	2879	2899	2919	2940	2960	2980	3001	3021
<b>4</b>	3041	3062	3082	3102	3122	3143	3163	3183	3203	3224
<b>5</b>	3244	3264	3284	3304	3325	3345	3365	3385	3405	3425
<b>6</b>	3445	3465	3486	3506	3526	3546	3566	3586	3606	3626
<b>7</b>	3646	3666	3686	3706	3726	3746	3766	3786	3806	3826
<b>8</b>	3846	3866	3885	3905	3925	3945	3965	3985	4005	4025
<b>9</b>	4044	4064	4084	4104	4124	4143	4163	4183	4203	4223
<b>220</b>	34242	34262	34282	34301	34321	34341	34361	34380	34400	34420
<b>1</b>	4439	4459	4479	4498	4518	4537	4557	4577	4596	4616
<b>2</b>	4635	4655	4674	4694	4713	4733	4753	4772	4792	4811
<b>3</b>	4830	4850	4869	4889	4908	4928	4947	4967	4986	5005
<b>4</b>	5025	5044	5064	5083	5102	5122	5141	5160	5180	5199
<b>5</b>	5218	5238	5257	5276	5295	5315	5334	5353	5372	5392
<b>6</b>	5411	5430	5449	5468	5488	5507	5526	5545	5564	5583
<b>7</b>	5603	5622	5641	5660	5679	5698	5717	5736	5755	5774
<b>8</b>	5793	5813	5832	5851	5870	5889	5908	5927	5946	5965
<b>9</b>	5984	6003	6021	6040	6059	6078	6097	6116	6135	6154
<b>230</b>	36173	36192	36211	36229	36248	36267	36286	36305	36324	36342
<b>1</b>	6361	6380	6399	6418	6436	6455	6474	6493	6511	6530
<b>2</b>	6549	6568	6586	6605	6624	6642	6661	6680	6698	6717
<b>3</b>	6736	6754	6773	6791	6810	6829	6847	6866	6884	6903
<b>4</b>	6922	6940	6959	6977	6996	7014	7033	7051	7070	7088
<b>5</b>	7107	7125	7144	7162	7181	7199	7218	7236	7254	7273
<b>6</b>	7291	7310	7328	7346	7365	7383	7401	7420	7438	7457
<b>7</b>	7475	7493	7511	7530	7548	7566	7585	7603	7621	7639
<b>8</b>	7658	7676	7694	7712	7731	7749	7767	7785	7803	7822
<b>9</b>	7840	7858	7876	7894	7912	7931	7949	7967	7985	8003
<b>240</b>	38021	38030	38057	38075	38093	38112	38130	38148	38166	38184
<b>1</b>	8202	8220	8238	8256	8274	8292	8310	8328	8346	8364
<b>2</b>	8382	8399	8417	8435	8453	8471	8489	8507	8525	8543
<b>3</b>	8561	8578	8596	8614	8632	8650	8668	8686	8703	8721
<b>4</b>	8739	8757	8775	8792	8810	8828	8846	8863	8881	8899
<b>5</b>	8917	8934	8952	8970	8987	9005	9023	9041	9058	9076
<b>6</b>	9094	9111	9129	9146	9164	9182	9199	9217	9235	9252
<b>7</b>	9270	9287	9305	9322	9340	9358	9375	9393	9410	9428
<b>8</b>	9445	9463	9480	9498	9515	9533	9550	9568	9585	9602
<b>9</b>	9620	9637	9655	9672	9690	9707	9724	9742	9759	9777
<b>250</b>	39794	39811	39829	39846	39863	39881	39898	39915	39933	39950

N	0	1	2	3	4	5	6	7	8	9
<b>250</b>	39794	39811	39829	39846	39863	39881	39898	39915	39933	39950
<b>1</b>	9967	9985	40002	40019	40037	40054	40071	40088	40106	40123
<b>2</b>	40140	40157	0175	0192	0209	0226	0243	0261	0278	0295
<b>3</b>	0312	0329	0346	0364	0381	0398	0415	0432	0449	0466
<b>4</b>	0483	0500	0518	0535	0552	0569	0586	0603	0620	0637
<b>5</b>	0654	0671	0688	0705	0722	0739	0756	0773	0790	0807
<b>6</b>	0824	0841	0858	0875	0892	0909	0926	0943	0960	0976
<b>7</b>	0993	1010	1027	1044	1061	1078	1095	1111	1128	1145
<b>8</b>	1162	1179	1196	1212	1229	1246	1263	1280	1296	1313
<b>9</b>	1330	1347	1363	1380	1397	1414	1430	1447	1464	1481
<b>260</b>	41497	41514	41531	41547	41564	41581	41597	41614	41631	41647
<b>1</b>	1664	1681	1697	1714	1731	1747	1764	1780	1797	1814
<b>2</b>	1830	1847	1863	1880	1896	1913	1929	1946	1963	1979
<b>3</b>	1996	2012	2029	2045	2062	2078	2095	2111	2127	2144
<b>4</b>	2160	2177	2193	2210	2226	2243	2259	2275	2292	2308
<b>5</b>	2325	2341	2357	2374	2390	2406	2423	2439	2455	2472
<b>6</b>	2488	2504	2521	2537	2553	2570	2586	2602	2619	2635
<b>7</b>	2651	2667	2684	2700	2716	2732	2749	2765	2781	2797
<b>8</b>	2813	2830	2846	2862	2878	2894	2911	2927	2943	2959
<b>9</b>	2975	2991	3008	3024	3040	3056	3072	3088	3104	3120
<b>270</b>	43136	43152	43169	43185	43201	43217	43233	43249	43265	43281
<b>1</b>	3297	3313	3329	3345	3361	3377	3393	3409	3425	3441
<b>2</b>	3457	3473	3489	3505	3521	3537	3553	3569	3584	3600
<b>3</b>	3616	3632	3648	3664	3680	3696	3712	3727	3743	3759
<b>4</b>	3775	3791	3807	3823	3838	3854	3870	3886	3902	3917
<b>5</b>	3933	3949	3965	3981	3996	4012	4028	4044	4059	4075
<b>6</b>	4091	4107	4122	4138	4154	4170	4186	4201	4217	4232
<b>7</b>	4248	4264	4279	4295	4311	4326	4342	4358	4373	4389
<b>8</b>	4404	4420	4436	4451	4467	4483	4498	4514	4529	4545
<b>9</b>	4560	4576	4592	4607	4623	4638	4654	4669	4685	4700
<b>280</b>	44716	44731	44747	44762	44778	44793	44809	44824	44840	44855
<b>1</b>	4871	4886	4902	4917	4932	4948	4963	4979	4994	5010
<b>2</b>	5025	5040	5056	5071	5086	5102	5117	5133	5148	5163
<b>3</b>	5179	5194	5209	5225	5240	5255	5271	5286	5301	5317
<b>4</b>	5332	5347	5362	5378	5393	5408	5423	5439	5454	5469
<b>5</b>	5484	5500	5515	5530	5545	5561	5576	5591	5606	5621
<b>6</b>	5637	5652	5667	5682	5697	5712	5728	5743	5758	5773
<b>7</b>	5788	5803	5818	5834	5849	5864	5879	5894	5909	5924
<b>8</b>	5939	5954	5969	5984	6000	6015	6030	6045	6060	6075
<b>9</b>	6090	6105	6120	6135	6150	6165	6180	6195	6210	6225
<b>290</b>	46240	46255	46270	46285	46300	46315	46330	46345	46359	46374
<b>1</b>	6389	6404	6419	6434	6449	6464	6479	6494	6509	6523
<b>2</b>	6538	6553	6568	6583	6598	6613	6627	6642	6657	6672
<b>3</b>	6687	6702	6716	6731	6746	6761	6776	6790	6805	6820
<b>4</b>	6835	6850	6864	6879	6894	6909	6923	6938	6953	6967
<b>5</b>	6982	6997	7012	7026	7041	7056	7070	7085	7100	7114
<b>6</b>	7129	7144	7159	7173	7188	7202	7217	7232	7246	7261
<b>7</b>	7276	7290	7305	7319	7334	7349	7363	7378	7392	7407
<b>8</b>	7422	7436	7451	7465	7480	7494	7509	7524	7538	7553
<b>9</b>	7567	7582	7596	7611	7625	7640	7654	7669	7683	7698
<b>300</b>	47712	47727	47741	47756	47770	47784	47799	47813	47828	47842

N	0	1	2	3	4	5	6	7	8	9
<b>800</b>	47712	47727	47741	47756	47770	47784	47799	47813	47828	47842
1	7857	7871	7885	7900	7914	7929	7943	7958	7972	7986
2	8001	8015	8029	8044	8058	8073	8087	8101	8116	8130
3	8144	8159	8173	8187	8202	8216	8230	8244	8259	8273
4	8287	8302	8316	8330	8344	8359	8373	8387	8401	8416
5	8430	8444	8458	8473	8487	8501	8515	8530	8544	8558
6	8572	8586	8601	8615	8629	8643	8657	8671	8686	8700
7	8714	8728	8742	8756	8770	8785	8799	8813	8827	8841
8	8855	8869	8883	8897	8911	8926	8940	8954	8968	8982
9	8996	9010	9024	9038	9052	9066	9080	9094	9108	9122
<b>810</b>	49136	49150	49164	49178	49192	49206	49220	49234	49248	49262
1	9276	9290	9304	9318	9332	9346	9360	9374	9388	9402
2	9415	9429	9443	9457	9471	9485	9499	9513	9527	9541
3	9554	9568	9582	9596	9610	9624	9638	9651	9665	9679
4	9693	9707	9721	9734	9748	9762	9776	9790	9803	9817
5	9831	9845	9859	9872	9886	9900	9914	9927	9941	9955
6	9969	9982	9996	50010	50024	50037	50051	50065	50079	50092
7	50106	50120	50133	0147	0161	0174	0188	0202	0215	0229
8	0243	0256	0270	0284	0297	0311	0325	0338	0352	0365
9	0379	0393	0406	0420	0433	0447	0461	0474	0488	0601
<b>820</b>	50515	50529	50542	50556	50569	50583	50596	50610	50623	50637
1	0651	0664	0678	0691	0705	0718	0732	0745	0759	0772
2	0786	0799	0813	0826	0840	0853	0866	0880	0893	0907
3	0920	0934	0947	0961	0974	0987	1001	1014	1028	1041
4	1055	1068	1081	1095	1108	1121	1135	1148	1162	1175
5	1188	1202	1215	1228	1242	1255	1268	1282	1295	1308
6	1322	1335	1348	1362	1375	1388	1402	1415	1428	1441
7	1455	1468	1481	1495	1508	1521	1534	1548	1561	1574
8	1587	1601	1614	1627	1640	1654	1667	1680	1693	1706
9	1720	1733	1746	1759	1772	1786	1799	1812	1825	1838
<b>830</b>	51851	51865	51878	51891	51904	51917	51930	51943	51957	51970
1	1983	1996	2009	2022	2035	2048	2061	2075	2088	2101
2	2114	2127	2140	2153	2166	2179	2192	2205	2218	2231
3	2244	2257	2270	2284	2297	2310	2323	2336	2349	2362
4	2375	2388	2401	2414	2427	2440	2453	2466	2479	2492
5	2504	2517	2530	2543	2556	2569	2582	2595	2608	2621
6	2634	2647	2660	2673	2686	2699	2711	2724	2737	2750
7	2763	2776	2789	2802	2815	2827	2840	2853	2866	2879
8	2892	2905	2917	2930	2943	2956	2969	2982	2994	3007
9	3020	3033	3046	3058	3071	3084	3097	3110	3122	3135
<b>840</b>	53148	53161	53173	53186	53199	53212	53224	53237	53250	53263
1	3275	3288	3301	3314	3326	3339	3352	3364	3377	3390
2	3403	3415	3428	3441	3453	3466	3479	3491	3504	3517
3	3529	3542	3555	3567	3580	3593	3605	3618	3631	3643
4	3656	3668	3681	3694	3706	3719	3732	3744	3757	3769
5	3782	3794	3807	3820	3832	3845	3857	3870	3882	3895
6	3908	3920	3933	3945	3958	3970	3983	3995	4008	4020
7	4033	4045	4058	4070	4083	4095	4108	4120	4133	4145
8	4158	4170	4183	4195	4208	4220	4233	4245	4258	4270
9	4283	4295	4307	4320	4332	4345	4357	4370	4382	4394
<b>850</b>	54407	54419	54432	54444	54456	54469	54481	54494	54506	54518

COMPARATIVE VALUES — (Continued)

M	Δ	Taper	1/4		1/2		3/4		1		1 1/4		1 1/2		2		2 1/4		3		3 1/4		4		5						
			1/4	1	1/4	1	1/4	2	1/4	2 1/4	1/4	2	1/4	2 1/4	1/4	2 1/4	1/4	2 1/4	1/4	2 1/4	1/4	2 1/4	1/4	2 1/4	1/4	2 1/4	1/4	2 1/4			
7° 00'	l	390.00	250.00	180.00	138.00	110.00	75.00	54.00	40.00	30.00	24.00	18.00	13.00	10.00	7.50	5.40	4.00	3.00	2.40	1.80	1.38	1.10	0.75	0.54	0.40	0.30	0.24	0.18	0.14		
	d	8.92	3.94	2.20	1.39	0.95	0.51	0.31	0.20	0.16	0.12	0.09	0.07	0.05	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01		
	o	13° 39'	8° 45'	6° 18'	4° 49 1/2'	3° 51'	2° 37 1/2'	1° 53 1/2'	1° 24'	1° 00'	0° 45'	0° 30'	0° 22 1/2'	0° 16 1/2'	0° 12 1/2'	0° 09 1/2'	0° 07 1/2'	0° 05 1/2'	0° 04 1/2'	0° 03 1/2'	0° 02 1/2'	0° 02 1/4'	0° 01 3/4'	0° 01 1/2'	0° 01 1/4'	0° 01 1/8'	0° 01 1/16'	0° 00 3/4'	0° 00 1/2'		
7° 30'	l	420.00	270.00	195.00	150.00	120.00	82.50	60.00	45.00	33.00	24.00	18.00	13.50	10.00	7.50	5.40	4.00	3.00	2.40	1.80	1.35	1.00	0.75	0.54	0.40	0.30	0.24	0.18	0.14		
	d	10.97	4.85	2.71	1.72	1.18	0.64	0.39	0.26	0.20	0.15	0.11	0.08	0.06	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01		
	o	15° 45'	10° 07 1/2'	7° 18 1/4'	5° 37 1/2'	4° 30'	3° 05 1/2'	2° 15'	1° 41 1/4'	1° 15'	0° 51'	0° 36'	0° 27 1/2'	0° 20 1/4'	0° 15 1/4'	0° 11 1/4'	0° 08 1/4'	0° 06 1/4'	0° 05 1/4'	0° 04 1/4'	0° 03 1/4'	0° 02 3/4'	0° 02 1/4'	0° 01 3/4'	0° 01 1/2'	0° 01 1/4'	0° 01 1/8'	0° 00 3/4'	0° 00 1/2'		
8° 00'	l	480.00	300.00	210.00	162.00	130.00	90.00	66.00	50.00	36.00	27.00	20.00	15.00	11.25	8.40	6.00	4.50	3.30	2.40	1.80	1.35	1.00	0.75	0.54	0.40	0.30	0.24	0.18	0.14		
	d	11.96	5.90	3.29	2.09	1.44	0.78	0.48	0.32	0.24	0.18	0.13	0.09	0.07	0.05	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
	o	18° 36'	11° 36'	8° 24'	6° 28 1/2'	5° 12'	3° 36'	2° 38 1/2'	1° 54'	1° 30'	1° 00'	0° 48'	0° 36'	0° 27 1/2'	0° 20 1/4'	0° 15 1/4'	0° 11 1/4'	0° 08 1/4'	0° 06 1/4'	0° 05 1/4'	0° 04 1/4'	0° 03 1/4'	0° 02 3/4'	0° 02 1/4'	0° 01 3/4'	0° 01 1/2'	0° 01 1/4'	0° 01 1/8'	0° 00 3/4'	0° 00 1/2'	
8° 30'	l	540.00	330.00	225.00	174.00	140.00	97.50	72.00	55.00	39.00	29.00	21.00	15.75	11.25	8.40	6.00	4.50	3.30	2.40	1.80	1.35	1.00	0.75	0.54	0.40	0.30	0.24	0.18	0.14		
	d	13.96	7.08	3.96	2.51	1.73	0.95	0.59	0.39	0.28	0.21	0.16	0.12	0.09	0.06	0.05	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
	o	21° 10 1/2'	13° 10 1/2'	9° 33 1/2'	7° 23 1/2'	5° 57'	4° 08 1/2'	3° 03 1/2'	2° 15'	1° 41 1/4'	1° 15'	0° 51'	0° 36'	0° 27 1/2'	0° 20 1/4'	0° 15 1/4'	0° 11 1/4'	0° 08 1/4'	0° 06 1/4'	0° 05 1/4'	0° 04 1/4'	0° 03 1/4'	0° 02 3/4'	0° 02 1/4'	0° 01 3/4'	0° 01 1/2'	0° 01 1/4'	0° 01 1/8'	0° 00 3/4'	0° 00 1/2'	
9° 00'	l	600.00	360.00	240.00	186.00	150.00	105.00	78.00	60.00	42.00	31.50	23.00	17.25	12.75	9.45	7.00	5.25	3.90	2.85	2.10	1.57	1.18	0.89	0.67	0.50	0.38	0.29	0.22	0.16	0.12	
	d	15.96	8.42	4.71	2.99	2.06	1.13	0.70	0.47	0.34	0.25	0.18	0.13	0.10	0.07	0.05	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
	o	22° 51'	14° 51'	10° 48'	8° 22 1/4'	6° 45'	4° 43 1/2'	3° 30 1/2'	2° 30'	1° 54'	1° 22 1/2'	0° 51'	0° 36'	0° 27 1/2'	0° 20 1/4'	0° 15 1/4'	0° 11 1/4'	0° 08 1/4'	0° 06 1/4'	0° 05 1/4'	0° 04 1/4'	0° 03 1/4'	0° 02 3/4'	0° 02 1/4'	0° 01 3/4'	0° 01 1/2'	0° 01 1/4'	0° 01 1/8'	0° 00 3/4'	0° 00 1/2'	
10° 00'	l	720.00	420.00	270.00	210.00	170.00	120.00	90.00	70.00	48.00	36.00	27.00	20.25	15.00	11.25	8.40	6.00	4.50	3.30	2.40	1.80	1.35	1.00	0.75	0.54	0.40	0.30	0.24	0.18	0.14	
	d	19.96	11.55	6.47	4.12	2.84	1.57	0.98	0.66	0.48	0.36	0.27	0.20	0.15	0.11	0.08	0.06	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	o	28° 30'	18° 30'	13° 30'	10° 30'	8° 30'	6° 00'	4° 30'	3° 30'	2° 30'	1° 54'	1° 22 1/2'	0° 51'	0° 36'	0° 27 1/2'	0° 20 1/4'	0° 15 1/4'	0° 11 1/4'	0° 08 1/4'	0° 06 1/4'	0° 05 1/4'	0° 04 1/4'	0° 03 1/4'	0° 02 3/4'	0° 02 1/4'	0° 01 3/4'	0° 01 1/2'	0° 01 1/4'	0° 01 1/8'	0° 00 3/4'	0° 00 1/2'

LOGARITHMS OF NUMBERS

123

N	0	1	2	3	4	5	6	7	8	9
<b>400</b>	60206	60217	60228	60239	60249	60260	60271	60282	60293	60304
<b>1</b>	0314	0325	0336	0347	0358	0369	0379	0390	0401	0412
<b>2</b>	0423	0433	0444	0455	0466	0477	0487	0498	0509	0520
<b>3</b>	0531	0541	0552	0563	0574	0584	0595	0606	0617	0627
<b>4</b>	0638	0649	0660	0670	0681	0692	0703	0713	0724	0735
<b>5</b>	0746	0756	0767	0778	0788	0799	0810	0821	0831	0842
<b>6</b>	0853	0863	0874	0885	0895	0906	0917	0927	0938	0949
<b>7</b>	0959	0970	0981	0991	1002	1013	1023	1034	1045	1055
<b>8</b>	1066	1077	1087	1098	1109	1119	1130	1140	1151	1162
<b>9</b>	1172	1183	1194	1204	1215	1225	1236	1247	1257	1268
<b>410</b>	61278	61289	61300	61310	61321	61331	61342	61352	61363	61374
<b>1</b>	1384	1395	1405	1416	1426	1437	1448	1458	1469	1479
<b>2</b>	1490	1500	1511	1521	1532	1542	1553	1563	1574	1584
<b>3</b>	1595	1606	1616	1627	1637	1648	1658	1669	1679	1690
<b>4</b>	1700	1711	1721	1731	1742	1752	1763	1773	1784	1794
<b>5</b>	1805	1815	1826	1836	1847	1857	1868	1878	1888	1899
<b>6</b>	1909	1920	1930	1941	1951	1962	1972	1982	1993	2003
<b>7</b>	2014	2024	2034	2045	2055	2066	2076	2086	2097	2107
<b>8</b>	2118	2128	2138	2149	2159	2170	2180	2190	2201	2211
<b>9</b>	2221	2232	2242	2252	2263	2273	2284	2294	2304	2315
<b>420</b>	62325	62335	62346	62356	62366	62377	62387	62397	62408	62418
<b>1</b>	2428	2439	2449	2459	2469	2480	2490	2500	2511	2521
<b>2</b>	2531	2542	2552	2562	2572	2583	2593	2603	2613	2624
<b>3</b>	2634	2644	2655	2665	2675	2685	2696	2706	2716	2726
<b>4</b>	2737	2747	2757	2767	2778	2788	2798	2808	2818	2829
<b>5</b>	2839	2849	2859	2870	2880	2890	2900	2910	2921	2931
<b>6</b>	2941	2951	2961	2972	2982	2992	3002	3012	3022	3033
<b>7</b>	3043	3053	3063	3073	3083	3094	3104	3114	3124	3134
<b>8</b>	3144	3155	3165	3175	3185	3195	3205	3215	3225	3236
<b>9</b>	3246	3256	3266	3276	3286	3296	3306	3317	3327	3337
<b>430</b>	63347	63357	63367	63377	63387	63397	63407	63417	63428	63438
<b>1</b>	3448	3458	3468	3478	3488	3498	3508	3518	3528	3538
<b>2</b>	3548	3558	3568	3579	3589	3599	3609	3619	3629	3639
<b>3</b>	3649	3659	3669	3679	3689	3699	3709	3719	3729	3739
<b>4</b>	3749	3759	3769	3779	3789	3799	3809	3819	3829	3839
<b>5</b>	3849	3859	3869	3879	3889	3899	3909	3919	3929	3939
<b>6</b>	3949	3959	3969	3979	3988	3998	4008	4018	4028	4038
<b>7</b>	4048	4058	4068	4078	4088	4098	4108	4118	4128	4137
<b>8</b>	4147	4157	4167	4177	4187	4197	4207	4217	4227	4237
<b>9</b>	4246	4256	4266	4276	4286	4296	4306	4316	4326	4336
<b>440</b>	64345	64355	64365	64375	64385	64395	64404	64414	64424	64434
<b>1</b>	4444	4454	4464	4473	4483	4493	4503	4513	4523	4532
<b>2</b>	4542	4552	4562	4572	4582	4591	4601	4611	4621	4631
<b>3</b>	4640	4650	4660	4670	4680	4690	4699	4709	4719	4729
<b>4</b>	4738	4748	4758	4768	4777	4787	4797	4807	4816	4825
<b>5</b>	4835	4845	4855	4865	4875	4885	4895	4904	4914	4924
<b>6</b>	4933	4943	4953	4963	4972	4982	4992	5002	5011	5021
<b>7</b>	5031	5040	5050	5060	5070	5079	5089	5099	5108	5118
<b>8</b>	5128	5137	5147	5157	5167	5176	5186	5196	5205	5215
<b>9</b>	5225	5234	5244	5254	5263	5273	5283	5292	5302	5312
<b>450</b>	65321	65331	65341	65350	65360	65369	65379	65389	65398	65408

N	0	1	2	3	4	5	6	7	8	9
<b>450</b>	65321	65331	65341	65350	65360	65369	65379	65389	65398	65408
1	5418	5427	5437	5447	5456	5466	5475	5485	5495	5504
2	5514	5523	5533	5543	5552	5562	5571	5581	5591	5600
3	5610	5619	5629	5639	5648	5658	5667	5677	5686	5696
4	5706	5715	5725	5734	5744	5753	5763	5772	5782	5792
5	5801	5811	5820	5830	5839	5849	5858	5868	5877	5887
6	5896	5906	5916	5925	5935	5944	5954	5963	5973	5982
7	5992	6001	6011	6020	6030	6039	6049	6058	6068	6077
8	6087	6096	6106	6115	6124	6134	6143	6153	6162	6172
9	6181	6191	6200	6210	6219	6229	6238	6247	6257	6266
<b>460</b>	66276	66285	66295	66304	66314	66323	66332	66342	66351	66361
1	6370	6380	6389	6398	6408	6417	6427	6436	6445	6455
2	6464	6474	6483	6492	6502	6511	6521	6530	6539	6549
3	6558	6567	6577	6586	6596	6605	6614	6624	6633	6642
4	6652	6661	6671	6680	6689	6699	6708	6717	6727	6736
5	6745	6755	6764	6773	6783	6792	6801	6811	6820	6829
6	6839	6848	6857	6867	6876	6885	6894	6904	6913	6922
7	6932	6941	6950	6960	6969	6978	6987	6997	7006	7015
8	7025	7034	7043	7052	7062	7071	7080	7089	7099	7108
9	7117	7127	7136	7145	7154	7164	7173	7182	7191	7201
<b>470</b>	67210	67219	67228	67237	67247	67256	67265	67274	67284	67293
1	7302	7311	7321	7330	7339	7348	7357	7367	7376	7385
2	7394	7403	7413	7422	7431	7440	7449	7459	7468	7477
3	7486	7495	7504	7514	7523	7532	7541	7550	7560	7569
4	7578	7587	7596	7605	7614	7624	7633	7642	7651	7660
5	7669	7679	7688	7697	7706	7715	7724	7733	7742	7752
6	7761	7770	7779	7788	7797	7806	7815	7825	7834	7843
7	7852	7861	7870	7879	7888	7897	7906	7916	7925	7934
8	7943	7952	7961	7970	7979	7988	7997	8006	8015	8024
9	8034	8043	8052	8061	8070	8079	8088	8097	8106	8115
<b>480</b>	68124	68133	68142	68151	68160	68169	68178	68187	68196	68205
1	8215	8224	8233	8242	8251	8260	8269	8278	8287	8296
2	8305	8314	8323	8332	8341	8350	8359	8368	8377	8386
3	8395	8404	8413	8422	8431	8440	8449	8458	8467	8476
4	8485	8494	8502	8511	8520	8529	8538	8547	8556	8565
5	8574	8583	8592	8601	8610	8619	8628	8637	8646	8655
6	8664	8673	8681	8690	8699	8708	8717	8726	8735	8744
7	8753	8762	8771	8780	8789	8797	8806	8815	8824	8833
8	8842	8851	8860	8869	8878	8886	8895	8904	8913	8922
9	8931	8940	8949	8958	8966	8975	8984	8993	9002	9011
<b>490</b>	69020	69028	69037	69046	69055	69064	69073	69082	69090	69099
1	9108	9117	9126	9135	9144	9152	9161	9170	9179	9188
2	9197	9205	9214	9223	9232	9241	9249	9258	9267	9276
3	9285	9294	9302	9311	9320	9329	9338	9346	9355	9364
4	9373	9381	9390	9399	9408	9417	9425	9434	9443	9452
5	9461	9469	9478	9487	9496	9504	9513	9522	9531	9539
6	9548	9557	9566	9574	9583	9592	9601	9609	9618	9627
7	9636	9644	9653	9662	9671	9679	9688	9697	9705	9714
8	9723	9732	9740	9749	9758	9767	9775	9784	9793	9801
9	9810	9819	9827	9836	9845	9854	9862	9871	9880	9888
<b>500</b>	69987	69996	69914	69923	69932	69940	69949	69958	69966	69975

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2	70070	70079	0088	0096	0105	0114	0122	0131	0140	0148
3	0157	0165	0174	0183	0191	0200	0209	0217	0226	0234
4	0243	0252	0260	0269	0278	0286	0295	0303	0312	0321
5	0329	0338	0346	0355	0364	0372	0381	0389	0398	0406
6	0415	0424	0432	0441	0449	0458	0467	0475	0484	0492
7	0501	0509	0518	0526	0535	0544	0552	0561	0569	0578
8	0586	0595	0603	0612	0621	0629	0638	0646	0655	0663
9	0672	0680	0689	0697	0706	0714	0723	0731	0740	0749
<b>510</b>	70757	70766	70774	70783	70791	70800	70808	70817	70825	70834
1	0842	0851	0859	0868	0876	0885	0893	0902	0910	0919
2	0927	0935	0944	0952	0961	0969	0978	0986	0995	1003
3	1012	1020	1029	1037	1046	1054	1063	1071	1079	1088
4	1096	1105	1113	1122	1130	1139	1147	1155	1164	1172
5	1181	1189	1198	1206	1214	1223	1231	1240	1248	1257
6	1265	1273	1282	1290	1299	1307	1315	1324	1332	1341
7	1349	1357	1366	1374	1383	1391	1399	1408	1416	1425
8	1433	1441	1450	1458	1466	1475	1483	1492	1500	1508
9	1517	1525	1533	1542	1550	1559	1567	1575	1584	1592
<b>520</b>	71600	71609	71617	71625	71634	71642	71650	71659	71667	71675
1	1684	1692	1700	1709	1717	1725	1734	1742	1750	1759
2	1767	1775	1784	1792	1800	1809	1817	1825	1834	1842
3	1850	1858	1867	1875	1883	1892	1900	1908	1917	1925
4	1933	1941	1950	1958	1966	1975	1983	1991	1999	2008
5	2016	2024	2032	2041	2049	2057	2066	2074	2082	2090
6	2099	2107	2115	2123	2132	2140	2148	2156	2165	2173
7	2181	2189	2198	2206	2214	2222	2230	2239	2247	2255
8	2263	2272	2280	2288	2296	2304	2313	2321	2329	2337
9	2346	2354	2362	2370	2378	2387	2395	2403	2411	2419
<b>530</b>	72428	72436	72444	72452	72460	72469	72477	72485	72493	72501
1	2509	2518	2526	2534	2542	2550	2558	2567	2575	2583
2	2591	2599	2607	2616	2624	2632	2640	2648	2656	2665
3	2673	2681	2689	2697	2705	2713	2722	2730	2738	2746
4	2754	2762	2770	2779	2787	2795	2803	2811	2819	2827
5	2835	2843	2852	2860	2868	2876	2884	2892	2900	2908
6	2916	2925	2933	2941	2949	2957	2965	2973	2981	2989
7	2997	3006	3014	3022	3030	3038	3046	3054	3062	3070
8	3078	3086	3094	3102	3111	3119	3127	3135	3143	3151
9	3159	3167	3175	3183	3191	3199	3207	3215	3223	3231
<b>540</b>	73239	73247	73255	73263	73272	73280	73288	73296	73304	73312
1	3320	3328	3336	3344	3352	3360	3368	3376	3384	3392
2	3400	3408	3416	3424	3432	3440	3448	3456	3464	3472
3	3480	3488	3496	3504	3512	3520	3528	3536	3544	3552
4	3560	3568	3576	3584	3592	3600	3608	3616	3624	3632
5	3640	3648	3656	3664	3672	3679	3687	3695	3703	3711
6	3719	3727	3735	3743	3751	3759	3767	3775	3783	3791
7	3799	3807	3815	3823	3830	3838	3846	3854	3862	3870
8	3878	3886	3894	3902	3910	3918	3926	3933	3941	3949
9	3957	3965	3973	3981	3989	3997	4005	4013	4020	4028
<b>550</b>	74036	74044	74052	74060	74068	74076	74084	74092	74099	74107



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<b>550</b>	74036	74044	74052	74060	74068	74076	74084	74092	74099	74107
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2	4194	4202	4210	4218	4225	4233	4241	4249	4257	4265
3	4273	4280	4288	4296	4304	4312	4320	4327	4335	4343
4	4351	4359	4367	4374	4382	4390	4398	4406	4414	4421
5	4429	4437	4445	4453	4461	4468	4476	4484	4492	4500
6	4507	4515	4523	4531	4539	4547	4554	4562	4570	4578
7	4586	4593	4601	4609	4617	4624	4632	4640	4648	4656
8	4663	4671	4679	4687	4695	4702	4710	4718	4726	4733
9	4741	4749	4757	4764	4772	4780	4788	4796	4803	4811
<b>560</b>	74819	74827	74834	74842	74850	74858	74865	74873	74881	74889
1	4896	4904	4912	4920	4927	4935	4943	4950	4958	4966
2	4974	4981	4989	4997	5005	5012	5020	5028	5035	5043
3	5051	5059	5066	5074	5082	5089	5097	5105	5113	5120
4	5128	5136	5143	5151	5159	5166	5174	5182	5189	5197
5	5205	5213	5220	5228	5236	5243	5251	5259	5266	5274
6	5282	5290	5297	5305	5312	5320	5328	5335	5343	5351
7	5358	5366	5374	5381	5389	5397	5404	5412	5420	5427
8	5435	5442	5450	5458	5465	5473	5481	5488	5496	5504
9	5511	5519	5526	5534	5542	5549	5557	5565	5572	5580
<b>570</b>	75587	75595	75603	75610	75618	75626	75633	75641	75648	75656
1	5664	5671	5679	5686	5694	5702	5709	5717	5724	5732
2	5740	5747	5755	5762	5770	5778	5785	5793	5800	5808
3	5815	5823	5831	5838	5846	5853	5861	5868	5876	5884
4	5891	5899	5906	5914	5921	5929	5937	5944	5952	5959
5	5967	5974	5982	5989	5997	6005	6012	6020	6027	6035
6	6042	6050	6057	6065	6072	6080	6087	6095	6103	6110
7	6118	6125	6133	6140	6148	6155	6163	6170	6178	6185
8	6193	6200	6208	6215	6223	6230	6238	6245	6253	6260
9	6268	6275	6283	6290	6298	6305	6313	6320	6328	6335
<b>580</b>	76343	76350	76358	76365	76373	76380	76388	76395	76403	76410
1	6418	6425	6433	6440	6448	6455	6462	6470	6477	6485
2	6492	6500	6507	6515	6522	6530	6537	6545	6552	6559
3	6567	6574	6582	6589	6597	6604	6612	6619	6626	6634
4	6641	6649	6656	6664	6671	6678	6686	6693	6701	6708
5	6716	6723	6730	6738	6745	6753	6760	6768	6775	6782
6	6790	6797	6805	6812	6819	6827	6834	6842	6849	6856
7	6864	6871	6879	6886	6893	6901	6908	6916	6923	6930
8	6938	6945	6953	6960	6967	6975	6982	6989	6997	7004
9	7012	7019	7026	7034	7041	7048	7056	7063	7070	7078
<b>590</b>	77085	77093	77100	77107	77115	77122	77129	77137	77144	77151
1	7159	7166	7173	7181	7188	7195	7203	7210	7217	7225
2	7232	7240	7247	7254	7262	7269	7276	7283	7291	7298
3	7305	7313	7320	7327	7335	7342	7349	7357	7364	7371
4	7379	7386	7393	7401	7408	7415	7422	7430	7437	7444
5	7452	7459	7466	7474	7481	7488	7495	7503	7510	7517
6	7525	7532	7539	7546	7554	7561	7568	7576	7583	7590
7	7597	7605	7612	7619	7627	7634	7641	7648	7656	7663
8	7670	7677	7685	7692	7699	7706	7714	7721	7728	7735
9	7743	7750	7757	7764	7772	7779	7786	7793	7801	7808
<b>600</b>	77815	77822	77830	77837	77844	77851	77859	77866	77873	77880

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2	7960	7967	7974	7981	7988	7996	8003	8010	8017	8025
3	8032	8039	8046	8053	8061	8068	8075	8082	8089	8097
4	8104	8111	8118	8125	8132	8140	8147	8154	8161	8168
5	8176	8183	8190	8197	8204	8211	8219	8226	8233	8240
6	8247	8254	8262	8269	8276	8283	8290	8297	8305	8312
7	8319	8326	8333	8340	8347	8355	8362	8369	8376	8383
8	8390	8398	8405	8412	8419	8426	8433	8440	8447	8455
9	8462	8469	8476	8483	8490	8497	8504	8512	8519	8526
<b>610</b>	78533	78540	78547	78554	78561	78569	78576	78583	78590	78597
1	8604	8611	8618	8625	8633	8640	8647	8654	8661	8668
2	8675	8682	8689	8696	8704	8711	8718	8725	8732	8739
3	8746	8753	8760	8767	8774	8781	8789	8796	8803	8810
4	8817	8824	8831	8838	8845	8852	8859	8866	8873	8880
5	8888	8895	8902	8909	8916	8923	8930	8937	8944	8951
6	8958	8965	8972	8979	8986	8993	9000	9007	9014	9021
7	9029	9036	9043	9050	9057	9064	9071	9078	9085	9092
8	9099	9106	9113	9120	9127	9134	9141	9148	9155	9162
9	9169	9176	9183	9190	9197	9204	9211	9218	9225	9232
<b>620</b>	79239	79246	79253	79260	79267	79274	79281	79288	79295	79302
1	9309	9316	9323	9330	9337	9344	9351	9358	9365	9372
2	9379	9386	9393	9400	9407	9414	9421	9428	9435	9442
3	9449	9456	9463	9470	9477	9484	9491	9498	9505	9511
4	9518	9525	9532	9539	9546	9553	9560	9567	9574	9581
5	9588	9595	9602	9609	9616	9623	9630	9637	9644	9650
6	9657	9664	9671	9678	9685	9692	9699	9706	9713	9720
7	9727	9734	9741	9748	9754	9761	9768	9775	9782	9789
8	9796	9803	9810	9817	9824	9831	9837	9844	9851	9858
9	9865	9872	9879	9886	9893	9900	9906	9913	9920	9927
<b>630</b>	79934	79941	79948	79955	79962	79969	79975	79982	79989	79996
1	80003	80010	80017	80024	80030	80037	80044	80051	80058	80065
2	0072	0079	0085	0092	0099	0106	0113	0120	0127	0134
3	0140	0147	0154	0161	0168	0175	0182	0188	0195	0202
4	0209	0216	0223	0229	0236	0243	0250	0257	0264	0271
5	0277	0284	0291	0298	0305	0312	0318	0325	0332	0339
6	0346	0353	0359	0366	0373	0380	0387	0393	0400	0407
7	0414	0421	0428	0434	0441	0448	0455	0462	0468	0475
8	0482	0489	0496	0502	0509	0516	0523	0530	0536	0543
9	0550	0557	0564	0570	0577	0584	0591	0598	0604	0611
<b>640</b>	80618	80625	80632	80638	80645	80652	80659	80665	80672	80679
1	0686	0693	0699	0706	0713	0720	0726	0733	0740	0747
2	0754	0760	0767	0774	0781	0787	0794	0801	0808	0814
3	0821	0828	0835	0841	0848	0855	0862	0868	0875	0882
4	0889	0895	0902	0909	0916	0922	0929	0936	0943	0949
5	0956	0963	0969	0976	0983	0990	0996	1003	1010	1017
6	1023	1030	1037	1043	1050	1057	1064	1070	1077	1084
7	1090	1097	1104	1111	1117	1124	1131	1137	1144	1151
8	1158	1164	1171	1178	1184	1191	1198	1204	1211	1218
9	1224	1231	1238	1245	1251	1258	1265	1271	1278	1285
<b>650</b>	81291	81298	81305	81311	81318	81325	81331	81338	81345	81351

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<b>3</b>	1491	1498	1505	1511	1518	1525	1531	1538	1544	1551
<b>4</b>	1558	1564	1571	1578	1584	1591	1598	1604	1611	1617
<b>5</b>	1624	1631	1637	1644	1651	1657	1664	1671	1677	1684
<b>6</b>	1690	1697	1704	1710	1717	1723	1730	1737	1743	1750
<b>7</b>	1757	1763	1770	1776	1783	1790	1796	1803	1809	1816
<b>8</b>	1823	1829	1836	1842	1849	1856	1862	1869	1875	1882
<b>9</b>	1889	1895	1902	1908	1915	1921	1928	1935	1941	1948
<b>660</b>	81954	81961	81968	81974	81981	81987	81994	82000	82007	82014
<b>1</b>	2020	2027	2033	2040	2046	2053	2060	2066	2073	2079
<b>2</b>	2086	2092	2099	2105	2112	2119	2125	2132	2138	2145
<b>3</b>	2151	2158	2164	2171	2178	2184	2191	2197	2204	2210
<b>4</b>	2217	2223	2230	2236	2243	2249	2256	2263	2269	2276
<b>5</b>	2282	2289	2295	2302	2308	2315	2321	2328	2334	2341
<b>6</b>	2347	2354	2360	2367	2373	2380	2387	2393	2400	2406
<b>7</b>	2413	2419	2426	2432	2439	2445	2452	2458	2465	2471
<b>8</b>	2478	2484	2491	2497	2504	2510	2517	2523	2530	2536
<b>9</b>	2543	2549	2556	2562	2569	2575	2582	2588	2595	2601
<b>670</b>	82607	82614	82620	82627	82633	82640	82646	82653	82659	82666
<b>1</b>	2672	2679	2685	2692	2698	2705	2711	2718	2724	2730
<b>2</b>	2737	2743	2750	2756	2763	2769	2776	2782	2789	2795
<b>3</b>	2802	2808	2814	2821	2827	2834	2840	2847	2853	2860
<b>4</b>	2866	2872	2879	2885	2892	2898	2905	2911	2918	2924
<b>5</b>	2930	2937	2943	2950	2956	2963	2969	2975	2982	2988
<b>6</b>	2995	3001	3008	3014	3020	3027	3033	3040	3046	3052
<b>7</b>	3059	3065	3072	3078	3085	3091	3097	3104	3110	3117
<b>8</b>	3123	3129	3136	3142	3149	3155	3161	3168	3174	3181
<b>9</b>	3187	3193	3200	3206	3213	3219	3225	3232	3238	3245
<b>680</b>	83251	83257	83264	83270	83276	83283	83289	83296	83302	83308
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<b>2</b>	3378	3385	3391	3398	3404	3410	3417	3423	3429	3436
<b>3</b>	3442	3448	3455	3461	3467	3474	3480	3487	3493	3499
<b>4</b>	3506	3512	3518	3525	3531	3537	3544	3550	3556	3563
<b>5</b>	3569	3575	3582	3588	3594	3601	3607	3613	3620	3626
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<b>7</b>	3696	3702	3708	3715	3721	3727	3734	3740	3746	3753
<b>8</b>	3759	3765	3771	3778	3784	3790	3797	3803	3809	3816
<b>9</b>	3822	3828	3835	3841	3847	3853	3860	3866	3872	3879
<b>690</b>	83885	83891	83897	83904	83910	83916	83923	83929	83935	83942
<b>1</b>	3948	3954	3960	3967	3973	3979	3985	3992	3998	4004
<b>2</b>	4011	4017	4023	4029	4036	4042	4048	4055	4061	4067
<b>3</b>	4073	4080	4086	4092	4098	4105	4111	4117	4123	4130
<b>4</b>	4136	4142	4148	4155	4161	4167	4173	4180	4186	4192
<b>5</b>	4198	4205	4211	4217	4223	4230	4236	4242	4248	4255
<b>6</b>	4261	4267	4273	4280	4286	4292	4298	4305	4311	4317
<b>7</b>	4323	4330	4336	4342	4348	4354	4361	4367	4373	4379
<b>8</b>	4386	4392	4398	4404	4410	4417	4423	4429	4435	4442
<b>9</b>	4448	4454	4460	4466	4473	4479	4485	4491	4497	4504
<b>700</b>	84510	84516	84522	84528	84535	84541	84547	84553	84559	84566

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<b>1</b>	4572	4578	4584	4590	4597	4603	4609	4615	4621	4628
<b>2</b>	4634	4640	4646	4652	4658	4665	4671	4677	4683	4689
<b>3</b>	4696	4702	4708	4714	4720	4726	4733	4739	4745	4751
<b>4</b>	4757	4763	4770	4776	4782	4788	4794	4800	4807	4813
<b>5</b>	4819	4825	4831	4837	4844	4850	4856	4862	4868	4874
<b>6</b>	4880	4887	4893	4899	4905	4911	4917	4924	4930	4936
<b>7</b>	4942	4948	4954	4960	4967	4973	4979	4985	4991	4997
<b>8</b>	5003	5009	5016	5022	5028	5034	5040	5046	5052	5058
<b>9</b>	5065	5071	5077	5083	5089	5095	5101	5107	5114	5120
<b>710</b>	85126	85132	85138	85144	85150	85156	85163	85169	85175	85181
<b>1</b>	5187	5193	5199	5205	5211	5217	5224	5230	5236	5242
<b>2</b>	5248	5254	5260	5266	5272	5278	5285	5291	5297	5303
<b>3</b>	5309	5315	5321	5327	5333	5339	5345	5352	5358	5364
<b>4</b>	5370	5376	5382	5388	5394	5400	5406	5412	5418	5425
<b>5</b>	5431	5437	5443	5449	5455	5461	5467	5473	5479	5485
<b>6</b>	5491	5497	5503	5509	5516	5522	5528	5534	5540	5546
<b>7</b>	5552	5558	5564	5570	5576	5582	5588	5594	5600	5606
<b>8</b>	5612	5618	5625	5631	5637	5643	5649	5655	5661	5667
<b>9</b>	5673	5679	5685	5691	5697	5703	5709	5715	5721	5727
<b>720</b>	85733	85739	85745	85751	85757	85763	85769	85775	85781	85788
<b>1</b>	5794	5800	5806	5812	5818	5824	5830	5836	5842	5848
<b>2</b>	5854	5860	5866	5872	5878	5884	5890	5896	5902	5908
<b>3</b>	5914	5920	5926	5932	5938	5944	5950	5956	5962	5968
<b>4</b>	5974	5980	5986	5992	5998	6004	6010	6016	6022	6028
<b>5</b>	6034	6040	6046	6052	6058	6064	6070	6076	6082	6088
<b>6</b>	6094	6100	6106	6112	6118	6124	6130	6136	6141	6147
<b>7</b>	6153	6159	6165	6171	6177	6183	6189	6195	6201	6207
<b>8</b>	6213	6219	6225	6231	6237	6243	6249	6255	6261	6267
<b>9</b>	6273	6279	6285	6291	6297	6303	6308	6314	6320	6326
<b>730</b>	86332	86338	86344	86350	86356	86362	86368	86374	86380	86386
<b>1</b>	6392	6398	6404	6410	6415	6421	6427	6433	6439	6445
<b>2</b>	6451	6457	6463	6469	6475	6481	6487	6493	6499	6504
<b>3</b>	6510	6516	6522	6528	6534	6540	6546	6552	6558	6564
<b>4</b>	6570	6576	6581	6587	6593	6599	6605	6611	6617	6623
<b>5</b>	6629	6635	6641	6646	6652	6658	6664	6670	6676	6682
<b>6</b>	6688	6694	6700	6705	6711	6717	6723	6729	6735	6741
<b>7</b>	6747	6753	6759	6764	6770	6776	6782	6788	6794	6800
<b>8</b>	6806	6812	6817	6823	6829	6835	6841	6847	6853	6859
<b>9</b>	6864	6870	6876	6882	6888	6894	6900	6906	6911	6917
<b>740</b>	86923	86929	86935	86941	86947	86953	86958	86964	86970	86976
<b>1</b>	6982	6988	6994	6999	7005	7011	7017	7023	7029	7035
<b>2</b>	7040	7046	7052	7058	7064	7070	7075	7081	7087	7093
<b>3</b>	7099	7105	7111	7116	7122	7128	7134	7140	7146	7151
<b>4</b>	7157	7163	7169	7175	7181	7186	7192	7198	7204	7210
<b>5</b>	7216	7221	7227	7233	7239	7245	7251	7256	7262	7268
<b>6</b>	7274	7280	7286	7291	7297	7303	7309	7315	7320	7326
<b>7</b>	7332	7338	7344	7349	7355	7361	7367	7373	7379	7384
<b>8</b>	7390	7396	7402	7408	7413	7419	7425	7431	7437	7442
<b>9</b>	7448	7454	7460	7466	7471	7477	7483	7489	7495	7500
<b>750</b>	87506	87512	87518	87523	87529	87535	87541	87547	87552	87558

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<b>750</b>	87506	87512	87518	87523	87529	87535	87541	87547	87552	87558
<b>1</b>	7564	7570	7576	7581	7587	7593	7599	7604	7610	7616
<b>2</b>	7622	7628	7633	7639	7645	7651	7656	7662	7668	7674
<b>3</b>	7679	7685	7691	7697	7703	7708	7714	7720	7726	7731
<b>4</b>	7737	7743	7749	7754	7760	7766	7772	7777	7783	7789
<b>5</b>	7795	7800	7806	7812	7818	7823	7829	7835	7841	7846
<b>6</b>	7852	7858	7864	7869	7875	7881	7887	7892	7898	7904
<b>7</b>	7910	7915	7921	7927	7933	7938	7944	7950	7955	7961
<b>8</b>	7967	7973	7978	7984	7990	7996	8001	8007	8013	8018
<b>9</b>	8024	8030	8036	8041	8047	8053	8058	8064	8070	8076
<b>760</b>	88081	88087	88093	88098	88104	88110	88116	88121	88127	88133
<b>1</b>	8138	8144	8150	8156	8161	8167	8173	8178	8184	8190
<b>2</b>	8195	8201	8207	8213	8218	8224	8230	8235	8241	8247
<b>3</b>	8252	8258	8264	8270	8275	8281	8287	8292	8298	8304
<b>4</b>	8309	8315	8321	8326	8332	8338	8343	8349	8355	8360
<b>5</b>	8366	8372	8377	8383	8389	8395	8400	8406	8412	8417
<b>6</b>	8423	8429	8434	8440	8446	8451	8457	8463	8468	8474
<b>7</b>	8480	8485	8491	8497	8502	8508	8513	8519	8525	8530
<b>8</b>	8536	8542	8547	8553	8559	8564	8570	8576	8581	8587
<b>9</b>	8593	8598	8604	8610	8615	8621	8627	8632	8638	8643
<b>770</b>	88649	88655	88660	88666	88672	88677	88683	88689	88694	88700
<b>1</b>	8705	8711	8717	8722	8728	8734	8739	8745	8750	8756
<b>2</b>	8762	8767	8773	8779	8784	8790	8795	8801	8807	8812
<b>3</b>	8818	8824	8829	8835	8840	8846	8852	8857	8863	8868
<b>4</b>	8874	8880	8885	8891	8897	8902	8908	8913	8919	8925
<b>5</b>	8930	8936	8941	8947	8953	8958	8964	8969	8975	8981
<b>6</b>	8986	8992	8997	9003	9009	9014	9020	9025	9031	9037
<b>7</b>	9042	9048	9053	9059	9064	9070	9076	9081	9087	9092
<b>8</b>	9098	9104	9109	9115	9120	9126	9131	9137	9143	9148
<b>9</b>	9154	9159	9165	9170	9176	9182	9187	9193	9198	9204
<b>780</b>	89209	89215	89221	89226	89232	89237	89243	89248	89254	89260
<b>1</b>	9265	9271	9276	9282	9287	9293	9298	9304	9310	9315
<b>2</b>	9321	9326	9332	9337	9343	9348	9354	9360	9365	9371
<b>3</b>	9376	9382	9387	9393	9398	9404	9409	9415	9421	9426
<b>4</b>	9432	9437	9443	9448	9454	9459	9465	9470	9476	9481
<b>5</b>	9487	9492	9498	9504	9509	9515	9520	9526	9531	9537
<b>6</b>	9542	9548	9553	9559	9564	9570	9575	9581	9586	9592
<b>7</b>	9597	9603	9609	9614	9620	9625	9631	9636	9642	9647
<b>8</b>	9653	9658	9664	9669	9675	9680	9686	9691	9697	9702
<b>9</b>	9708	9713	9719	9724	9730	9735	9741	9746	9752	9757
<b>790</b>	89763	89768	89774	89779	89785	89790	89796	89801	89807	89812
<b>1</b>	9818	9823	9829	9834	9840	9845	9851	9856	9862	9867
<b>2</b>	9873	9878	9883	9889	9894	9900	9905	9911	9916	9922
<b>3</b>	9927	9933	9938	9944	9949	9955	9960	9966	9971	9977
<b>4</b>	9982	9988	9993	9998	9999	9999	9999	9999	9999	9999
<b>5</b>	90037	90042	90048	90053	90059	90064	90069	90075	90080	90086
<b>6</b>	0091	0097	0102	0108	0113	0119	0124	0129	0135	0140
<b>7</b>	0146	0151	0157	0162	0168	0173	0179	0184	0189	0195
<b>8</b>	0200	0206	0211	0217	0222	0227	0233	0238	0244	0249
<b>9</b>	0255	0260	0266	0271	0276	0282	0287	0293	0298	0304
<b>800</b>	90309	90314	90320	90325	90331	90336	90342	90347	90352	90358

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<b>800</b>	90309	90314	90320	90325	90331	90336	90342	90347	90352	90358
1	0363	0369	0374	0380	0385	0390	0396	0401	0407	0412
2	0417	0423	0428	0434	0439	0445	0450	0455	0461	0466
3	0472	0477	0482	0488	0493	0499	0504	0509	0515	0520
4	0526	0531	0536	0542	0547	0553	0558	0563	0569	0574
5	0580	0585	0590	0596	0601	0607	0612	0617	0623	0628
6	0634	0639	0644	0650	0655	0660	0666	0671	0677	0682
7	0687	0693	0698	0703	0709	0714	0720	0725	0730	0736
8	0741	0747	0752	0757	0763	0768	0773	0779	0784	0789
9	0795	0800	0806	0811	0816	0822	0827	0832	0838	0843
<b>810</b>	90849	90854	90859	90865	90870	90875	90881	90886	90891	90897
1	0902	0907	0913	0918	0924	0929	0934	0940	0945	0950
2	0956	0961	0966	0972	0977	0982	0988	0993	0998	1004
3	1009	1014	1020	1025	1030	1036	1041	1046	1052	1057
4	1062	1068	1073	1078	1084	1089	1094	1100	1105	1110
5	1116	1121	1126	1132	1137	1142	1148	1153	1158	1164
6	1169	1174	1180	1185	1190	1196	1201	1206	1212	1217
7	1222	1228	1233	1238	1243	1249	1254	1259	1265	1270
8	1275	1281	1286	1291	1297	1302	1307	1312	1318	1323
9	1328	1334	1339	1344	1350	1355	1360	1365	1371	1376
<b>820</b>	91381	91387	91392	91397	91403	91408	91413	91418	91424	91429
1	1434	1440	1445	1450	1455	1461	1466	1471	1477	1482
2	1487	1492	1498	1503	1508	1514	1519	1524	1529	1535
3	1540	1545	1551	1556	1561	1566	1572	1577	1582	1587
4	1593	1598	1603	1609	1614	1619	1624	1630	1635	1640
5	1645	1651	1656	1661	1666	1672	1677	1682	1687	1693
6	1698	1703	1709	1714	1719	1724	1730	1735	1740	1745
7	1751	1756	1761	1766	1772	1777	1782	1787	1793	1798
8	1803	1808	1814	1819	1824	1829	1834	1840	1845	1850
9	1855	1861	1866	1871	1876	1882	1887	1892	1897	1903
<b>830</b>	91908	91913	91918	91924	91929	91934	91939	91944	91950	91955
1	1960	1965	1971	1976	1981	1986	1991	1997	2002	2007
2	2012	2018	2023	2028	2033	2038	2044	2049	2054	2059
3	2065	2070	2075	2080	2085	2091	2096	2101	2106	2111
4	2117	2122	2127	2132	2137	2143	2148	2153	2158	2163
5	2169	2174	2179	2184	2189	2195	2200	2205	2210	2215
6	2221	2226	2231	2236	2241	2247	2252	2257	2262	2267
7	2273	2278	2283	2288	2293	2298	2304	2309	2314	2319
8	2324	2330	2335	2340	2345	2350	2355	2361	2366	2371
9	2376	2381	2387	2392	2397	2402	2407	2412	2418	2423
<b>840</b>	92428	92433	92438	92443	92449	92454	92459	92464	92469	92474
1	2480	2485	2490	2495	2500	2505	2511	2516	2521	2526
2	2531	2536	2542	2547	2552	2557	2562	2567	2572	2578
3	2583	2588	2593	2598	2603	2609	2614	2619	2624	2629
4	2634	2639	2645	2650	2655	2660	2665	2670	2675	2681
5	2686	2691	2696	2701	2706	2711	2716	2722	2727	2732
6	2737	2742	2747	2752	2758	2763	2768	2773	2778	2783
7	2788	2793	2799	2804	2809	2814	2819	2824	2829	2834
8	2840	2845	2850	2855	2860	2865	2870	2875	2881	2886
9	2891	2896	2901	2906	2911	2916	2921	2927	2932	2937
<b>850</b>	92942	92947	92952	92957	92962	92967	92973	92978	92983	92988

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<b>850</b>	92042	92047	92052	92057	92062	92067	92073	92078	92083	92088
1	2993	2998	3003	3008	3013	3018	3024	3029	3034	3039
2	3044	3049	3054	3059	3064	3069	3075	3080	3085	3090
3	3095	3100	3105	3110	3115	3120	3125	3131	3136	3141
4	3146	3151	3156	3161	3166	3171	3176	3181	3186	3192
5	3197	3202	3207	3212	3217	3222	3227	3232	3237	3242
6	3247	3252	3258	3263	3268	3273	3278	3283	3288	3293
7	3298	3303	3308	3313	3318	3323	3328	3334	3339	3344
8	3349	3354	3359	3364	3369	3374	3379	3384	3389	3394
9	3399	3404	3409	3414	3420	3425	3430	3435	3440	3445
<b>860</b>	93450	93455	93460	93465	93470	93475	93480	93485	93490	93495
1	3500	3505	3510	3515	3520	3526	3531	3536	3541	3546
2	3551	3556	3561	3566	3571	3576	3581	3586	3591	3596
3	3601	3606	3611	3616	3621	3626	3631	3636	3641	3646
4	3651	3656	3661	3666	3671	3676	3682	3687	3692	3697
5	3702	3707	3712	3717	3722	3727	3732	3737	3742	3747
6	3752	3757	3762	3767	3772	3777	3782	3787	3792	3797
7	3802	3807	3812	3817	3822	3827	3832	3837	3842	3847
8	3852	3857	3862	3867	3872	3877	3882	3887	3892	3897
9	3902	3907	3912	3917	3922	3927	3932	3937	3942	3947
<b>870</b>	93952	93957	93962	93967	93972	93977	93982	93987	93992	93997
1	4002	4007	4012	4017	4022	4027	4032	4037	4042	4047
2	4052	4057	4062	4067	4072	4077	4082	4086	4091	4096
3	4101	4106	4111	4116	4121	4126	4131	4136	4141	4146
4	4151	4156	4161	4166	4171	4176	4181	4186	4191	4196
5	4201	4206	4211	4216	4221	4226	4231	4236	4240	4245
6	4250	4255	4260	4265	4270	4275	4280	4285	4290	4295
7	4300	4305	4310	4315	4320	4325	4330	4335	4340	4345
8	4349	4354	4359	4364	4369	4374	4379	4384	4389	4394
9	4399	4404	4409	4414	4419	4424	4429	4433	4438	4443
<b>880</b>	94448	94453	94458	94463	94468	94473	94478	94483	94488	94493
1	4498	4503	4507	4512	4517	4522	4527	4532	4537	4542
2	4547	4552	4557	4562	4567	4571	4576	4581	4586	4591
3	4596	4601	4606	4611	4616	4621	4626	4630	4635	4640
4	4645	4650	4655	4660	4665	4670	4675	4680	4685	4689
5	4694	4699	4704	4709	4714	4719	4724	4729	4734	4738
6	4743	4748	4753	4758	4763	4768	4773	4778	4783	4787
7	4792	4797	4802	4807	4812	4817	4822	4827	4832	4836
8	4841	4846	4851	4856	4861	4866	4871	4876	4880	4885
9	4890	4895	4900	4905	4910	4915	4919	4924	4929	4934
<b>890</b>	94939	94944	94949	94954	94959	94963	94968	94973	94978	94983
1	4988	4993	4998	5002	5007	5012	5017	5022	5027	5032
2	5036	5041	5046	5051	5056	5061	5066	5071	5075	5080
3	5085	5090	5095	5100	5105	5109	5114	5119	5124	5129
4	5134	5139	5143	5148	5153	5158	5163	5168	5173	5177
5	5182	5187	5192	5197	5202	5207	5211	5216	5221	5226
6	5231	5236	5240	5245	5250	5255	5260	5265	5270	5274
7	5279	5284	5289	5294	5299	5303	5308	5313	5318	5323
8	5328	5332	5337	5342	5347	5352	5357	5361	5366	5371
9	5376	5381	5386	5390	5395	5400	5405	5410	5415	5419
<b>900</b>	95424	95429	95434	95439	95444	95448	95453	95458	95463	95468

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<b>900</b>	95424	95429	95434	95439	95444	95448	95453	95458	95463	95468
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<b>2</b>	5521	5525	5530	5535	5540	5545	5550	5554	5559	5564
<b>3</b>	5569	5574	5578	5583	5588	5593	5598	5602	5607	5612
<b>4</b>	5617	5622	5626	5631	5636	5641	5646	5650	5655	5660
<b>5</b>	5665	5670	5674	5679	5684	5689	5694	5698	5703	5708
<b>6</b>	5713	5718	5722	5727	5732	5737	5742	5746	5751	5756
<b>7</b>	5761	5766	5770	5775	5780	5785	5789	5794	5799	5804
<b>8</b>	5809	5813	5818	5823	5828	5832	5837	5842	5847	5852
<b>9</b>	5856	5861	5866	5871	5875	5880	5885	5890	5895	5899
<b>910</b>	95904	95909	95914	95918	95923	95928	95933	95938	95942	95947
<b>1</b>	5952	5957	5961	5966	5971	5976	5980	5985	5990	5995
<b>2</b>	5999	6004	6009	6014	6019	6023	6028	6033	6038	6042
<b>3</b>	6047	6052	6057	6061	6066	6071	6076	6080	6085	6090
<b>4</b>	6095	6099	6104	6109	6114	6118	6123	6128	6133	6137
<b>5</b>	6142	6147	6152	6156	6161	6166	6171	6175	6180	6185
<b>6</b>	6190	6194	6199	6204	6209	6213	6218	6223	6227	6232
<b>7</b>	6237	6242	6246	6251	6256	6261	6265	6270	6275	6280
<b>8</b>	6284	6289	6294	6298	6303	6308	6313	6317	6322	6327
<b>9</b>	6332	6336	6341	6346	6350	6355	6360	6365	6369	6374
<b>920</b>	96379	96384	96388	96393	96398	96402	96407	96412	96417	96421
<b>1</b>	6426	6431	6435	6440	6445	6450	6454	6459	6464	6468
<b>2</b>	6473	6478	6483	6487	6492	6497	6501	6506	6511	6515
<b>3</b>	6520	6525	6530	6534	6539	6544	6548	6553	6558	6562
<b>4</b>	6567	6572	6577	6581	6586	6591	6595	6600	6605	6609
<b>5</b>	6614	6619	6624	6628	6633	6638	6642	6647	6652	6656
<b>6</b>	6661	6666	6670	6675	6680	6685	6689	6694	6699	6703
<b>7</b>	6708	6713	6717	6722	6727	6731	6736	6741	6745	6750
<b>8</b>	6755	6759	6764	6769	6774	6778	6783	6788	6792	6797
<b>9</b>	6802	6806	6811	6816	6820	6825	6830	6834	6839	6844
<b>930</b>	96848	96853	96858	96862	96867	96872	96876	96881	96886	96890
<b>1</b>	6895	6900	6904	6909	6914	6918	6923	6928	6932	6937
<b>2</b>	6942	6946	6951	6956	6960	6965	6970	6974	6979	6984
<b>3</b>	6988	6993	6997	7002	7007	7011	7016	7021	7025	7030
<b>4</b>	7035	7039	7044	7049	7053	7058	7063	7067	7072	7077
<b>5</b>	7081	7086	7090	7095	7100	7104	7109	7114	7118	7123
<b>6</b>	7128	7132	7137	7142	7146	7151	7155	7160	7165	7169
<b>7</b>	7174	7179	7183	7188	7192	7197	7202	7206	7211	7216
<b>8</b>	7220	7225	7230	7234	7239	7243	7248	7253	7257	7262
<b>9</b>	7267	7271	7276	7280	7285	7290	7294	7299	7304	7308
<b>940</b>	97318	97317	97322	97327	97331	97336	97340	97345	97350	97354
<b>1</b>	7359	7364	7368	7373	7377	7382	7387	7391	7396	7400
<b>2</b>	7405	7410	7414	7419	7424	7428	7433	7437	7442	7447
<b>3</b>	7451	7456	7460	7465	7470	7474	7479	7483	7488	7493
<b>4</b>	7497	7502	7506	7511	7516	7520	7525	7529	7534	7539
<b>5</b>	7543	7548	7552	7557	7562	7566	7571	7575	7580	7585
<b>6</b>	7589	7594	7598	7603	7607	7612	7617	7621	7626	7630
<b>7</b>	7635	7640	7644	7649	7653	7658	7663	7667	7672	7676
<b>8</b>	7681	7685	7690	7695	7699	7704	7708	7713	7717	7722
<b>9</b>	7727	7731	7736	7740	7745	7749	7754	7759	7763	7768
<b>950</b>	97772	97777	97782	97786	97791	97795	97800	97804	97809	97813



N	0	1	2	3	4	5	6	7	8	9
<b>950</b>	97772	97777	97782	97786	97791	97795	97800	97804	97809	97813
<b>1</b>	7818	7823	7827	7832	7836	7841	7845	7850	7855	7859
<b>2</b>	7864	7868	7873	7877	7882	7886	7891	7896	7900	7905
<b>3</b>	7909	7914	7918	7923	7928	7932	7937	7941	7946	7950
<b>4</b>	7955	7959	7964	7968	7973	7978	7982	7987	7991	7996
<b>5</b>	8000	8005	8009	8014	8019	8023	8028	8032	8037	8041
<b>6</b>	8046	8050	8055	8059	8064	8068	8073	8078	8082	8087
<b>7</b>	8091	8096	8100	8105	8109	8114	8118	8123	8127	8132
<b>8</b>	8137	8141	8146	8150	8155	8159	8164	8168	8173	8177
<b>9</b>	8182	8186	8191	8195	8200	8204	8209	8214	8218	8223
<b>960</b>	98227	98232	98236	98241	98245	98250	98254	98259	98263	98268
<b>1</b>	8272	8277	8281	8286	8290	8295	8299	8304	8308	8313
<b>2</b>	8318	8322	8327	8331	8336	8340	8345	8349	8354	8358
<b>3</b>	8363	8367	8372	8376	8381	8385	8390	8394	8399	8403
<b>4</b>	8408	8412	8417	8421	8426	8430	8435	8439	8444	8448
<b>5</b>	8453	8457	8462	8466	8471	8475	8480	8484	8489	8493
<b>6</b>	8498	8502	8507	8511	8516	8520	8525	8529	8534	8538
<b>7</b>	8543	8547	8552	8556	8561	8565	8570	8574	8579	8583
<b>8</b>	8588	8592	8597	8601	8605	8610	8614	8619	8623	8628
<b>9</b>	8632	8637	8641	8646	8650	8655	8659	8664	8668	8673
<b>970</b>	98677	98682	98686	98691	98695	98700	98704	98709	98713	98717
<b>1</b>	8722	8726	8731	8735	8740	8744	8749	8753	8758	8762
<b>2</b>	8767	8771	8776	8780	8784	8789	8793	8798	8802	8807
<b>3</b>	8811	8816	8820	8825	8829	8834	8838	8843	8847	8851
<b>4</b>	8856	8860	8865	8869	8874	8878	8883	8887	8892	8896
<b>5</b>	8900	8905	8909	8914	8918	8923	8927	8932	8936	8941
<b>6</b>	8945	8949	8954	8958	8963	8967	8972	8976	8981	8985
<b>7</b>	8989	8994	8998	9003	9007	9012	9016	9021	9025	9029
<b>8</b>	9034	9038	9043	9047	9052	9056	9061	9065	9069	9074
<b>9</b>	9078	9083	9087	9092	9096	9100	9105	9109	9114	9118
<b>980</b>	99123	99127	99131	99136	99140	99145	99149	99154	99158	99162
<b>1</b>	9167	9171	9176	9180	9185	9189	9193	9198	9202	9207
<b>2</b>	9211	9216	9220	9224	9229	9233	9238	9242	9247	9251
<b>3</b>	9255	9260	9264	9269	9273	9277	9282	9286	9291	9295
<b>4</b>	9300	9304	9308	9313	9317	9322	9326	9330	9335	9339
<b>5</b>	9344	9348	9352	9357	9361	9366	9370	9374	9379	9383
<b>6</b>	9388	9392	9396	9401	9405	9410	9414	9419	9423	9427
<b>7</b>	9432	9436	9441	9445	9449	9454	9458	9463	9467	9471
<b>8</b>	9476	9480	9484	9489	9493	9498	9502	9506	9511	9515
<b>9</b>	9520	9524	9528	9533	9537	9542	9546	9550	9555	9559
<b>990</b>	99564	99568	99572	99577	99581	99585	99590	99594	99599	99603
<b>1</b>	9607	9612	9616	9621	9625	9629	9634	9638	9642	9647
<b>2</b>	9651	9656	9660	9664	9669	9673	9677	9682	9686	9691
<b>3</b>	9695	9699	9704	9708	9712	9717	9721	9726	9730	9734
<b>4</b>	9739	9743	9747	9752	9756	9760	9765	9769	9774	9778
<b>5</b>	9782	9787	9791	9795	9800	9804	9808	9813	9817	9822
<b>6</b>	9826	9830	9835	9839	9843	9848	9852	9856	9861	9865
<b>7</b>	9870	9874	9878	9883	9887	9891	9896	9900	9904	9909
<b>8</b>	9913	9917	9922	9926	9930	9935	9939	9944	9948	9952
<b>9</b>	9957	9961	9965	9970	9974	9978	9983	9987	9991	9996
<b>1000</b>	00000	00004	00009	00013	00017	00022	00026	00030	00035	00039

LOGARITHMIC SINES AND COSINES

°	0°		1°		2°		°
	Sine	Cosine	Sine	Cosine	Sine	Cosine	
0	—∞	10.00000	8.24186	9.99993	8.54282	9.99974	60
1	6.46373	00000	24903	99993	54642	99973	59
2	76476	00000	25609	99993	54999	99973	58
3	94055	00000	26304	99993	55354	99972	57
4	7.06579	00000	26988	99992	55705	99972	56
5	16270	00000	27661	99992	56054	69971	55
6	24188	00000	28324	99992	56400	99971	54
7	30882	00000	28977	99992	56743	99970	53
8	36682	00000	29621	99992	57084	99970	52
9	41797	00000	30255	99991	57421	99969	51
10	7.46373	10.00000	8.30879	9.99991	8.57757	9.99969	50
11	50512	00000	31495	99991	58089	99968	49
12	54291	00000	32108	99990	58419	99968	48
13	57767	00000	32702	99990	58747	99967	47
14	60985	00000	33292	99990	59072	99967	46
15	63982	00000	33875	99990	59395	99967	45
16	66784	00000	34450	99989	59715	99966	44
17	69417	9.99999	35018	99989	60033	99966	43
18	71900	99999	35578	99989	60349	99965	42
19	74248	99999	36131	99989	60662	99964	41
20	7.76175	9.99999	8.36678	9.99988	8.60973	9.99964	40
21	78594	99999	37217	99988	61282	99963	39
22	80615	99999	37750	99988	61589	99963	38
23	82545	99999	38276	99987	61894	99962	37
24	84393	99999	38796	99987	62196	99962	36
25	86166	99999	39310	99987	62497	99961	35
26	87870	99999	39818	99986	62795	99961	34
27	89509	99999	40320	99986	63091	99960	33
28	91088	99999	40816	99986	63385	99960	32
29	92612	99998	41307	99985	63678	99959	31
30	7.94084	9.99998	8.41792	9.99985	8.63968	9.99959	30
31	95508	99998	42272	99985	64256	99958	29
32	96887	99998	42746	99984	64543	99958	28
33	98223	99998	43216	99984	64827	99957	27
34	99520	99998	43680	99984	65110	99956	26
35	8.00779	99998	44139	99983	65391	99956	25
36	82002	99998	44594	99983	65670	99955	24
37	83192	99997	45044	99983	65947	99955	23
38	84350	99997	45489	99982	66223	99954	22
39	85478	99997	45930	99982	66497	99954	21
40	8.06578	9.99997	8.46366	9.99982	8.66769	9.99953	20
41	07650	99997	46799	99981	67039	99952	19
42	08696	99997	47226	99981	67308	99952	18
43	09718	99997	47650	99981	67575	99951	17
44	10717	99996	48069	99980	67841	99951	16
45	11693	99996	48485	99980	68104	99950	15
46	12647	99996	48896	99979	68367	99949	14
47	13581	99996	49304	99979	68627	99949	13
48	14495	99996	49708	99979	68886	99948	12
49	15391	99996	50108	99978	69144	99948	11
50	8.16268	9.99995	8.50504	9.99978	8.69400	9.99947	10
51	17128	99995	50897	99977	69654	99946	9
52	17971	99995	51287	99977	69907	99946	8
53	18798	99995	51673	99977	70159	99945	7
54	19610	99995	52055	99976	70409	99944	6
55	20407	99994	52434	99976	70658	99944	5
56	21189	99994	52810	99975	70905	99943	4
57	21958	99994	53183	99975	71151	99943	3
58	22713	99994	53552	99974	71395	99942	2
59	23456	99994	53919	99974	71638	99941	1
60	24186	99993	54282	99974	71880	99940	0
	Cosine Sine		Cosine Sine		Cosine Sine		
	89°		88°		87°		

	3°		4°		5°		
	Sine	Cosine	Sine	Cosine	Sine	Cosine	
0	8.71880	9.99940	8.84358	9.99894	8.94030	9.99834	60
1	72120	99940	84589	99893	94174	99833	59
2	72359	99939	84718	99892	94317	99832	58
3	72597	99938	84807	99891	94461	99831	57
4	72834	99938	85075	99891	94608	99830	56
5	73069	99937	85252	99890	94746	99829	55
6	73308	99936	85429	99889	94887	99828	54
7	73535	99936	85605	99888	95029	99827	53
8	73767	99935	85780	99887	95170	99825	52
9	73997	99934	85955	99886	95310	99824	51
10	8.74226	9.99934	8.86128	9.99885	8.95450	9.99823	50
11	74454	99933	86301	99884	95589	99822	49
12	74680	99932	86474	99883	95728	99821	48
13	74906	99932	86645	99882	95867	99820	47
14	75130	99931	86816	99881	96005	99819	46
15	75353	99930	86987	99880	96143	99817	45
16	75575	99929	87156	99879	96280	99816	44
17	75795	99929	87325	99879	96417	99815	43
18	76015	99928	87494	99878	96553	99814	42
19	76234	99927	87661	99877	96689	99813	41
20	8.76451	9.99926	8.87829	9.99876	8.96825	9.99812	40
21	76667	99926	87995	99875	96960	99810	39
22	76883	99925	88161	99874	97095	99809	38
23	77097	99924	88326	99873	97229	99808	37
24	77310	99923	88490	99872	97363	99807	36
25	77522	99923	88654	99871	97496	99806	35
26	77733	99922	88817	99870	97629	99804	34
27	77943	99921	88980	99869	97762	99803	33
28	78152	99920	89142	99868	97894	99802	32
29	78360	99920	89304	99867	98026	99801	31
30	8.78568	9.99919	8.89464	9.99866	8.98157	9.99800	30
31	78774	99918	89625	99865	98288	99798	29
32	78979	99917	89784	99864	98419	99797	28
33	79183	99917	89943	99863	98549	99796	27
34	79386	99916	90102	99862	98679	99795	26
35	79588	99915	90260	99861	98808	99793	25
36	79789	99914	90417	99860	98937	99792	24
37	79990	99913	90574	99859	99066	99791	23
38	80189	99913	90730	99858	99194	99790	22
39	80388	99912	90885	99857	99322	99788	21
40	8.80585	9.99911	8.91040	9.99856	8.99450	9.99787	20
41	80782	99910	91195	99855	99577	99786	19
42	80978	99909	91349	99854	99704	99785	18
43	81173	99909	91502	99853	99830	99783	17
44	81367	99908	91655	99852	99956	99782	16
45	81560	99907	91807	99851	9.00082	99781	15
46	81752	99906	91959	99850	00207	99780	14
47	81944	99905	92110	99849	00332	99778	13
48	82134	99904	92261	99847	00456	99777	12
49	82324	99904	92411	99846	00581	99776	11
50	8.82513	9.99903	8.92561	9.99845	9.00704	9.99775	10
51	82701	99902	92710	99844	00828	99773	9
52	82888	99901	92859	99843	00951	99772	8
53	83075	99900	93007	99842	01074	99771	7
54	83261	99899	93154	99841	01196	99769	6
55	83446	99898	93301	99840	01318	99768	5
56	83630	99898	93448	99839	01440	99767	4
57	83813	99897	93594	99838	01561	99765	3
58	83996	99896	93740	99837	01682	99764	2
59	84177	99895	93885	99836	01803	99763	1
60	84358	99894	94030	99834	01923	99761	0
	Cosine	Sine	Cosine	Sine	Cosine	Sine	
	86°		85°		84°		

LOGARITHMIC SINES AND COSINES

	6°		7°		8°		
	Sine	Cosine	Sine	Cosine	Sine	Cosine	
0	9.01928	9.90761	9.06689	9.99675	9.14856	9.99575	60
1	02043	99760	06892	99674	14445	99574	59
2	02163	99759	06795	99673	14535	99573	58
3	02288	99757	06897	99670	14624	99570	57
4	02402	99756	06999	99669	14714	99568	56
5	02520	99755	09101	99667	14803	99566	55
6	02639	99753	09202	99666	14891	99565	54
7	02757	99752	09304	99664	14980	99563	53
8	02874	99751	09405	99663	15069	99561	52
9	02993	99749	09506	99661	15157	99559	51
10	9.03109	9.99748	9.09606	9.99659	9.15245	9.99557	50
11	06296	99747	09707	99658	15333	99556	49
12	03342	99745	09807	99656	15421	99554	48
13	03458	99744	09907	99655	15508	99552	47
14	03574	99742	10006	99653	15596	99550	46
15	03690	99741	10106	99651	15683	99548	45
16	03805	99740	10205	99650	15770	99546	44
17	03920	99738	10304	99648	15857	99545	43
18	04034	99737	10402	99647	15944	99543	42
19	04149	99736	10501	99645	16030	99541	41
20	9.04262	9.99734	9.10609	9.99643	9.16116	9.99539	40
21	04376	99733	10697	99642	16203	99537	39
22	04490	99731	10795	99640	16289	99535	38
23	04603	99730	10893	99638	16374	99533	37
24	04715	99728	10990	99637	16460	99532	36
25	04828	99727	11087	99635	16545	99530	35
26	04940	99726	11184	99633	16631	99528	34
27	05052	99724	11281	99632	16716	99526	33
28	05164	99723	11377	99630	16801	99524	32
29	05275	99721	11474	99629	16886	99522	31
30	9.05386	9.99720	9.11570	9.99627	9.16970	9.99520	30
31	05497	99718	11566	99625	17055	99518	29
32	05607	99717	11661	99624	17139	99517	28
33	05717	99716	11857	99622	17223	99515	27
34	05827	99714	11952	99620	17307	99513	26
35	05937	99713	12047	99619	17391	99511	25
36	06046	99711	12142	99617	17474	99509	24
37	06155	99710	12236	99615	17558	99507	23
38	06264	99708	12331	99613	17641	99505	22
39	06372	99707	12425	99612	17724	99503	21
40	9.06481	9.99705	9.12519	9.99610	9.17807	9.99501	20
41	06589	99704	12612	99608	17890	99499	19
42	06696	99702	12706	99607	17973	99497	18
43	06804	99701	12799	99605	18055	99496	17
44	06911	99699	12892	99603	18137	99494	16
45	07018	99698	12985	99601	18220	99492	15
46	07124	99696	13078	99600	18302	99490	14
47	07231	99695	13171	99598	18383	99488	13
48	07337	99693	13263	99596	18465	99486	12
49	07443	99692	13355	99595	18547	99484	11
50	9.07548	9.99690	9.13447	9.99593	9.18628	9.99482	10
51	07653	99689	13539	99591	18709	99480	9
52	07758	99687	13630	99589	18790	99478	8
53	07863	99686	13722	99588	18871	99476	7
54	07968	99684	13813	99586	18952	99474	6
55	08073	99683	13904	99584	19033	99472	5
56	08178	99681	13994	99582	19113	99470	4
57	08280	99680	14085	99581	19193	99468	3
58	08385	99678	14175	99579	19273	99466	2
59	08486	99677	14266	99577	19353	99464	1
60	08589	99675	14356	99575	19433	99462	0
	Cosine		Cosine		Cosine		
	Sine		Sine		Sine		
	88°		82°		81°		

	9°		10°		11°		
	Sine	Cosine	Sine	Cosine	Sine	Cosine	
0	9.19433	9.99462	9.23967	9.99335	9.28060	9.99195	60
1	19513	99460	24039	99333	28125	99192	59
2	19592	99458	24110	99331	28190	99190	58
3	19672	99456	24181	99328	28254	99187	57
4	19751	99454	24253	99326	28319	99185	56
5	19830	99452	24324	99324	28384	99183	55
6	19909	99450	24395	99322	28448	99180	54
7	19988	99448	24466	99319	28512	99177	53
8	20067	99446	24536	99317	28577	99175	52
9	20145	99444	24607	99315	28641	99172	51
10	9.20223	9.99442	9.24677	9.99313	9.28705	9.99170	50
11	20302	99440	24748	99310	28769	99167	49
12	20380	99438	24818	99308	28833	99165	48
13	20458	99436	24888	99306	28896	99162	47
14	20535	99434	24958	99304	28960	99160	46
15	20613	99432	25028	99301	29024	99157	45
16	20691	99429	25098	99299	29087	99155	44
17	20768	99427	25168	99297	29150	99152	43
18	20845	99425	25237	99294	29214	99150	42
19	20922	99423	25307	99292	29277	99147	41
20	9.20999	9.99421	9.25376	9.99290	9.29340	9.99145	40
21	21076	99419	25445	99288	29403	99142	39
22	21153	99417	25514	99285	29466	99140	38
23	21230	99415	25583	99283	29529	99137	37
24	21306	99413	25652	99281	29591	99135	36
25	21382	99411	25721	99278	29654	99132	35
26	21458	99409	25790	99276	29716	99130	34
27	21534	99407	25858	99274	29779	99127	33
28	21610	99404	25927	99271	29841	99124	32
29	21685	99402	25995	99269	29903	99122	31
30	9.21761	9.99400	9.26063	9.99267	9.29966	9.99119	30
31	21836	99398	26131	99264	30028	99117	29
32	21912	99396	26199	99262	30090	99114	28
33	21987	99394	26267	99260	30151	99112	27
34	22062	99392	26335	99257	30213	99109	26
35	22137	99390	26403	99255	30275	99106	25
36	22211	99388	26470	99252	30336	99104	24
37	22286	99385	26538	99250	30398	99101	23
38	22361	99383	26605	99248	30459	99099	22
39	22435	99381	26672	99245	30521	99096	21
40	9.22509	9.99379	9.26739	9.99243	9.30582	9.99092	20
41	22583	99377	26806	99241	30643	99091	19
42	22657	99375	26873	99238	30704	99088	18
43	22731	99372	26940	99236	30765	99086	17
44	22805	99370	27007	99233	30826	99083	16
45	22878	99368	27073	99231	30887	99080	15
46	22952	99366	27140	99229	30947	99078	14
47	23025	99364	27206	99226	31008	99075	13
48	23098	99362	27273	99224	31068	99072	12
49	23171	99359	27339	99221	31129	99070	11
50	9.23344	9.99357	9.27405	9.99219	9.31189	9.99067	10
51	23317	99355	27471	99217	31250	99064	9
52	23390	99353	27537	99214	31310	99062	8
53	23462	99351	27602	99212	31370	99059	7
54	23535	99348	27668	99209	31430	99056	6
55	23607	99346	27734	99207	31490	99054	5
56	23679	99344	27799	99204	31549	99051	4
57	23752	99342	27864	99202	31609	99048	3
58	23823	99340	27930	99200	31668	99046	2
59	23895	99337	27995	99197	31728	99043	1
60	23967	99335	28060	99195	31788	99040	0
	Cosine	Sine	Cosine	Sine	Cosine	Sine	
	80°		79°		78°		

# LOGARITHMIC SINES AND COSINES

139

°	12°		13°		14°		°
	Sine	Cosine	Sine	Cosine	Sine	Cosine	
0	9.31788	9.99040	9.35209	9.98872	9.38368	9.98690	60
1	31847	99038	35263	98869	38418	98687	59
2	31907	99035	35318	98867	38469	98684	58
3	31966	99032	35373	98864	38519	98681	57
4	32025	99029	35427	98861	38570	98678	56
5	32084	99027	35481	98858	38620	98675	55
6	32143	99024	35536	98855	38670	98671	54
7	32202	99022	35590	98852	38721	98668	53
8	32261	99019	35644	98849	38771	98665	52
9	32319	99016	35698	98846	38821	98662	51
10	9.32378	9.99013	9.35752	9.98843	9.38871	9.98659	50
11	32437	99011	35806	98840	38921	98656	49
12	32495	99008	35860	98837	38971	98652	48
13	32553	99005	35914	98834	39021	98649	47
14	32612	99002	35968	98831	39071	98646	46
15	32670	99000	36022	98828	39121	98643	45
16	32728	98997	36075	98825	39170	98640	44
17	32786	98994	36129	98822	39220	98636	43
18	32844	98991	36182	98819	39270	98633	42
19	32902	98989	36236	98816	39319	98630	41
20	9.32960	9.98986	9.36289	9.98813	9.39369	9.98627	40
21	32918	98983	36342	98810	39418	98623	39
22	32975	98980	36395	98807	39467	98620	38
23	33033	98978	36449	98804	39517	98617	37
24	33090	98975	36502	98801	39566	98614	36
25	33148	98972	36555	98798	39615	98610	35
26	33205	98969	36608	98795	39664	98607	34
27	33262	98967	36660	98792	39713	98604	33
28	33320	98964	36713	98789	39762	98601	32
29	33377	98961	36766	98786	39811	98597	31
30	9.33534	9.98958	9.36819	9.98783	9.39860	9.98594	30
31	33391	98955	36871	98780	39909	98591	29
32	33447	98953	36924	98777	39958	98588	28
33	33504	98950	36976	98774	40006	98584	27
34	33561	98947	37028	98771	40055	98581	26
35	33618	98944	37081	98768	40103	98578	25
36	33674	98941	37133	98765	40152	98574	24
37	33731	98938	37185	98762	40200	98571	23
38	33787	98936	37237	98759	40249	98568	22
39	33843	98933	37289	98756	40297	98565	21
40	9.34100	9.98930	9.37341	9.98753	9.40346	9.98561	20
41	34156	98927	37393	98750	40394	98558	19
42	34212	98924	37445	98746	40442	98555	18
43	34268	98921	37497	98743	40490	98551	17
44	34324	98919	37549	98740	40538	98548	16
45	34380	98916	37600	98737	40586	98545	15
46	34436	98913	37652	98734	40634	98541	14
47	34491	98910	37703	98731	40682	98538	13
48	34547	98907	37755	98728	40730	98535	12
49	34603	98904	37806	98725	40778	98531	11
50	9.34658	9.98901	9.37858	9.98722	9.40825	9.98528	10
51	34713	98898	37909	98719	40873	98525	9
52	34769	98896	37960	98715	40921	98521	8
53	34824	98893	38011	98712	40968	98518	7
54	34879	98890	38062	98709	41016	98515	6
55	34934	98887	38113	98706	41063	98511	5
56	34989	98884	38164	98703	41111	98508	4
57	35044	98881	38215	98700	41158	98505	3
58	35099	98878	38266	98697	41205	98501	2
59	35154	98875	38317	98694	41252	98498	1
60	35209	98872	38368	98690	41300	98494	0
	Cosine Sine		Cosine Sine		Cosine Sine		
	77°		76°		75°		

	15°		16°		17°		
	Sine	Cosine	Sine	Cosine	Sine	Cosine	
0	9.41300	9.98494	9.44034	9.98284	9.46594	9.98066	60
1	41347	98491	44078	98281	46635	98056	59
2	41394	98488	44122	98277	46676	98052	58
3	41441	98484	44166	98273	46717	98048	57
4	41488	98481	44210	98270	46758	98044	56
5	41535	98477	44253	98266	46800	98040	55
6	41582	98474	44297	98262	46841	98036	54
7	41628	98471	44341	98259	46882	98032	53
8	41675	98467	44385	98255	46923	98029	52
9	41722	98464	44428	98251	46964	98025	51
10	9.41768	9.98460	9.44472	9.98248	9.47005	9.98021	50
11	41815	98457	44516	98244	47045	98017	49
12	41861	98453	44559	98240	47086	98013	48
13	41908	98450	44602	98237	47127	98009	47
14	41954	98447	44646	98233	47168	98005	46
15	42001	98443	44689	98229	47209	98001	45
16	42047	98440	44733	98226	47249	97997	44
17	42093	98436	44776	98222	47290	97993	43
18	42140	98433	44819	98218	47330	97989	42
19	42186	98429	44862	98215	47371	97986	41
20	9.42232	9.98426	9.44905	9.98211	9.47411	9.97982	40
21	42278	98422	44948	98207	47452	97978	39
22	42324	98419	44992	98204	47492	97974	38
23	42370	98415	45035	98200	47533	97970	37
24	42416	98412	45077	98196	47573	97966	36
25	42461	98409	45120	98192	47613	97962	35
26	42507	98405	45163	98189	47654	97958	34
27	42553	98402	45206	98185	47694	97954	33
28	42599	98398	45249	98181	47734	97950	32
29	42644	98395	45292	98177	47774	97946	31
30	9.42690	9.98391	9.45324	9.98174	9.47814	9.97942	30
31	42735	98388	45377	98170	47854	97938	29
32	42781	98384	45419	98166	47894	97934	28
33	42826	98381	45462	98162	47934	97930	27
34	42872	98377	45504	98159	47974	97926	26
35	42917	98373	45547	98155	48014	97922	25
36	42962	98370	45589	98151	48054	97918	24
37	43008	98366	45632	98147	48094	97914	23
38	43053	98363	45674	98144	48133	97910	22
39	43098	98359	45716	98140	48173	97906	21
40	9.43143	9.98356	9.45758	9.98136	9.48213	9.97902	20
41	43188	98352	45801	98132	48252	97898	19
42	43233	98349	45843	98129	48292	97894	18
43	43278	98345	45885	98125	48332	97890	17
44	43323	98342	45927	98121	48371	97886	16
45	43367	98338	45969	98117	48411	97882	15
46	43412	98334	46011	98113	48450	97878	14
47	43457	98331	46053	98110	48490	97874	13
48	43502	98327	46095	98106	48529	97870	12
49	43546	98324	46136	98102	48568	97866	11
50	9.43591	9.98320	9.46178	9.98098	9.48607	9.97861	10
51	43635	98317	46220	98094	48647	97857	9
52	43680	98313	46262	98090	48686	97853	8
53	43724	98309	46303	98087	48725	97849	7
54	43769	98306	46345	98083	48764	97845	6
55	43813	98302	46386	98079	48803	97841	5
56	43857	98299	46428	98075	48842	97837	4
57	43901	98295	46469	98071	48881	97833	3
58	43946	98291	46511	98067	48920	97829	2
59	43990	98288	46552	98063	48959	97825	1
60	44034	98284	46594	98060	48998	97821	0
	Cosine	Sine	Cosine	Sine	Cosine	Sine	
	74°		73°		72°		

LOGARITHMIC SINES AND COSINES

°	18°		19°		20°		°
	Sine	Cosine	Sine	Cosine	Sine	Cosine	
0	9.48998	9.97821	9.51264	9.97567	9.53405	9.97299	60
1	49007	97817	51301	97563	53440	97294	59
2	49076	97812	51338	97558	53475	97289	58
3	49153	97808	51374	97554	53509	97285	57
4	49153	97804	51411	97550	53544	97280	56
5	49192	97800	51447	97545	53578	97276	55
6	49231	97796	51484	97541	53613	97271	54
7	49269	97792	51520	97536	53647	97266	53
8	49308	97788	51557	97532	53682	97262	52
9	49347	97784	51593	97528	53716	97257	51
10	9.49385	9.97779	9.51629	9.97523	9.53751	9.97252	50
11	49424	97775	51666	97519	53785	97248	49
12	49462	97771	51702	97515	53819	97243	48
13	49500	97767	51738	97510	53854	97238	47
14	49539	97763	51774	97506	53888	97234	46
15	49577	97759	51811	97501	53922	97229	45
16	49615	97754	51847	97497	53957	97224	44
17	49654	97750	51883	97492	53991	97220	43
18	49692	97746	51919	97488	54025	97215	42
19	49730	97742	51955	97484	F 059	97210	41
20	9.49708	9.97738	9.51991	9.97479	9.54093	9.97206	40
21	49806	97734	52027	97475	54127	97201	39
22	49844	97729	52063	97470	54161	97196	38
23	49882	97725	52099	97466	54195	97192	37
24	49920	97721	52135	97461	54229	97187	36
25	49958	97717	52171	97457	54263	97182	35
26	49996	97713	52207	97453	54297	97178	34
27	50034	97708	52242	97448	54331	97173	33
28	50072	97704	52278	97444	54365	97168	32
29	50110	97700	52314	97439	54399	97163	31
30	9.50148	9.97696	9.52350	9.97435	9.54433	9.97159	30
31	50185	97691	52385	97430	54466	97154	29
32	50223	97687	52421	97426	54500	97149	28
33	50261	97683	52456	97421	54534	97145	27
34	50298	97679	52492	97417	54567	97140	26
35	50336	97674	52527	97412	54601	97135	25
36	50374	97670	52563	97408	54635	97130	24
37	50411	97666	52598	97403	54668	97126	23
38	50449	97662	52634	97399	54702	97121	22
39	50486	97657	52669	97394	54735	97116	21
40	9.50523	9.97653	9.52705	9.97390	9.54769	9.97111	20
41	50561	97649	52740	97385	54802	97107	19
42	50599	97645	52775	97381	54836	97102	18
43	50635	97640	52811	97376	54869	97097	17
44	50673	97636	52846	97372	54903	97092	16
45	50710	97632	52881	97367	54936	97087	15
46	50747	97628	52916	97363	54969	97083	14
47	50784	97623	52951	97358	55003	97078	13
48	50821	97619	52986	97353	55036	97073	12
49	50858	97615	53021	97349	55069	97068	11
50	9.50896	9.97610	9.53056	9.97344	9.55102	9.97063	10
51	50933	97606	53092	97340	55136	97059	9
52	50970	97602	53126	97335	55169	97054	8
53	51007	97597	53161	97331	55202	97049	7
54	51043	97593	53196	97326	55235	97044	6
55	51080	97589	53231	97322	55268	97039	5
56	51117	97584	53266	97317	55301	97035	4
57	51154	97580	53301	97312	55334	97030	3
58	51191	97576	53336	97308	55367	97025	2
59	51227	97571	53370	97303	55400	97020	1
60	51264	97567	53405	97299	55433	97015	0
	Cosine		Cosine		Cosine		
	Sine		Sine		Sine		
	71°		70°		69°		



°	21°		22°		23°		°
	Sine	Cosine	Sine	Cosine	Sine	Cosine	
0	9.55433	9.97015	9.57358	9.96717	9.59188	9.96408	60
1	55466	97010	57389	96711	59218	96397	59
2	55499	97005	57420	96706	59247	96392	58
3	55532	97001	57451	96701	59277	96387	57
4	55564	96996	57482	96696	59307	96381	56
5	55597	96991	57514	96691	59336	96376	55
6	55630	96986	57545	96686	59366	96370	54
7	55663	96981	57576	96681	59396	96365	53
8	55695	96976	57607	96676	59425	96360	52
9	55728	96971	57638	96670	59455	96354	51
10	9.55761	9.96966	9.57669	9.96665	9.59484	9.96349	50
11	55793	96962	57700	96660	59514	96343	49
12	55826	96957	57731	96655	59543	96338	48
13	55858	96952	57762	96650	59573	96333	47
14	55891	96947	57793	96645	59602	96327	46
15	55923	96942	57824	96640	59632	96322	45
16	55956	96937	57855	96634	59661	96316	44
17	55988	96932	57885	96629	59690	96311	43
18	56021	96927	57916	96624	59720	96305	42
19	56053	96922	57947	96619	59749	96300	41
20	9.56085	9.96917	9.57978	9.96614	9.59778	9.96294	40
21	56118	96912	58008	96608	59808	96289	39
22	56150	96907	58039	96603	59837	96284	38
23	56182	96903	58070	96598	59866	96278	37
24	56215	96898	58101	96593	59895	96273	36
25	56247	96893	58131	96588	59924	96267	35
26	56279	96888	58162	96582	59954	96262	34
27	56311	96883	58192	96577	59983	96256	33
28	56343	96878	58223	96572	60012	96251	32
29	56375	96873	58253	96567	60041	96245	31
30	9.56408	9.96838	9.58284	9.96562	9.60070	9.96240	30
31	56440	96861	58314	96556	60099	96234	29
32	56472	96858	58345	96551	60128	96229	28
33	56504	96853	58375	96546	60157	96223	27
34	56536	96848	58406	96541	60186	96218	26
35	56568	96843	58436	96535	60215	96212	25
36	56599	96838	58467	96530	60244	96207	24
37	56631	96833	58497	96525	60273	96201	23
38	56663	96828	58527	96520	60302	96196	22
39	56695	96823	58557	96514	60331	96190	21
40	9.56727	9.96818	9.58588	9.96509	9.60359	9.96185	20
41	56759	96813	58618	96504	60388	96179	19
42	56790	96808	58648	96498	60417	96174	18
43	56822	96803	58678	96493	60446	96168	17
44	56854	96798	58709	96488	60474	96162	16
45	56886	96793	58739	96483	60503	96157	15
46	56917	96788	58769	96477	60532	96151	14
47	56949	96783	58799	96472	60561	96146	13
48	56980	96778	58829	96467	60589	96140	12
49	57012	96772	58859	96461	60618	96135	11
50	9.57044	9.96767	9.58889	9.96456	9.60646	9.96129	10
51	57075	96762	58919	96451	60675	96123	9
52	57107	96757	58949	96445	60704	96118	8
53	57138	96752	58979	96440	60732	96112	7
54	57169	96747	59009	96435	60761	96107	6
55	57201	96742	59039	96429	60789	96101	5
56	57232	96737	59069	96424	60818	96095	4
57	57264	96732	59098	96417	60846	96090	3
58	57295	96727	59128	96413	60875	96084	2
59	57326	96722	59158	96408	60903	96079	1
60	57358	96717	59188	96403	60931	96073	0
	Cosine	Sine	Cosine	Sine	Cosine	Sine	
	65°		67°		66°		

LOGARITHMIC SINES AND COSINES

°	24°		25°		26°		°
	Sine	Cosine	Sine	Cosine	Sine	Cosine	
0	9.60931	9.96073	9.62595	9.95728	9.64184	9.95366	60
1	60960	96067	62622	95722	64210	95360	59
2	60988	96062	62649	95716	64236	95354	58
3	61016	96056	62676	95710	64262	95348	57
4	61045	96050	62703	95704	64288	95341	56
5	61073	96045	62730	95698	64313	95335	55
6	61101	96039	62757	95692	64339	95329	54
7	61129	96034	62784	95686	64365	95323	53
8	61158	96028	62811	95680	64391	95317	52
9	61186	96022	62838	95674	64417	95310	51
10	9.61214	9.96017	9.62865	9.95668	9.64442	9.95304	50
11	61242	96011	62862	95663	64468	95298	49
12	61270	96005	62918	95657	64494	95292	48
13	61298	96000	62945	95651	64519	95286	47
14	61326	95994	62972	95645	64545	95279	46
15	61354	95988	62999	95639	64571	95273	45
16	61382	95982	63026	95633	64596	95267	44
17	61411	95977	63052	95627	64622	95261	43
18	61438	95971	63079	95621	64647	95254	42
19	61466	95965	63106	95615	64673	95248	41
20	9.61494	9.95960	9.63133	9.95609	9.64698	9.95242	40
21	61522	95954	63159	95603	64724	95236	39
22	61550	95948	63186	95597	64749	95229	38
23	61578	95942	63213	95591	64775	95223	37
24	61606	95937	63239	95585	64800	95217	36
25	61634	95931	63266	95579	64826	95211	35
26	61662	95925	63292	95573	64851	95204	34
27	61689	95920	63319	95567	64877	95198	33
28	61717	95914	63345	95561	64902	95192	32
29	61745	95908	63372	95555	64927	95185	31
30	9.61773	9.95902	9.63398	9.95549	9.64953	9.95179	30
31	61800	95897	63425	95543	64978	95173	29
32	61828	95891	63451	95537	65003	95167	28
33	61856	95885	63478	95531	65029	95160	27
34	61883	95879	63504	95525	65054	95154	26
35	61911	95873	63531	95519	65079	95148	25
36	61939	95868	63557	95513	65104	95141	24
37	61966	95862	63583	95507	65130	95135	23
38	61994	95856	63610	95500	65155	95129	22
39	62021	95850	63636	95494	65180	95123	21
40	9.62049	9.95844	9.63662	9.95488	9.65205	9.95116	20
41	62076	95839	63689	95482	65230	95110	19
42	62104	95833	63715	95476	65255	95103	18
43	62131	95827	63741	95470	65281	95097	17
44	62159	95821	63767	95464	65306	95090	16
45	62186	95815	63794	95458	65331	95084	15
46	62214	95810	63820	95452	65356	95078	14
47	62241	95804	63846	95446	65381	95071	13
48	62268	95798	63872	95440	65406	95065	12
49	62296	95792	63898	95434	65431	95059	11
50	9.62328	9.95786	9.63924	9.95427	9.65456	9.95052	10
51	62355	95780	63950	95421	65481	95046	9
52	62377	95775	63976	95415	65506	95039	8
53	62405	95769	64002	95409	65531	95033	7
54	62432	95763	64028	95403	65556	95027	6
55	62459	95757	64054	95397	65580	95020	5
56	62486	95751	64080	95391	65605	95014	4
57	62513	95745	64106	95384	65630	95007	3
58	62541	95739	64132	95378	65655	95001	2
59	62568	95733	64158	95372	65680	94995	1
60	62595	95728	64184	95366	65705	94988	0
	Cosine	Sine	Cosine	Sine	Cosine	Sine	
	65°		64°		63°		

/	27°		28°		29°		/
	Sine	Cosine	Sine	Cosine	Sine	Cosine	
0	9.65705	9.94988	9.67161	9.94598	9.68557	9.94182	60
1	65729	94982	67186	94587	68580	94175	59
2	65754	94975	67208	94580	68603	94168	58
3	65779	94969	67232	94573	68625	94161	57
4	65804	94962	67256	94567	68648	94154	56
5	65828	94956	67280	94560	68671	94147	55
6	65853	94949	67303	94553	68694	94140	54
7	65878	94943	67327	94546	68716	94133	53
8	65902	94936	67350	94540	68739	94126	52
9	65927	94930	67374	94533	68762	94119	51
10	9.65952	9.94923	9.67398	9.94526	9.68784	9.94112	50
11	65976	94917	67421	94519	68807	94105	49
12	66001	94911	67445	94513	68829	94098	48
13	66025	94904	67468	94506	68852	94090	47
14	66050	94898	67492	94499	68875	94083	46
15	66075	94891	67515	94492	68897	94076	45
16	66099	94885	67539	94485	68920	94069	44
17	66124	94878	67562	94479	68942	94062	43
18	66148	94871	67586	94472	68965	94055	42
19	66173	94865	67609	94465	68987	94048	41
20	9.66197	9.94858	9.67633	9.94458	9.69010	9.94041	40
21	66221	94852	67656	94451	69032	94034	39
22	66246	94845	67680	94445	69055	94027	38
23	66270	94839	67703	94438	69077	94020	37
24	66295	94832	67726	94431	69100	94012	36
25	66319	94826	67750	94424	69122	94005	35
26	66343	94819	67773	94417	69144	93998	34
27	66368	94813	67796	94410	69167	93991	33
28	66392	94806	67820	94404	69189	93984	32
29	66416	94799	67843	94397	69212	93977	31
30	9.66441	9.94793	9.67866	9.94390	9.69234	9.93970	30
31	66465	94786	67890	94383	69256	93963	29
32	66489	94780	67913	94376	69279	93955	28
33	66513	94773	67936	94369	69301	93948	27
34	66537	94767	67959	94362	69323	93941	26
35	66562	94760	67982	94355	69345	93934	25
36	66586	94753	68006	94349	69368	93927	24
37	66610	94747	68029	94342	69390	93920	23
38	66634	94740	68052	94335	69412	93912	22
39	66658	94734	68075	94328	69434	93905	21
40	9.66682	9.94727	9.68098	9.94321	9.69456	9.93898	20
41	66706	94720	68121	94314	69479	93891	19
42	66731	94714	68144	94307	69501	93884	18
43	66755	94707	68167	94300	69523	93876	17
44	66779	94700	68190	94293	69545	93869	16
45	66803	94694	68213	94286	69567	93862	15
46	66827	94687	68237	94279	69589	93855	14
47	66851	94680	68260	94273	69611	93847	13
48	66875	94674	68283	94266	69633	93840	12
49	66899	94667	68305	94259	69655	93833	11
50	9.66922	9.94660	9.68328	9.94252	9.69677	9.93826	10
51	66946	94654	68351	94245	69699	93819	9
52	66970	94647	68374	94238	69721	93811	8
53	66994	94640	68397	94231	69743	93804	7
54	67018	94634	68420	94224	69765	93797	6
55	67042	94627	68443	94217	69787	93789	5
56	67066	94620	68466	94210	69809	93782	4
57	67090	94614	68489	94203	69831	93775	3
58	67113	94607	68512	94196	69853	93768	2
59	67137	94600	68534	94189	69875	93760	1
60	67161	94593	68557	94182	69897	93753	0
/	Cosine	Sine	Cosine	Sine	Cosine	Sine	/
	62°		61°		60°		

# LOGARITHMIC SINES AND COSINES

°	30°		31°		32°		°
	Sine	Cosine	Sine	Cosine	Sine	Cosine	
0	9.68907	9.93753	9.71184	9.93307	9.73421	9.92842	60
1	69019	93746	71305	93399	72441	92834	59
2	69941	93738	71328	93391	72461	92826	58
3	69963	93731	71347	93384	72482	92818	57
4	69984	93724	71368	93376	72502	92810	56
5	70006	93717	71389	93369	72522	92803	55
6	70028	93709	71310	93361	72542	92795	54
7	70050	93702	71331	93353	72562	92787	53
8	70072	93695	71352	93346	72582	92779	52
9	70093	93687	71373	93338	72602	92771	51
10	9.70115	9.93680	9.71393	9.93230	9.72622	9.92763	50
11	70137	93673	71414	93222	72643	92755	49
12	70159	93665	71435	93215	72663	92747	48
13	70180	93658	71456	93207	72683	92739	47
14	70202	93650	71477	93200	72703	92731	46
15	70224	93643	71498	93192	72723	92723	45
16	70245	93636	71519	93184	72743	92715	44
17	70267	93628	71539	93177	72763	92707	43
18	70288	93621	71560	93169	72783	92699	42
19	70310	93614	71581	93161	72803	92691	41
20	9.70332	9.93605	9.71602	9.93154	9.72822	9.92683	40
21	70353	93599	71622	93146	72843	92675	39
22	70375	93591	71643	93138	72863	92667	38
23	70396	93584	71664	93131	72883	92659	37
24	70418	93577	71685	93123	72902	92651	36
25	70439	93569	71705	93115	72922	92643	35
26	70461	93562	71726	93108	72942	92635	34
27	70482	93554	71747	93100	72962	92627	33
28	70504	93547	71767	93092	72982	92619	32
29	70525	93539	71788	93084	73002	92611	31
30	9.70547	9.93532	9.71809	9.93077	9.73022	9.92603	30
31	70568	93525	71829	93069	73041	92595	29
32	70590	93517	71850	93061	73061	92587	28
33	70611	93510	71870	93053	73081	92579	27
34	70633	93502	71891	93046	73101	92571	26
35	70654	93495	71911	93038	73121	92563	25
36	70675	93487	71932	93030	73140	92555	24
37	70697	93480	71952	93022	73160	92546	23
38	70718	93472	71973	93014	73180	92538	22
39	70739	93465	71994	93007	73200	92530	21
40	9.70761	9.93457	9.72014	9.92999	9.73219	9.92522	20
41	70782	93450	72034	92991	73239	92514	19
42	70803	93442	72055	92983	73259	92506	18
43	70824	93435	72075	92976	73278	92498	17
44	70846	93427	72096	92968	73298	92490	16
45	70867	93420	72116	92960	73318	92482	15
46	70888	93412	72137	92952	73337	92474	14
47	70909	93405	72157	92944	73357	92465	13
48	70931	93397	72177	92936	73377	92457	12
49	70952	93390	72198	92929	73396	92449	11
50	9.70973	9.93382	9.72218	9.92921	9.73416	9.92441	10
51	70994	93375	72238	92913	73435	92433	9
52	71015	93367	72259	92905	73455	92425	8
53	71036	93360	72279	92897	73474	92416	7
54	71058	93352	72299	92889	73494	92408	6
55	71079	93344	72320	92881	73513	92400	5
56	71100	93337	72340	92874	73533	92392	4
57	71121	93329	72360	92866	73552	92384	3
58	71142	93322	72381	92858	73572	92376	2
59	71163	93314	72401	92850	73591	92367	1
60	71184	93307	72421	92842	73611	92359	0
	Cosine	Sine	Cosine	Sine	Cosine	Sine	
	59°		58°		57°		

	83°		84°		85°		
	Sine	Cosine	Sine	Cosine	Sine	Cosine	
0	9.73611	9.92359	9.74756	9.91857	9.75859	9.91386	60
1	73630	92351	74775	91849	75877	91328	59
2	73650	92343	74794	91840	75895	91319	58
3	73669	92335	74812	91832	75913	91310	57
4	73689	92326	74831	91823	75931	91301	56
5	73708	92318	74850	91815	75949	91292	55
6	73727	92310	74868	91806	75967	91283	54
7	73747	92302	74887	91798	75985	91274	53
8	73766	92293	74906	91789	76003	91266	52
9	73785	92285	74924	91781	76021	91257	51
10	9.73805	9.92277	9.74943	9.91772	9.76039	9.91248	50
11	73824	92269	74961	91763	76057	91239	49
12	73843	92260	74980	91755	76075	91230	48
13	73863	92252	74999	91746	76093	91221	47
14	73882	92244	75017	91738	76111	91212	46
15	73901	92235	75036	91729	76129	91203	45
16	73921	92227	75054	91720	76146	91194	44
17	73940	92219	75073	91712	76164	91185	43
18	73959	92211	75091	91703	76182	91176	42
19	73978	92202	75110	91695	76200	91167	41
20	9.73997	9.92194	9.75128	9.91686	9.76218	9.91158	40
21	74017	92186	75147	91677	76236	91149	39
22	74036	92177	75165	91669	76253	91141	38
23	74055	92169	75184	91660	76271	91132	37
24	74074	92161	75202	91651	76289	91123	36
25	74093	92152	75221	91643	76307	91114	35
26	74113	92144	75239	91634	76324	91105	34
27	74132	92136	75258	91625	76342	91096	33
28	74151	92127	75276	91617	76360	91087	32
29	74170	92119	75294	91608	76378	91078	31
30	9.74189	9.92111	9.75313	9.91599	9.76395	9.91069	30
31	74208	92102	75331	91591	76413	91060	29
32	74227	92094	75350	91582	76431	91051	28
33	74246	92086	75368	91573	76448	91042	27
34	74265	92077	75386	91565	76466	91033	26
35	74284	92069	75405	91556	76484	91023	25
36	74303	92060	75423	91547	76501	91014	24
37	74322	92052	75441	91538	76519	91005	23
38	74341	92044	75459	91529	76537	90996	22
39	74360	92035	75478	91521	76554	90987	21
40	9.74379	9.92027	9.75496	9.91512	9.76572	9.90978	20
41	74398	92018	75514	91504	76590	90969	19
42	74417	92010	75533	91495	76607	90960	18
43	74436	92002	75551	91486	76625	90951	17
44	74455	91993	75569	91477	76642	90942	16
45	74474	91985	75587	91469	76660	90933	15
46	74493	91976	75605	91460	76677	90924	14
47	74512	91968	75624	91451	76695	90915	13
48	74531	91959	75642	91442	76712	90906	12
49	74549	91951	75660	91433	76730	90896	11
50	9.74568	9.91942	9.75678	9.91425	9.76747	9.90887	10
51	74587	91934	75696	91416	76765	90878	9
52	74606	91925	75714	91407	76782	90869	8
53	74625	91917	75733	91398	76800	90860	7
54	74644	91908	75751	91389	76817	90851	6
55	74662	91900	75769	91381	76835	90842	5
56	74681	91891	75787	91372	76852	90832	4
57	74700	91883	75805	91363	76870	90823	3
58	74719	91874	75823	91354	76887	90814	2
59	74737	91866	75841	91345	76904	90805	1
60	74756	91857	75859	91336	76922	90796	0
	Cosine	Sine	Cosine	Sine	Cosine	Sine	
		56°		55°		54°	

°	36°		37°		38°		°
	Sine	Cosine	Sine	Cosine	Sine	Cosine	
0	9.76922	9.90796	9.77946	9.90235	9.78934	9.89653	60
1	76939	90787	77963	90295	78950	89643	59
2	76957	90777	77980	90216	78967	89633	58
3	76974	90768	77997	90206	78983	89624	57
4	76991	90759	78013	90197	78999	89614	56
5	77009	90750	78030	90187	79015	89601	55
6	77026	90741	78047	90178	79031	89594	54
7	77043	90731	78063	90168	79047	89584	53
8	77061	90722	78080	90159	79063	89574	52
9	77078	90713	78097	90149	79079	89564	51
10	9.77095	9.90704	9.78113	9.90139	9.79095	9.89554	50
11	77112	90694	78130	90130	79111	89544	49
12	77130	90685	78147	90120	79128	89534	48
13	77147	90676	78163	90111	79144	89524	47
14	77164	90667	78180	90101	79160	89514	46
15	77181	90657	78197	90091	79176	89504	45
16	77199	90648	78213	90082	79192	89495	44
17	77216	90639	78230	90072	79208	89485	43
18	77233	90630	78246	90063	79224	89475	42
19	77250	90620	78263	90053	79240	89465	41
20	9.77268	9.90611	9.78280	9.90043	9.79256	9.89455	40
21	77285	90602	78296	90034	79272	89445	39
22	77302	90592	78313	90024	79288	89435	38
23	77319	90583	78329	90014	79304	89425	37
24	77336	90574	78346	90005	79319	89415	36
25	77353	90565	78362	89995	79335	89405	35
26	77370	90555	78379	89985	79351	89395	34
27	77387	90546	78395	89976	79367	89385	33
28	77405	90537	78412	89966	79383	89375	32
29	77422	90527	78428	89956	79399	89364	31
30	9.77439	9.90518	9.78445	9.89947	9.79415	9.89354	30
31	77456	90509	78461	89937	79431	89344	29
32	77473	90499	78478	89927	79447	89334	28
33	77490	90490	78494	89918	79463	89324	27
34	77507	90480	78510	89909	79478	89314	26
35	77524	90471	78527	89898	79494	89301	25
36	77541	90462	78543	89888	79510	89291	24
37	77559	90452	78560	89879	79526	89284	23
38	77575	90443	78576	89869	79542	89274	22
39	77592	90434	78592	89859	79558	89264	21
40	9.77609	9.90434	9.78609	9.89849	9.79573	9.89254	20
41	77626	90415	78625	89840	79589	89244	19
42	77643	90405	78642	89830	79605	89233	18
43	77660	90396	78658	89820	79621	89223	17
44	77677	90386	78674	89810	79636	89213	16
45	77694	90377	78691	89801	79652	89203	15
46	77711	90368	78707	89791	79668	89193	14
47	77728	90358	78723	89781	79684	89183	13
48	77744	90349	78739	89771	79699	89173	12
49	77761	90339	78756	89761	79715	89162	11
50	9.77778	9.90330	9.78772	9.89752	9.79731	9.89152	10
51	77795	90320	78788	89742	79746	89142	9
52	77812	90311	78805	89732	79762	89132	8
53	77829	90301	78821	89722	79778	89122	7
54	77846	90292	78837	89712	79793	89112	6
55	77862	90282	78853	89702	79809	89101	5
56	77879	90273	78869	89693	79825	89091	4
57	77896	90263	78886	89683	79840	89081	3
58	77913	90254	78902	89673	79856	89071	2
59	77930	90244	78918	89663	79872	89060	1
60	77946	90235	78934	89653	79887	89050	0
°	Cosine	Sine	Cosine	Sine	Cosine	Sine	°
	58°		52°		51°		

°	39°		40°		41°		°
	Sine	Cosine	Sine	Cosine	Sine	Cosine	
0	9.79887	9.89050	9.80807	9.88425	9.81694	9.87778	60
1	79903	89040	80822	88415	81709	87767	59
2	79918	89030	80837	88404	81723	87758	58
3	79934	89021	80852	88394	81738	87745	57
4	79950	89009	80867	88383	81752	87734	56
5	79965	88999	80882	88372	81767	87723	55
6	79981	88989	80897	88362	81781	87712	54
7	79996	88978	80912	88351	81796	87701	53
8	80012	88968	80927	88340	81810	87690	52
9	80027	88958	80942	88330	81825	87679	51
10	9.80043	9.88948	9.80957	9.88319	9.81839	9.87668	50
11	80058	88937	80972	88308	81854	87657	49
12	80074	88927	80987	88298	81868	87646	48
13	80089	88917	81002	88287	81882	87635	47
14	80105	88906	81017	88276	81897	87624	46
15	80120	88896	81032	88266	81911	87613	45
16	80136	88886	81047	88255	81926	87601	44
17	80151	88875	81061	88244	81940	87590	43
18	80166	88865	81076	88234	81955	87579	42
19	80182	88855	81091	88223	81969	87568	41
20	9.80197	9.88844	9.81106	9.88212	9.81983	9.87557	40
21	80213	88834	81121	88201	81998	87546	39
22	80228	88824	81136	88191	82012	87535	38
23	80244	88813	81151	88180	82026	87524	37
24	80259	88803	81166	88169	82041	87513	36
25	80274	88793	81180	88158	82055	87501	35
26	80290	88782	81195	88148	82069	87490	34
27	80305	88772	81210	88137	82084	87479	33
28	80320	88761	81225	88126	82098	87468	32
29	80336	88751	81240	88115	82112	87457	31
30	9.80351	9.88741	9.81254	9.88105	9.82126	9.87446	30
31	80366	88730	81269	88094	82141	87434	29
32	80382	88720	81284	88083	82155	87423	28
33	80397	88709	81299	88072	82169	87412	27
34	80412	88699	81314	88061	82184	87401	26
35	80428	88688	81328	88051	82198	87390	25
36	80443	88678	81343	88040	82212	87378	24
37	80458	88668	81358	88029	82226	87367	23
38	80473	88657	81372	88018	82240	87356	22
39	80489	88647	81387	88007	82255	87345	21
40	9.80504	9.88636	9.81402	9.87996	9.82269	9.87334	20
41	80519	88626	81417	87985	82283	87322	19
42	80534	88615	81431	87975	82297	87311	18
43	80550	88605	81446	87964	82311	87300	17
44	80565	88594	81461	87953	82326	87288	16
45	80580	88584	81475	87942	82340	87277	15
46	80595	88573	81490	87931	82354	87266	14
47	80610	88563	81505	87920	82368	87255	13
48	80625	88552	81519	87909	82382	87243	12
49	80641	88542	81534	87898	82396	87232	11
50	9.80656	9.88531	9.81549	9.87887	9.82410	9.87221	10
51	80671	88521	81563	87877	82424	87209	9
52	80686	88510	81578	87866	82438	87198	8
53	80701	88499	81592	87855	82452	87187	7
54	80716	88489	81607	87844	82467	87175	6
55	80731	88478	81622	87833	82481	87164	5
56	80746	88468	81636	87822	82495	87153	4
57	80762	88457	81651	87811	82509	87141	3
58	80777	88447	81665	87800	82523	87130	2
59	80792	88436	81680	87789	82537	87119	1
60	80807	88425	81694	87778	82551	87107	0
	Cosine	Sine	Cosine	Sine	Cosine	Sine	
	50°		40°		48°		

# LOGARITHMIC SINES AND COSINES

	42°		43°		44°		
	Sine	Cosine	Sine	Cosine	Sine	Cosine	
0	9.82551	9.87107	9.88378	9.86413	9.84177	9.85693	60
1	82565	87096	88392	86401	84190	85681	59
2	82579	87085	88405	86389	84203	85669	58
3	82593	87073	88419	86377	84216	85657	57
4	82607	87062	88432	86366	84229	85645	56
5	82621	87050	88446	86354	84242	85632	55
6	82635	87039	88459	86342	84255	85620	54
7	82649	87028	88473	86330	84269	85608	53
8	82663	87016	88486	86318	84282	85596	52
9	82677	87005	88500	86306	84295	85583	51
10	9.82691	9.86993	9.88513	9.86295	9.84308	9.85571	50
11	82705	86982	88527	86283	84321	85559	49
12	82719	86970	88540	86271	84334	85547	48
13	82733	86959	88554	86259	84347	85534	47
14	82747	86947	88567	86247	84360	85522	46
15	82761	86936	88581	86235	84373	85510	45
16	82775	86924	88594	86223	84385	85497	44
17	82788	86913	88608	86211	84398	85485	43
18	82802	86902	88621	86200	84411	85473	42
19	82816	86890	88634	86188	84424	85460	41
20	9.82830	9.86879	9.88648	9.86176	9.84437	9.85448	40
21	82844	86867	88661	86164	84450	85436	39
22	82858	86855	88674	86152	84463	85423	38
23	82872	86844	88688	86140	84476	85411	37
24	82885	86832	88701	86128	84489	85399	36
25	82899	86821	88715	86116	84502	85386	35
26	82913	86809	88728	86104	84515	85374	34
27	82927	86798	88741	86092	84528	85361	33
28	82941	86786	88755	86080	84540	85349	32
29	82955	86775	88768	86068	84553	85337	31
30	9.82968	9.86763	9.88781	9.86056	9.84566	9.85324	30
31	82982	86752	88795	86044	84579	85312	29
32	82996	86740	88808	86032	84592	85299	28
33	83010	86728	88821	86020	84605	85287	27
34	83023	86717	88834	86008	84618	85274	26
35	83037	86705	88848	85996	84630	85262	25
36	83051	86694	88861	85984	84643	85250	24
37	83065	86682	88874	85972	84656	85237	23
38	83078	86670	88887	85960	84669	85225	22
39	83092	86659	88901	85948	84682	85212	21
40	9.83106	9.86647	9.88914	9.85939	9.84694	9.85200	20
41	83120	86635	88927	85924	84707	85187	19
42	83133	86624	88940	85912	84720	85175	18
43	83147	86612	88954	85900	84733	85162	17
44	83161	86600	88967	85888	84745	85150	16
45	83174	86589	88980	85876	84758	85137	15
46	83188	86577	88993	85864	84771	85125	14
47	83202	86565	89006	85851	84784	85112	13
48	83215	86554	89020	85839	84796	85100	12
49	83229	86542	89033	85827	84809	85087	11
50	9.83242	9.86530	9.89046	9.85815	9.84822	9.85074	10
51	83256	86518	89059	85803	84835	85062	9
52	83270	86507	89072	85791	84847	85049	8
53	83283	86495	89085	85779	84860	85037	7
54	83297	86483	89098	85766	84873	85024	6
55	83310	86472	89112	85754	84885	85012	5
56	83324	86460	89125	85742	84898	84999	4
57	83338	86448	89138	85730	84911	84986	3
58	83351	86436	89151	85718	84923	84974	2
59	83365	86425	89164	85706	84936	84961	1
60	83378	86413	89177	85693	84949	84949	0
	<b>Cosine</b>	<b>Sine</b>	<b>Cosine</b>	<b>Sine</b>	<b>Cosine</b>	<b>Sine</b>	
	42°		46°		45°		



°	0°		1°		2°		°
	Tan	Cotan	Tan	Cotan	Tan	Cotan	
0	—∞	∞	8.24192	11.75808	8.54308	11.45692	60
1	6.46373	13.53027	24910	75090	54669	45331	59
2	76476	23254	25616	74384	55027	44973	58
3	94085	05915	26312	73688	55382	44618	57
4	7.06579	12.93421	26996	73004	55734	44265	56
5	16270	83730	27669	72331	56083	43917	55
6	24188	75812	28332	71668	56429	43571	54
7	30882	69118	28986	71014	56772	43227	53
8	36682	63318	29629	70371	57114	42886	52
9	41797	58203	30263	69737	57452	42548	51
10	7.46373	12.53627	8.30888	11.69112	8.57788	11.42212	50
11	50512	49488	31505	68495	58121	41879	49
12	54291	45709	32112	67888	58451	41549	48
13	57707	42233	32711	67280	58779	41221	47
14	60986	39014	33302	66698	59105	40895	46
15	63982	36018	33886	66114	59428	40572	45
16	66785	33215	34461	65539	59749	40251	44
17	69418	30582	35029	64971	60068	39932	43
18	71900	28100	35590	64410	60384	39616	42
19	74248	25752	36143	63857	60698	39302	41
20	7.76476	12.23524	8.36689	11.63311	8.61009	11.38991	40
21	78595	21405	37229	63271	61319	38681	39
22	80615	19385	37762	62738	61626	38374	38
23	82546	17454	38289	62171	61931	38069	37
24	84394	15606	38809	61591	62234	37766	36
25	86167	13833	39323	60977	62535	37465	35
26	87871	12129	39832	60368	62834	37166	34
27	89510	10490	40334	59766	63131	36869	33
28	91089	8911	40830	59170	63426	36574	32
29	92612	7387	41321	58579	63718	36282	31
30	7.94086	12.05914	8.41807	11.58193	8.64009	11.35991	30
31	95510	04490	42287	57713	64298	36502	29
32	96889	03111	42762	57238	64585	36215	28
33	98225	01775	43232	56768	64870	35930	27
34	99522	00478	43696	56304	65154	35646	26
35	8.00781	11.99219	44156	55844	65435	35365	25
36	02004	97996	44611	55389	65715	35085	24
37	03194	96806	45061	54939	65993	34807	23
38	04353	95647	45507	54493	66269	34531	22
39	05481	94519	45948	54052	66543	34257	21
40	8.06581	11.93419	8.46885	11.53615	8.66816	11.33184	20
41	07653	92347	46371	53183	67087	33913	19
42	08700	91300	46845	52755	67356	33644	18
43	09722	90278	47309	52331	67624	33376	17
44	10720	89280	47769	51911	67890	33110	16
45	11696	88304	48225	51495	68154	32846	15
46	12651	87349	48677	51083	68417	32583	14
47	13585	86415	49125	50675	68678	32322	13
48	14500	85500	49572	50271	68938	32062	12
49	15395	84605	50130	49870	69196	31804	11
50	8.16273	11.83727	8.50527	11.49473	8.69453	11.30547	10
51	17133	82867	50620	49480	69458	31547	9
52	17976	82024	51110	48990	69762	31298	8
53	18804	81196	51606	48504	70064	31050	7
54	19616	80384	52079	47921	70365	30805	6
55	20413	79587	52559	47341	70664	30562	5
56	21195	78805	53035	46765	70962	30320	4
57	21964	78036	53508	46192	71258	30080	3
58	22720	77280	53978	45622	71553	29842	2
59	23462	76538	53445	45055	71847	29606	1
60	24192	75808	54308	45692	71940	28060	0
	Cotan	Tan	Cotan	Tan	Cotan	Tan	
	89°		88°		87°		

LOG. TANGENTS AND COTANGENTS

°	3°		4°		5°		°
	Tan	Cotan	Tan	Cotan	Tan	Cotan	
0	8.71940	11.28060	8.84464	11.15536	8.94195	11.05805	60
1	79181	27819	84646	15854	94340	05660	59
2	79430	27580	84826	15174	94485	05515	58
3	79659	27341	85006	14494	94630	05370	57
4	79896	27104	85185	13815	94773	05227	56
5	79132	26868	85363	13137	94917	05083	55
6	79366	26634	85540	12460	95060	04940	54
7	79600	26400	85717	11783	95202	04798	53
8	79832	26163	85893	11107	95344	04656	52
9	74063	25937	86069	10431	95486	04514	51
10	8.74292	11.25708	8.86243	11.13757	8.95627	11.04373	50
11	74521	25479	86417	13083	95767	04238	49
12	74748	25252	86591	12409	95908	04092	48
13	74974	25026	86763	11737	96047	03953	47
14	75199	24801	86935	11065	96187	03813	46
15	75423	24577	87106	10394	96325	03675	45
16	75645	24355	87277	9723	96464	03538	44
17	75867	24133	87447	9053	96602	03398	43
18	76087	23914	87616	8384	96739	03261	42
19	76306	23694	87785	7715	96877	03123	41
20	8.76525	11.23475	8.87953	11.12047	8.97013	11.02987	40
21	76742	23253	88120	7046	97150	02880	39
22	76958	23042	88287	6377	97285	02715	38
23	77173	22827	88453	5708	97421	02579	37
24	77387	22613	88618	5039	97556	02444	36
25	77600	22400	88783	4370	97691	02309	35
26	77811	22189	88948	3701	97825	02175	34
27	78022	21978	89111	3032	97959	02041	33
28	78232	21768	89274	2363	98092	01908	32
29	78441	21559	89437	1694	98225	01775	31
30	8.78649	11.21351	8.89598	11.10402	8.98358	11.01642	30
31	78855	21145	89760	10240	98490	01510	29
32	79061	20939	89920	9570	98622	01378	28
33	79266	20734	90080	8900	98753	01247	27
34	79470	20530	90240	8230	98884	01116	26
35	79673	20327	90399	7560	99015	00985	25
36	79875	20125	90557	6890	99145	00855	24
37	80076	19924	90715	6220	99275	00725	23
38	80277	19723	90872	5550	99405	00595	22
39	80476	19524	91029	4880	99534	00466	21
40	8.80674	11.19326	8.91185	11.08815	8.99662	11.00338	20
41	80672	19128	91184	4210	99662	00339	19
42	81068	18932	91345	3540	99791	00211	18
43	81264	18736	91505	2870	99920	00081	17
44	81459	18541	91663	2200	10.00046	10.99954	16
45	81653	18347	91821	1530	00174	99826	15
46	81846	18154	91978	860	00301	99699	14
47	82038	17962	92134	190	00427	99573	13
48	82230	17770	92290	50	00553	99447	12
49	82420	17580	92445	0	00679	99321	11
50	8.82610	11.17390	8.92716	11.07284	9.00090	10.99910	10
51	82799	17201	92600	0	00805	99195	9
52	82987	17013	92755	0	01055	98745	8
53	83175	16825	92910	0	01179	98621	7
54	83361	16639	93065	0	01303	98497	6
55	83547	16453	93220	0	01427	98373	5
56	83732	16268	93375	0	01550	98249	4
57	83916	16084	93530	0	01673	98125	3
58	84100	15900	93685	0	01796	98001	2
59	84282	15718	93840	0	01919	97877	1
60	84464	15536	94000	0	02042	97753	0
	Cotan	Tan	Cotan	Tan	Cotan	Tan	
	86°		85°		84°		

	6°		7°		8°		
	Tan	Cotan	Tan	Cotan	Tan	Cotan	
0	9.02162	10.97888	9.08914	10.91086	9.14780	10.85220	60
1	02283	97717	90919	90981	14872	85128	59
2	02404	97596	09123	90877	14963	85037	58
3	02525	97475	09227	90773	15054	84946	57
4	02645	97355	09330	90670	15145	84855	56
5	02766	97234	09434	90566	15236	84764	55
6	02885	97115	09537	90463	15327	84673	54
7	03005	96995	09640	90360	15417	84583	53
8	03124	96876	09742	90258	15508	84492	52
9	03242	96758	09845	90155	15598	84402	51
10	9.03361	10.96039	9.09947	10.90053	9.15688	10.84312	50
11	03479	96521	10049	89951	15777	84223	49
12	03597	96403	10150	89850	15867	84133	48
13	03714	96286	10252	89748	15956	84044	47
14	03832	96168	10353	89647	16046	83954	46
15	03948	96052	10454	89546	16135	83865	45
16	04065	95935	10555	89445	16224	83776	44
17	04181	95819	10656	89344	16312	83688	43
18	04297	95703	10756	89244	16401	83599	42
19	04413	95587	10856	89144	16489	83511	41
20	9.04528	10.95472	9.10856	10.89044	9.16577	10.83423	40
21	04643	95357	11056	88944	16665	83355	39
22	04758	95242	11155	88845	16753	83247	38
23	04873	95127	11254	88746	16841	83159	37
24	04987	95013	11353	88647	16928	83072	36
25	05101	94899	11452	88548	17016	82984	35
26	05214	94786	11551	88449	17103	82897	34
27	05328	94672	11649	88351	17190	82810	33
28	05441	94559	11747	88253	17277	82723	32
29	05553	94447	11845	88155	17363	82637	31
30	9.05666	10.94334	9.11943	10.88057	9.17450	10.82550	30
31	05778	94222	12046	87960	17436	82464	29
32	05890	94110	12138	87862	17522	82378	28
33	06002	93998	12235	87765	17608	82292	27
34	06113	93887	12332	87668	17694	82206	26
35	06224	93776	12428	87572	17780	82120	25
36	06335	93665	12525	87475	17865	82035	24
37	06445	93555	12621	87379	17951	81949	23
38	06556	93444	12717	87283	18036	81864	22
39	06666	93334	12813	87187	18121	81779	21
40	9.06775	10.93225	9.12909	10.87091	9.18306	10.81694	20
41	06885	93115	13004	86996	18209	81609	19
42	06994	93006	13099	86901	18295	81525	18
43	07103	92897	13194	86806	18380	81440	17
44	07211	92789	13289	86711	18464	81356	16
45	07320	92680	13384	86616	18548	81272	15
46	07428	92572	13478	86522	18632	81188	14
47	07536	92464	13573	86427	18716	81104	13
48	07643	92357	13667	86333	18800	81021	12
49	07751	92249	13761	86239	18883	80937	11
50	9.07858	10.92142	9.13854	10.86146	9.19146	10.80854	10
51	07964	92036	13948	86052	18967	80771	9
52	08071	91929	14041	85959	19051	80688	8
53	08177	91823	14134	85866	19135	80605	7
54	08283	91717	14227	85773	19218	80522	6
55	08389	91611	14320	85680	19302	80439	5
56	08495	91505	14412	85588	19385	80357	4
57	08600	91400	14504	85496	19468	80275	3
58	08705	91295	14597	85403	19551	80193	2
59	08810	91190	14688	85312	19633	80111	1
60	08914	91086	14780	85220	19716	80029	
	Cotan	Tan	Cotan	Tan	Cotan	Tan	
	83°		82°		81°		

9°		10°		11°		'
Tan	Cotan	Tan	Cotan	Tan	Cotan	
9.19971	10.80029	9.34632	10.75368	9.28865	10.71135	60
20053	79947	24706	75294	28933	71067	59
20134	79866	24779	75221	29000	71000	58
20216	79784	24853	75147	29067	70933	57
20297	79703	24926	75074	29134	70866	56
20378	79622	25000	75000	29201	70799	55
20459	79541	25073	74927	29268	70732	54
20540	79460	25146	74854	29335	70665	53
20621	79379	25219	74781	29402	70598	52
20701	79299	25292	74708	29468	70532	51
9.20782	10.79218	9.25385	10.74695	9.29535	10.70465	50
20862	79138	25357	74623	29501	70399	49
20942	79058	25430	74550	29568	70332	48
21022	78978	25502	74477	29634	70266	47
21102	78898	25575	74404	29701	70200	46
21182	78818	25647	74331	29768	70134	45
21261	78739	25720	74258	29834	70068	44
21341	78659	25792	74185	29901	70002	43
21420	78580	25865	74112	29968	69936	42
21499	78501	25937	74039	30034	69870	41
9.21578	10.78422	9.26096	10.73914	9.30195	10.69805	40
21657	78423	26068	73842	30261	69739	39
21736	78344	26140	73769	30328	69674	38
21814	78264	26212	73696	30394	69609	37
21893	78185	26284	73623	30461	69543	36
21971	78105	26356	73550	30527	69478	35
22049	78026	26428	73477	30594	69413	34
22127	77946	26500	73404	30660	69348	33
22205	77867	26572	73331	30727	69283	32
22283	77787	26644	73258	30793	69218	31
9.22361	10.77639	9.26797	10.73203	9.30846	10.69154	30
22438	77642	26716	73183	30911	69089	29
22516	77564	26788	73163	30975	69025	28
22594	77487	26860	73143	31040	68960	27
22670	77409	26932	73123	31104	68896	26
22747	77332	27004	73103	31168	68832	25
22824	77254	27076	73083	31233	68767	24
22901	77177	27148	73063	31297	68703	23
22977	77100	27220	73043	31361	68639	22
23054	77022	27292	73023	31425	68575	21
9.23130	10.76850	9.27496	10.72504	9.31489	10.68511	20
23205	76794	27366	72484	31552	68448	19
23283	76717	27438	72464	31616	68384	18
23359	76641	27510	72444	31679	68321	17
23435	76565	27582	72424	31743	68257	16
23510	76490	27654	72404	31806	68194	15
23585	76414	27726	72384	31870	68130	14
23661	76339	27798	72364	31933	68067	13
23737	76263	27870	72344	31996	68004	12
23812	76188	27942	72324	32059	67941	11
9.23887	10.76113	9.28186	10.71814	9.32122	10.67878	10
23962	76038	28014	71746	32185	67815	9
24037	75963	28086	71677	32248	67752	8
24112	75888	28158	71609	32311	67689	7
24186	75814	28230	71541	32373	67627	6
24261	75739	28302	71473	32436	67564	5
24335	75665	28374	71405	32498	67502	4
24410	75590	28446	71337	32561	67439	3
24484	75516	28518	71270	32623	67377	2
24558	75442	28590	71202	32685	67315	1
24632	75368	28662	71135	32747	67253	0
Cotan	Tan	Cotan	Tan	Cotan	Tan	
80°		79°		78°		

	12°		13°		14°		
	Tan	Cotan	Tan	Cotan	Tan	Cotan	
0	9.32747	10.67258	9.36336	10.63664	9.39677	10.60323	60
1	32810	67190	36394	63606	39731	60269	59
2	32872	67128	36452	63548	39785	60215	58
3	32933	67067	36509	63491	39838	60162	57
4	32995	67005	36566	63434	39893	60108	56
5	33057	66943	36624	63376	39945	60055	55
6	33119	66881	36681	63319	39999	60001	54
7	33180	66820	36738	63262	40052	59948	53
8	33242	66758	36795	63205	40106	59894	52
9	33303	66697	36852	63148	40159	59841	51
10	9.33865	10.66035	9.36909	10.63091	9.40212	10.59788	50
11	3426	66574	36966	63034	40266	59734	49
12	34327	66513	37023	62977	40319	59681	48
13	34388	66452	37080	62920	40372	59628	47
14	34449	66391	37137	62863	40425	59575	46
15	34510	66330	37193	62807	40478	59522	45
16	34571	66269	37250	62750	40531	59469	44
17	34632	66208	37306	62694	40584	59416	43
18	34693	66147	37363	62637	40636	59364	42
19	34754	66087	37419	62581	40689	59311	41
20	9.34974	10.66020	9.37476	10.62524	9.40742	10.59258	40
21	34814	65966	37532	62468	40795	59205	39
22	34875	65905	37588	62412	40847	59153	38
23	34936	65845	37644	62356	40900	59100	37
24	34997	65785	37700	62300	40952	59048	36
25	35058	65724	37756	62244	41005	58995	35
26	35119	65664	37812	62188	41057	58943	34
27	35180	65604	37868	62132	41109	58891	33
28	35242	65544	37924	62076	41161	58839	32
29	35303	65484	37980	62020	41214	58786	31
30	9.34576	10.65434	9.38035	10.61965	9.41266	10.58734	30
31	34635	65365	38091	61909	41318	58682	29
32	34695	65305	38147	61853	41370	58630	28
33	34755	65245	38202	61798	41422	58578	27
34	34814	65186	38257	61743	41474	58526	26
35	34874	65126	38313	61687	41526	58474	25
36	34933	65067	38368	61632	41578	58422	24
37	34992	65008	38423	61577	41629	58371	23
38	35051	64949	38479	61521	41681	58319	22
39	35111	64889	38534	61466	41733	58267	21
40	9.35170	10.64880	9.38589	10.61411	9.41784	10.58216	20
41	35229	64771	38644	61356	41786	58164	19
42	35288	64712	38699	61301	41837	58113	18
43	35347	64653	38754	61246	41889	58061	17
44	35405	64595	38808	61192	41940	58010	16
45	35464	64536	38863	61137	42041	57959	15
46	35523	64477	38918	61082	42093	57907	14
47	35581	64419	38972	61028	42144	57856	13
48	35640	64360	39027	60973	42195	57805	12
49	35698	64302	39082	60918	42246	57754	11
50	9.35757	10.64243	9.39136	10.60864	9.42297	10.57703	10
51	35815	64185	39190	60810	42348	57652	9
52	35873	64127	39245	60755	42399	57601	8
53	35931	64069	39299	60701	42450	57550	7
54	35989	64011	39353	60647	42501	57499	6
55	36047	63953	39407	60593	42552	57448	5
56	36105	63895	39461	60539	42603	57397	4
57	36163	63837	39515	60485	42653	57347	3
58	36221	63779	39569	60431	42704	57296	2
59	36279	63721	39623	60377	42755	57245	1
60	36336	63664	39677	60323	42805	57195	0
	Cotan	Tan	Cotan	Tan	Cotan	Tan	
	27°		26°		25°		

LOG. TANGENTS AND COTANGENTS

	15°		16°		17°		
	Tan	Cotan	Tan	Cotan	Tan	Cotan	
0	9.43805	10.57195	9.45750	10.54250	9.48534	10.51466	60
1	42856	57144	45797	54203	48579	51421	59
2	42906	57094	45845	54155	48624	51376	58
3	42957	57043	45892	54108	48669	51331	57
4	43007	56993	45940	54060	48714	51286	56
5	43057	56943	45987	54013	48759	51241	55
6	43108	56892	46035	53965	48804	51196	54
7	43158	56842	46082	53918	48849	51151	53
8	43208	56792	46130	53870	48894	51106	52
9	43258	56742	46177	53823	48939	51061	51
10	9.43908	10.56992	9.46224	10.53776	9.48984	10.51016	50
11	43258	56642	46271	53729	49029	50971	49
12	43408	56592	46319	53681	49073	50927	48
13	43458	56542	46366	53634	49118	50882	47
14	43508	56492	46413	53587	49163	50837	46
15	43558	56442	46460	53540	49207	50793	45
16	43607	56393	46507	53493	49252	50748	44
17	43657	56343	46554	53446	49296	50704	43
18	43707	56293	46601	53399	49341	50659	42
19	43756	56244	46648	53352	49385	50615	41
20	9.43906	10.56194	9.46691	10.53306	9.49430	10.50570	40
21	43855	56145	46741	53259	49474	50525	39
22	43905	56095	46788	53212	49519	50481	38
23	43954	56046	46835	53165	49563	50437	37
24	44004	55996	46881	53119	49607	50393	36
25	44053	55947	46928	53072	49652	50348	35
26	44102	55898	46975	53025	49696	50304	34
27	44151	55849	47021	52979	49740	50260	33
28	44201	55799	47068	52932	49784	50216	32
29	44250	55750	47114	52886	49828	50172	31
30	9.44399	10.55701	9.47160	10.52840	9.49872	10.50128	30
31	44348	55652	47207	52793	49916	50084	29
32	44397	55603	47253	52747	49960	50040	28
33	44446	55554	47299	52701	50004	49996	27
34	44495	55505	47346	52654	50048	49952	26
35	44544	55456	47392	52608	50092	49908	25
36	44592	55408	47438	52562	50136	49864	24
37	44641	55359	47484	52516	50180	49820	23
38	44690	55310	47530	52470	50224	49777	22
39	44738	55262	47576	52424	50267	49733	21
40	9.44787	10.55213	9.47622	10.52378	9.50311	10.49689	20
41	44836	55164	47622	52332	50355	49645	19
42	44884	55116	47714	52286	50398	49602	18
43	44933	55067	47760	52240	50442	49558	17
44	44981	55019	47806	52194	50485	49515	16
45	45029	54971	47852	52148	50529	49471	15
46	45078	54922	47897	52103	50572	49428	14
47	45126	54874	47943	52057	50616	49384	13
48	45174	54825	47989	52011	50659	49341	12
49	45222	54778	48035	51965	50703	49297	11
50	9.45271	10.54729	9.48080	10.51920	9.50746	10.49254	10
51	45319	54681	48126	51874	50789	49211	9
52	45367	54633	48171	51829	50833	49167	8
53	45415	54585	48217	51783	50876	49124	7
54	45463	54537	48262	51738	50919	49081	6
55	45511	54489	48307	51693	50962	49038	5
56	45559	54441	48353	51647	51005	48995	4
57	45606	54394	48398	51602	51048	48952	3
58	45654	54346	48443	51557	51092	48908	2
59	45702	54298	48489	51511	51135	48865	1
60	45750	54250	48534	51466	51178	48822	0
	Cotan	Tan	Cotan	Tan	Cotan	Tan	
	74°		73°		72°		

°	18°		19°		20°		°
	Tan	Cotan	Tan	Cotan	Tan	Cotan	
0	9.51178	10.48822	9.53697	10.46303	9.56107	10.43893	60
1	51321	48779	53738	46262	56146	43854	59
2	51264	48736	53779	46221	56185	438.5	58
3	51306	48694	53820	46180	56224	43776	57
4	51349	48651	53861	46139	56264	43736	56
5	51392	48608	53902	46098	56303	43697	55
6	51435	48565	53943	46057	56342	43658	54
7	51478	48522	53984	46016	56381	43619	53
8	51520	48480	54025	45975	56420	43580	52
9	51563	48437	54065	45935	56459	43541	51
10	9.51606	10.48394	9.54106	10.45894	9.56498	10.43502	50
11	51648	48352	54147	45853	56537	43463	49
12	51691	48309	54187	45813	56576	43424	48
13	51734	48266	54228	45772	56615	43385	47
14	51776	48224	54269	45731	56654	43346	46
15	51819	48181	54309	45691	56693	43307	45
16	51861	48139	54350	45650	56732	43268	44
17	51903	48097	54390	45610	56771	4' 2.9	43
18	51946	48054	54431	45569	56810	43190	42
19	51988	48012	54471	45529	56849	43151	41
20	9.52031	10.47966	9.54512	10.45488	9.56887	10.43113	40
21	52073	47927	54552	45448	56926	43074	39
22	52115	47885	54593	45407	56965	43035	38
23	52157	47843	54633	45367	57004	42996	37
24	52200	47800	54673	45327	57042	42958	36
25	52242	47758	54714	45286	57081	42919	35
26	52284	47716	54754	45246	57120	42880	34
27	52326	47674	54794	45206	57158	42842	33
28	52368	47632	54835	45165	57197	42803	32
29	52410	47590	54875	45125	57235	42765	31
30	9.52452	10.47548	9.54915	10.45085	9.57274	10.42726	30
31	52494	47506	54955	45045	57312	42688	29
32	52536	47464	54995	45005	57351	42649	28
33	52578	47422	55035	44965	57389	42611	27
34	52620	47380	55075	44925	57428	42572	26
35	52661	47339	55115	44885	57466	42534	25
36	52703	47297	55155	44845	57504	42496	24
37	52745	47255	55195	44805	57543	42457	23
38	52787	47213	55235	44765	57581	42419	22
39	52829	47171	55275	44725	57619	42381	21
40	9.52870	10.47130	9.55815	10.44685	9.57658	10.42342	20
41	52912	47088	55355	44645	57696	42304	19
42	52953	47047	55395	44605	57734	42266	18
43	52995	47005	55434	44566	57772	42228	17
44	53037	46963	55474	44526	57810	42190	16
45	53078	46922	55514	44486	57849	42151	15
46	53120	46880	55554	44446	57887	42113	14
47	53161	46839	55593	44407	57925	42075	13
48	53202	46798	55633	44367	57963	42037	12
49	53244	46756	55673	44327	58001	41999	11
50	9.53285	10.46715	9.55712	10.44288	9.58089	10.41961	10
51	53327	46673	55752	44248	58077	41923	9
52	53368	46632	55791	44209	58115	41885	8
53	53409	46591	55831	44169	58153	41847	7
54	53450	46550	55870	44130	58191	41809	6
55	53492	46508	55910	44090	58229	41771	5
56	53533	46467	55949	44051	58267	41733	4
57	53574	46426	55989	44011	58304	41696	3
58	53615	46385	56028	43972	58342	41658	2
59	53656	46344	56067	43933	58380	41620	1
60	53697	46303	56107	43893	58418	41582	0
	Cotan	Tan	Cotan	Tan	Cotan	Tan	
	71°		70°		69°		

# LOG. TANGENTS AND COTANGENTS

/	21°		22°		23°		/
	Tan	Cotan	Tan	Cotan	Tan	Cotan	
0	9.58418	10.41582	9.60641	10.39359	9.62785	10.37215	60
1	58455	41545	60677	39323	62820	37180	59
2	58493	41507	60714	39286	62855	37145	58
3	58531	41469	60750	39250	62890	37110	57
4	58569	41431	60786	39214	62926	37074	56
5	58606	41394	60823	39177	62961	37039	55
6	58644	41356	60859	39141	62996	37004	54
7	58681	41319	60895	39105	63031	36969	53
8	58719	41281	60931	39069	63066	36934	52
9	58757	41243	60967	39033	63101	36899	51
10	9.58794	10.41206	9.61004	10.38996	9.63135	10.36865	50
11	58832	41168	61040	38960	63170	36830	49
12	58869	41131	61076	38924	63205	36795	48
13	58907	41093	61112	38888	63240	36760	47
14	58944	41056	61148	38852	63275	36725	46
15	58981	41019	61184	38816	63310	36690	45
16	59019	40981	61220	38780	63345	36655	44
17	59056	40944	61256	38744	63379	36621	43
18	59094	40906	61292	38708	63414	36586	42
19	59131	40869	61328	38672	63449	36551	41
20	9.59168	10.40832	9.61864	10.38636	9.63484	10.36516	40
21	59205	40795	61400	38600	63519	36481	39
22	59243	40757	61436	38564	63553	36447	38
23	59280	40720	61472	38528	63588	36412	37
24	59317	40683	61508	38492	63623	36377	36
25	59354	40646	61544	38456	63657	36343	35
26	59391	40609	61579	38421	63692	36308	34
27	59429	40571	61615	38385	63726	36274	33
28	59466	40534	61651	38349	63761	36240	32
29	59503	40497	61687	38313	63796	36204	31
30	9.59540	10.40460	9.61732	10.38278	9.63830	10.36170	30
31	59577	40423	61758	38242	63865	36135	29
32	59614	40386	61794	38206	63899	36101	28
33	59651	40349	61830	38170	63934	36066	27
34	59688	40312	61865	38135	63968	36032	26
35	59725	40275	61901	38099	64003	35997	25
36	59762	40238	61936	38064	64037	35963	24
37	59799	40201	61972	38028	64072	35928	23
38	59836	40165	62008	37992	64106	35894	22
39	59872	40128	62043	37957	64140	35860	21
40	9.59909	10.40091	9.62079	10.37921	9.64175	10.35825	20
41	59946	40054	62114	37886	64209	35791	19
42	59983	40017	62150	37850	64243	35757	18
43	60019	39981	62185	37815	64278	35722	17
44	60056	39944	62221	37779	64312	35688	16
45	60093	39907	62256	37744	64346	35654	15
46	60130	39870	62292	37708	64381	35619	14
47	60166	39834	62327	37673	64415	35585	13
48	60203	39797	62362	37638	64449	35551	12
49	60240	39760	62398	37602	64483	35517	11
50	9.60276	10.39724	9.63433	10.37567	9.64517	10.35483	10
51	60313	39687	62468	37532	64552	35448	9
52	60349	39651	62504	37496	64586	35414	8
53	60386	39614	62539	37461	64620	35380	7
54	60422	39578	62574	37426	64654	35346	6
55	60459	39541	62609	37391	64688	35312	5
56	60495	39505	62645	37355	64722	35278	4
57	60532	39468	62680	37320	64756	35244	3
58	60568	39432	62715	37285	64790	35210	2
59	60605	39395	62750	37250	64824	35176	1
60	60641	39359	62785	37215	64858	35142	0
	Cotan	Tan	Cotan	Tan	Cotan	Tan	
	68°		67°		66°		



	24°		25°		26°		
	Tan	Cotan	Tan	Cotan	Tan	Cotan	
0	9.64858	10.35142	9.66867	10.33133	9.68818	10.31182	60
1	64892	35108	66900	33100	68850	31150	59
2	64926	35074	66933	33067	68882	31118	58
3	64960	35040	66966	33034	68914	31086	57
4	64994	35006	66999	33001	68946	31054	56
5	65028	34972	67032	32968	68978	31022	55
6	65062	34938	67065	32935	69010	30990	54
7	65096	34904	67098	32902	69042	30958	53
8	65130	34870	67131	32869	69074	30926	52
9	65164	34836	67163	32837	69106	30894	51
10	9.65197	10.34803	9.67196	10.32804	9.69138	10.30862	50
11	65231	34769	67229	32771	69170	30830	49
12	65265	34735	67262	32738	69202	30798	48
13	65299	34701	67295	32705	69234	30766	47
14	65333	34667	67327	32673	69266	30734	46
15	65366	34634	67360	32640	69298	30702	45
16	65400	34600	67393	32607	69329	30671	44
17	65434	34566	67426	32574	69361	30639	43
18	65467	34533	67458	32542	69393	30607	42
19	65501	34499	67491	32509	69425	30575	41
20	9.65535	10.34465	9.67524	10.32473	9.69457	10.30543	40
21	65568	34432	67556	32444	69488	30512	39
22	65602	34398	67589	32411	69520	30480	38
23	65636	34364	67622	32378	69552	30448	37
24	65669	34331	67654	32345	69584	30416	36
25	65703	34297	67687	32313	69615	30385	35
26	65736	34264	67719	32281	69647	30353	34
27	65770	34230	67752	32248	69679	30321	33
28	65803	34197	67785	32215	69710	30290	32
29	65837	34163	67817	32183	69742	30258	31
30	9.65870	10.34130	9.67850	10.32150	9.69774	10.30228	30
31	65904	34096	67882	32118	69805	30195	29
32	65937	34063	67915	32085	69837	30163	28
33	65971	34029	67947	32053	69868	30132	27
34	66004	33996	67980	32020	69900	30100	26
35	66038	33962	68012	31988	69932	30068	25
36	66071	33929	68044	31956	69963	30037	24
37	66104	33896	68077	31923	69995	30005	23
38	66138	33862	68109	31891	70026	29974	22
39	66171	33829	68142	31858	70058	29942	21
40	9.66204	10.33796	9.68174	10.31826	9.70089	10.29911	20
41	66238	33762	68206	31794	70121	29879	19
42	66271	33729	68239	31761	70152	29848	18
43	66304	33696	68271	31729	70184	29816	17
44	66337	33663	68303	31697	70215	29785	16
45	66371	33629	68336	31664	70247	29753	15
46	66404	33596	68368	31632	70278	29722	14
47	66437	33563	68400	31600	70309	29691	13
48	66470	33530	68432	31568	70341	29659	12
49	66503	33497	68465	31535	70372	29628	11
50	9.66537	10.33463	9.68497	10.31503	9.70404	10.29596	10
51	66570	33460	68529	31471	70435	29565	9
52	66603	33397	68561	31439	70466	29534	8
53	66636	33364	68593	31407	70498	29502	7
54	66669	33331	68626	31374	70529	29471	6
55	66702	33298	68658	31342	70560	29440	5
56	66735	33265	68690	31310	70592	29408	4
57	66768	33232	68722	31278	70623	29377	3
58	66801	33199	68754	31246	70654	29346	2
59	66834	33166	68786	31214	70685	29315	1
60	66867	33133	68818	31182	70717	29283	0
	Cotan	Tan	Cotan	Tan	Cotan	Tan	
	65°		64°		63°		

	27°		28°		29°		
	Tan	Cotan	Tan	Cotan	Tan	Cotan	
0	9.70717	10.29283	9.72567	10.27433	9.74375	10.25625	60
1	70748	29252	72598	27402	74405	25695	59
2	70779	29221	72628	27372	74435	25665	58
3	70810	29190	72659	27341	74465	25635	57
4	70841	29159	72689	27311	74494	25606	56
5	70873	29127	72720	27280	74524	25576	55
6	70904	29096	72750	27250	74554	25546	54
7	70935	29065	72780	27220	74583	25517	53
8	70966	29034	72811	27189	74613	25487	52
9	70997	29003	72841	27159	74643	25457	51
10	9.71028	10.28972	9.72872	10.27128	9.74673	10.25337	50
11	71059	28941	72902	27098	74702	25428	49
12	71090	28910	72932	27068	74732	25398	48
13	71121	28879	72963	27037	74762	25368	47
14	71153	28847	72993	27007	74791	25339	46
15	71184	28816	73023	26977	74821	25310	45
16	71215	28785	73054	26946	74851	25280	44
17	71246	28754	73084	26916	74880	25250	43
18	71277	28723	73114	26886	74910	25220	42
19	71308	28692	73144	26856	74939	25191	41
20	9.71339	10.28661	9.73175	10.26825	9.74969	10.25031	40
21	71370	28660	73205	26785	74998	25002	39
22	71401	28609	73235	26765	75028	24972	38
23	71431	28569	73265	26735	75058	24942	37
24	71462	28528	73295	26705	75087	24913	36
25	71493	28507	73326	26674	75117	24883	35
26	71524	28476	73356	26644	75146	24854	34
27	71555	28445	73386	26614	75176	24824	33
28	71586	28414	73416	26584	75205	24795	32
29	71617	28383	73446	26554	75235	24765	31
30	9.71648	10.28352	9.73476	10.26524	9.75264	10.24736	30
31	71679	28321	73507	26493	75294	24706	29
32	71709	28291	73537	26463	75323	24677	28
33	71740	28260	73567	26433	75353	24647	27
34	71771	28229	73597	26403	75382	24618	26
35	71802	28198	73627	26373	75411	24589	25
36	71833	28167	73657	26343	75441	24559	24
37	71863	28137	73687	26313	75470	24530	23
38	71894	28106	73717	26283	75500	24500	22
39	71925	28075	73747	26253	75529	24471	21
40	9.71955	10.28045	9.73777	10.26223	9.75558	10.24442	20
41	71986	28044	73807	26193	75588	24412	19
42	72017	28013	73837	26163	75617	24383	18
43	72048	27982	73867	26133	75647	24353	17
44	72078	27952	73897	26103	75676	24324	16
45	72109	27921	73927	26073	75705	24295	15
46	72140	27890	73957	26043	75735	24265	14
47	72170	27860	73987	26013	75764	24236	13
48	72201	27829	74017	25983	75793	24207	12
49	72231	27799	74047	25953	75822	24178	11
50	9.72262	10.27738	9.74077	10.25923	9.75882	10.24148	10
51	72293	27767	74107	25893	75881	24119	9
52	72323	27737	74137	25863	75910	24090	8
53	72354	27706	74166	25834	75939	24061	7
54	72384	27676	74196	25804	75969	24031	6
55	72415	27645	74226	25774	75998	24002	5
56	72445	27615	74256	25744	76027	23973	4
57	72476	27584	74286	25714	76056	23944	3
58	72506	27554	74316	25684	76086	23914	2
59	72537	27523	74345	25655	76115	23885	1
60	72567	27493	74375	25625	76144	23856	0
	Cotan	Tan	Cotan	Tan	Cotan	Tan	
	62°		61°		60°		

	30°		31°		32°		
	Tan	Cotan	Tan	Cotan	Tan	Cotan	
0	9.76144	10.23856	9.77877	10.22123	9.79579	10.20421	60
1	76173	23827	77906	23094	79607	20393	59
2	76202	23798	77935	23065	79635	20365	58
3	76231	23769	77963	23037	79663	20337	57
4	76261	23739	77992	23008	79691	20309	56
5	76290	23710	78020	21980	79719	20281	55
6	76319	23681	78049	21951	79747	20253	54
7	76348	23652	78077	21923	79776	20224	53
8	76377	23623	78106	21894	79804	20196	52
9	76406	23594	78135	21865	79832	20168	51
10	9.76435	10.23565	9.78168	10.21837	9.79860	10.20140	50
11	76464	23536	78192	21808	79888	20112	49
12	76493	23507	78220	21780	79916	20084	48
13	76522	23478	78249	21751	79944	20056	47
14	76551	23449	78277	21723	79972	20028	46
15	76580	23420	78306	21694	80000	20000	45
16	76609	23391	78334	21666	80028	19972	44
17	76639	23361	78363	21637	80056	19944	43
18	76668	23332	78391	21609	80084	19916	42
19	76697	23303	78419	21581	80112	19888	41
20	9.76725	10.23275	9.78448	10.21552	9.80140	10.19860	40
21	76754	23246	78476	21524	80168	19832	39
22	76783	23217	78505	21495	80196	19804	38
23	76812	23188	78533	21467	80224	19777	37
24	76841	23159	78562	21438	80251	19749	36
25	76870	23130	78590	21410	80279	19721	35
26	76899	23101	78618	21382	80307	19693	34
27	76928	23072	78647	21353	80335	19665	33
28	76957	23043	78675	21325	80363	19637	32
29	76986	23014	78704	21296	80391	19609	31
30	9.77015	10.22985	9.78732	10.21368	9.80419	10.19581	30
31	77044	22956	78760	21340	80447	19553	29
32	77073	22927	78789	21311	80474	19526	28
33	77101	22899	78817	21283	80502	19498	27
34	77130	22870	78845	21255	80530	19470	26
35	77159	22841	78874	21226	80558	19442	25
36	77188	22812	78902	21198	80586	19414	24
37	77217	22783	78930	21170	80614	19386	23
38	77246	22754	78959	21141	80642	19358	22
39	77274	22726	78987	21113	80669	19331	21
40	9.77303	10.22697	9.79015	10.20985	9.80697	10.19303	20
41	77332	22668	79043	20957	80725	19275	19
42	77361	22639	79072	20928	80753	19247	18
43	77390	22610	79100	20900	80781	19219	17
44	77418	22582	79128	20872	80808	19192	16
45	77447	22553	79156	20844	80836	19164	15
46	77476	22524	79185	20815	80864	19136	14
47	77505	22495	79213	20787	80892	19108	13
48	77533	22467	79241	20759	80919	19081	12
49	77562	22438	79269	20731	80947	19053	11
50	9.77591	10.22409	9.79297	10.20703	9.80975	10.19025	10
51	77619	22381	79296	20674	81003	18997	9
52	77648	22352	79324	20646	81030	18970	8
53	77677	22323	79352	20618	81058	18942	7
54	77706	22294	79380	20590	81086	18914	6
55	77734	22266	79408	20562	81113	18887	5
56	77763	22237	79436	20534	81141	18859	4
57	77791	22209	79465	20505	81169	18831	3
58	77820	22180	79493	20477	81196	18804	2
59	77849	22151	79521	20449	81224	18776	1
60	77877	22123	79549	20421	81252	18748	0
	Cotan	Tan	Cotan	Tan	Cotan	Tan	
	59°		58°		57°		

LOG. TANGENTS AND COTANGENTS

	33°		34°		35°		
	Tan	Cotan	Tan	Cotan	Tan	Cotan	
0	9.81252	10.18748	9.83899	10.17101	9.84523	10.15477	60
1	81279	18721	83926	17074	84550	15450	59
2	81307	18693	83958	17047	84576	15424	58
3	81335	18665	83990	17020	84603	15397	57
4	81362	18638	84008	16992	84630	15370	56
5	81390	18610	84035	16965	84657	15343	55
6	81418	18582	84062	16938	84684	15316	54
7	81445	18555	84089	16911	84711	15289	53
8	81473	18527	84117	16883	84738	15262	52
9	81500	18500	84144	16856	84764	15236	51
10	9.81538	10.18472	9.83171	10.16829	9.84791	10.15209	50
11	81556	18444	83198	16802	84818	15182	49
12	81583	18417	83225	16775	84845	15155	48
13	81611	18389	83252	16748	84872	15128	47
14	81638	18362	83280	16720	84899	15101	46
15	81666	18334	83307	16693	84925	15075	45
16	81693	18307	83334	16666	84952	15048	44
17	81721	18279	83361	16639	84979	15021	43
18	81748	18252	83388	16612	85006	14994	42
19	81776	18224	83415	16585	85033	14967	41
20	9.81808	10.18197	9.83442	10.16558	9.85059	10.14941	40
21	81831	18169	83470	16530	85086	14914	39
22	81858	18142	83497	16503	85113	14887	38
23	81886	18114	83524	16476	85140	14860	37
24	81913	18087	83551	16449	85166	14834	36
25	81941	18059	83578	16422	85193	14807	35
26	81968	18032	83605	16395	85220	14780	34
27	81996	18004	83632	16368	85247	14753	33
28	82023	17977	83659	16341	85273	14727	32
29	82051	17949	83686	16314	85300	14700	31
30	9.82078	10.17922	9.83713	10.16287	9.85327	10.14673	30
31	82106	17894	83740	16260	85354	14646	29
32	82133	17867	83768	16232	85380	14620	28
33	82161	17839	83795	16205	85407	14593	27
34	82188	17812	83822	16178	85434	14566	26
35	82215	17785	83849	16151	85460	14540	25
36	82243	17757	83876	16124	85487	14513	24
37	82270	17730	83903	16097	85514	14486	23
38	82298	17702	83930	16070	85540	14460	22
39	82325	17675	83957	16043	85567	14433	21
40	9.82352	10.17648	9.83984	10.16016	9.85594	10.14406	20
41	82380	17630	84011	15989	85620	14380	19
42	82407	17593	84038	15962	85647	14353	18
43	82435	17565	84065	15935	85674	14326	17
44	82462	17538	84092	15908	85700	14300	16
45	82489	17511	84119	15881	85727	14273	15
46	82517	17483	84146	15854	85754	14246	14
47	82544	17456	84173	15827	85780	14220	13
48	82571	17429	84200	15800	85807	14193	12
49	82599	17401	84227	15773	85834	14166	11
50	9.82626	10.17374	9.84254	10.15746	9.85860	10.14140	10
51	82653	17347	84280	15720	85887	14113	9
52	82681	17319	84307	15693	85913	14087	8
53	82708	17292	84334	15666	85940	14060	7
54	82735	17265	84361	15639	85967	14033	6
55	82762	17238	84388	15612	85993	14007	5
56	82790	17210	84415	15585	86020	13980	4
57	82817	17183	84442	15558	86046	13954	3
58	82844	17156	84469	15531	86073	13927	2
59	82871	17129	84496	15504	86100	13900	1
60	82899	17101	84523	15477	86126	13874	0
	Cotan	Tan	Cotan	Tan	Cotan	Tan	
	56°		55°		54°		

	86°		87°		88°		
	Tan	Cotan	Tan	Cotan	Tan	Cotan	
0	9.86126	10.13874	9.87711	10.12289	9.89281	10.10719	60
1	86153	13847	87738	12262	89307	10693	59
2	86179	13821	87764	12236	89333	10667	58
3	86206	13794	87790	12210	89359	10641	57
4	86232	13768	87817	12183	89385	10615	56
5	86259	13741	87843	12157	89411	10589	55
6	86285	13715	87869	12131	89437	10563	54
7	86312	13688	87895	12105	89463	10537	53
8	86338	13662	87922	12078	89489	10511	52
9	86365	13635	87948	12052	89515	10485	51
10	9.86392	10.13608	9.87974	10.12026	9.89541	10.10459	50
11	86418	13582	88000	12000	89567	10433	49
12	86445	13555	88027	11973	89593	10407	48
13	86471	13529	88053	11947	89619	10381	47
14	86498	13502	88079	11921	89645	10355	46
15	86524	13476	88105	11895	89671	10329	45
16	86551	13449	88131	11869	89697	10303	44
17	86577	13423	88158	11842	89723	10277	43
18	86603	13397	88184	11816	89749	10251	42
19	86630	13370	88210	11790	89775	10225	41
20	9.86656	10.13344	9.88236	10.11764	9.89801	10.10199	40
21	86683	13317	88262	11738	89827	10173	39
22	86709	13291	88289	11711	89853	10147	38
23	86736	13264	88315	11685	89879	10121	37
24	86762	13238	88341	11659	89905	10095	36
25	86789	13211	88367	11633	89931	10069	35
26	86815	13185	88393	11607	89957	10043	34
27	86842	13158	88420	11580	89983	10017	33
28	86868	13132	88446	11554	90009	9991	32
29	86894	13106	88472	11528	90035	9965	31
30	9.86921	10.13079	9.88498	10.11502	9.90061	10.09939	30
31	86947	13053	88524	11476	90086	99914	29
32	86974	13026	88550	11450	90112	99888	28
33	87000	13000	88577	11423	90138	99862	27
34	87027	12973	88603	11397	90164	99836	26
35	87053	12947	88629	11371	90190	99810	25
36	87079	12921	88655	11345	90216	99784	24
37	87106	12894	88681	11319	90242	99758	23
38	87132	12868	88707	11293	90268	99732	22
39	87158	12842	88733	11267	90294	99706	21
40	9.87185	10.12815	9.88759	10.11241	9.90320	10.09680	20
41	87211	12789	88786	11214	90346	99654	19
42	87238	12762	88812	11188	90371	99629	18
43	87264	12736	88838	11162	90397	99603	17
44	87290	12710	88864	11136	90423	99577	16
45	87317	12683	88890	11110	90449	99551	15
46	87343	12657	88916	11084	90475	99525	14
47	87369	12631	88942	11058	90501	99499	13
48	87396	12604	88968	11032	90527	99473	12
49	87422	12578	88994	11006	90553	99447	11
50	9.87448	10.12552	9.89020	10.10980	9.90578	10.09422	10
51	87475	12525	89046	10954	90604	99396	9
52	87501	12499	89073	10927	90630	99370	8
53	87527	12473	89099	10901	90656	99344	7
54	87554	12446	89125	10875	90682	99318	6
55	87580	12420	89151	10849	90708	99292	5
56	87606	12394	89177	10823	90734	99266	4
57	87633	12367	89203	10797	90760	99241	3
58	87659	12341	89229	10771	90785	99215	2
59	87685	12315	89255	10745	90811	99189	1
60	87711	12289	89281	10719	90837	99163	0
	Cotan	Tan	Cotan	Tan	Cotan	Tan	
	53°		52°		51°		

LOG. TANGENTS AND COTANGENTS

	39°		40°		41°		
	Tan	Cotan	Tan	Cotan	Tan	Cotan	
0	9.90837	10.09163	9.92381	10.07619	9.93916	10.06084	60
1	90863	09137	92407	07593	93942	06058	59
2	90889	09111	92433	07567	93967	06032	58
3	90914	09086	92458	07542	93993	06007	57
4	90940	09060	92484	07516	94018	05982	56
5	90966	09034	92510	07490	94044	05956	55
6	90992	09008	92535	07465	94069	05931	54
7	91018	08982	92561	07439	94095	05905	53
8	91043	08957	92587	07413	94120	05880	52
9	91019	08931	92612	07388	94146	05854	51
10	9 91095	10.08905	9.92638	10.07362	9.94171	10.05829	50
11	91121	08879	92663	07337	94197	05803	49
12	91147	08853	92689	07311	94222	05778	48
13	91172	08828	92715	07285	94248	05752	47
14	91198	08802	92740	07260	94273	05727	46
15	91224	08776	92766	07234	94299	05701	45
16	91250	08750	92792	07208	94324	05676	44
17	91276	08724	92817	07183	94350	05650	43
18	91301	08699	92843	07157	94375	05625	42
19	91327	08673	92868	07132	94401	05599	41
20	9.91333	10.08647	9.92894	10.07106	9.94426	10.05574	40
21	91379	08621	92920	07080	94452	05548	39
22	91404	08596	92945	07055	94477	05523	38
23	91430	08570	92971	07029	94503	05497	37
24	91456	08544	92996	07004	94528	05472	36
25	91482	08518	93022	06978	94554	05446	35
26	91507	08493	93048	06952	94579	05421	34
27	91533	08467	93073	06927	94604	05396	33
28	91559	08441	93099	06901	94630	05370	32
29	91585	08415	93124	06876	94655	05345	31
30	9.91610	10.08390	9.93150	10.06850	9.94681	10.05319	30
31	91636	08364	93175	06825	94706	05294	29
32	91662	08338	93201	06799	94732	05268	28
33	91688	08312	93227	06773	94757	05243	27
34	91713	08287	93252	06748	94783	05217	26
35	91739	08261	93278	06722	94808	05192	25
36	91765	08235	93303	06697	94834	05166	24
37	91791	08209	93329	06671	94859	05141	23
38	91816	08184	93354	06646	94884	05116	22
39	91842	08158	93380	06620	94910	05090	21
40	9.91868	10.08132	9.93406	10.06594	9.94935	10.05065	20
41	91893	08107	93431	06569	94961	05039	19
42	91919	08081	93457	06543	94986	05014	18
43	91945	08055	93482	06518	95012	04988	17
44	91971	08029	93508	06492	95037	04963	16
45	91996	08004	93533	06467	95062	04938	15
46	92022	07978	93559	06441	95088	04912	14
47	92048	07952	93584	06416	95113	04887	13
48	92073	07927	93610	06390	95139	04861	12
49	92099	07901	93636	06364	95164	04836	11
50	9.92125	10.07875	9.93661	10.06339	9.95190	10.04810	10
51	92150	07850	93687	06313	95215	04785	9
52	92176	07824	93712	06288	95240	04760	8
53	92202	07798	93738	06262	95266	04734	7
54	92227	07773	93763	06237	95291	04709	6
55	92253	07747	93789	06211	95317	04683	5
56	92279	07721	93814	06186	95342	04658	4
57	92304	07696	93840	06160	95368	04632	3
58	92330	07670	93865	06135	95393	04607	2
59	92356	07644	93891	06109	95418	04582	1
60	92381	07619	93916	06084	95444	04556	0
	Cotan	Tan	Cotan	Tan	Cotan	Tan	
	50°		40°		48°		

	42°		43°		44°		
	Tan	Cotan	Tan	Cotan	Tan	Cotan	
0	9.95444	10.04556	9.96966	10.03034	9.98484	10.01516	60
1	95469	04531	96991	03009	98509	01491	59
2	95495	04505	97016	02984	98534	01466	58
3	95520	04480	97042	02958	98560	01440	57
4	95545	04455	97067	02933	98585	01415	56
5	95571	04429	97092	02908	98610	01390	55
6	95596	04404	97118	02882	98635	01365	54
7	95622	04378	97143	02857	98661	01339	53
8	95647	04353	97168	02832	98686	01314	52
9	95672	04328	97193	02807	98711	01289	51
10	9.95698	10.04302	9.97219	10.02781	9.98737	10.01263	50
11	95723	04277	97244	02756	98762	01238	49
12	95748	04252	97269	02731	98787	01213	48
13	95774	04226	97295	02705	98812	01188	47
14	95799	04201	97320	02680	98838	01162	46
15	95825	04175	97345	02655	98863	01137	45
16	95850	04150	97371	02629	98888	01112	44
17	95875	04125	97396	02604	98913	01087	43
18	95901	04099	97421	02579	98939	01061	42
19	95926	04074	97447	02553	98964	01036	41
20	9.95952	10.04048	9.97472	10.02528	9.98989	10.01011	40
21	95977	04023	97497	02503	99015	00985	39
22	96002	03998	97522	02477	99040	00960	38
23	96028	03972	97548	02452	99065	00935	37
24	96053	03947	97573	02427	99090	00910	36
25	96078	03922	97598	02402	99116	00884	35
26	96104	03896	97624	02376	99141	00859	34
27	96129	03871	97649	02351	99166	00834	33
28	96155	03845	97674	02326	99191	00809	32
29	96180	03820	97700	02300	99217	00783	31
30	9.96205	10.03795	9.97725	10.02275	9.99242	10.00758	30
31	96231	03769	97750	02250	99267	00733	29
32	96256	03744	97776	02224	99293	00707	28
33	96281	03719	97801	02199	99318	00682	27
34	96307	03693	97826	02174	99343	00657	26
35	96332	03668	97851	02149	99368	00632	25
36	96357	03643	97877	02123	99394	00606	24
37	96383	03617	97902	02098	99419	00581	23
38	96408	03592	97927	02073	99444	00556	22
39	96433	03567	97953	02047	99469	00531	21
40	9.96459	10.03541	9.97978	10.02022	9.99495	10.00505	20
41	96484	03516	98003	01997	99520	00480	19
42	96510	03490	98029	01971	99545	00455	18
43	96535	03465	98054	01946	99570	00430	17
44	96560	03440	98079	01921	99596	00404	16
45	96586	03414	98104	01896	99621	00379	15
46	96611	03389	98130	01870	99646	00354	14
47	96636	03364	98155	01845	99672	00328	13
48	96662	03338	98180	01820	99697	00303	12
49	96687	03313	98206	01794	99722	00278	11
50	9.96712	10.03288	9.98231	10.01769	9.99747	10.00253	10
51	96738	03262	98256	01744	99773	00227	9
52	96763	03237	98281	01719	99798	00202	8
53	96788	03212	98307	01693	99823	00177	7
54	96814	03186	98332	01668	99848	00152	6
55	96839	03161	98357	01643	99874	00126	5
56	96864	03136	98383	01617	99899	00101	4
57	96890	03110	98408	01592	99924	00076	3
58	96915	03085	98433	01567	99949	00051	2
59	96940	03060	98458	01542	99975	00025	1
60	96966	03034	98484	01516	10.00000	00000	0
	Cotan	Tan	Cotan	Tan	Cotan	Tan	
	47°		46°		45°		

LOG. VERSED SINES AND EXTERNAL SECANTS 165

0°				1°					
'	Log. Vers.	D	Log. Exsec.	D	Log. Vers.	D	Log. Exsec.	D	'
0	— ∞		— ∞		6.18271	1435	6.18278	1436	0
1	2.62642	60206	2.62642	60206	19707	1412	19714	1412	1
2	3.22848	35218	3.22848	35218	21119	1389	21126	1390	2
3	3.58066	24987	3.58066	24987	22509	1368	22516	1368	3
4	3.83054	19382	3.83054	19382	23877	1345	23884	1347	4
5	4.02436	15836	4.02436	15836	6.25223	1322	6.25231	1322	5
6	18272	13389	18272	13389	26549	1306	26557	1306	6
7	31662	11598	31662	11598	27856	1286	27864	1287	7
8	43260	10230	43260	10230	29142	1268	29151	1288	8
9	53493	9151	53491	9151	30410	1250	30419	1250	9
10	6.62642	8278	4.62642	8279	6.31660	1232	6.31669	1232	10
11	70920	7558	70921	7557	32892	1214	32901	1215	11
12	78478	6953	78478	6952	34107	1198	34116	1198	12
13	85431	6437	85431	6437	35305	1182	35315	1182	13
14	91868	5992	91868	5993	36487	1166	36497	1166	14
15	4.97860	5605	4.97861	5605	6.37653	1150	6.37663	1151	15
16	5.03466	5266	5.03466	5266	38803	1135	38814	1135	16
17	08732	4964	08732	4964	39938	1121	39949	1121	17
18	13696	4696	13697	4696	41059	1106	41070	1106	18
19	18393	4455	18393	4456	42165	1093	42177	1093	19
20	5.22848	4238	5.22849	4238	6.43258	1078	6.43270	1079	20
21	27086	4040	27087	4040	44337	1066	44349	1066	21
22	31126	3861	31127	3861	45403	1052	45415	1053	22
23	34987	3697	34988	3697	46455	1040	46468	1040	23
24	38684	3545	38685	3545	47496	1028	47509	1028	24
25	5.42230	3407	5.42231	3407	6.48524	1016	6.48537	1015	25
26	45638	3278	45638	3278	49539	1004	49553	1004	26
27	48915	3158	48916	3159	50544	992	50557	993	27
28	52073	3048	52075	3048	51536	981	51550	993	28
29	55121	2945	55123	2945	52518	970	52532	982	29
30	5.58066	2848	5.58068	2848	6.53488	960	6.53503	960	30
31	60914	2756	60916	2756	54448	949	54463	950	31
32	63672	2672	63674	2672	55397	939	55413	939	32
33	66344	2593	66346	2593	56336	929	56352	939	33
34	68937	2518	68940	2517	57265	919	57281	929	34
35	5.71455	2447	5.71457	2447	6.58184	909	6.58201	909	35
36	73902	2379	73904	2380	59093	900	59110	900	36
37	76282	2316	76284	2316	59993	891	60011	891	37
38	78598	2256	78601	2256	60884	882	60902	891	38
39	80854	2199	80857	2199	61766	872	61784	882	39
40	5.83053	2145	5.83056	2145	6.62639	864	6.62657	873	40
41	85198	2093	85201	2093	63503	855	63522	864	41
42	87291	2044	87295	2043	64359	847	64378	856	42
43	89335	1996	89338	1997	65206	839	65226	848	43
44	91332	1952	91335	1952	66045	831	66065	839	44
45	5.93284	1909	5.93288	1909	6.66876	823	6.66897	831	45
46	95193	1868	95197	1868	67700	815	67720	823	46
47	97061	1829	97065	1829	68515	808	68536	816	47
48	5.98890	1790	5.98894	1791	69323	800	69345	808	48
49	6.00660	1755	6.00685	1755	70124	793	70145	800	49
50	6.02435	1720	6.02440	1720	6.70917	786	6.70939	794	50
51	04155	1688	04160	1687	71703	779	71725	786	51
52	05842	1654	05847	1654	72482	772	72505	779	52
53	07496	1623	07501	1623	73254	765	73277	772	53
54	09120	1594	09125	1594	74019	758	74043	765	54
55	6.10714	1565	6.10719	1565	6.74777	752	6.74802	759	55
56	12279	1537	12284	1537	75529	745	75554	752	56
57	13816	1511	13822	1511	76275	739	76300	746	57
58	15327	1484	15333	1485	77014	733	77040	739	58
59	16811	1460	16818	1460	77747	726	77773	733	59
60	6.18271		6.18278		6.78474		6.78500	727	60
'	Log. Vers.	D	Log. Exsec.	D	Log. Vers.	D	Log. Exsec.	D	'



166 LOG. VERSED SINES AND EXTERNAL SECANTS

2°

3°

	Log. Vers.	D	Log. Exsec.	D	Log. Vers.	D	Log. Exsec.	D	
0	6.78474	721	6.78500	721	7.13687	481	7.13745	481	0
1	.79195	714	.79221	715	.14168	478	.14228	479	1
2	.79909	709	.79937	709	.14646	473	.14707	476	2
3	.80618	703	.80646	703	.15122	473	.15183	476	3
4	.81322	697	.81350	698	.15595	470	.15657	474	4
5	6.82019	692	6.82048	692	7.16066	468	7.16129	469	5
6	.82711	686	.82740	687	.16534	466	.16598	466	6
7	.83398	681	.83427	682	.17000	463	.17064	464	7
8	.84079	676	.84109	676	.17463	460	.17528	461	8
9	.84755	670	.84785	671	.17923	458	.17988	459	9
10	6.85425	665	6.85457	666	7.18382	455	7.18445	456	10
11	.86091	660	.86123	660	.18837	453	.18895	454	11
12	.86751	655	.86783	656	.19291	451	.19359	452	12
13	.87407	650	.87439	651	.19742	448	.19811	449	13
14	.88057	646	.88090	646	.20191	445	.20260	447	14
15	6.88703	641	6.88737	641	7.20637	444	7.20707	445	15
16	.89344	636	.89378	636	.21081	442	.21152	442	16
17	.89980	631	.90015	632	.21523	440	.21595	440	17
18	.90612	627	.90647	628	.21963	437	.22035	438	18
19	.91238	622	.91275	623	.22400	435	.22473	436	19
20	6.91862	618	6.91898	618	7.22836	433	7.22909	434	20
21	.92480	613	.92516	614	.23269	431	.23343	431	21
22	.93093	609	.93131	610	.23700	429	.23775	429	22
23	.93703	605	.93741	605	.24129	426	.24204	427	23
24	.94308	601	.94346	601	.24555	424	.24632	424	24
25	6.94909	597	6.94948	597	7.24980	422	7.25057	423	25
26	.95506	592	.95545	593	.25402	420	.25480	421	26
27	.96099	589	.96139	589	.25823	418	.25902	419	27
28	.96688	584	.96728	585	.26241	418	.26321	417	28
29	.97272	581	.97313	581	.26658	414	.26738	415	29
30	6.97853	577	6.97895	577	7.27072	412	7.27153	413	30
31	.98430	573	.98472	574	.27485	410	.27567	411	31
32	.99004	569	.99046	570	.27895	409	.27978	409	32
33	6.99573	565	6.99616	566	.28304	406	.28387	407	33
34	7.00139	562	7.00182	563	.28711	405	.28795	405	34
35	7.00701	558	7.00745	559	7.29116	402	7.29200	404	35
36	.01259	555	.01304	555	.29518	401	.29604	402	36
37	.01814	551	.01860	552	.29919	399	.30006	400	37
38	.02366	548	.02412	548	.30319	397	.30406	400	38
39	.02914	544	.02960	545	.30716	395	.30804	398	39
40	7.03458	541	7.03505	541	7.31112	393	7.31201	395	40
41	.03999	537	.04047	538	.31505	392	.31595	393	41
42	.04537	534	.04585	535	.31897	390	.31988	391	42
43	.05071	531	.05120	531	.32288	388	.32379	389	43
44	.05603	527	.05652	528	.32676	386	.32768	388	44
45	7.06130	525	7.06180	525	7.33063	385	7.33155	385	45
46	.06655	521	.06706	522	.33448	383	.33542	384	46
47	.07177	518	.07228	519	.33831	382	.33926	383	47
48	.07695	515	.07747	516	.34213	380	.34309	380	48
49	.08211	512	.08263	513	.34593	378	.34689	379	49
50	7.08723	509	7.08776	509	7.34971	377	7.35069	377	50
51	.09232	506	.09284	507	.35348	375	.35446	376	51
52	.09739	503	.09793	503	.35723	373	.35821	374	52
53	.10242	500	.10297	501	.36097	371	.36196	373	53
54	.10743	497	.10798	498	.36468	370	.36568	371	54
55	7.11240	495	7.11297	495	7.36839	368	7.36940	368	55
56	.11735	492	.11792	493	.37207	367	.37310	368	56
57	.12227	489	.12285	490	.37574	366	.37678	368	57
58	.12716	486	.12775	487	.37940	364	.38044	366	58
59	.13203	484	.13262	484	.38304	362	.38409	365	59
60	7.13687	481	7.13746	481	7.38667	362	7.38773	363	60
	Log. Vers.	D	Log. Exsec.	D	Log. Vers.	D	Log. Exsec.	D	

LOG. VERSED SINES AND EXTERNAL SECANTS 187

4°				5°								
Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D		P. P.			
7.38667	361	7.38773	361	7.58039	289	7.58204	290	0		360	350	340
-39028	359	-39134	360	-58328	287	-58494	288	1	6	36.0	35.0	34.0
-39387	358	-39495	359	-58615	287	-58783	289	2	7	42.0	40.8	39.6
-39745	356	-39854	357	-58902	286	-59071	287	3	8	48.0	46.6	45.3
-40102	355	-40211	356	-59188	285	-59358	285	4	9	54.0	51.5	51.0
7.40457	355	7.40567	356	7.59473	285	7.59645	286	5	10	60.0	58.3	56.6
-40810	353	-40922	354	-59758	284	-59930	285	6	20	120.0	116.6	113.3
-41163	352	-41275	353	-60041	283	-60214	284	7	30	180.0	175.0	170.0
-41513	350	-41627	352	-60323	282	-60498	283	8	40	240.0	233.3	226.6
-41863	349	-41977	350	-60604	281	-60780	282	9	50	300.0	291.6	283.3
7.42211	348	7.42326	349	7.60885	280	7.61062	281	10				
-42557	346	-42673	347	-61164	279	-61342	280	11	6	33.0	32.0	31.0
-42903	345	-43019	346	-61443	279	-61622	279	12	7	38.5	37.3	36.1
-43246	343	-43364	345	-61721	277	-61901	279	13	8	44.0	42.6	41.3
-43589	342	-43708	343	-61998	277	-62179	278	14	9	49.5	48.0	46.5
7.43930	341	7.44050	342	7.62274	276	7.62456	277	15	10	55.0	53.3	51.6
-44270	339	-44390	340	-62549	275	-62733	276	16	20	110.0	106.6	103.3
-44608	338	-44730	339	-62823	275	-63008	274	17	30	165.0	160.0	155.0
-44946	337	-45068	338	-63096	275	-63282	274	18	40	220.0	213.3	206.6
-45281	335	-45405	337	-63369	274	-63556	274	19	50	275.0	266.6	258.3
7.45616	334	7.45740	335	7.63641	272	7.63829	273	20				
-45949	333	-46075	334	-63911	272	-64101	271	21	6	30.0	29.0	28.0
-46281	332	-46407	332	-64181	269	-64372	270	22	7	35.0	33.6	32.6
-46612	330	-46739	330	-64451	268	-64643	269	23	8	40.0	38.6	37.3
-46941	328	-47070	329	-64719	268	-64912	269	24	9	45.0	43.5	42.0
7.47270	327	7.47399	328	7.64986	267	7.65181	269	25	10	50.0	48.3	46.5
-47597	325	-47727	327	-65253	266	-65449	268	26	20	100.0	96.6	93.3
-47922	324	-48054	325	-65519	265	-65716	267	27	30	150.0	145.0	140.0
-48247	323	-48379	324	-65784	264	-65982	266	28	40	200.0	193.3	186.6
-48570	322	-48703	323	-66048	263	-66247	264	29	50	250.0	241.6	233.3
7.48892	321	7.49026	322	7.66311	263	7.66512	264	30				
-49213	320	-49348	321	-66574	263	-66776	263	31	6	27.0	26.0	25.0
-49533	318	-49669	319	-66836	261	-67039	262	32	7	31.5	30.3	29.1
-49852	317	-49989	318	-67097	260	-67301	261	33	8	36.0	34.6	33.3
-50169	316	-50307	317	-67357	259	-67562	261	34	9	40.5	39.0	37.5
7.50485	315	7.50624	316	7.67617	258	7.67823	260	35	10	45.0	43.3	41.6
-50800	314	-50941	315	-67875	258	-68083	259	36	20	90.0	86.6	83.3
-51114	313	-51256	313	-68133	257	-68342	258	37	30	135.0	130.0	125.0
-51427	311	-51569	313	-68390	256	-68601	257	38	40	180.0	173.3	166.6
-51739	311	-51882	311	-68647	255	-68858	257	39	50	225.0	216.6	208.3
7.52050	309	7.52194	310	7.68902	255	7.69115	256	40				
-52359	308	-52504	309	-69157	254	-69371	255	41	6	24.0	23.0	22.0
-52667	307	-52814	308	-69411	253	-69627	254	42	7	28.0	26.6	25.6
-52975	306	-53122	307	-69665	252	-69881	254	43	8	32.0	30.6	29.3
-53281	305	-53429	306	-69917	252	-70135	253	44	9	36.0	34.5	33.0
7.53586	304	7.53735	305	7.70169	251	7.70388	252	45	10	40.0	38.3	36.6
-53890	303	-54041	304	-70421	250	-70641	252	46	20	80.0	78.6	75.3
-54193	302	-54345	303	-70671	250	-70893	251	47	30	120.0	115.0	110.0
-54495	300	-54648	302	-70921	249	-71144	250	48	40	160.0	153.3	146.6
-54796	300	-54950	301	-71170	248	-71394	249	49	50	200.0	191.6	183.3
7.55098	299	7.55251	299	7.71418	247	7.71644	248	50				
-55395	297	-55550	298	-71666	247	-71892	248	51	6	21.0	20.0	19.0
-55692	297	-55849	298	-71913	246	-72141	247	52	7	24.5	23.3	22.1
-55989	295	-56147	296	-72159	245	-72388	246	53	8	28.0	26.6	25.3
-56285	295	-56444	296	-72404	245	-72635	245	54	9	31.5	30.0	28.5
7.56580	293	7.56740	295	7.72649	244	7.72881	245	55	10	35.0	33.3	31.6
-56873	292	-57035	294	-72893	243	-73126	245	56	20	70.0	66.6	63.3
-57166	292	-57329	293	-73137	242	-73371	244	57	30	105.0	100.0	95.0
-57458	290	-57682	292	-73379	242	-73615	243	58	40	140.0	133.3	126.6
-57749	290	-57913	291	-73621	241	-73859	242	59	50	175.0	166.6	158.3
7.58039	290	7.58204	291	7.73863	241	7.74101	242	60				
Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D		P. P.			

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	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D		P. P.
0	7.73863	241	7.74101	242	7.87238	206	7.87563	208	0	180 0 0
1	.74104	240	.74343	241	.87444	205	.87771	207	1	6 18.0 0.9
2	.74344	239	.74585	241	.87650	205	.87978	207	2	7 21.0 1.1
3	.74583	239	.74826	240	.87855	204	.88185	206	3	8 24.0 1.2
4	.74822	238	.75066	239	.88060	204	.88391	206	4	9 27.0 1.4
5	7.75060	238	7.75305	239	7.88264	204	7.88597	206	5	10 30.0 1.6
6	.75297	237	.75544	238	.88468	204	.88803	205	6	20 60.0 3.1
7	.75534	236	.75782	238	.88672	203	.89008	205	7	30 90.0 4.7
8	.75770	236	.76019	237	.88875	203	.89212	204	8	40 120.0 6.3
9	.76006	235	.76256	237	.89077	202	.89416	204	9	50 150.0 7.9
10	7.76240	234	7.76492	235	7.89279	202	7.89620	203	10	8 8 7
11	.76477	233	.76728	235	.89481	201	.89823	202	11	60 8 0.8
12	.76705	233	.76963	235	.89682	200	.90025	202	12	71 0 0.9
13	.76941	232	.77197	234	.89882	200	.90228	202	13	81 1 1.0
14	.77175	232	.77431	233	.90082	199	.90429	201	14	91 3 1.2
15	7.77405	231	7.77664	232	7.90282	199	7.90630	201	15	101 4 1.3
16	.77636	230	.77897	231	.90481	198	.90831	200	16	20 2 8.2
17	.77867	230	.78128	231	.90680	198	.91032	199	17	30 4 2.4
18	.78097	229	.78360	230	.90878	197	.91231	199	18	40 5 6.5
19	.78326	228	.78590	230	.91076	197	.91431	199	19	50 7 1.6
20	7.78554	228	7.78820	229	7.91273	197	7.91630	199	20	7 7 6
21	.78783	227	.79050	229	.91470	196	.91828	198	21	60 7 0.6
22	.79010	227	.79279	228	.91667	196	.92027	197	22	70 8 0.7
23	.79237	226	.79507	228	.91863	195	.92224	197	23	80 9 0.8
24	.79463	225	.79735	227	.92058	195	.92421	197	24	90 9 1.0
25	7.79689	225	7.79962	226	7.92253	195	7.92618	197	25	101 1 1.2
26	.79914	224	.80188	226	.92448	194	.92815	196	26	20 2 3.2
27	.80138	224	.80414	225	.92642	194	.93016	195	27	30 3 5.3
28	.80362	223	.80639	225	.92836	193	.93206	195	28	40 4 6.4
29	.80586	223	.80864	224	.93029	193	.93401	195	29	50 5 8.5
30	7.80808	222	7.81088	224	7.93222	192	7.93596	194	30	5 5 4
31	.81031	221	.81312	224	.93415	192	.93790	194	31	60 5 0.5
32	.81252	221	.81535	223	.93607	191	.93984	193	32	70 6 0.6
33	.81473	220	.81758	222	.93799	191	.94177	193	33	80 7 0.7
34	.81694	220	.81980	222	.93990	191	.94370	193	34	90 8 0.8
35	7.81914	219	7.82201	221	7.94181	190	7.94532	192	35	10 9 0.8
36	.82133	219	.82422	220	.94371	190	.94754	192	36	20 1 1.1
37	.82352	218	.82642	219	.94561	189	.94946	191	37	30 2 3.3
38	.82570	218	.82862	219	.94751	189	.95137	191	38	40 3 5.5
39	.82788	217	.83081	219	.94940	189	.95328	191	39	50 4 6.4
40	7.83005	217	7.83300	219	7.95129	188	7.95519	190	40	60 5 0.5
41	.83222	216	.83518	217	.95317	187	.95709	189	41	70 6 0.6
42	.83438	215	.83735	217	.95505	188	.95898	189	42	80 7 0.7
43	.83653	215	.83952	216	.95693	187	.96088	188	43	90 8 0.8
44	.83868	215	.84169	216	.95880	187	.96276	188	44	100 9 0.9
45	7.84083	214	7.84385	215	7.96065	186	7.96465	188	45	20 1 1.1
46	.84297	213	.84600	215	.96253	186	.96653	188	46	30 1 7.1
47	.84510	213	.84815	214	.96439	185	.96841	187	47	40 2 3.2
48	.84723	212	.85030	213	.96624	185	.97028	187	48	50 2 9.2
49	.84935	212	.85243	213	.96809	184	.97215	186	49	60 3 0.3
50	7.85147	211	7.85457	213	7.96994	184	7.97401	186	50	70 4 0.4
51	.85359	211	.85670	212	.97178	184	.97587	186	51	80 5 0.5
52	.85570	210	.85882	211	.97362	184	.97773	185	52	90 6 0.6
53	.85780	210	.86094	211	.97546	183	.97958	185	53	100 7 0.7
54	.85990	209	.86305	211	.97729	183	.98143	184	54	20 1 1.1
55	7.86199	209	7.86516	210	7.97912	182	7.98327	184	55	30 2 3.3
56	.86408	208	.86726	210	.98094	182	.98512	183	56	40 3 5.5
57	.86616	208	.86936	209	.98276	182	.98695	183	57	50 4 6.4
58	.86824	207	.87146	208	.98458	181	.98879	183	58	60 5 8.5
59	.87031	206	.87354	208	.98639	181	.99062	182	59	70 6 0.6
60	7.87238	206	7.87563	208	7.98820	181	7.99244	182	60	80 7 0.7
	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D		P. P.

LOG. VERSED SINES AND EXTERNAL SECANTS 169

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Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	'	P. P.
7.98820	180	7.99244	182	8.09031	160	8.09569	162	0	180 170 160
.99000	180	.99427	182	.09192	160	.09732	162	1	6 18.0 17.0 16.0
.99180	179	.99609	181	.09352	160	.09894	162	2	7 21.0 19.8 18.6
.99360	179	.99790	181	.09512	159	.10056	161	3	8 24.0 22.6 21.3
.99539	179	.99971	180	.09671	159	.10217	161	4	9 27.0 25.5 24.0
7.99718	179	8.00152	180	8.09830	159	8.10378	161	5	10 30.0 28.3 26.6
7.99897	178	.00332	180	.09989	159	.10539	161	6	20 60.0 56.6 53.3
8.00075	178	.00512	180	.10148	158	.10700	160	7	30 90.0 85.0 80.0
.00253	177	.00692	179	.10306	158	.10860	160	8	40 120.0 113.3 106.6
.00431	177	.00871	179	.10464	158	.11020	160	9	50 150.0 141.6 133.3
8.00608	176	8.01050	178	8.10622	157	8.11180	160	10	
.00784	176	.01229	178	.10779	157	.11340	159	11	150 140
.00961	176	.01407	178	.10938	157	.11499	159	12	6 15.0 14.0
.01137	176	.01585	178	.11093	157	.11658	159	13	7 17.5 16.3
.01313	176	.01763	177	.11250	156	.11816	158	14	8 20.0 18.6
8.01488	175	8.01940	177	8.11406	156	8.11975	158	15	9 22.5 21.0
.01663	175	.02117	176	.11562	155	.12133	158	16	10 25.0 23.3
.01838	174	.02293	176	.11718	155	.12291	157	17	20 50.0 46.6
.02012	174	.02469	175	.11873	155	.12448	157	18	30 75.0 70.0
.02186	174	.02645	175	.12029	155	.12605	157	19	40 100.0 93.3
8.02359	173	8.02820	175	8.12184	155	8.12762	157	20	50 125.0 116.6
.02533	173	.02995	175	.12338	154	.12919	157	21	
.02706	172	.03170	174	.12492	154	.13075	156	22	5 0.9 0.9 0.8
.02878	172	.03345	174	.12647	153	.13232	156	23	6 0.9 0.9 0.8
.03050	172	.03519	173	.12800	153	.13387	155	24	7 1.1 1.1 1.0
8.03222	171	8.03692	173	8.12954	153	8.13543	156	25	8 1.2 1.2 1.1
.03394	171	.03866	173	.13107	153	.13698	155	26	9 1.4 1.3 1.3
.03565	171	.04039	173	.13260	152	.13854	154	27	10 1.6 1.5 1.4
.03736	170	.04212	172	.13413	152	.14008	154	28	20 3.1 3.0 2.8
.03906	170	.04384	172	.13565	152	.14163	154	29	30 4.7 4.5 4.2
8.04076	170	8.04556	172	8.13717	152	8.14317	154	30	40 6.3 6.0 5.6
.04246	169	.04729	171	.13869	152	.14471	154	31	50 7.9 7.7 7.1
.04416	169	.04899	171	.14021	151	.14625	153	32	
.04585	169	.05070	171	.14172	151	.14778	153	33	8 7.0 7.0 6.8
.04754	168	.05241	170	.14323	151	.14932	153	34	9 1.0 1.0 0.9
8.04922	168	8.05411	170	8.14474	150	8.15085	152	35	10 1.2 1.1 1.0
.05090	168	.05581	170	.14625	150	.15237	152	36	20 2.6 2.5 2.3
.05258	168	.05751	169	.14775	150	.15390	152	37	30 4.3 4.3 4.0
.05426	167	.05921	169	.14925	150	.15542	152	38	40 5.3 5.3 4.6
.05593	167	.06090	169	.15075	149	.15694	152	39	50 6.6 6.6 2.5 8
8.05780	166	8.06259	169	8.15225	149	8.15846	152	40	
.05926	166	.06427	168	.15374	149	.15997	151	41	
.06093	166	.06595	168	.15523	149	.16148	151	42	6 6 6
.06259	165	.06763	168	.15672	149	.16299	151	43	7 0.7 0.7
.06424	165	.06931	167	.15820	148	.16450	150	44	8 0.8 0.8
8.06589	165	8.07098	167	8.15968	148	8.16600	150	45	9 1.0 0.9
.06754	165	.07265	166	.16116	148	.16750	150	46	10 1.1 1.0
.06919	164	.07431	166	.16264	147	.16900	149	47	20 2.2 2.0
.07083	164	.07598	166	.16412	147	.17050	149	48	30 3.3 3.0
.07247	164	.07764	166	.16559	147	.17199	149	49	40 4.3 4.0
8.07411	163	8.07925	165	8.16706	147	8.17349	149	50	50 5.4 5.0
.07575	163	.08089	165	.16852	146	.17497	148	51	
.07738	162	.08260	164	.16999	146	.17645	148	52	5 5
.07900	162	.08423	164	.17145	146	.17793	148	53	6 0.5 0.5
.08063	162	.08589	164	.17291	145	.17943	148	54	7 0.6 0.6
8.08225	161	8.08753	163	8.17437	145	8.18091	147	55	8 0.6 0.7
.08387	161	.08917	163	.17582	145	.18238	147	56	10 0.9 0.8
.08549	161	.09081	163	.17728	145	.18386	147	57	20 1.8 1.6
.08710	161	.09244	163	.17873	144	.18533	147	58	30 2.7 2.5
.08871	160	.09407	162	.18017	144	.18680	146	59	40 3.6 3.3
8.09031	160	8.09569	162	8.18162	144	8.18827	146	60	50 4.4 4.1
Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	'	P. P.

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	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D		P. P.
0	8.18162	144	8.18827	146	8.26417	131	8.27223	135	0	
1	.18306	144	.18973	146	.26548	131	.27356	135	1	
2	.18450	144	.19120	146	.26679	131	.27490	135	2	
3	.18594	143	.19266	145	.26810	130	.27623	133	3	
4	.18738	143	.19411	145	.26941	130	.27756	133	4	
5	8.18881	143	8.19557	145	8.27071	130	8.27889	132	5	
6	.19024	142	.19702	145	.27201	130	.28021	132	6	
7	.19167	142	.19847	145	.27331	130	.28153	132	7	
8	.19309	142	.19992	144	.27461	130	.28286	132	8	
9	.19452	142	.20137	144	.27590	129	.28418	132	9	
10	8.19594	142	8.20281	144	8.27719	129	8.28550	132	10	
11	.19736	142	.20425	144	.27849	128	.28681	131	11	
12	.19878	141	.20569	144	.27977	128	.28813	131	12	
13	.20019	141	.20713	143	.28106	128	.28944	131	13	
14	.20160	141	.20857	143	.28235	128	.29075	131	14	
15	8.20301	140	8.21000	143	8.28363	128	8.29206	131	15	
16	.20442	140	.21143	143	.28491	128	.29336	130	16	
17	.20582	140	.21286	142	.28619	128	.29467	130	17	
18	.20723	140	.21428	142	.28747	127	.29597	130	18	
19	.20863	140	.21571	142	.28875	127	.29727	130	19	
20	8.21003	139	8.21713	142	8.29002	127	8.29857	130	20	
21	.21142	139	.21855	141	.29129	127	.29987	129	21	
22	.21282	139	.21985	141	.29256	127	.30117	129	22	
23	.21421	139	.22138	141	.29383	127	.30246	129	23	
24	.21560	138	.22279	141	.29510	126	.30375	129	24	
25	8.21698	138	8.22420	140	8.29636	126	8.30504	129	25	
26	.21837	138	.22561	140	.29763	126	.30633	129	26	
27	.21975	138	.22701	140	.29889	126	.30762	128	27	
28	.22113	138	.22842	140	.30015	125	.30890	128	28	
29	.22251	137	.22982	140	.30140	125	.31019	128	29	
30	8.22389	137	8.23122	140	8.30266	125	8.31147	128	30	
31	.22526	137	.23262	139	.30391	125	.31275	127	31	
32	.22663	137	.23401	139	.30516	125	.31402	127	32	
33	.22800	136	.23540	139	.30642	125	.31530	127	33	
34	.22937	137	.23679	139	.30766	124	.31657	127	34	
35	8.23073	136	8.23815	139	8.30891	124	8.31785	127	35	
36	.23209	136	.23957	138	.31015	124	.31912	127	36	
37	.23346	135	.24095	138	.31140	124	.32039	126	37	
38	.23481	136	.24234	138	.31264	124	.32165	126	38	
39	.23617	136	.24372	138	.31388	124	.32292	126	39	
40	8.23752	135	8.24509	137	8.31511	123	8.32418	126	40	
41	.23888	135	.24647	138	.31635	123	.32544	126	41	
42	.24023	135	.24784	137	.31758	123	.32670	126	42	
43	.24158	135	.24922	137	.31882	123	.32796	125	43	
44	.24292	134	.25059	137	.32005	123	.32922	125	44	
45	8.24426	134	8.25195	136	8.32128	123	8.33047	125	45	
46	.24561	134	.25332	136	.32250	122	.33173	125	46	
47	.24695	134	.25468	136	.32373	122	.33298	125	47	
48	.24828	133	.25604	136	.32495	122	.33423	125	48	
49	.24962	133	.25740	136	.32617	122	.33547	124	49	
50	8.25095	133	8.25876	135	8.32739	122	8.33672	124	50	
51	.25228	133	.26012	135	.32861	121	.33797	124	51	
52	.25361	133	.26147	135	.32983	121	.33921	124	52	
53	.25494	132	.26282	135	.33104	121	.34045	123	53	
54	.25627	133	.26417	135	.33225	121	.34169	123	54	
55	8.25759	132	8.26552	134	8.33347	121	8.34293	124	55	
56	.25891	132	.26686	134	.33468	120	.34417	123	56	
57	.26023	132	.26821	134	.33588	120	.34540	123	57	
58	.26155	131	.26955	134	.33709	120	.34663	123	58	
59	.26286	131	.27089	134	.33829	120	.34786	123	59	
60	8.26417	131	8.27223	134	8.33950	120	8.34906	123	60	
	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D		P. P.

130 120  
 6 13.0 12.0  
 7 15.0 14.0  
 8 17.0 16.0  
 9 19.5 18.0  
 10 21.0 20.0  
 20 43.0 40.0  
 30 65.0 60.0  
 40 86.5 80.0  
 50 108.3 100.0

4 3  
 60.4.0.4 0.3  
 70.5.0.4 0.4  
 80.6.0.5 0.4  
 90.7.0.6 0.5  
 100.7.0.6 0.6  
 20 1.5 1.1 1.7  
 30 2.2 2.0 1.5  
 40 3.0 2.6 2.3  
 50 3.7 3.3 2.9

3 2  
 80.3.0.2  
 70.3.0.3  
 80.4.0.3  
 90.4.0.4  
 100.5.0.4

2 1  
 20 1.0 0.8  
 30 1.5 1.1  
 40 2.0 1.6  
 50 2.5 2.1

2 1  
 60.2.0.1  
 70.3.0.2  
 80.3.0.2  
 90.3.0.2  
 100.3.0.2  
 30 1.0 0.7  
 40 1.3 1.0  
 50 1.6 1.2

1 0  
 60.1.0.0  
 70.1.0.0  
 80.1.0.0  
 90.1.0.1  
 100.1.0.1  
 20 0.3 0.1  
 30 0.5 0.1  
 40 0.6 0.3  
 50 0.8 0.4

LOG. VERSED SINES AND EXTERNAL SECANTS 171

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	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D		P. P.
0	8.33950	120	8.34909	123	8.40875	110	8.42002	113	0	120 119 118
1	.34070	119	.35032	122	.40885	110	.42116	113	1	6 12.0 11.9 11.8
2	.34190	120	.35155	122	.41096	110	.42229	113	2	7 14.0 13.9 13.7
3	.34309	119	.35277	122	.41206	110	.42343	113	3	8 16.0 15.8 15.7
4	.34429	120	.35399	122	.41317	110	.42456	113	4	9 18.0 17.8 17.7
5	8.34549	119	8.36522	122	8.41427	110	8.42569	113	5	10 20.0 19.8 19.6
6	.34668	119	.35644	122	.41537	110	.42682	113	6	20 40.0 39.6 38.3
7	.34787	119	.35765	122	.41647	110	.42795	113	7	30 60.0 59.5 59.0
8	.34906	119	.35887	122	.41757	109	.42908	113	8	40 80.0 79.3 78.6
9	.35025	119	.36009	121	.41867	110	.43021	112	9	50 100.0 99.1 98.3
0	8.35143	118	8.36130	121	8.41976	109	8.43133	112	10	117 116 115
1	.35262	118	.36251	121	.42086	109	.43246	112	11	6 11.7 11.6 11.5
2	.35380	118	.36372	120	.42195	109	.43359	112	12	7 13.6 13.5 13.4
3	.35498	118	.36493	121	.42304	109	.43470	112	13	8 15.6 15.4 15.3
4	.35616	118	.36614	121	.42413	109	.43582	112	14	9 17.5 17.4 17.2
5	8.35734	117	8.36734	120	8.42522	109	8.43694	112	15	10 19.5 19.3 19.1
6	.35852	117	.36855	120	.42630	108	.43805	111	16	20 39.0 38.6 38.3
7	.35969	117	.36975	120	.42739	108	.43917	111	17	30 58.5 58.0 57.5
8	.36086	117	.37095	120	.42847	108	.44028	111	18	40 78.0 77.3 76.6
9	.36204	117	.37215	120	.42956	108	.44139	111	19	50 97.5 96.6 95.8
0	8.36321	116	8.37335	119	8.43064	108	8.44251	111	20	114 113 112
1	.36437	116	.37454	119	.43172	108	.44362	111	21	6 11.4 11.3 11.2
2	.36554	116	.37574	119	.43280	108	.44473	110	22	7 13.3 13.2 13.0
3	.36671	116	.37693	119	.43388	107	.44583	110	23	8 15.2 15.0 14.9
4	.36787	116	.37812	119	.43495	107	.44694	110	24	9 17.1 16.9 16.8
5	8.36903	115	8.37931	118	8.43603	107	8.44804	110	25	10 19.0 18.8 18.6
6	.37019	116	.38050	119	.43710	107	.44915	110	26	20 38.0 37.6 37.3
7	.37135	116	.38169	119	.43817	107	.45025	110	27	30 57.0 56.5 56.0
8	.37251	115	.38287	118	.43924	107	.45135	110	28	40 76.0 75.3 74.6
9	.37366	115	.38406	118	.44031	106	.45245	109	29	50 95.0 94.1 93.3
0	8.37482	115	8.38524	118	8.44138	106	8.45355	110	30	111 110 109
1	.37597	115	.38642	118	.44245	106	.45465	109	31	6 11.1 11.0 10.9
2	.37712	115	.38760	118	.44351	106	.45574	109	32	7 12.9 12.8 12.7
3	.37827	115	.38878	117	.44458	106	.45684	109	33	8 14.8 14.6 14.5
4	.37942	114	.38995	117	.44564	106	.45793	109	34	9 16.6 16.5 16.3
5	8.38057	114	8.39113	117	8.44670	106	8.45902	109	35	10 18.5 18.1 18.1
6	.38171	114	.39230	117	.44776	105	.46011	109	36	20 37.0 36.6 36.3
7	.38286	114	.39347	117	.44882	105	.46120	109	37	30 55.5 55.0 54.5
8	.38400	114	.39464	117	.44988	105	.46229	109	38	40 74.0 73.3 72.6
9	.38514	114	.39581	116	.45093	105	.46338	109	39	50 92.5 91.6 90.8
0	8.38628	113	8.39698	116	8.45199	105	8.46446	109	40	108 107 106
1	.38741	114	.39814	116	.45304	105	.46555	108	41	6 10.8 10.7 10.6
2	.38855	113	.39931	116	.45409	105	.46663	108	42	7 12.6 12.5 12.3
3	.38969	113	.40047	116	.45514	105	.46771	108	43	8 14.4 14.3 14.1
4	.39082	113	.40163	116	.45619	105	.46879	108	44	9 16.2 16.0 15.9
5	8.39195	113	8.40279	116	8.45724	104	8.46987	107	45	10 18.0 17.8 17.6
6	.39308	113	.40395	115	.45829	105	.47095	107	46	20 36.0 35.5 35.3
7	.39421	113	.40511	115	.45934	104	.47202	107	47	30 54.0 53.5 53.0
8	.39534	112	.40626	115	.46038	104	.47311	107	48	40 72.0 71.3 70.6
9	.39646	112	.40742	115	.46142	104	.47417	107	49	50 90.0 89.1 88.3
0	8.39758	112	8.40857	115	8.46247	104	8.47525	107	50	105 104 0
1	.39871	112	.40972	115	.46351	104	.47632	107	51	6 10.5 10.4 10.0
2	.39983	112	.41087	115	.46455	103	.47739	107	52	7 12.2 12.1 12.0
3	.40095	112	.41202	114	.46559	104	.47846	106	53	8 14.0 13.8 13.0
4	.40207	112	.41317	114	.46662	104	.47953	106	54	9 15.7 15.6 15.1
5	8.40318	111	8.41431	114	8.46766	103	8.48060	107	55	10 17.5 17.3 17.0
6	.40430	111	.41546	114	.46869	103	.48165	106	56	20 35.0 34.0 33.0
7	.40541	111	.41660	114	.46972	103	.48273	106	57	30 53.0 52.0 51.0
8	.40652	111	.41774	114	.47076	103	.48379	106	58	40 70.0 69.3 68.0
9	.40764	111	.41888	114	.47179	103	.48485	106	59	50 87.5 86.6 85.4
0	8.40875	111	8.42002	114	8.47282	103	8.48591	106	60	105 104 0
	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D		P. P.

172 LOG. VERSED SINES AND EXTERNAL SECANTS

14°

15°

14°			15°			P. P.		
Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	
0	8.47282	102	8.48591	106	8.53242	96	8.54748	0
1	.47384	103	.48697	106	.53338	95	.54847	1
2	.47487	102	.48803	106	.53434	95	.54946	2
3	.47590	102	.48909	105	.53530	95	.55045	3
4	.47692	102	.49014	105	.53625	95	.55144	4
5	8.47795	102	8.49120	105	8.53721	95	8.55243	5
6	.47897	102	.49225	105	.53816	95	.55342	6
7	.47999	102	.49331	105	.53911	95	.55441	7
8	.48101	102	.49436	105	.54007	95	.55539	8
9	.48203	102	.49541	105	.54102	95	.55638	9
10	8.48304	101	8.49646	105	8.54197	94	8.55736	10
11	.48406	101	.49750	104	.54291	95	.55834	11
12	.48507	101	.49855	104	.54386	94	.55933	12
13	.48609	101	.49960	104	.54481	94	.56031	13
14	.48710	101	.50064	104	.54575	94	.56129	14
15	8.48811	101	8.50168	104	8.54670	94	8.56226	15
16	.48912	101	.50273	104	.54764	94	.56324	16
17	.49013	100	.50377	104	.54858	94	.56422	17
18	.49114	101	.50481	104	.54952	94	.56519	18
19	.49215	100	.50585	103	.55046	94	.56617	19
20	8.49315	100	8.50688	103	8.55140	93	8.56714	20
21	.49415	100	.50792	103	.55234	93	.56812	21
22	.49516	100	.50896	103	.55328	93	.56909	22
23	.49616	100	.50999	103	.55421	93	.57006	23
24	.49716	100	.51102	103	.55515	93	.57103	24
25	8.49816	100	8.51205	103	8.55608	93	8.57200	25
26	.49916	99	.51309	103	.55701	93	.57296	26
27	.50015	99	.51412	102	.55795	93	.57393	27
28	.50115	100	.51514	102	.55888	93	.57490	28
29	.50215	99	.51617	102	.55981	93	.57586	29
30	8.50314	99	8.51720	102	8.56074	93	8.57682	30
31	.50413	99	.51822	102	.56166	92	.57779	31
32	.50512	99	.51925	102	.56259	92	.57875	32
33	.50611	99	.52027	102	.56352	92	.57971	33
34	.50710	99	.52129	102	.56444	92	.58067	34
35	8.50809	98	8.52231	102	8.56536	92	8.58163	35
36	.50908	98	.52333	102	.56629	92	.58259	36
37	.51006	98	.52435	101	.56721	92	.58354	37
38	.51105	98	.52537	101	.56813	92	.58450	38
39	.51203	98	.52639	101	.56905	92	.58546	39
40	8.51301	98	8.52740	101	8.56997	92	8.58641	40
41	.51399	98	.52841	101	.57089	91	.58736	41
42	.51497	98	.52943	101	.57180	91	.58832	42
43	.51595	97	.53044	101	.57272	91	.58927	43
44	.51693	97	.53145	101	.57363	91	.59022	44
45	8.51791	97	8.53246	101	8.57455	91	8.59117	45
46	.51888	97	.53347	101	.57546	91	.59211	46
47	.51986	97	.53448	101	.57637	91	.59306	47
48	.52083	97	.53548	100	.57728	91	.59401	48
49	.52180	97	.53649	100	.57819	91	.59495	49
50	8.52277	97	8.53749	100	8.57910	90	8.59590	50
51	.52374	97	.53850	100	.58001	90	.59684	51
52	.52471	96	.53950	100	.58092	91	.59779	52
53	.52568	96	.54050	100	.58182	90	.59873	53
54	.52665	97	.54150	100	.58273	90	.59967	54
55	8.52761	96	8.54250	100	8.58363	90	8.60061	55
56	.52858	96	.54350	99	.58453	90	.60155	56
57	.52954	96	.54449	100	.58544	90	.60249	57
58	.53050	96	.54549	99	.58634	90	.60342	58
59	.53146	96	.54649	99	.58724	90	.60436	59
60	8.53242	96	8.54748	99	8.58814	90	8.60530	60
	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D

103 102 101

6	10.0	10.2	10.1
7	12.0	11.9	11.8
8	13.7	13.6	13.4
9	15.4	15.3	15.1
10	17.1	17.0	16.8
20	34.3	34.0	33.6
30	51.5	51.0	50.5
40	68.6	68.0	67.3
50	85.8	85.0	84.1

100 99 98

6	10.0	9.9	9.8
7	11.6	11.5	11.4
8	13.3	13.2	13.0
9	15.0	14.8	14.7
10	16.6	16.5	16.3
20	33.3	33.0	32.6
30	50.0	49.5	49.0
40	66.6	66.0	65.3
50	83.3	82.5	82.6

97 96 95

6	9.7	9.6	9.5
7	11.3	11.2	11.1
8	12.9	12.8	12.6
9	14.5	14.4	14.2
10	16.1	16.0	15.8
20	32.3	32.0	31.6
30	48.5	48.0	47.5
40	64.6	64.0	63.3
50	80.8	80.0	79.1

94 93 92

6	9.4	9.3	9.2
7	10.9	10.8	10.7
8	12.5	12.4	12.2
9	14.1	13.9	13.8
10	15.6	15.5	15.3
20	31.3	31.0	30.6
30	47.0	46.5	46.0
40	62.6	62.0	61.3
50	78.3	77.5	76.6

91 90 0

6	9.1	9.0	0.0
7	10.6	10.5	0.0
8	12.1	12.0	0.0
9	13.6	13.5	0.1
10	15.1	15.0	0.1
20	30.3	30.0	0.1
30	45.5	45.0	0.2
40	60.6	60.0	0.3
50	75.8	75.0	0.4

P. P.

LOG. VERSED SINES AND EXTERNAL SECANTS 173

16°

17°

°	16°			17°			°	P. P.					
	Lg. Vers.	D	Log. Exs.	Lg. Vers.	D	Log. Exs.							
0	8.58814	90	8.80530	93	8.64043	84	8.65984	88	0	93	92	91	
1	.58904	89	.80623	93	.84128	84	.66072	88	1	0	9.3	9.2	9.1
2	.58993	89	.80716	93	.84212	84	.66160	88	2	7	10.8	10.4	10.6
3	.59083	89	.80810	93	.84296	84	.66248	88	3	8	12.4	12.2	12.1
4	.59173	89	.80903	93	.84381	84	.66336	88	4	9	13.9	13.8	13.6
5	.59262	89	.80996	93	.84465	84	.66425	88	5	10	15.5	15.3	15.1
6	.59351	89	.81089	93	.84549	84	.66512	87	6	20	31.0	30.6	30.5
7	.59441	89	.81182	93	.84633	84	.66600	88	7	30	46.5	46.0	45.5
8	.59530	89	.81275	93	.84717	84	.66688	88	8	40	62.0	61.3	60.6
9	.59619	89	.81368	93	.84801	84	.66776	87	9	50	77.5	76.6	75.8
10	8.59708	89	8.61460	92	8.64884	85	8.66863	88	10		90	89	88
11	.59797	89	.81553	92	.84968	84	.66951	87	11	6	9.0	8.9	8.8
12	.59886	89	.81645	92	.85052	84	.67039	87	12	7	10.5	10.4	10.2
13	.59974	88	.81738	92	.85135	83	.67126	87	13	8	12.0	11.8	11.7
14	60063	88	.81830	92	.85218	83	.67213	87	14	9	13.5	13.3	13.2
15	8.60152	88	8.61922	92	8.65302	83	8.67301	87	15	10	15.0	14.8	14.6
16	.60240	88	.82014	92	.85385	83	.67388	87	16	20	31.0	29.6	29.3
17	.60328	88	.82106	92	.85468	83	.67475	87	17	30	46.5	44.4	44.0
18	.60417	88	.82198	92	.85551	83	.67562	87	18	40	62.0	59.3	58.6
19	.60505	88	.82290	91	.85634	83	.67649	87	19	50	77.5	74.1	73.3
20	8.60593	88	8.62382	92	8.65717	83	8.67736	86	20		87	86	85
21	.60681	88	.82474	91	.85800	82	.67822	86	21	6	8.7	8.6	8.5
22	.60769	88	.82565	91	.85883	82	.67909	86	22	7	10.1	10.0	9.9
23	.60857	87	.82657	91	.85965	82	.67996	86	23	8	11.6	11.4	11.3
24	.60944	87	.82748	91	.86048	82	.68082	86	24	9	13.1	12.9	12.7
25	8.61032	87	8.62840	91	8.66131	82	8.68169	86	25	10	14.5	14.3	14.1
26	.61119	87	.82931	91	.86213	82	.68255	86	26	20	29.0	28.6	28.3
27	.61207	87	.83022	91	.86295	82	.68341	86	27	30	43.5	43.0	42.5
28	.61294	87	.83113	91	.86378	82	.68428	86	28	40	58.0	57.3	56.6
29	.61381	87	.83204	90	.86460	82	.68514	86	29	50	72.5	71.6	70.8
30	8.61469	87	8.63295	91	8.66542	82	8.68600	86	30		84	83	82
31	.61556	87	.83386	91	.86624	82	.68686	86	31	6	8.4	8.3	8.2
32	.61643	87	.83477	91	.86706	82	.68772	86	32	7	9.8	9.7	9.5
33	.61730	86	.83567	90	.86788	82	.68858	86	33	8	11.1	11.0	10.9
34	.61816	86	.83658	90	.86870	81	.68944	86	34	9	12.6	12.4	12.3
35	8.61903	86	8.63748	90	8.66951	81	8.69029	86	35	10	14.0	13.8	13.6
36	.61990	86	.83839	90	.87033	81	.69115	86	36	20	28.0	27.6	27.3
37	.62076	86	.83929	90	.87115	81	.69201	86	37	30	42.0	41.5	41.0
38	.62163	86	.84019	90	.87196	81	.69286	86	38	40	56.0	55.3	54.6
39	.62245	86	.84109	90	.87277	81	.69372	86	39	50	70.0	69.1	68.3
40	8.62336	86	8.64199	90	8.67359	81	8.69457	85	40		81	80	79
41	.62422	86	.84289	90	.87440	81	.69542	85	41	6	8.1	8.0	7.9
42	.62508	86	.84379	90	.87521	81	.69627	85	42	7	9.4	9.3	9.2
43	.62594	86	.84469	89	.87602	81	.69712	85	43	8	10.8	10.6	10.5
44	.62680	86	.84559	89	.87683	81	.69798	85	44	9	12.1	12.0	11.8
45	8.62766	86	8.64649	90	8.67751	81	8.69883	85	45	10	13.5	13.3	13.1
46	.62852	86	.84738	89	.87845	81	.69967	85	46	20	27.0	26.6	26.3
47	.62937	86	.84828	89	.87926	81	.70052	85	47	30	40.0	39.5	39.0
48	.63023	85	.84917	89	.88007	80	.70137	85	48	40	54.0	53.3	52.6
49	.63108	85	.85006	89	.88087	80	.70222	85	49	50	67.5	66.6	65.8
50	8.63194	85	8.65096	89	8.68168	80	8.70306	84	50		0	0	0
51	.63279	85	.85185	89	.88248	80	.70391	84	51	6	8.0	7.9	7.8
52	.63364	85	.85274	89	.88329	80	.70475	84	52	7	9.3	9.2	9.1
53	.63449	85	.85363	89	.88409	80	.70560	84	53	8	10.7	10.6	10.5
54	.63534	85	.85452	89	.88489	80	.70644	84	54	9	12.1	12.0	11.8
55	8.63619	85	8.65541	89	8.68569	80	8.70728	84	55	10	13.5	13.3	13.1
56	.63704	85	.85629	88	.88650	80	.70813	84	56	20	27.0	26.6	26.3
57	.63789	85	.85718	88	.88730	80	.70897	84	57	30	40.0	39.5	39.0
58	.63874	84	.85807	88	.88810	80	.70981	84	58	40	54.0	53.3	52.6
59	.63959	84	.85895	88	.88889	79	.71065	84	59	50	67.5	66.6	65.8
60	8.64043	D	8.65984	D	8.68969	D	8.71149	D	60		0	0	0
	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D					



174 LOG. VERSED SINES AND EXTERNAL SECANTS

18°

19°

'	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	'	P. P.
0	8.68969	78	8.71149	83	8.73625	75	8.76058	78	0	
1	.69049	80	.71232	82	.73700	75	.76137	80	1	
2	.69129	79	.71316	83	.73775	75	.76217	79	2	
3	.69208	79	.71400	84	.73851	75	.76297	79	3	
4	.69288	79	.71484	84	.73926	75	.76376	79	4	84 83 82
5	8.69367	79	8.71567	83	8.74001	75	8.76456	80	5	6 8.4 8.3 8.2
6	.69446	79	.71651	83	.74076	75	.76536	79	6	7 9.8 9.7 9.5
7	.69526	79	.71734	83	.74151	75	.76615	79	7	8 11.2 11.0 10.9
8	.69605	79	.71817	83	.74226	75	.76694	79	8	9 12.6 12.4 12.3
9	.69684	79	.71901	83	.74301	75	.76774	79	9	10 14.0 13.8 13.6
10	8.69763	79	8.71984	83	8.74376	75	8.76853	79	10	20 28.0 27.8 27.3
11	.69842	79	.72067	83	.74451	74	.76932	79	11	30 42.0 41.5 41.0
12	.69921	78	.72150	83	.74526	74	.77011	79	12	40 56.0 55.3 54.6
13	.70000	79	.72233	83	.74600	74	.77090	79	13	50 70.0 69.1 68.3
14	.70079	78	.72316	83	.74675	74	.77169	79	14	
15	8.70157	78	8.72399	82	8.74749	74	8.77248	79	15	81 80 79
16	.70239	78	.72481	82	.74824	74	.77327	79	16	6 8.1 8.0 7.9
17	.70314	78	.72564	83	.74898	74	.77406	78	17	7 9.4 9.3 9.2
18	.70393	78	.72647	82	.74973	74	.77485	79	18	8 10.8 10.6 10.5
19	.70471	78	.72729	82	.75047	74	.77563	78	19	9 12.1 12.0 11.9
20	8.70550	78	8.72812	85	8.75121	74	8.77642	78	20	10 13.5 13.3 13.1
21	.70628	78	.72894	85	.75195	74	.77720	78	21	20 27.0 26.6 26.3
22	.70706	78	.72977	82	.75269	74	.77799	79	22	30 40.5 40.0 39.5
23	.70784	78	.73059	82	.75343	74	.77877	78	23	40 54.0 53.3 52.6
24	.70862	78	.73141	82	.75417	74	.77956	78	24	50 67.5 66.6 65.3
25	8.70940	78	8.73223	82	8.75491	74	8.78034	78	25	
26	.71018	78	.73306	82	.75565	74	.78112	78	26	78 77 76
27	.71096	78	.73388	82	.75639	73	.78191	78	27	6 7.8 7.7 7.6
28	.71174	77	.73470	81	.75712	73	.78269	78	28	7 9.1 9.0 8.9
29	.71251	77	.73551	81	.75786	73	.78347	78	29	8 10.4 10.3 10.1
30	8.71329	77	8.73633	82	8.75860	74	8.78425	78	30	9 11.7 11.5 11.4
31	.71406	77	.73715	82	.75933	73	.78503	78	31	10 13.0 12.7 12.6
32	.71484	77	.73797	81	.76006	73	.78581	78	32	20 26.0 25.5 25.3
33	.71561	77	.73878	81	.76080	73	.78659	78	33	30 39.0 38.3 38.0
34	.71639	77	.73960	81	.76153	73	.78736	77	34	40 52.0 51.1 50.6
35	8.71716	77	8.74041	81	8.76226	73	8.78814	78	35	50 65.0 64.1 63.3
36	.71793	77	.74123	81	.76300	73	.78892	77	36	
37	.71870	77	.74204	81	.76373	73	.78969	77	37	
38	.71947	77	.74286	81	.76446	73	.79047	77	38	
39	.72024	77	.74367	81	.76519	73	.79124	77	39	
40	8.72101	76	8.74448	81	8.76592	72	8.79202	77	40	75 74 73
41	.72178	76	.74529	81	.76664	72	.79279	77	41	6 7.5 7.4 7.3
42	.72255	76	.74610	81	.76737	72	.79357	77	42	7 8.7 8.6 8.5
43	.72331	76	.74691	81	.76810	72	.79434	77	43	8 10.0 9.8 9.7
44	.72408	76	.74772	80	.76883	72	.79511	77	44	9 11.2 11.1 10.9
45	8.72485	76	8.74853	81	8.76955	72	8.79588	77	45	10 12.5 12.3 12.1
46	.72561	76	.74934	80	.77028	72	.79665	77	46	20 25.0 24.6 24.3
47	.72637	76	.75014	80	.77100	72	.79742	77	47	30 37.5 37.0 36.5
48	.72714	76	.75095	80	.77173	72	.79819	77	48	40 50.0 49.3 48.6
49	.72790	76	.75175	80	.77245	72	.79896	77	49	50 62.5 61.6 60.8
50	8.72865	76	8.75256	80	8.77317	72	8.79973	76	50	
51	.72942	76	.75336	80	.77390	72	.80050	76	51	6 7.2 7.1 7.0
52	.73018	76	.75417	80	.77462	72	.80126	76	52	7 8.4 8.3 8.2
53	.73094	76	.75497	80	.77534	72	.80203	76	53	8 9.6 9.4 9.3
54	.73170	76	.75577	80	.77606	72	.80280	76	54	9 10.8 10.6 10.5
55	8.73246	76	8.75658	80	8.77678	72	8.80356	76	55	10 12.0 11.8 11.6
56	.73322	76	.75738	80	.77750	72	.80433	76	56	20 24.0 23.6 23.3
57	.73398	75	.75818	80	.77822	72	.80509	76	57	30 37.0 36.5 36.0
58	.73473	75	.75898	80	.77893	71	.80586	76	58	40 50.0 49.3 48.6
59	.73549	76	.75978	80	.77965	71	.80662	76	59	50 62.0 61.6 60.8
60	8.73625	75	8.76058	80	8.78037	71	8.80738	76	60	

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20° 21°

°	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	°	P. P.
0	8.78037	71	8.80738	76	8.82229	68	8.85214	73	0	
1	.78108	71	.80814	76	.82297	68	.85287	73	1	
2	.78180	71	.80891	76	.82366	68	.85360	73	2	
3	.78251	71	.80967	76	.82434	68	.85433	73	3	
4	.78323	71	.81043	76	.82502	68	.85506	73	4	<b>76 75 74</b>
5	8.78394	71	8.81119	76	8.82569	67	8.85579	73	5	6 7.6 7.5 7.4
6	.78466	71	.81195	76	.82637	68	.85651	73	6	7 8.8 8.7 8.6
7	.78537	71	.81271	75	.82705	67	.85724	72	7	8 10.1 10.0 9.9
8	.78608	71	.81346	76	.82773	68	.85797	73	8	9 11.4 11.2 11.1
9	.78679	71	.81422	76	.82841	68	.85869	72	9	10 12.6 12.6 12.5
10	8.78750	71	8.81498	75	8.82908	67	8.85942	72	10	20 25.3 25.0 21.6
11	.78821	71	.81573	76	.82976	67	.86014	72	11	30 38.0 37.5 37.0
12	.78892	71	.81649	75	.83043	67	.86087	72	12	40 60.6 50.0 49.3
13	.78963	70	.81725	75	.83111	67	.86159	72	13	50 63.3 62.5 61.6
14	.79034	70	.81800	75	.83178	67	.86231	72	14	
15	8.79105	71	8.81876	75	8.83246	67	8.86304	72	15	<b>73 72 71</b>
16	.79175	70	.81951	75	.83313	67	.86376	72	16	6 7.8 7.8 7.2 7.1
17	.79246	70	.82026	75	.83380	67	.86448	72	17	7 8.9 8.5 8.4 8.3
18	.79317	70	.82102	75	.83447	67	.86520	72	18	8 9.7 9.6 9.6 9.4
19	.79387	70	.82177	75	.83515	67	.86592	72	19	9 10.6 10.8 10.6 10.3
20	8.79458	70	8.82252	75	8.83582	67	8.86664	72	20	10 12.1 12.0 11.9 11.6
21	.79528	70	.82327	75	.83649	67	.86736	72	21	20 24.3 24.0 23.8 23.6
22	.79598	70	.82402	75	.83716	67	.86808	72	22	30 36.5 36.0 35.5 35.3
23	.79669	70	.82477	74	.83783	67	.86880	72	23	40 48.6 48.0 47.5 47.1
24	.79739	70	.82552	74	.83850	67	.86952	71	24	50 60.8 60.0 59.1
25	8.79809	70	8.82627	75	8.83916	66	8.87024	71	25	<b>70 69 68</b>
26	.79879	70	.82702	74	.83983	66	.87095	71	26	6 7.0 6.9 6.8
27	.79949	70	.82776	74	.84050	67	.87167	71	27	7 8.1 8.1 8.0 7.9
28	.80019	70	.82851	74	.84117	67	.87239	71	28	8 9.3 9.3 9.2 9.0
29	.80089	70	.82926	74	.84183	67	.87310	71	29	9 10.5 10.5 10.3 10.2
30	8.80159	70	8.83000	74	8.84250	66	8.87382	71	30	10 11.6 11.5 11.3 11.1
31	.80229	70	.83075	74	.84316	66	.87453	71	31	20 23.3 23.0 22.6 22.5
32	.80299	69	.83149	74	.84383	66	.87525	71	32	30 35.0 34.5 34.0 33.8
33	.80369	69	.83224	74	.84449	66	.87596	71	33	40 46.5 46.0 45.5 45.3
34	.80438	69	.83298	74	.84515	66	.87668	71	34	50 58.3 57.5 56.6
35	8.80508	69	8.83373	74	8.84582	66	8.87739	71	35	
36	.80577	69	.83447	74	.84648	66	.87810	71	36	
37	.80647	69	.83521	74	.84714	66	.87881	71	37	<b>67 66 65</b>
38	.80716	69	.83595	74	.84780	66	.87953	71	38	6 6.7 6.6 6.5
39	.80786	69	.83670	74	.84846	66	.88024	71	39	7 7.8 7.7 7.6
40	8.80855	69	8.83744	74	8.84912	66	8.88095	71	40	8 8.9 8.8 8.8 8.6
41	.80924	69	.83818	74	.84978	66	.88166	71	41	9 10.0 9.9 9.9 9.7
42	.80993	69	.83892	74	.85044	66	.88237	71	42	10 11.1 11.0 11.0 10.8
43	.81063	69	.83966	73	.85110	66	.88308	71	43	20 22.3 22.0 21.8 21.6
44	.81132	69	.84039	73	.85176	66	.88379	71	44	30 33.5 33.0 32.5 32.3
45	8.81201	69	8.84113	74	8.85242	65	8.88449	71	45	40 44.4 44.0 43.5 43.3
46	.81270	69	.84187	74	.85308	65	.88520	70	46	50 55.8 55.0 54.1
47	.81339	68	.84261	74	.85373	65	.88591	70	47	
48	.81407	68	.84334	73	.85439	65	.88661	70	48	
49	.81476	68	.84408	73	.85506	65	.88732	70	49	<b>0</b>
50	8.81545	68	8.84481	73	8.85570	65	8.88803	70	50	60.0 0
51	.81614	68	.84555	73	.85626	65	.88873	70	51	70.0 0
52	.81682	68	.84628	73	.85680	65	.88944	70	52	80.0 0
53	.81751	68	.84702	73	.85735	65	.89014	70	53	90.1 0
54	.81819	68	.84775	73	.85789	65	.89085	70	54	100.1 0
55	8.81888	68	8.84848	73	8.85897	65	8.89155	70	55	200.2 0
56	.81956	68	.84922	73	.85966	65	.89225	70	56	300.0 0
57	.82025	68	.84995	73	.86027	65	.89295	70	57	400.0 0
58	.82093	68	.85068	73	.86092	65	.89366	70	58	500.4 0
59	.82161	68	.85141	73	.86158	65	.89436	70	59	
60	8.82229	68	8.85214	73	8.86223	65	8.89506	70	60	
	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D		P. P.

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23°

Lg. Vers.		D	Log. Exs.		D	Lg. Vers.		D	Log. Exs.		D	P. P.			
0	8.86223	64	8.89506	70	8.90034	62	8.93631	67	0	1					
1	8.86287	65	8.89576	70	8.90098	62	8.93699	67	6	7.0	6.9	6.8			
2	8.86352	65	8.89646	70	8.90158	62	8.93766	67	7	8.1	8.0	7.9			
3	8.86417	65	8.89716	70	8.90220	62	8.93833	67	8	9.3	9.2	9.0			
4	8.86482	65	8.89786	69	8.90282	62	8.93901	67	9	10.5	10.3	10.2			
5	8.86547	64	8.89856	70	8.90344	62	8.93968	67	10	11.6	11.4	11.3			
6	8.86612	65	8.89926	69	8.90406	61	8.94035	67	20	23.3	23.0	22.6			
7	8.86676	64	8.89995	70	8.90467	62	8.94102	67	30	35.0	34.5	34.0			
8	8.86741	64	8.90065	69	8.90529	61	8.94170	67	40	46.6	46.0	45.3			
9	8.86805	64	8.90135	70	8.90591	61	8.94237	67	50	58.3	57.5	56.6			
10	8.86870	64	8.90205	69	8.90652	61	8.94304	67							
11	8.86934	64	8.90274	69	8.90714	61	8.94371	67							
12	8.86999	64	8.90344	69	8.90776	61	8.94438	67							
13	8.87063	64	8.90413	69	8.90837	61	8.94505	67							
14	8.87127	64	8.90483	69	8.90899	61	8.94572	67							
15	8.87192	64	8.90552	69	8.90960	61	8.94639	66							
16	8.87256	64	8.90622	69	8.91021	61	8.94705	66							
17	8.87320	64	8.90691	69	8.91082	61	8.94772	66							
18	8.87384	64	8.90760	69	8.91143	61	8.94839	66							
19	8.87448	64	8.90830	69	8.91205	61	8.94906	66							
20	8.87512	64	8.90899	69	8.91267	61	8.94972	66							
21	8.87576	64	8.90968	69	8.91328	61	8.95039	66							
22	8.87640	64	8.91037	69	8.91389	61	8.95105	66							
23	8.87704	64	8.91106	69	8.91450	61	8.95172	66							
24	8.87768	63	8.91175	69	8.91511	61	8.95238	66							
25	8.87832	64	8.91244	69	8.91572	61	8.95305	66							
26	8.87895	64	8.91313	69	8.91633	61	8.95371	66							
27	8.87959	64	8.91382	69	8.91694	61	8.95437	66							
28	8.88023	63	8.91451	69	8.91755	60	8.95504	66							
29	8.88086	63	8.91520	69	8.91815	60	8.95570	66							
30	8.88150	63	8.91588	69	8.91876	60	8.95636	66							
31	8.88213	63	8.91657	69	8.91937	60	8.95703	66							
32	8.88277	63	8.91726	69	8.91997	60	8.95769	66							
33	8.88340	63	8.91794	69	8.92058	60	8.95835	66							
34	8.88404	63	8.91863	69	8.92119	60	8.95901	66							
35	8.88467	63	8.91932	69	8.92179	60	8.95967	66							
36	8.88530	63	8.92000	69	8.92240	60	8.96033	66							
37	8.88593	63	8.92068	69	8.92300	60	8.96099	66							
38	8.88656	63	8.92137	69	8.92361	60	8.96165	66							
39	8.88720	63	8.92205	69	8.92421	60	8.96231	66							
40	8.88783	63	8.92274	69	8.92487	60	8.96297	66							
41	8.88846	63	8.92342	69	8.92542	60	8.96362	66							
42	8.88909	62	8.92410	69	8.92602	60	8.96428	66							
43	8.88971	63	8.92478	69	8.92662	60	8.96494	66							
44	8.89034	63	8.92546	69	8.92722	60	8.96560	66							
45	8.89097	62	8.92615	69	8.92782	60	8.96625	65							
46	8.89160	63	8.92683	69	8.92845	60	8.96691	65							
47	8.89223	63	8.92751	69	8.92902	60	8.96757	66							
48	8.89285	62	8.92819	69	8.92965	60	8.96822	65							
49	8.89348	63	8.92887	69	8.93022	60	8.96888	65							
50	8.89411	62	8.92955	69	8.93082	60	8.96953	65							
51	8.89473	62	8.93022	68	8.93142	60	8.97018	65							
52	8.89536	62	8.93090	67	8.93202	60	8.97084	65							
53	8.89598	62	8.93158	68	8.93261	60	8.97149	65							
54	8.89660	62	8.93226	68	8.93321	60	8.97214	65							
55	8.89723	62	8.93293	68	8.93381	60	8.97280	65							
56	8.89785	62	8.93361	67	8.93440	60	8.97345	65							
57	8.89847	62	8.93429	67	8.93500	60	8.97410	65							
58	8.89910	62	8.93496	67	8.93560	60	8.97475	65							
59	8.89972	62	8.93564	67	8.93619	60	8.97540	65							
60	8.00034	D	8.93631	D	8.93679	D	8.97606	D							

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24°

25°

24°			25°			P. P.		
Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	
8.93679	59	8.97608	65	8.97170	57	9.01443	62	0
.93738	59	.97671	65	.97227	56	.01505	62	1
.93797	59	.97738	65	.97284	57	.01568	62	2
.93857	59	.97801	65	.97341	57	.01631	62	3
.93916	59	.97865	64	.97398	57	.01694	62	4
8.93975	59	8.97930	65	8.97455	56	9.01758	62	5
.94034	59	.97995	65	.97511	56	.01819	62	6
.94094	59	.98060	64	.97568	56	.01882	62	7
.94153	59	.98125	65	.97625	56	.01944	62	8
.94212	59	.98190	64	.97681	56	.02007	62	9
8.94271	59	8.98254	64	8.97738	56	9.02070	62	10
.94330	59	.98319	64	.97795	57	.02132	62	11
.94389	59	.98383	64	.97851	56	.02195	62	12
.94448	59	.98448	65	.97908	56	.02257	62	13
.94506	58	.98513	64	.97964	56	.02319	62	14
8.94565	59	8.98577	64	8.98020	56	9.02382	62	15
.94624	58	.98642	64	.98077	56	.02444	62	16
.94683	58	.98706	64	.98133	56	.02506	62	17
.94742	58	.98770	64	.98190	56	.02568	62	18
.94800	58	.98835	64	.98246	56	.02631	62	19
8.94859	58	8.98899	64	8.98302	56	9.02693	62	20
.94917	58	.98963	64	.98358	56	.02755	62	21
.94976	58	.99028	64	.98414	56	.02817	62	22
.95034	58	.99092	64	.98470	56	.02880	62	23
.95093	58	.99156	64	.98527	56	.02942	62	24
8.95151	58	8.99220	64	8.98583	56	9.03004	62	25
.95210	58	.99284	64	.98639	56	.03066	62	26
.95269	58	.99348	64	.98695	56	.03128	62	27
.95328	58	.99411	64	.98750	56	.03190	62	28
.95384	58	.99476	64	.98806	56	.03252	62	29
8.95443	58	8.99540	64	8.98862	56	9.03313	61	30
.95501	58	.99604	64	.98918	56	.03375	62	31
.95559	58	.99668	64	.98974	55	.03437	62	32
.95617	58	.99732	64	.99030	56	.03499	61	33
.95675	58	.99796	63	.99085	55	.03561	61	34
8.95733	58	8.99860	64	8.99141	55	9.03622	61	35
.95791	58	.99923	63	.99197	55	.03684	61	36
.95849	58	.99987	63	.99252	55	.03746	61	37
.95907	58	9.00051	63	.99308	55	.03807	61	38
.95965	58	.00114	63	.99363	55	.03869	61	39
8.96023	58	8.00178	64	8.99419	55	9.03930	61	40
.96080	57	.00242	63	.99474	55	.03992	61	41
.96138	57	.00305	63	.99529	55	.04053	61	42
.96196	57	.00369	63	.99585	55	.04115	61	43
.96253	57	.00432	63	.99640	55	.04176	61	44
8.96311	57	8.00495	63	8.99695	55	9.04238	61	45
.96368	57	.00559	63	.99751	55	.04299	61	46
.96426	57	.00622	63	.99806	55	.04360	61	47
.96483	57	.00686	63	.99861	55	.04421	61	48
.96541	57	.00749	63	.99916	55	.04483	61	49
8.96598	57	8.00812	63	8.99971	55	9.04544	61	50
.96656	57	.00875	63	9.00026	55	.04605	61	51
.96713	57	.00938	63	.00081	55	.04667	61	52
.96770	57	.01002	63	.00136	55	.04727	61	53
.96827	57	.01065	63	.00191	55	.04787	61	54
8.96885	57	8.01128	63	8.00246	55	9.04850	61	55
.96942	57	.01191	63	.00301	55	.04911	61	56
.96999	57	.01254	63	.00356	55	.04972	61	57
.97058	57	.01317	63	.00411	55	.05033	61	58
.97113	57	.01380	63	.00466	55	.05093	61	59
8.97170	57	8.01443	63	8.00521	54	9.05154	61	60
Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	

P. P.		
65	64	63
6	6.5	6.4
7	7.8	7.4
8	8.8	8.5
9	9.7	9.6
10	10.8	10.6
20	21.6	21.0
30	32.5	32.0
40	43.4	42.0
50	54.1	52.5
62	61	60
6	6.2	6.1
7	7.2	7.1
8	8.2	8.1
9	9.2	9.1
10	10.2	10.1
20	20.3	20.0
30	30.5	30.0
40	41.0	40.0
50	51.6	50.0
59	58	57
6	5.9	5.8
7	6.9	6.7
8	7.7	7.6
9	8.7	8.5
10	9.6	9.5
20	19.6	19.0
30	29.5	28.5
40	39.3	38.0
50	49.1	47.5
56	55	54
6	5.6	5.5
7	6.5	6.4
8	7.4	7.2
9	8.4	8.1
10	9.4	9.1
20	18.6	18.0
30	28.0	27.0
40	37.3	36.0
50	46.5	45.0
0	0	0
7	0.0	0.0
8	0.0	0.0
9	0.1	0.1
10	0.1	0.1
20	0.2	0.2
30	0.3	0.3
40	0.4	0.4

178 LOG. VERSED SINES AND EXTERNAL SECANTS

26° 27°

	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D		P. P.
0	0.00520	55	9.05154	61	9.03740	52	9.08752	59	0	
1	.00575	54	.05215	61	.03792	52	.08811	59	1	
2	.00630	54	.05276	60	.03845	53	.08870	59	2	
3	.00684	54	.05337	60	.03898	52	.08929	59	3	
4	.00739	54	.05399	60	.03950	52	.08988	59	4	
5	9.00794	55	9.05454	60	9.04002	52	9.09047	59	5	61 60 59
6	.00848	54	.05515	61	.04055	52	.09106	59	6	6.1 6.0 5.9
7	.00903	54	.05576	60	.04107	52	.09164	59	7	7.1 7.0 6.9
8	.00957	54	.05638	60	.04160	52	.09223	59	8	8.1 8.0 7.9
9	.01011	54	.05701	60	.04212	52	.09282	59	9	9.1 9.0 8.9
10	9.01066	55	9.05762	61	9.04264	52	9.09341	59	10	10.0 10.0 9.9
11	.01120	54	.05822	60	.04317	52	.09400	59	11	20.20.3 20.0.19.
12	.01174	54	.05883	60	.04369	52	.09458	59	12	30.30.5 30.0.29.
13	.01229	54	.05943	60	.04421	52	.09517	59	13	40.40.8 40.0.39.
14	.01283	54	.06004	60	.04473	52	.09576	59	14	50.50.6 50.0.49.
15	9.01337	55	9.06064	60	9.04525	52	9.09634	59	15	58 57
16	.01391	54	.06124	60	.04577	52	.09693	59	16	6 5.8 5.7
17	.01445	54	.06185	60	.04630	52	.09752	59	17	7 6.7 6.6
18	.01499	54	.06245	60	.04682	52	.09810	59	18	8 7.7 7.6
19	.01554	54	.06305	60	.04734	52	.09869	59	19	9 8.7 8.6
20	9.01608	55	9.06366	60	9.04786	52	9.09927	59	20	10 9.6 9.5
21	.01662	53	.06426	60	.04837	52	.09986	59	21	20.19.3 19.0.
22	.01716	54	.06486	60	.04889	52	.10044	59	22	30.29.0 28.0.
23	.01769	54	.06546	60	.04941	52	.10102	59	23	40.38.6 38.0.
24	.01823	54	.06606	60	.04993	52	.10161	59	24	50.48.3 47.0.
25	9.01877	55	9.06667	60	9.05045	51	9.10219	59	25	
26	.01931	53	.06727	60	.05097	52	.10278	59	26	55 54
27	.01985	54	.06787	60	.05148	51	.10336	59	27	6 5.5 5.4
28	.02038	53	.06847	60	.05200	52	.10394	59	28	7 6.4 6.3
29	.02092	54	.06907	60	.05252	52	.10452	59	29	8 7.7 7.6
30	9.02145	55	9.06967	60	9.05303	51	9.10511	59	30	9 8.7 8.6
31	.02199	54	.07027	60	.05355	52	.10569	59	31	10 9.6 9.5
32	.02253	54	.07087	59	.05407	51	.10627	59	32	20.18.3 18.0.
33	.02307	53	.07146	60	.05458	51	.10685	59	33	30.27.7 27.0.
34	.02360	53	.07206	60	.05510	51	.10743	59	34	40.36.3 36.0.
35	9.02414	55	9.07266	60	9.05561	51	9.10801	59	35	50.45.8 45.0.
36	.02467	53	.07326	59	.05613	51	.10859	59	36	
37	.02521	53	.07386	59	.05664	51	.10917	59	37	53 52
38	.02574	53	.07445	59	.05715	51	.10975	59	38	6 5.3 5.2
39	.02627	53	.07505	59	.05767	51	.11033	59	39	7 6.2 6.0
40	9.02681	55	9.07565	59	9.05818	51	9.11091	59	40	8 7.2 7.0
41	.02734	53	.07624	59	.05869	51	.11149	59	41	9 8.1 7.9
42	.02787	53	.07684	59	.05921	51	.11207	59	42	10 8.8 8.6
43	.02840	53	.07743	59	.05972	51	.11265	59	43	20.17.7 17.0.
44	.02894	53	.07803	59	.06023	51	.11323	59	44	30.26.5 26.0.
45	9.02947	55	9.07863	59	9.06074	51	9.11380	59	45	40.35.3 34.0.
46	.03000	53	.07922	59	.06125	51	.11438	59	46	50.44.1 43.0.
47	.03053	53	.07981	59	.06176	51	.11496	59	47	
48	.03106	53	.08041	59	.06227	51	.11554	59	48	
49	.03159	53	.08100	59	.06278	51	.11611	59	49	
50	9.03212	55	9.08160	59	9.06330	51	9.11668	59	50	51 50
51	.03265	53	.08219	59	.06380	51	.11727	59	51	6 5.1 5.0
52	.03318	53	.08278	59	.06431	51	.11784	59	52	7 6.0 6.0
53	.03371	53	.08338	59	.06482	51	.11842	59	53	8 7.0 7.0
54	.03423	52	.08397	59	.06533	51	.11899	59	54	10 8.0 8.0
55	9.03476	55	9.08456	59	9.06584	50	9.11957	59	55	20.17.0 17.0.
56	.03529	53	.08515	59	.06635	50	.12015	59	56	30.25.8 25.0.
57	.03582	54	.08574	59	.06686	50	.12072	59	57	40.34.0 34.0.
58	.03634	52	.08634	59	.06736	50	.12129	59	58	50.42.5 42.0.
59	.03687	53	.08693	59	.06787	50	.12187	59	59	
60	9.03740	52	9.08752	59	9.06838	50	9.12244	59	60	
Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D		P. P.	

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28°				29°				P. P.			
'	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D			
0	9.06888	50	9.12244	57	9.09823	49	9.15641	56	0		
1	.06888	51	.12302	57	.09872	48	.15697	55	1	6	57
2	.06893	50	.12359	57	.09920	49	.15752	56	2	7	57
3	.06899	50	.12416	57	.09969	48	.15808	55	3	8	57
4	.07040	50	.12474	57	.10018	48	.15864	55	4	9	57
5	9.07091	50	9.12531	57	9.10067	49	9.15920	56	5	10	57
6	.07141	50	.12588	57	.10116	48	.15975	55	6	20	19
7	.07192	50	.12645	57	.10164	48	.16031	56	7	3	28
8	.07242	50	.12703	57	.10213	49	.16087	55	8	40	35
9	.07293	50	.12760	57	.10261	48	.16142	55	9	50	47
10	9.07343	50	9.12817	57	9.10310	48	9.16198	56	10		
11	.07393	50	.12874	57	.10358	48	.16254	55	11	6	56
12	.07444	50	.12931	57	.10407	48	.16309	55	12	7	56
13	.07494	50	.12988	57	.10455	48	.16365	55	13	8	56
14	.07544	50	.13045	57	.10504	48	.16420	55	14	8	7
15	9.07594	50	9.13102	57	9.10552	48	9.16476	55	15	9	8
16	.07644	50	.131	57	.10601	48	.16531	55	16	10	9
17	.07695	50	.13216	56	.10649	48	.16587	55	17	20	18
18	.07745	50	.13273	56	.10697	48	.16642	55	18	30	28
19	.07795	50	.13330	56	.10746	48	.16698	55	19	40	35
20	9.07845	50	9.13387	57	9.10794	48	9.16753	55	20	50	46
21	.07895	50	.13444	57	.10842	48	.16808	55	21		
22	.07945	50	.13500	56	.10890	48	.16864	55	22	6	54
23	.07995	50	.13557	56	.10939	48	.16919	55	23	7	54
24	.08045	50	.13614	56	.10987	48	.16974	55	24	8	54
25	9.08095	50	9.13671	57	9.11035	48	9.17029	55	25	8	2
26	.08145	50	.13727	56	.11083	48	.17085	55	26	10	9
27	.08193	50	.13784	56	.11131	48	.17140	55	27	20	18
28	.08243	49	.13841	56	.11179	48	.17195	55	28	30	27
29	.08292	49	.13897	56	.11227	48	.17250	55	29	40	36
30	9.08344	49	9.13954	57	9.11275	48	9.17305	55	30	50	45
31	.08394	49	.14011	56	.11323	48	.17361	55	31		
32	.08443	49	.14067	56	.11371	48	.17416	55	32	6	51
33	.08493	49	.14124	56	.11419	47	.17471	55	33	7	50
34	.08543	49	.14180	56	.11467	47	.17526	55	34	8	50
35	9.08592	49	9.14237	56	9.11515	48	9.17581	55	35	8	6
36	.08642	49	.14293	56	.11562	47	.17636	55	36	9	6
37	.08691	49	.14350	56	.11610	48	.17691	55	37	10	8
38	.08741	49	.14406	56	.11658	47	.17746	55	38	20	17
39	.08790	49	.14462	56	.11706	47	.17801	55	39	30	25
40	9.08840	49	9.14519	56	9.11754	48	9.17856	55	40	40	34
41	.08890	49	.14575	56	.11801	47	.17910	55	41	50	42
42	.08939	49	.14631	56	.11849	48	.17965	55	42		
43	.08988	49	.14688	56	.11897	47	.18020	55	43	6	49
44	.09037	49	.14744	56	.11944	47	.18075	55	44	7	48
45	9.09087	49	9.14800	56	9.11992	47	9.18130	55	45	8	48
46	.09136	49	.14855	56	.12039	47	.18185	55	46	8	6
47	.09185	49	.14913	56	.12087	47	.18239	55	47	9	6
48	.09234	49	.14969	56	.12134	47	.18294	55	48	10	8
49	.09284	49	.15025	56	.12182	47	.18349	55	49	20	16
50	9.09333	49	9.15081	56	9.12229	47	9.18403	55	50	30	24
51	.09382	49	.15137	56	.12277	47	.18458	55	51	40	32
52	.09431	49	.15193	56	.12324	47	.18513	55	52	50	40
53	.09480	49	.15249	56	.12371	47	.18567	55	53		
54	.09529	49	.15305	56	.12419	47	.18622	55	54	6	48
55	9.09578	49	9.15361	56	9.12466	47	9.18676	55	55	7	47
56	.09627	49	.15417	56	.12513	47	.18731	55	56	8	47
57	.09676	48	.15473	56	.12560	47	.18786	55	57	8	6
58	.09725	48	.15529	56	.12608	47	.18840	55	58	10	8
59	.09774	49	.15585	56	.12655	47	.18894	55	59	20	16
60	9.09823	49	9.15641	56	9.12702	47	9.18949	55	60	30	24
	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D			

P. P.

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	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D		P. P.
0	9.12702	47	9.18949	54	9.15483	45	9.22176	53	0	
1	.12749	47	.19003	54	.15528	45	.22220	53	1	
2	.12796	47	.19059	54	.15574	45	.22265	53	2	
3	.12843	47	.19112	54	.15619	45	.22310	53	3	
4	.12890	47	.19167	54	.15665	45	.22358	53	4	
5	9.12937	47	9.19221	54	9.15710	45	9.22441	53	5	
6	.12984	47	.19275	54	.15755	45	.22494	53	6	
7	.13031	47	.19329	54	.15801	45	.22547	53	7	
8	.13078	47	.19384	54	.15846	45	.22600	53	8	
9	.13125	47	.19438	54	.15891	45	.22653	53	9	
10	9.13172	46	9.19492	54	9.15937	45	9.22706	53	10	
11	.13219	47	.19546	54	.15982	45	.22759	53	11	
12	.13266	47	.19601	54	.16027	45	.22812	53	12	
13	.13313	47	.19655	54	.16073	45	.22865	53	13	
14	.13359	46	.19709	54	.16118	45	.22918	52	14	
15	9.13406	46	9.19763	54	9.16163	45	9.22971	53	15	
16	.13453	47	.19817	54	.16208	45	.23024	52	16	
17	.13500	46	.19871	54	.16253	45	.23076	53	17	
18	.13546	46	.19925	54	.16298	45	.23129	52	18	
19	.13593	46	.19979	54	.16343	45	.23182	52	19	
20	9.13639	46	9.20033	54	9.16388	45	9.23235	53	20	
21	.13686	46	.20087	54	.16434	45	.23287	52	21	
22	.13733	46	.20141	54	.16479	44	.23340	52	22	
23	.13779	46	.20195	54	.16523	45	.23393	53	23	
24	.13826	46	.20249	53	.16568	45	.23446	52	24	
25	9.13872	46	9.20303	54	9.16613	45	9.23498	52	25	
26	.13919	46	.20357	54	.16658	45	.23551	52	26	
27	.13965	46	.20411	54	.16703	45	.23603	52	27	
28	.14011	46	.20465	54	.16748	45	.23656	52	28	
29	.14058	46	.20518	53	.16793	44	.23709	53	29	
30	9.14104	46	9.20572	54	9.16838	44	9.23761	52	30	
31	.14151	46	.20626	53	.16882	44	.23814	52	31	
32	.14197	46	.20680	53	.16927	45	.23866	52	32	
33	.14243	46	.20733	53	.16972	44	.23919	52	33	
34	.14289	46	.20787	54	.17017	45	.23971	52	34	
35	9.14336	46	9.20841	53	9.17061	44	9.24024	52	35	
36	.14382	46	.20894	54	.17106	45	.24076	52	36	
37	.14428	46	.20948	53	.17151	44	.24128	52	37	
38	.14474	46	.21002	53	.17195	44	.24181	52	38	
39	.14520	46	.21055	53	.17240	44	.24233	52	39	
40	9.14566	46	9.21109	53	9.17284	44	9.24285	52	40	
41	.14612	46	.21162	53	.17329	44	.24338	52	41	
42	.14658	46	.21216	53	.17373	44	.24390	52	42	
43	.14704	46	.21269	53	.17418	44	.24442	52	43	
44	.14750	46	.21323	53	.17462	44	.24495	52	44	
45	9.14796	46	9.21376	53	9.17507	44	9.24547	52	45	
46	.14842	46	.21430	53	.17551	44	.24599	52	46	
47	.14888	46	.21483	53	.17596	44	.24651	52	47	
48	.14934	45	.21537	53	.17640	44	.24704	52	48	
49	.14980	46	.21590	53	.17684	44	.24756	52	49	
50	9.15026	45	9.21643	53	9.17729	44	9.24808	52	50	
51	.15071	46	.21697	53	.17773	44	.24860	52	51	
52	.15117	46	.21750	53	.17817	44	.24912	52	52	
53	.15163	45	.21803	53	.17861	44	.24964	52	53	
54	.15209	45	.21857	53	.17906	44	.25016	52	54	
55	9.15254	45	9.21910	53	9.17950	44	9.25068	52	55	
56	.15300	45	.21963	53	.17994	44	.25120	52	56	
57	.15346	45	.22016	53	.18038	44	.25172	52	57	
58	.15391	45	.22070	53	.18082	44	.25224	52	58	
59	.15437	46	.22123	53	.18126	44	.25276	52	59	
60	9.15483	46	9.22176	53	9.18170	44	9.25328	52	60	
	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D		P. P.

P. P.

54 53

6 5.4 5.4 5.3  
7 6.2 6.3 6.4  
8 7.2 7.2 7.1  
9 8.2 8.1 8.0  
10 9.1 9.0 8.9  
11 10.1 10.0 9.9  
12 11.1 11.0 10.9  
13 12.1 12.0 11.9  
14 13.1 13.0 12.9

53 52 52

6 5.3 5.2 5.2  
7 6.2 6.1 6.0  
8 7.0 7.0 6.9  
9 7.9 7.9 7.8  
10 8.8 8.7 8.6  
11 9.7 9.7 9.6  
12 10.6 10.5 10.4  
13 11.5 11.4 11.3  
14 12.4 12.3 12.2

47 47 46

6 4.7 4.7 4.6  
7 5.5 5.5 5.4  
8 6.3 6.2 6.2  
9 7.1 7.0 7.0  
10 7.9 7.9 7.7  
11 8.8 8.8 8.6  
12 9.7 9.5 9.3  
13 10.6 10.3 10.1  
14 11.5 11.2 10.9

46 45 45

6 4.6 4.5 4.5  
7 5.3 5.3 5.2  
8 6.1 6.0 6.0  
9 6.9 6.8 6.7  
10 7.7 7.6 7.5  
11 8.5 8.4 8.3  
12 9.3 9.2 9.1  
13 10.1 10.0 9.9  
14 10.9 10.8 10.7

44 44

6 4.4 4.4 4.4  
7 5.2 5.1 5.1  
8 6.0 5.9 5.8  
9 6.7 6.6 6.6  
10 7.4 7.3 7.3  
11 8.2 8.1 8.0  
12 9.0 8.9 8.8  
13 9.8 9.7 9.6  
14 10.6 10.5 10.4

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Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	P. P.
18170	44	25328	52	9.20771	42	9.28412	51	0
18214	44	25380	52	20814	42	28463	51	1
18258	44	25432	52	20856	42	28514	51	2
18302	44	25484	51	20899	43	28564	50	3
18346	44	25539	51	20942	43	28615	51	4
18390	44	25588	52	9.20984	42	9.28665	51	5
18434	44	25640	52	21027	42	28717	51	6
18478	44	25692	52	21069	42	28768	50	7
18522	44	25743	52	21112	42	28818	50	8
18566	43	25795	51	21154	42	28869	50	9
18610	44	25847	51	9.21196	42	9.28920	51	10
18654	44	25899	52	21239	42	28970	50	11
18697	44	25950	51	21281	42	29021	50	12
18741	44	26002	52	21324	42	29072	51	13
18785	43	26054	51	21366	42	29122	50	14
18829	44	26105	51	9.21408	42	9.29173	51	15
18872	43	26157	52	21451	42	29223	50	16
18916	43	26209	51	21493	42	29274	50	17
18959	43	26260	51	21535	42	29324	50	18
19003	44	26312	51	21577	42	29375	51	19
19047	43	26364	52	9.21620	42	9.29426	50	20
19090	43	26415	51	21662	42	29476	50	21
19134	43	26467	51	21704	42	29527	50	22
19177	43	26518	51	21746	42	29577	50	23
19221	43	26570	51	21788	42	29627	50	24
19264	43	26621	51	9.21830	42	9.29678	50	25
19308	43	26673	51	21872	42	29728	50	26
19351	43	26724	51	21914	42	29779	50	27
19395	43	26776	51	21956	42	29829	50	28
19438	43	26827	51	21998	42	29879	50	29
19481	43	26878	51	9.22040	42	9.29930	50	30
19525	43	26930	51	22082	42	29980	50	31
19568	43	26981	51	22124	42	30030	50	32
19611	43	27032	51	22166	42	30081	50	33
19654	43	27084	51	22208	42	30131	50	34
19698	43	27135	51	9.22250	42	9.30181	50	35
19741	43	27186	51	22292	41	30231	50	36
19784	43	27238	51	22334	42	30282	50	37
19827	43	27289	51	22376	41	30332	50	38
19870	43	27340	51	22417	41	30382	50	39
19914	43	27391	51	9.22459	42	9.30432	50	40
19957	43	27443	51	22501	41	30482	50	41
20000	43	27494	51	22543	42	30533	50	42
20043	43	27545	51	22584	41	30583	50	43
20086	43	27596	51	22626	41	30633	50	44
20129	43	27647	51	9.22668	42	9.30683	50	45
20172	43	27698	51	22709	41	30733	50	46
20215	43	27749	51	22751	41	30783	50	47
20258	43	27800	51	22792	41	30833	50	48
20301	43	27852	51	22834	41	30883	50	49
20343	43	27903	51	9.22876	41	9.30933	50	50
20386	43	27954	51	22917	41	30983	50	51
20429	43	28005	51	22959	41	31033	50	52
20472	43	28056	51	23000	41	31083	50	53
20515	43	28107	51	23042	41	31133	50	54
20558	43	28157	51	9.23083	41	9.31183	49	55
20600	43	28208	51	23124	41	31233	50	56
20643	43	28259	51	23166	41	31283	50	57
20686	43	28310	51	23207	41	31333	50	58
20728	43	28361	51	23248	41	31383	50	59
20771	43	28412	50	9.23290	41	9.31433	49	60
Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	P. P.



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'	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	'	P. P.
0	9.23290	41	9.31432	50	9.25731	40	9.34395	49	0	50 40 49
1	9.23331	41	9.31482	50	9.25771	40	9.34444	48	1	6 5.0 4.9
2	9.23372	41	9.31532	50	9.25811	40	9.34492	47	2	7 5.8 5.8
3	9.23414	41	9.31582	49	9.25851	40	9.34541	46	3	8 6.6 6.6
4	9.23455	41	9.31632	50	9.25891	40	9.34590	45	4	9 7.5 7.4
5	9.23496	41	9.31681	49	9.25931	40	9.34639	44	5	10 8.3 8.2
6	9.23537	41	9.31731	50	9.25971	40	9.34688	43	6	20 16.6 16.5
7	9.23579	41	9.31781	49	9.26011	40	9.34737	42	7	30 25.0 24.7
8	9.23620	41	9.31831	50	9.26051	39	9.34785	41	8	40 33.3 33.0
9	9.23661	41	9.31880	49	9.26091	40	9.34834	40	9	50 41.6 41.2
10	9.23702	41	9.31930	50	9.26131	40	9.34883	39	10	48 48
11	9.23743	41	9.31980	49	9.26171	39	9.34932	48	11	6 4.8 4.8
12	9.23784	41	9.32029	49	9.26210	40	9.34980	47	12	7 5.6 5.6
13	9.23825	41	9.32079	50	9.26250	40	9.35029	46	13	8 6.4 6.4
14	9.23866	41	9.32129	49	9.26290	40	9.35078	45	14	9 7.3 7.2
15	9.23907	41	9.32178	49	9.26330	39	9.35127	44	15	10 8.1 8.0
16	9.23948	41	9.32228	49	9.26370	39	9.35175	43	16	20 16.0 16.0
17	9.23989	41	9.32277	49	9.26409	40	9.35224	42	17	30 24.2 24.0
18	9.24030	41	9.32327	50	9.26449	39	9.35273	41	18	40 32.3 32.0
19	9.24071	40	9.32377	49	9.26489	39	9.35321	40	19	50 40.4 40.0
20	9.24112	41	9.32426	49	9.26528	40	9.35370	39	20	41 41
21	9.24153	41	9.32476	49	9.26568	40	9.35419	38	21	6 4.1 4.1
22	9.24194	41	9.32525	49	9.26608	39	9.35467	37	22	7 4.8 4.8
23	9.24235	40	9.32575	49	9.26647	39	9.35516	36	23	8 5.5 5.4
24	9.24275	41	9.32624	49	9.26687	39	9.35564	35	24	9 6.2 6.1
25	9.24316	40	9.32673	49	9.26726	40	9.35613	34	25	10 6.9 6.8
26	9.24357	40	9.32723	49	9.26766	39	9.35661	33	26	20 13.8 13.6
27	9.24398	40	9.32772	49	9.26806	39	9.35710	32	27	30 20.5 20.5
28	9.24438	41	9.32822	49	9.26845	39	9.35758	31	28	40 27.6 27.3
29	9.24479	40	9.32871	49	9.26885	39	9.35807	30	29	50 34.6 34.1
30	9.24520	40	9.32920	49	9.26924	39	9.35855	29	30	45 40
31	9.24561	40	9.32970	49	9.26964	39	9.35904	28	31	6 4.0 4.0
32	9.24601	40	9.33019	49	9.27003	39	9.35952	27	32	7 4.7 4.7
33	9.24642	40	9.33069	49	9.27042	39	9.36001	26	33	8 5.4 5.3
34	9.24682	40	9.33118	49	9.27082	39	9.36049	25	34	9 6.1 6.0
35	9.24723	40	9.33167	49	9.27121	39	9.36098	24	35	10 6.7 6.6
36	9.24764	40	9.33216	49	9.27161	39	9.36146	23	36	20 13.5 13.3
37	9.24804	40	9.33266	49	9.27200	39	9.36194	22	37	30 20.2 20.0
38	9.24845	40	9.33315	49	9.27239	39	9.36243	21	38	40 27.0 26.8
39	9.24885	40	9.33364	49	9.27278	39	9.36291	20	39	50 33.7 33.3
40	9.24926	40	9.33413	49	9.27318	39	9.36340	19	40	39 39
41	9.24966	40	9.33463	49	9.27357	39	9.36388	18	41	6 3.9 3.9
42	9.25007	40	9.33512	49	9.27396	39	9.36436	17	42	7 4.6 4.5
43	9.25047	40	9.33561	49	9.27435	39	9.36484	16	43	8 5.2 5.2
44	9.25087	40	9.33610	49	9.27475	39	9.36533	15	44	9 5.9 5.8
45	9.25128	40	9.33659	49	9.27514	39	9.36581	14	45	10 6.6 6.5
46	9.25168	40	9.33708	49	9.27553	39	9.36629	13	46	20 13.1 13.0
47	9.25209	40	9.33758	49	9.27592	39	9.36678	12	47	30 19.7 19.5
48	9.25249	40	9.33807	49	9.27631	39	9.36726	11	48	40 26.3 26.0
49	9.25289	40	9.33856	49	9.27670	39	9.36774	10	49	50 32.9 32.5
50	9.25329	40	9.33905	49	9.27709	39	9.36822	9	50	6 3.8
51	9.25370	40	9.33954	49	9.27749	39	9.36870	8	51	7 4.5
52	9.25410	40	9.34003	49	9.27788	39	9.36919	7	52	8 5.1
53	9.25450	40	9.34052	49	9.27827	39	9.36967	6	53	9 5.8
54	9.25490	40	9.34101	49	9.27866	39	9.37015	5	54	10 6.4
55	9.25531	40	9.34150	49	9.27905	39	9.37063	4	55	20 12.8
56	9.25571	40	9.34199	49	9.27944	39	9.37111	3	56	30 19.2
57	9.25611	40	9.34248	49	9.27982	39	9.37159	2	57	40 25.6
58	9.25651	40	9.34297	49	9.28021	39	9.37207	1	58	50 32.1
59	9.25691	40	9.34346	49	9.28060	39	9.37255	0	59	
60	9.25731	40	9.34395	49	9.28099	39	9.37303	0	60	
	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D		P. P.

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hrs.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	P. P.
199	39	9.37303	48	9.30398	37	9.40163	47	0
38	35	.37352	48	.30436	37	.40210	47	1
77	39	.37400	48	.30474	37	.40258	47	2
116	39	.37448	48	.30511	37	.40305	47	3
155	39	.37496	48	.30549	37	.40352	47	4
193	35	9.37544	48	9.30587	38	9.40399	47	5
132	35	.37592	48	.30624	37	.40447	47	6
171	39	.37640	47	.30662	38	.40494	47	7
110	38	.37687	48	.30700	37	.40541	47	8
148	38	.37735	48	.30737	37	.40588	47	9
187	39	9.37783	48	9.30775	37	9.40635	47	10
528	38	.37831	48	.30812	37	.40682	47	11
564	39	.37877	48	.30850	37	.40730	47	12
303	35	.37927	47	.30887	37	.40777	47	13
142	35	.37975	47	.30925	37	.40824	47	14
380	35	9.38023	48	9.30962	37	9.40871	47	15
719	38	.38071	48	.31000	37	.40918	47	16
757	38	.38119	48	.31037	37	.40965	47	17
796	39	.38166	47	.31075	37	.41012	47	18
335	38	.38214	48	.31112	37	.41059	47	19
373	35	9.38262	48	9.31150	37	9.41106	47	20
312	38	.38310	47	.31187	37	.41153	47	21
350	38	.38357	48	.31224	37	.41200	47	22
988	35	.38405	48	.31262	37	.41247	47	23
127	38	.38453	47	.31299	37	.41294	47	24
665	38	9.38501	48	9.31336	37	9.41341	47	25
104	38	.38548	48	.31374	37	.41388	47	26
142	38	.38596	47	.31411	37	.41435	47	27
180	38	.38644	48	.31448	37	.41482	47	28
219	38	.38692	48	.31485	37	.41529	47	29
257	38	9.38739	47	9.31523	37	9.41576	47	30
295	38	.38787	47	.31560	37	.41623	47	31
334	38	.38834	47	.31597	37	.41670	47	32
372	38	.38882	48	.31634	37	.41717	47	33
410	39	.38930	47	.31671	37	.41763	47	34
448	38	9.38977	47	9.31708	37	9.41810	47	35
487	38	.39025	47	.31746	37	.41857	47	36
525	38	.39072	47	.31783	37	.41904	47	37
563	38	.39120	48	.31820	37	.41951	47	38
601	38	.39168	47	.31857	37	.41998	47	39
639	38	9.39215	47	9.31894	37	9.42044	47	40
677	38	.39263	48	.31931	37	.42091	47	41
715	38	.39310	47	.31968	37	.42138	47	42
754	38	.39358	47	.32005	37	.42185	47	43
792	38	.39405	47	.32042	37	.42231	47	44
830	38	9.39453	47	9.32079	37	9.42278	47	45
868	38	.39500	47	.32116	37	.42325	47	46
906	38	.39548	47	.32153	37	.42372	47	47
944	38	.39595	47	.32190	37	.42418	47	48
982	38	.39642	47	.32227	37	.42465	47	49
020	37	9.39690	47	9.32263	36	9.42512	46	50
057	37	.39737	47	.32300	37	.42559	46	51
095	38	.39785	47	.32337	36	.42605	46	52
133	38	.39832	47	.32374	37	.42652	46	53
171	38	.39879	47	.32411	37	.42698	46	54
209	38	9.39927	47	9.32447	36	9.42745	46	55
247	37	.39974	47	.32484	37	.42792	46	56
285	37	.40021	47	.32521	36	.42838	46	57
322	37	.40069	47	.32558	37	.42885	46	58
360	38	.40116	47	.32594	36	.42931	46	59
398	38	9.40163	47	9.32631	37	9.42978	46	60
ers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	P. P.

P. P.	
48	48
6	4.8
7	5.6
8	6.4
9	7.3
10	8.1
20	16.0
30	24.0
40	32.0
50	40.0
47	47
6	4.7
7	5.5
8	6.3
9	7.1
10	7.9
20	15.6
30	23.3
40	31.0
50	38.7
46	46
6	4.6
7	5.4
8	6.2
9	7.0
10	7.7
20	15.5
30	23.2
40	31.0
50	38.7
39	38
6	3.9
7	4.5
8	5.2
9	5.8
10	6.5
20	13.0
30	19.5
40	26.0
50	32.5
38	37
6	3.7
7	4.4
8	5.0
9	5.7
10	6.3
20	12.5
30	18.7
40	25.0
50	31.2
37	36
6	3.7
7	4.3
8	4.9
9	5.5
10	6.1
20	12.3
30	18.5
40	24.6
50	30.7



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VERS.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	P. P.
36913	34	9.48488	45	9.38968	34	9.51190	45	0
36948	34	.48533	45	.39002	33	.51235	44	1
36982	35	.48578	45	.39035	33	.51279	44	2
37017	34	.48624	45	.39069	34	.51324	45	3
37052	34	.48669	45	.39103	33	.51369	44	4
37086	34	9.48714	45	9.39137	34	9.51414	45	5
37121	34	.48759	45	.39170	33	.51458	44	6
37156	34	.48805	45	.39204	34	.51503	44	7
37190	34	.48850	45	.39238	33	.51548	44	8
37225	34	.48895	45	.39271	33	.51592	44	9
37259	34	9.48940	45	9.39305	33	9.51637	45	10
37294	34	.48986	45	.39339	34	.51682	44	11
37328	34	.49031	45	.39372	33	.51726	44	12
37363	34	.49076	45	.39406	33	.51771	45	13
37397	34	.49121	45	.39439	33	.51816	44	14
37432	34	9.49166	45	9.39473	33	9.51860	45	15
37466	34	.49211	45	.39507	34	.51905	44	16
37501	34	.49257	45	.39540	33	.51950	44	17
37535	34	.49302	45	.39574	33	.51994	44	18
37570	34	.49347	45	.39607	33	.52039	44	19
37604	34	9.49392	45	9.39641	33	9.52084	44	20
37639	34	.49437	45	.39674	33	.52128	44	21
37673	34	.49482	45	.39708	33	.52173	44	22
37707	34	.49527	45	.39741	33	.52217	44	23
37742	34	.49572	45	.39774	33	.52262	44	24
37776	34	9.49618	45	9.39808	33	9.52306	44	25
37810	34	.49663	45	.39841	33	.52351	44	26
37845	34	.49708	45	.39875	33	.52396	44	27
37879	34	.49753	45	.39908	33	.52440	44	28
37913	34	.49798	45	.39941	33	.52485	44	29
37947	34	9.49843	45	9.39975	33	9.52529	44	30
37982	34	.49888	45	.40008	33	.52574	44	31
38016	34	.49933	45	.40041	33	.52618	44	32
38050	34	.49978	45	.40075	33	.52663	44	33
38084	34	.50023	45	.40108	33	.52707	44	34
38118	34	9.50068	45	9.40141	33	9.52752	44	35
38153	34	.50113	45	.40175	33	.52796	44	36
38187	34	.50158	45	.40208	33	.52841	44	37
38221	34	.50203	45	.40241	33	.52885	44	38
38255	34	.50248	45	.40274	33	.52930	44	39
38289	34	9.50293	45	9.40307	33	9.52974	44	40
38323	34	.50338	45	.40341	33	.53018	44	41
38357	34	.50383	44	.40374	33	.53063	44	42
38391	34	.50427	45	.40407	33	.53107	44	43
38425	34	.50472	45	.40440	33	.53152	44	44
38459	34	9.50517	45	9.40473	33	9.53196	44	45
38493	34	.50562	45	.40506	33	.53240	44	46
38527	34	.50607	44	.40540	33	.53285	44	47
38561	34	.50652	45	.40573	33	.53329	44	48
38595	34	.50697	45	.40606	33	.53374	44	49
38629	34	9.50742	45	9.40639	33	9.53418	44	50
38663	34	.50787	44	.40672	33	.53462	44	51
38697	34	.50831	45	.40705	33	.53507	44	52
38731	34	.50875	45	.40738	33	.53551	44	53
38765	34	.50920	44	.40771	33	.53595	44	54
38799	34	9.50966	45	9.40804	33	9.53640	44	55
38833	34	.51011	44	.40837	33	.53684	44	56
38867	33	.51055	44	.40870	33	.53728	44	57
38900	34	.51100	45	.40903	33	.53773	44	58
38934	34	.51145	45	.40936	33	.53817	44	59
38968	34	9.51190	44	9.40969	33	9.53861	44	60
VERS.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	P. P.

45 45

6 4.5 4.5  
7 5.3 5.2  
8 6.0 6.0  
9 6.8 6.7  
10 7.6 7.5  
20 15.1 15.0  
30 22.7 22.5  
40 32.3 30.0  
50 37.9 37.5

44 44

6 4.4 4.4  
7 5.2 5.1  
8 5.9 5.8  
9 6.7 6.6  
10 7.4 7.3  
20 14.8 14.6  
30 22.2 22.0  
40 29.6 29.3  
50 37.1 36.6

35 34

6 3.5 3.4  
7 4.1 4.0  
8 4.6 4.6  
9 5.2 5.2  
10 5.8 5.7  
20 11.6 11.5  
30 17.5 17.2  
40 23.3 23.0  
50 29.1 28.7

34 33

6 3.4 3.3  
7 3.9 3.9  
8 4.5 4.4  
9 5.1 5.0  
10 5.6 5.6  
20 11.3 11.1  
30 17.0 16.7  
40 22.6 22.3  
50 28.3 27.9

33

6 3.3  
7 3.8  
8 4.4  
9 4.9  
10 5.5  
20 11.0  
30 16.5  
40 22.0  
50 27.5

P. P.

188 LOG. VERSED SINES AND EXTERNAL SECANTS

46° 47°

'	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	'	P. P.
0	9.48478	30	9.64301	43	9.50243	29	9.66864	42	0	
1	48508	29	64344	42	50272	29	66907	43	1	
2	48538	30	64387	42	50301	29	66950	42	2	
3	48568	29	64430	43	50330	29	66992	42	3	
4	48597	29	64473	43	50359	29	67035	42	4	
5	9.48627	30	9.64515	42	9.50388	29	9.67077	42	5	6 4.3 42
6	48657	29	64558	43	50417	29	67120	42	6	7 5.0 4.0
7	48686	30	64601	42	50446	29	67162	42	7	8 5.7 5.6
8	48716	29	64644	43	50475	29	67205	42	8	9 6.4 6.4
9	48746	29	64687	42	50504	29	67248	42	9	10 7.1 7.1
10	9.48775	30	9.64729	42	9.50533	29	9.67290	42	10	20 14.3 14.3
11	48805	29	64772	43	50562	29	67333	42	11	30 21.5 21.5
12	48835	30	64815	42	50591	29	67375	42	12	40 28.6 28.6
13	48864	29	64858	43	50619	29	67418	42	13	50 35.8 35.4
14	48894	29	64901	42	50648	29	67460	42	14	
15	9.48923	30	9.64943	42	9.50677	29	9.67503	42	15	42
16	48953	29	64986	43	50706	29	67546	42	16	6 4.2
17	48983	30	65029	42	50735	29	67588	42	17	7 4.9
18	49012	29	65072	43	50764	29	67631	42	18	8 5.6
19	49042	29	65114	42	50793	29	67673	42	19	9 6.3
20	9.49071	30	9.65157	42	9.50821	29	9.67716	42	20	10 7.0
21	49101	29	65200	43	50850	29	67758	42	21	20 14.0
22	49130	29	65243	42	50879	29	67801	42	22	30 21.0
23	49160	29	65285	43	50908	29	67843	42	23	40 28.0
24	49189	29	65328	42	50937	29	67886	42	24	50 35.0
25	9.49219	30	9.65371	42	9.50965	29	9.67928	42	25	
26	49248	29	65414	43	50994	29	67971	42	26	
27	49278	30	65456	42	51023	29	68013	42	27	6 3.0 2.9
28	49307	29	65499	43	51052	29	68056	42	28	7 3.5 3.4
29	49336	29	65542	42	51080	29	68098	42	29	8 4.0 3.9
30	9.49300	30	9.65585	42	9.51109	29	9.68141	42	30	9 4.5 4.4
31	49395	29	65627	43	51138	29	68183	42	31	10 5.0 4.9
32	49425	29	65670	42	51167	29	68226	42	32	20 10.0 9.8
33	49454	30	65713	43	51195	29	68268	42	33	30 15.0 14.7
34	49483	29	65755	42	51224	29	68311	42	34	40 20.0 19.6
35	9.49513	30	9.65798	42	9.51253	29	9.68353	42	35	50 25.0 24.6
36	49542	29	65841	43	51281	29	68396	42	36	
37	49571	30	65884	42	51310	29	68438	42	37	
38	49601	29	65926	43	51338	29	68481	42	38	29 2.9 2.8
39	49630	29	65969	42	51367	29	68523	42	39	7 3.4 3.3
40	9.49059	30	9.66012	42	9.51396	29	9.68566	42	40	8 3.9 3.8
41	49689	29	66054	43	51424	29	68608	42	41	9 4.3 4.3
42	49718	30	66097	42	51453	29	68651	42	42	10 4.7 4.7
43	49747	29	66140	43	51481	29	68693	42	43	20 9.6 9.5
44	49776	29	66182	42	51510	29	68735	42	44	30 14.5 14.2
45	9.49806	30	9.66225	42	9.51539	29	9.68778	42	45	40 19.3 19.0
46	49835	29	66268	43	51567	29	68820	42	46	50 24.1 23.7
47	49864	29	66310	42	51596	29	68863	42	47	
48	49893	30	66353	43	51624	29	68905	42	48	
49	49922	29	66396	42	51653	29	68948	42	49	
50	9.49952	30	9.66438	42	9.51681	29	9.68990	42	50	6 2.9 2.8
51	49981	29	66481	43	51710	29	69033	42	51	7 3.4 3.3
52	50010	30	66523	42	51738	29	69075	42	52	8 3.7 3.7
53	50039	29	66566	43	51767	29	69117	42	53	9 4.2 4.2
54	50068	29	66609	42	51795	29	69160	42	54	10 4.6 4.6
55	9.50097	30	9.66651	42	9.51823	29	9.69202	42	55	20 9.3 9.3
56	50126	29	66694	43	51852	29	69245	42	56	30 14.0 14.0
57	50155	30	66737	42	51880	29	69287	42	57	40 18.6 18.6
58	50185	29	66779	43	51909	29	69330	42	58	50 23.3 23.3
59	50214	29	66822	42	51937	29	69372	42	59	
60	9.50243	30	9.66864	42	9.51965	29	9.69414	42	60	
'	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	'	P. P.

LOG. VERSED SINES AND EXTERNAL SECANTS 189

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	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D		P. P.
0	9.51965	28	9.69412	42	9.53648	27	9.71954	42	0	
1	51994	28	69457	42	53676	28	71999	42	1	
2	52022	28	69499	42	53704	27	72035	42	2	
3	52050	28	69542	42	53731	27	72081	42	3	
4	52079	28	69584	42	53759	27	72123	42	4	
5	9.52107	28	9.69626	42	9.53787	28	9.72165	42	5	
6	52135	28	69669	42	53814	27	72207	42	6	
7	52164	28	69711	42	53842	27	72250	42	7	
8	52192	28	69753	42	53870	28	72292	42	8	
9	52220	28	69796	42	53897	27	72334	42	9	
10	9.52249	28	9.69838	42	9.53925	27	9.72376	42	10	
11	52277	28	69881	42	53952	28	72419	42	11	
12	52305	28	69923	42	53980	27	72461	42	12	
13	52333	28	69965	42	54008	27	72503	42	13	
14	52362	28	70008	42	54035	27	72545	42	14	
15	9.52390	28	9.70050	42	9.54063	27	9.72587	42	15	
16	52418	28	70092	42	54090	27	72630	42	16	
17	52446	28	70135	42	54118	27	72672	42	17	
18	52474	28	70177	42	54145	27	72714	42	18	
19	52503	28	70220	42	54173	27	72756	42	19	
20	9.52531	28	9.70262	42	9.54200	27	9.72799	42	20	
21	52559	28	70304	42	54228	27	72841	42	21	
22	52587	28	70347	42	54255	27	72883	42	22	
23	52615	28	70389	42	54283	27	72925	42	23	
24	52643	28	70431	42	54310	27	72967	42	24	
25	9.52671	28	9.70474	42	9.54338	27	9.73010	42	25	
26	52699	28	70516	42	54365	27	73052	42	26	
27	52727	28	70558	42	54393	27	73094	42	27	
28	52756	28	70601	42	54420	27	73136	42	28	
29	52784	28	70643	42	54448	27	73178	42	29	
30	9.52812	28	9.70685	42	9.54475	27	9.73221	42	30	
31	52840	28	70728	42	54502	27	73263	42	31	
32	52868	28	70770	42	54530	27	73305	42	32	
33	52896	28	70812	42	54557	27	73347	42	33	
34	52924	28	70854	42	54585	27	73389	42	34	
35	9.52952	28	9.70897	42	9.54612	27	9.73431	42	35	
36	52980	28	70939	42	54639	27	73474	42	36	
37	53008	28	70981	42	54667	27	73516	42	37	
38	53036	28	71024	42	54694	27	73558	42	38	
39	53064	28	71066	42	54721	27	73600	42	39	
40	9.53092	28	9.71108	42	9.54748	27	9.73642	42	40	
41	53120	27	71151	42	54776	27	73685	42	41	
42	53147	28	71193	42	54803	27	73727	42	42	
43	53175	28	71235	42	54830	27	73769	42	43	
44	53203	28	71278	42	54858	27	73811	42	44	
45	9.53231	28	9.71320	42	9.54885	27	9.73853	42	45	
46	53259	27	71362	42	54912	27	73895	42	46	
47	53287	28	71404	42	54939	27	73938	42	47	
48	53315	28	71447	42	54967	27	73980	42	48	
49	53343	27	71489	42	54994	27	74022	42	49	
50	9.53370	27	9.71531	42	9.55021	27	9.74064	42	50	
51	53398	28	71573	42	55048	27	74106	42	51	
52	53426	28	71616	42	55075	27	74148	42	52	
53	53454	27	71658	42	55103	27	74191	42	53	
54	53482	28	71700	42	55130	27	74233	42	54	
55	9.53509	28	9.71743	42	9.55157	27	9.74275	42	55	
56	53537	27	71785	42	55184	27	74317	42	56	
57	53565	28	71827	42	55211	27	74359	42	57	
58	53593	27	71869	42	55238	27	74401	42	58	
59	53621	28	71912	42	55265	27	74444	42	59	
60	9.53648	28	9.71954	42	9.55292	27	9.74486	42	60	
	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D		P. P.

P. P.

P. P.

6 4.2 4.2  
 7 4.6 4.9  
 8 5.6 5.8  
 9 6.4 6.3  
 10 7.1 7.0  
 20 14.1 14.0  
 30 21.5 21.0  
 40 28.3 28.0  
 50 35.4 35.0  
  
 28 28  
 6 2.8 2.8  
 7 3.3 3.5  
 8 3.8 3.7  
 9 4.3 4.2  
 10 4.7 4.6  
 20 9.5 9.3  
 30 14.2 14.0  
 40 19.0 18.6  
 50 23.7 23.3

188 LOG. VERSED SINES AND EXTERNAL SECANTS

46° 47°

	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D		P. P.
0	9.48478	30	9.64301	43	9.50243	29	9.66864	42	0	
1	.48508	29	.64344	42	.50272	29	.66907	43	1	
2	.48538	30	.64387	43	.50301	29	.66950	42	2	
3	.48568	29	.64430	43	.50330	29	.66992	42	3	
4	.48597	30	.64473	43	.50359	29	.67035	42	4	
5	9.48627	30	9.64515	43	9.50388	29	9.67077	42	5	
6	.48657	29	.64558	43	.50417	29	.67120	42	6	
7	.48686	30	.64601	43	.50446	29	.67162	42	7	
8	.48716	30	.64644	42	.50475	29	.67205	43	8	
9	.48746	29	.64687	43	.50504	29	.67248	42	9	
10	9.48775	30	9.64729	43	9.50533	29	9.67290	42	10	
11	.48805	30	.64772	43	.50562	29	.67333	42	11	
12	.48835	29	.64815	43	.50591	28	.67375	42	12	
13	.48864	30	.64858	42	.50619	28	.67418	42	13	
14	.48894	29	.64901	43	.50648	29	.67460	42	14	
15	9.48923	30	9.64943	43	9.50677	29	9.67503	42	15	43
16	.48953	30	.64986	42	.50706	28	.67546	42	16	6 4.2
17	.48983	29	.65029	43	.50735	29	.67588	42	17	7 4.9
18	.49012	30	.65072	42	.50764	29	.67631	42	18	8 5.6
19	.49042	29	.65114	43	.50793	28	.67673	42	19	9 6.3
20	9.49071	30	9.65157	43	9.50821	28	9.67716	42	20	10 7.0
21	.49101	29	.65200	42	.50850	29	.67758	42	21	20 14.0
22	.49130	30	.65243	42	.50879	29	.67801	42	22	30 21.0
23	.49160	29	.65285	43	.50908	28	.67843	42	23	40 28.0
24	.49189	30	.65328	42	.50937	28	.67886	42	24	50 35.0
25	9.49219	30	9.65371	43	9.50965	28	9.67928	42	25	
26	.49248	29	.65414	43	.50994	28	.67971	42	26	30 29
27	.49278	30	.65456	42	.51023	29	.68013	42	27	6 3.0 2.9
28	.49307	29	.65499	43	.51052	28	.68056	42	28	7 3.5 3.4
29	.49336	30	.65542	42	.51080	28	.68098	42	29	8 4.0 3.9
30	9.49365	30	9.65585	42	9.51109	28	9.68141	42	30	9 4.5 4.4
31	.49395	29	.65627	43	.51138	29	.68183	42	31	10 5.0 4.9
32	.49425	30	.65670	42	.51167	28	.68226	42	32	20 10.0 9.8
33	.49454	29	.65713	42	.51195	28	.68268	42	33	30 15.0 14.7
34	.49483	30	.65755	42	.51224	28	.68311	42	34	40 20.0 19.6
35	9.49513	30	9.65798	43	9.51253	29	9.68353	42	35	50 25.0 24.6
36	.49542	29	.65841	43	.51281	28	.68396	42	36	
37	.49571	30	.65884	42	.51310	28	.68438	42	37	
38	.49601	29	.65926	42	.51338	29	.68481	42	38	
39	.49630	30	.65969	42	.51367	28	.68523	42	39	
40	9.49659	30	9.66012	42	9.51396	28	9.68566	42	40	6 2.9 2.8
41	.49689	29	.66054	42	.51424	28	.68608	42	41	7 3.4 3.3
42	.49718	30	.66097	42	.51453	28	.68651	42	42	8 3.9 3.8
43	.49747	29	.66140	42	.51481	28	.68693	42	43	10 4.4 4.3
44	.49776	30	.66182	42	.51510	28	.68735	42	44	20 9.6 9.5
45	9.49806	30	9.66225	42	9.51539	29	9.68778	42	45	30 14.5 14.2
46	.49835	29	.66268	42	.51567	28	.68820	42	46	40 19.3 19.0
47	.49864	30	.66310	42	.51596	28	.68863	42	47	50 24.1 23.7
48	.49893	29	.66353	42	.51624	28	.68905	42	48	
49	.49922	30	.66396	42	.51653	28	.68948	42	49	
50	9.49952	30	9.66438	42	9.51681	28	9.68990	42	50	28
51	.49981	29	.66481	42	.51710	28	.69033	42	51	6 2.8
52	.50010	30	.66523	42	.51738	28	.69075	42	52	7 3.2 3.1
53	.50039	29	.66566	42	.51767	28	.69117	42	53	9 4.2 4.1
54	.50068	30	.66609	42	.51795	28	.69160	42	54	10 4.6 4.5
55	9.50097	30	9.66651	42	9.51823	28	9.69202	42	55	20 9.8
56	.50126	29	.66694	42	.51852	28	.69245	42	56	30 14.0
57	.50155	30	.66737	42	.51880	28	.69287	42	57	40 18.6
58	.50185	29	.66779	42	.51909	28	.69330	42	58	50 23.3
59	.50214	30	.66822	42	.51937	28	.69372	42	59	
60	9.50243	30	9.66864	42	9.51965	28	9.69414	42	60	
	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D		P. P.

LOG. VERSED SINES AND EXTERNAL SECANTS 191

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VERS.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	'	P. P.
847	26	9.79537	42	9.60008	25	9.82062	42	0.	
8497	25	.79579	42	.60034	25	.82104	42	1	
8523	26	.79621	42	.60059	25	.82146	42	2	
8549	26	.79663	42	.60084	25	.82188	42	3	
8575	26	.79705	42	.60110	25	.82230	42	4	
8601	26	9.79747	42	9.60135	25	9.82272	42	5	
8626	25	.79789	42	.60160	25	.82315	42	6	
8652	26	.79831	42	.60185	25	.82357	42	7	
8678	25	.79874	42	.60211	25	.82399	42	8	
8704	25	.79916	42	.60236	25	.82441	42	9	
8730	25	9.79958	42	9.60261	25	9.82483	42	10	
8755	25	.80000	42	.60286	25	.82525	42	11	
8781	26	.80042	42	.60312	25	.82567	42	12	
8807	26	.80084	42	.60337	25	.82609	42	13	
8833	25	.80126	42	.60362	25	.82651	42	14	
8859	25	9.80168	42	9.60387	25	9.82694	42	15	
8884	25	.80210	42	.60412	25	.82736	42	16	
8910	25	.80252	42	.60438	25	.82778	42	17	
8936	26	.80294	42	.60463	25	.82820	42	18	
8962	26	.80336	42	.60488	25	.82862	42	19	
8987	25	9.80378	42	9.60513	25	9.82904	42	20	
9013	26	.80420	42	.60538	25	.82946	42	21	
9039	26	.80463	42	.60563	25	.82988	42	22	
9064	26	.80505	42	.60589	25	.83031	42	23	
9090	26	.80547	42	.60614	25	.83073	42	24	
9116	25	9.80589	42	9.60639	26	9.83115	42	25	
9141	25	.80631	42	.60664	25	.83157	42	26	
9167	26	.80673	42	.60689	25	.83199	42	27	
9193	25	.80715	42	.60714	25	.83241	42	28	
9218	25	.80757	42	.60739	25	.83283	42	29	
9244	25	9.80799	42	9.60764	25	9.83325	42	30	
9270	26	.80841	42	.60789	25	.83368	42	31	
9295	25	.80883	42	.60814	25	.83410	42	32	
9321	25	.80925	42	.60839	25	.83452	42	33	
9346	25	.80968	42	.60864	25	.83494	42	34	
9372	25	9.81010	42	9.60889	25	9.83536	42	35	
9397	25	.81052	42	.60914	25	.83578	42	36	
9423	26	.81094	42	.60939	25	.83620	42	37	
9449	25	.81136	42	.60964	25	.83663	42	38	
9474	25	.81178	42	.60989	25	.83705	42	39	
9500	25	9.81220	42	9.61014	25	9.83747	42	40	
9525	25	.81262	42	.61039	25	.83789	42	41	
9551	25	.81304	42	.61064	25	.83831	42	42	
9576	25	.81346	42	.61089	25	.83873	42	43	
9602	25	.81388	42	.61114	25	.83916	42	44	
9627	25	9.81430	42	9.61139	25	9.83958	42	45	
9653	25	.81473	42	.61164	25	.84000	42	46	
9678	25	.81515	42	.61189	24	.84042	42	47	
9704	25	.81557	42	.61214	25	.84084	42	48	
9729	25	.81599	42	.61239	25	.84126	42	49	
9754	25	9.81641	42	9.61264	25	9.84168	42	50	
9780	25	.81683	42	.61289	25	.84211	42	51	
9805	25	.81725	42	.61313	24	.84253	42	52	
9831	25	.81767	42	.61338	25	.84295	42	53	
9856	25	.81809	42	.61363	25	.84337	42	54	
9881	25	9.81851	42	9.61388	24	9.84379	42	55	
9907	25	.81894	42	.61413	25	.84422	42	56	
9932	25	.81936	42	.61438	24	.84464	42	57	
9958	25	.81978	42	.61462	24	.84506	42	58	
9983	25	.82020	42	.61487	25	.84548	42	59	
60008	25	9.82062	42	9.61512	25	9.84590	42	60	
VERS.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	'	P. P.

42 42  
 6 4.2 4.2  
 7 4.0 4.9  
 8 5.6 5.6  
 9 6.4 6.3  
 10 7.1 7.0  
 20 14.1 14.0  
 30 21.1 21.0  
 40 28.3 28.0  
 50 35.4 35.0

26 25  
 6 2.6 2.5  
 7 3.0 3.0  
 8 3.4 3.9  
 9 3.9 3.1  
 10 4.3 4.2  
 20 8.6 8.5  
 30 13.0 12.7  
 40 17.3 17.0  
 50 21.6 21.2

25 24  
 6 2.5 2.4  
 7 2.9 2.8  
 8 3.3 3.2  
 9 3.7 3.7  
 10 4.1 4.1  
 20 8.3 8.1  
 30 12.5 12.2  
 40 16.6 16.3  
 50 20.8 20.4



190 LOG. VERSED SINES AND EXTERNAL SECANTS

50°

51°

50°				51°				P. P.	
'	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	'
0	9.55292		9.74486		9.56900		9.77012		0
1	.55319	27	.74528	42	.56928	26	.77055	42	1
2	.55347	27	.74570	42	.56953	26	.77097	42	2
3	.55374	27	.74612	42	.56979	26	.77139	42	3
4	.55401	27	.74654	42	.57005	26	.77181	42	4
5	9.55428	27	9.74696	42	9.57032	26	9.77223	42	5
6	.55455	27	.74739	42	.57058	26	.77265	42	6
7	.55482	27	.74781	42	.57085	26	.77307	42	7
8	.55509	27	.74823	42	.57111	26	.77349	42	8
9	.55536	27	.74865	42	.57138	26	.77391	42	9
10	9.55563	27	9.74907	42	9.57164	26	9.77433	42	10
11	.55590	27	.74949	42	.57190	26	.77475	42	11
12	.55617	27	.74991	42	.57217	26	.77517	42	12
13	.55644	27	.75033	42	.57243	26	.77560	42	13
14	.55671	27	.75076	42	.57269	26	.77602	42	14
15	9.55698	27	9.75118	42	9.57296	26	9.77644	42	15
16	.55725	26	.75160	42	.57322	26	.77686	42	16
17	.55751	26	.75202	42	.57348	26	.77728	42	17
18	.55778	27	.75244	42	.57375	26	.77770	42	18
19	.55805	27	.75286	42	.57401	26	.77812	42	19
20	9.55832	27	9.75328	42	9.57427	26	9.77854	42	20
21	.55859	26	.75370	42	.57454	26	.77896	42	21
22	.55886	26	.75413	42	.57480	26	.77938	42	22
23	.55913	27	.75455	42	.57506	26	.77980	42	23
24	.55940	26	.75497	42	.57532	26	.78022	42	24
25	9.55968	27	9.75539	42	9.57559	26	9.78064	42	25
26	.55993	27	.75581	42	.57585	26	.78107	42	26
27	.56020	26	.75623	42	.57611	26	.78149	42	27
28	.56047	26	.75665	42	.57637	26	.78191	42	28
29	.56074	27	.75707	42	.57664	26	.78233	42	29
30	9.56101	26	9.75750	42	9.57690	26	9.78275	42	30
31	.56127	27	.75792	42	.57716	26	.78317	42	31
32	.56154	26	.75834	42	.57742	26	.78359	42	32
33	.56181	27	.75876	42	.57768	26	.78401	42	33
34	.56208	26	.75918	42	.57794	26	.78443	42	34
35	9.56234	26	9.75960	42	9.57821	26	9.78485	42	35
36	.56261	26	.76002	42	.57847	26	.78527	42	36
37	.56288	27	.76044	42	.57873	26	.78569	42	37
38	.56315	26	.76086	42	.57899	26	.78611	42	38
39	.56341	26	.76128	42	.57925	26	.78653	42	39
40	9.56368	27	9.76171	42	9.57951	26	9.78696	42	40
41	.56395	26	.76213	42	.57977	26	.78738	42	41
42	.56421	26	.76255	42	.58003	26	.78780	42	42
43	.56448	27	.76297	42	.58029	26	.78822	42	43
44	.56475	26	.76339	42	.58055	26	.78864	42	44
45	9.56501	26	9.76381	42	9.58082	26	9.78906	42	45
46	.56528	26	.76423	42	.58108	26	.78948	42	46
47	.56554	27	.76465	42	.58134	26	.78990	42	47
48	.56581	26	.76507	42	.58160	26	.79032	42	48
49	.56608	26	.76549	42	.58186	26	.79074	42	49
50	9.56634	26	9.76592	42	9.58212	26	9.79116	42	50
51	.56661	26	.76634	42	.58238	26	.79158	42	51
52	.56687	26	.76676	42	.58264	26	.79200	42	52
53	.56714	27	.76718	42	.58290	26	.79242	42	53
54	.56741	26	.76760	42	.58316	26	.79285	42	54
55	9.56767	26	9.76802	42	9.58342	26	9.79327	42	55
56	.56794	26	.76844	42	.58367	26	.79369	42	56
57	.56820	26	.76886	42	.58393	26	.79411	42	57
58	.56847	26	.76928	42	.58419	26	.79453	42	58
59	.56873	26	.76970	42	.58445	26	.79495	42	59
60	9.56900	26	9.77012	42	9.58471	26	9.79537	42	60

P. P.	
42	42
6	4.2
7	4.9
8	5.6
9	6.4
10	7.1
20	14.0
30	21.0
40	28.0
50	35.0
27	27
6	2.7
7	3.2
8	3.6
9	4.1
10	4.6
20	9.0
30	13.5
40	18.0
50	22.5
26	26
6	2.6
7	3.1
8	3.5
9	4.0
10	4.4
20	8.8
30	13.2
40	17.6
50	22.1
25	25
6	2.5
7	3.0
8	3.4
9	3.8
10	4.2
20	8.5
30	12.7
40	17.0
50	21.2

P. P.

E

LOG. VERSED SINES AND EXTERNAL SECANTS 193

56°

57°

56°		57°		P. P.					
Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	P. P.	
0	9.64425	23	9.89868	42	9.65285	23	9.92222	43	0
1	9.64448	24	89711	43	65859	23	92267	42	1
2	9.64472	25	89753	44	65882	23	92310	43	2
3	9.64496	26	89796	45	65905	23	92353	42	3
4	9.64520	27	89838	46	65928	23	92395	43	4
5	9.64543	28	89881	47	65952	23	92438	43	5
6	9.64567	29	89923	48	65975	23	92481	42	6
7	9.64591	30	89966	49	65998	23	92524	43	7
8	9.64615	31	90008	50	66021	23	92566	42	8
9	9.64638	32	90051	51	66044	23	92609	43	9
10	9.64662	33	9.90094	43	9.66068	23	9.92652	42	10
11	9.64685	34	90136	44	66091	23	92695	43	11
12	9.64709	35	90179	45	66114	23	92737	42	12
13	9.64733	36	90221	46	66137	23	92780	43	13
14	9.64756	37	90264	47	66160	23	92823	42	14
15	9.64780	38	9.90306	48	9.66183	23	9.92866	43	15
16	9.64804	39	90349	49	66207	23	92909	42	16
17	9.64827	40	90391	50	66230	23	92951	43	17
18	9.64851	41	90434	51	66253	23	92994	42	18
19	9.64875	42	90476	52	66276	23	93037	43	19
20	9.64898	43	9.90519	42	9.66299	23	9.93080	43	20
21	9.64922	44	90561	43	66322	23	93123	42	21
22	9.64945	45	90604	44	66345	23	93165	43	22
23	9.64969	46	90647	45	66368	23	93208	42	23
24	9.64992	47	90689	46	66391	23	93251	43	24
25	9.65016	48	9.90732	47	9.66415	23	9.93294	42	25
26	9.65040	49	90774	48	66438	23	93337	43	26
27	9.65063	50	90817	49	66461	23	93380	42	27
28	9.65087	51	90860	50	66484	23	93423	43	28
29	9.65110	52	90902	51	66507	23	93465	42	29
30	9.65134	53	9.90945	47	9.66530	23	9.93508	43	30
31	9.65157	54	90987	48	66553	23	93551	42	31
32	9.65181	55	91030	49	66576	23	93594	43	32
33	9.65204	56	91073	50	66599	23	93637	42	33
34	9.65228	57	91115	51	66622	23	93680	43	34
35	9.65251	58	9.91158	47	9.66645	23	9.93722	42	35
36	9.65275	59	91200	48	66668	23	93765	43	36
37	9.65298	60	91243	49	66691	23	93808	42	37
38	9.65321	61	91286	50	66714	23	93851	43	38
39	9.65345	62	91328	51	66737	23	93894	42	39
40	9.65368	63	9.91371	47	9.66760	23	9.93937	43	40
41	9.65392	64	91414	48	66783	23	93980	42	41
42	9.65415	65	91456	49	66805	23	94023	43	42
43	9.65439	66	91499	50	66828	23	94066	42	43
44	9.65462	67	91541	51	66851	23	94109	43	44
45	9.65485	68	9.91584	47	9.66874	23	9.94151	42	45
46	9.65509	69	91627	48	66897	23	94194	43	46
47	9.65532	70	91669	49	66920	22	94237	42	47
48	9.65556	71	91712	50	66943	23	94280	43	48
49	9.65579	72	91755	51	66966	23	94323	42	49
50	9.65602	73	9.91797	47	9.66989	23	9.94366	43	50
51	9.65626	74	91840	48	67012	22	94409	42	51
52	9.65649	75	91883	49	67034	23	94452	43	52
53	9.65672	76	91926	50	67057	23	94495	42	53
54	9.65696	77	91968	51	67080	23	94538	43	54
55	9.65719	78	9.92011	47	9.67103	23	9.94581	42	55
56	9.65742	79	92054	48	67126	23	94624	43	56
57	9.65765	80	92096	49	67149	22	94667	42	57
58	9.65789	81	92139	50	67171	23	94710	43	58
59	9.65812	82	92182	51	67194	22	94753	42	59
60	9.65835	83	9.92224	47	9.67217	22	9.94796	43	60
Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	P. P.	

43 42  
4.3 4.2  
5.0 4.9  
5.7 5.6  
6.4 6.4  
7.1 7.1  
14.1 14.1  
21.5 21.2  
28.6 28.6  
35.8 35.4

24 23  
2.4 2.3  
3.2 3.1  
3.8 3.7  
4.4 4.3  
5.0 4.9  
5.6 5.5  
6.2 6.1  
6.8 6.7  
7.4 7.3  
8.0 7.9  
8.6 8.5  
9.2 9.1  
9.8 9.7  
10.4 10.3  
11.0 10.9  
11.6 11.5  
12.2 12.1  
12.8 12.7  
13.4 13.3  
14.0 13.9  
14.6 14.5  
15.2 15.1  
15.8 15.7  
16.4 16.3  
17.0 16.9  
17.6 17.5  
18.2 18.1  
18.8 18.7  
19.4 19.3  
20.0 19.9

192 LOG. VERSED SINES AND EXTERNAL SECANTS

54°

55°

	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D		P. P.
0	9.61512	24	9.84590	42	9.62984	24	9.87125	42	0	
1	.61537	25	.84635	42	.63008	24	.87167	42	1	
2	.61562	24	.84675	42	.63033	24	.87209	42	2	
3	.61586	25	.84717	42	.63057	24	.87252	42	3	
4	.61611	24	.84759	42	.63081	24	.87294	42	4	
5	9.61636	24	9.84801	42	9.63105	24	9.87336	42	5	
6	.61661	25	.84843	42	.63129	24	.87379	42	6	
7	.61685	24	.84886	42	.63154	24	.87421	42	7	
8	.61710	25	.84928	42	.63178	24	.87463	42	8	
9	.61735	24	.84970	42	.63202	24	.87506	42	9	
10	9.61760	24	9.85012	42	9.63226	24	9.87548	42	10	
11	.61784	25	.85054	42	.63250	24	.87590	42	11	
12	.61809	24	.85097	42	.63274	24	.87633	42	12	
13	.61834	25	.85139	42	.63298	24	.87675	42	13	
14	.61858	24	.85181	42	.63323	24	.87717	42	14	
15	9.61883	24	9.85223	42	9.63347	24	9.87760	42	15	
16	.61908	25	.85265	42	.63371	24	.87802	42	16	
17	.61932	24	.85308	42	.63395	24	.87844	42	17	
18	.61957	25	.85350	42	.63419	24	.87887	42	18	
19	.61982	24	.85392	42	.63443	24	.87929	42	19	
20	9.62006	24	9.85434	42	9.63468	24	9.87971	42	20	
21	.62031	25	.85476	42	.63492	24	.88014	42	21	
22	.62055	24	.85519	42	.63516	24	.88056	42	22	
23	.62080	25	.85561	42	.63540	24	.88099	42	23	
24	.62105	24	.85603	42	.63564	24	.88141	42	24	
25	9.62129	24	9.85645	42	9.63588	24	9.88183	42	25	
26	.62154	25	.85688	42	.63612	24	.88226	42	26	
27	.62178	24	.85730	42	.63636	24	.88268	42	27	
28	.62203	25	.85772	42	.63660	24	.88310	42	28	
29	.62227	24	.85814	42	.63684	24	.88353	42	29	
30	9.62252	24	9.85857	42	9.63708	24	9.88395	42	30	
31	.62276	25	.85899	42	.63732	24	.88438	42	31	
32	.62301	24	.85941	42	.63756	24	.88480	42	32	
33	.62325	25	.85983	42	.63780	24	.88522	42	33	
34	.62350	24	.86026	42	.63804	24	.88565	42	34	
35	9.62374	24	9.86068	42	9.63828	24	9.88607	42	35	
36	.62399	25	.86110	42	.63852	24	.88650	42	36	
37	.62423	24	.86152	42	.63876	24	.88692	42	37	
38	.62448	25	.86195	42	.63900	24	.88734	42	38	
39	.62472	24	.86237	42	.63924	24	.88777	42	39	
40	9.62497	24	9.86279	42	9.63948	24	9.88819	42	40	
41	.62521	25	.86321	42	.63972	24	.88862	42	41	
42	.62546	24	.86364	42	.63996	24	.88904	42	42	
43	.62570	25	.86406	42	.64019	24	.88947	42	43	
44	.62594	24	.86448	42	.64043	24	.88989	42	44	
45	9.62619	24	9.86490	42	9.64067	24	9.89031	42	45	
46	.62643	25	.86533	42	.64091	24	.89074	42	46	
47	.62668	24	.86575	42	.64115	24	.89116	42	47	
48	.62692	25	.86617	42	.64139	24	.89159	42	48	
49	.62716	24	.86659	42	.64163	24	.89201	42	49	
50	9.62741	24	9.86702	42	9.64187	24	9.89244	42	50	
51	.62765	25	.86744	42	.64210	24	.89286	42	51	
52	.62789	24	.86786	42	.64234	24	.89329	42	52	
53	.62814	25	.86828	42	.64258	24	.89371	42	53	
54	.62838	24	.86871	42	.64282	24	.89414	42	54	
55	9.62862	24	9.86913	42	9.64306	24	9.89456	42	55	
56	.62887	25	.86956	42	.64330	24	.89499	42	56	
57	.62911	24	.86998	42	.64353	24	.89541	42	57	
58	.62935	25	.87040	42	.64377	24	.89583	42	58	
59	.62960	24	.87082	42	.64401	24	.89626	42	59	
60	9.62984	24	9.87125	42	9.64425	24	9.89668	42	60	
	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D		P. P.

42 42  
6 4.2 4.2  
7 4.9 4.9  
8 5.6 5.6  
9 6.4 6.3  
10 7.1 7.0  
20 14.1 14.0  
30 21.2 21.0  
40 28.3 28.0  
50 35.4 35.0

25 24  
6 2.5 2.4  
7 2.9 2.8  
8 3.3 3.2  
9 3.7 3.7  
10 4.1 4.1  
20 8.3 8.2  
30 12.5 12.2  
40 16.6 16.3  
50 20.8 20.4

24 23  
6 2.4 2.3  
7 2.8 2.7  
8 3.2 3.1  
9 3.6 3.5  
10 4.0 3.9  
20 8.0 7.8  
30 12.0 11.7  
40 16.0 15.6  
50 20.0 19.6

LOG. VERSED SINES AND EXTERNAL SECANTS 195  
60° 61°

	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	P. P.
0	9.69897	22	10.00000	44	9.71197	21	10.02639	44	0
1	.69919	21	.00044	43	.71218	21	.02684	44	1
2	.69940	22	.00087	43	.71239	21	.02728	44	2
3	.69962	22	.00131	44	.71261	21	.02772	44	3
4	.69984	22	.00175	44	.71282	21	.02816	44	4
5	9.70005	22	10.00219	44	9.71304	21	10.02861	44	5
6	.70028	21	.00262	43	.71325	21	.02905	44	6
7	.70050	22	.00306	44	.71346	21	.02949	44	7
8	.70072	22	.00350	44	.71368	21	.02994	44	8
9	.70093	21	.00394	43	.71389	21	.03038	44	9
10	9.70115	22	10.00438	44	9.71411	21	10.03082	44	10
11	.70137	21	.00482	43	.71432	21	.03127	44	11
12	.70159	22	.00525	43	.71453	21	.03171	44	12
13	.70181	22	.00569	44	.71475	21	.03215	44	13
14	.70202	21	.00613	44	.71496	21	.03260	44	14
15	9.70224	22	10.00657	44	9.71517	21	10.03304	44	15
16	.70246	21	.00701	43	.71539	21	.03348	44	16
17	.70268	22	.00745	44	.71560	21	.03393	44	17
18	.70289	22	.00789	44	.71581	21	.03437	44	18
19	.70311	21	.00833	44	.71603	21	.03481	44	19
20	9.70333	22	10.00877	43	9.71624	21	10.03526	44	20
21	.70355	21	.00920	44	.71645	21	.03570	44	21
22	.70377	22	.00964	44	.71667	21	.03615	44	22
23	.70398	21	.01008	44	.71688	21	.03659	44	23
24	.70420	21	.01052	44	.71709	21	.03704	44	24
25	9.70441	22	10.01096	44	9.71730	21	10.03748	44	25
26	.70463	21	.01140	44	.71752	21	.03793	44	26
27	.70485	21	.01184	44	.71773	21	.03837	44	27
28	.70507	22	.01228	44	.71794	21	.03881	44	28
29	.70528	21	.01272	44	.71815	21	.03926	44	29
30	9.70550	22	10.01316	44	9.71837	21	10.03970	44	30
31	.70572	21	.01360	44	.71858	21	.04015	44	31
32	.70593	21	.01404	44	.71879	21	.04059	44	32
33	.70615	21	.01448	44	.71900	21	.04104	45	33
34	.70636	21	.01492	44	.71922	21	.04149	45	34
35	9.70658	22	10.01536	44	9.71943	21	10.04193	44	35
36	.70680	21	.01580	44	.71964	21	.04238	44	36
37	.70701	21	.01624	44	.71985	21	.04282	44	37
38	.70723	22	.01668	44	.72006	21	.04327	44	38
39	.70745	21	.01712	44	.72028	21	.04371	44	39
40	9.70766	22	10.01756	44	9.72049	21	10.04416	44	40
41	.70788	21	.01800	44	.72070	21	.04461	45	41
42	.70809	21	.01844	44	.72091	21	.04505	44	42
43	.70831	21	.01889	44	.72112	21	.04550	44	43
44	.70852	21	.01933	44	.72133	21	.04594	44	44
45	9.70874	22	10.01977	44	9.72154	21	10.04639	44	45
46	.70896	21	.02021	44	.72176	21	.04684	44	46
47	.70917	21	.02065	44	.72197	21	.04728	44	47
48	.70939	21	.02109	44	.72218	21	.04773	45	48
49	.70960	21	.02153	44	.72239	21	.04818	45	49
50	9.70982	22	10.02197	44	9.72260	21	10.04863	44	50
51	.71003	21	.02242	44	.72281	21	.04907	44	51
52	.71025	21	.02286	44	.72302	21	.04952	44	52
53	.71046	21	.02330	44	.72323	21	.04996	45	53
54	.71068	21	.02374	44	.72344	21	.05041	44	54
55	9.71089	22	10.02418	44	9.72365	21	10.05086	45	55
56	.71111	21	.02463	44	.72386	21	.05131	44	56
57	.71132	21	.02507	44	.72408	21	.05175	44	57
58	.71154	21	.02551	44	.72429	21	.05220	45	58
59	.71175	21	.02595	44	.72450	21	.05265	44	59
60	9.71197	22	10.02639	44	9.72471	21	10.05310	45	60
	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	P. P.

P. P.

		45	44
6	4.5	4.4	
7	5.2	5.2	
8	6.0	5.9	
9	6.7	6.7	
10	7.5	7.4	
20	15.0	14.8	
30	22.5	22.2	
40	30.0	29.6	
50	37.5	37.1	
		44	43
6	4.4	4.3	
7	5.1	5.1	
8	5.8	5.8	
9	6.6	6.6	
10	7.3	7.2	
20	14.6	14.5	
30	22.0	21.7	
40	29.3	29.0	
50	36.6	36.2	
		22	21
6	2.2	2.1	
7	2.5	2.5	
8	2.9	2.8	
9	3.3	3.2	
10	3.6	3.6	
20	7.3	7.1	
30	11.0	10.7	
40	14.6	14.3	
50	18.3	17.9	
		21	
6	2.1		
7	2.4		
8	2.8		
9	3.1		
10	3.5		
20	7.0		
30	10.5		
40	14.0		
50	17.5		

194 LOG. VERSED SINES AND EXTERNAL SECANTS

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	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	P. P.
0	9.67217	23	9.94798	43	9.68571	22	9.97387	43	0
1	.67240	23	.94839	43	.68593	22	.97430	43	1
2	.67263	23	.94882	43	.68615	22	.97473	43	2
3	.67285	23	.94925	43	.68637	22	.97517	43	3
4	.67308	23	.94968	43	.68660	22	.97560	43	4
5	9.67331	23	9.95011	43	9.68682	22	9.97603	43	5
6	.67354	23	.95054	43	.68704	22	.97647	43	6
7	.67376	23	.95097	43	.68727	22	.97690	43	7
8	.67399	23	.95140	43	.68749	22	.97734	43	8
9	.67422	23	.95183	43	.68771	22	.97777	43	9
10	9.67445	23	9.95225	43	9.68793	22	9.97820	43	10
11	.67467	23	.95269	43	.68816	22	.97864	43	11
12	.67490	23	.95313	43	.68838	22	.97907	43	12
13	.67513	23	.95356	43	.68860	22	.97951	43	13
14	.67535	23	.95399	43	.68882	22	.97994	43	14
15	9.67558	23	9.95442	43	9.68905	22	9.98038	43	15
16	.67581	23	.95485	43	.68927	22	.98081	43	16
17	.67603	23	.95528	43	.68949	22	.98125	43	17
18	.67626	23	.95571	43	.68971	22	.98168	43	18
19	.67649	23	.95614	43	.68993	22	.98211	43	19
20	9.67671	23	9.95657	43	9.69016	22	9.98255	43	20
21	.67694	23	.95700	43	.69038	22	.98298	43	21
22	.67717	23	.95744	43	.69060	22	.98342	43	22
23	.67739	23	.95787	43	.69082	22	.98385	43	23
24	.67762	23	.95830	43	.69104	22	.98429	43	24
25	9.67784	23	9.95873	43	9.69126	22	9.98472	43	25
26	.67807	23	.95916	43	.69149	22	.98516	43	26
27	.67830	23	.95959	43	.69171	22	.98559	43	27
28	.67852	23	.96002	43	.69193	22	.98603	43	28
29	.67875	23	.96046	43	.69215	22	.98647	43	29
30	9.67897	23	9.96089	43	9.69237	22	9.98690	43	30
31	.67920	23	.96132	43	.69259	22	.98734	43	31
32	.67942	23	.96175	43	.69281	22	.98777	43	32
33	.67965	23	.96218	43	.69303	22	.98821	43	33
34	.67987	23	.96261	43	.69325	22	.98864	43	34
35	9.68010	23	9.96305	43	9.69347	22	9.98908	43	35
36	.68032	23	.96348	43	.69369	22	.98952	43	36
37	.68055	23	.96391	43	.69392	22	.98995	43	37
38	.68077	23	.96434	43	.69414	22	.99039	43	38
39	.68100	23	.96477	43	.69436	22	.99082	43	39
40	9.68122	23	9.96521	43	9.69458	22	9.99126	43	40
41	.68145	23	.96564	43	.69480	22	.99170	43	41
42	.68167	23	.96607	43	.69502	22	.99213	43	42
43	.68190	23	.96650	43	.69524	22	.99257	43	43
44	.68212	23	.96694	43	.69546	22	.99300	43	44
45	9.68235	23	9.96737	43	9.69568	22	9.99344	43	45
46	.68257	23	.96780	43	.69590	22	.99388	43	46
47	.68280	23	.96824	43	.69612	22	.99431	43	47
48	.68302	23	.96867	43	.69634	22	.99475	43	48
49	.68324	23	.96910	43	.69656	22	.99519	43	49
50	9.68347	23	9.96953	43	9.69673	22	9.99562	43	50
51	.68369	23	.96997	43	.69700	21	.99606	43	51
52	.68392	23	.97040	43	.69721	22	.99650	43	52
53	.68414	23	.97083	43	.69743	22	.99694	43	53
54	.68436	23	.97127	43	.69765	22	.99737	43	54
55	9.68459	23	9.97170	43	9.69787	22	9.99781	43	55
56	.68481	23	.97213	43	.69809	22	.99825	43	56
57	.68503	23	.97257	43	.69831	21	.99868	43	57
58	.68526	23	.97300	43	.69853	22	.99912	43	58
59	.68548	23	.97343	43	.69875	22	.99956	43	59
60	9.68571	23	9.97387	43	9.69897	22	10.00000	44	60

44 43  
6 4.4 4.3  
7 5.4 5.1  
8 5.5 5.8  
9 6.6 6.5  
10 7.7 7.2  
20 14.8 14.5  
30 22.0 21.7  
40 29.3 29.0  
50 36.6 36.2

43  
6 4.3  
7 5.0  
8 5.7  
9 6.4  
10 7.1  
20 14.3  
30 21.6  
40 28.6  
50 35.8

23 22  
6 2.3 2.2  
7 2.7 2.6  
8 3.0 3.0  
9 3.4 3.4  
10 3.8 3.7  
20 7.6 7.5  
30 11.5 11.2  
40 15.3 15.0  
50 19.1 18.7

22 21  
6 2.2 2.1  
7 2.5 2.5  
8 2.9 2.8  
9 3.3 3.2  
10 3.6 3.6  
20 7.3 7.1  
30 11.0 10.7  
40 14.8 14.3  
50 18.3 17.9

Lg. Vers. D Log. Exs. D Lg. Vers. D Log. Exs. D P. P.

LOG. VERSED SINES AND EXTERNAL SECANTS 197

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	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D		P. P.
0	9.74945	20	10.10760	46	9.78145	19	10.13551	47	0	
1	.74965	20	.10807	46	.78166	20	.13596	47	1	
2	.74985	20	.10853	46	.78186	20	.13645	47	2	
3	.75005	20	.10899	46	.78206	19	.13692	47	3	
4	.75026	20	.10945	46	.78225	20	.13739	47	4	
5	9.75046	20	10.10991	46	9.78245	20	10.13786	47	5	
6	.75066	20	.11037	46	.78265	19	.13833	47	6	
7	.75086	20	.11084	46	.78285	20	.13880	47	7	
8	.75106	20	.11130	46	.78304	19	.13927	47	8	
9	.75126	20	.11176	46	.78324	20	.13974	47	9	
10	9.75147	20	10.11222	46	9.78344	19	10.14021	47	10	
11	.75167	20	.11269	46	.78364	20	.14068	47	11	
12	.75187	20	.11315	46	.78384	20	.14115	47	12	
13	.75207	20	.11361	46	.78403	19	.14162	47	13	
14	.75227	20	.11407	46	.78423	20	.14210	47	14	
15	9.75247	20	10.11454	46	9.78443	19	10.14257	47	15	
16	.75267	20	.11500	46	.78463	20	.14304	47	16	
17	.75287	20	.11546	46	.78482	19	.14351	47	17	
18	.75308	20	.11593	46	.78502	20	.14398	47	18	
19	.75328	20	.11639	46	.78522	19	.14445	47	19	
20	9.75348	20	10.11685	46	9.78541	19	10.14493	47	20	
21	.75368	20	.11732	46	.78561	20	.14540	47	21	
22	.75388	20	.11778	46	.78581	19	.14587	47	22	
23	.75408	20	.11825	46	.78600	20	.14634	47	23	
24	.75428	20	.11871	46	.78620	20	.14682	47	24	
25	9.75448	20	10.11917	46	9.78640	19	10.14729	47	25	
26	.75468	20	.11964	46	.78659	20	.14776	47	26	
27	.75488	20	.12010	46	.78679	20	.14823	47	27	
28	.75508	20	.12057	46	.78699	19	.14871	47	28	
29	.75528	20	.12103	46	.78718	20	.14918	47	29	
30	9.75548	20	10.12150	46	9.78738	19	10.14965	47	30	
31	.75568	20	.12196	46	.78758	20	.15013	47	31	
32	.75588	20	.12243	46	.78777	19	.15060	47	32	
33	.75608	20	.12289	46	.78797	20	.15108	47	33	
34	.75628	20	.12336	46	.78817	20	.15155	47	34	
35	9.75648	20	10.12383	47	9.78836	19	10.15202	47	35	
36	.75668	20	.12429	46	.78856	20	.15250	47	36	
37	.75688	20	.12476	46	.78875	20	.15297	47	37	
38	.75708	20	.12522	46	.78895	19	.15345	47	38	
39	.75728	20	.12569	46	.78915	20	.15392	47	39	
40	9.75748	20	10.12616	47	9.78934	19	10.15440	47	40	
41	.75768	20	.12662	46	.78954	20	.15487	47	41	
42	.75788	20	.12709	46	.78973	19	.15535	47	42	
43	.75808	19	.12756	47	.78993	20	.15582	47	43	
44	.75828	20	.12802	46	.79012	19	.15630	47	44	
45	9.75848	20	10.12849	47	9.79032	20	10.15678	48	45	
46	.75868	20	.12896	47	.79052	19	.15725	47	46	
47	.75888	20	.12942	46	.79071	20	.15773	47	47	
48	.75908	20	.12989	47	.79091	19	.15820	47	48	
49	.75928	20	.13036	46	.79110	20	.15868	47	49	
50	9.75947	19	10.13083	47	9.79130	19	10.15916	47	50	
51	.75967	20	.13130	47	.79149	20	.15963	48	51	
52	.75987	20	.13176	46	.79169	19	.16011	48	52	
53	.76007	19	.13223	47	.79188	20	.16059	47	53	
54	.76027	20	.13270	46	.79208	19	.16106	47	54	
55	9.76047	20	10.13317	47	9.79227	20	10.16154	48	55	
56	.76067	20	.13364	47	.79247	19	.16202	47	56	
57	.76087	19	.13411	46	.79266	20	.16250	48	57	
58	.76106	20	.13457	47	.79286	19	.16298	47	58	
59	.76126	20	.13504	47	.79305	20	.16345	47	59	
60	9.76145	20	10.13551	47	9.79325	19	10.16393	48	60	
	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D		P. P.

48 47  
 6 4.8 4.7  
 7 5.6 5.5  
 8 6.4 6.3  
 9 7.2 7.1  
 10 8.0 7.9  
 20 16.0 15.8  
 30 24.0 23.7  
 40 32.0 31.6  
 50 40.0 39.6

47 46  
 6 4.7 4.6  
 7 5.5 5.4  
 8 6.2 6.2  
 9 7.0 7.7  
 10 7.8 7.7  
 20 15.6 15.7  
 30 23.5 23.3  
 40 31.3 31.0  
 50 39.1 38.7

46  
 6 4.6 4.6  
 7 5.3 5.3  
 8 6.1 6.1  
 9 6.9 6.9  
 10 7.6 7.6  
 20 15.3 15.3  
 30 23.0 23.0  
 40 30.6 30.6  
 50 38.3 38.3

20 20  
 6 2.0 2.0  
 7 2.4 2.3  
 8 2.7 2.6  
 9 3.1 3.0  
 10 3.4 3.3  
 20 6.8 6.6  
 30 10.2 10.0  
 40 13.6 13.3  
 50 17.1 16.6

19  
 6 1.9 1.9  
 7 2.3 2.3  
 8 2.6 2.6  
 9 2.9 2.9  
 10 3.2 3.2  
 20 6.5 6.5  
 30 9.7 9.7  
 40 13.0 13.0  
 50 16.2 16.2

198 LOG. VERSED SINES AND EXTERNAL SECANTS

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Lg. Vers.		D	Log. Exs.		D	Lg. Vers.		D	Log. Exs.		D	P. P.	
0	9.77325	19	10.16393	48	9.78481	19	10.19283	49	0				
1	.77344	19	.16441	47	.78500	19	.19342	49	1				
2	.77363	19	.16489	48	.78519	19	.19391	48	2				
3	.77383	19	.16537	48	.78538	19	.19439	49	3				
4	.77402	19	.16585	48	.78557	19	.19488	49	4				
5	9.77422	19	10.16633	48	9.78576	19	10.19537	49	5				
6	.77441	19	.16680	47	.78595	19	.19586	49	6				
7	.77461	19	.16728	48	.78614	19	.19635	49	7				
8	.77480	19	.16776	48	.78633	19	.19684	49	8				
9	.77499	19	.16824	48	.78652	19	.19733	49	9				
10	9.77519	19	10.16872	48	9.78671	19	10.19782	49	10				
11	.77538	19	.16920	48	.78690	19	.19831	49	11				
12	.77557	19	.16968	48	.78709	19	.19880	49	12				
13	.77577	19	.17016	48	.78728	19	.19929	49	13				
14	.77596	19	.17064	48	.78747	19	.19979	49	14				
15	9.77616	19	10.17112	48	9.78766	19	10.20028	49	15				
16	.77635	19	.17160	48	.78785	19	.20077	49	16				
17	.77654	19	.17209	48	.78804	19	.20126	49	17				
18	.77674	19	.17257	48	.78823	19	.20175	49	18				
19	.77693	19	.17305	48	.78842	19	.20224	49	19				
20	9.77712	19	10.17353	48	9.78861	19	10.20273	49	20				
21	.77732	19	.17401	48	.78880	19	.20323	49	21				
22	.77751	19	.17449	48	.78899	19	.20372	49	22				
23	.77770	19	.17498	48	.78918	19	.20422	49	23				
24	.77790	19	.17546	48	.78937	19	.20470	49	24				
25	9.77809	19	10.17594	48	9.78956	19	10.20520	49	25				
26	.77828	19	.17642	48	.78975	19	.20569	49	26				
27	.77847	19	.17690	48	.78994	19	.20618	49	27				
28	.77867	19	.17739	48	.79013	19	.20668	49	28				
29	.77886	19	.17787	48	.79032	19	.20717	49	29				
30	9.77905	19	10.17835	48	9.79051	19	10.20767	49	30				
31	.77925	19	.17884	48	.79069	19	.20816	49	31				
32	.77944	19	.17932	48	.79088	19	.20865	49	32				
33	.77963	19	.17980	48	.79107	19	.20915	49	33				
34	.77982	19	.18029	48	.79126	19	.20964	49	34				
35	9.78002	19	10.18077	48	9.79145	19	10.21014	49	35				
36	.78021	19	.18126	48	.79164	19	.21063	49	36				
37	.78040	19	.18174	48	.79183	19	.21113	49	37				
38	.78059	19	.18222	48	.79202	19	.21162	49	38				
39	.78078	19	.18271	48	.79220	19	.21212	49	39				
40	9.78098	19	10.18319	48	9.79239	19	10.21262	49	40				
41	.78117	19	.18368	48	.79258	19	.21311	49	41				
42	.78136	19	.18416	48	.79277	19	.21361	49	42				
43	.78155	19	.18465	49	.79296	19	.21410	49	43				
44	.78174	19	.18514	48	.79315	19	.21460	49	44				
45	9.78194	19	10.18562	48	9.79333	19	10.21510	49	45				
46	.78213	19	.18611	48	.79352	19	.21560	49	46				
47	.78232	19	.18659	48	.79371	19	.21609	49	47				
48	.78251	19	.18708	49	.79390	19	.21659	49	48				
49	.78270	19	.18757	49	.79409	19	.21709	49	49				
50	9.78289	19	10.18805	48	9.79427	19	10.21759	49	50				
51	.78309	19	.18854	49	.79446	19	.21808	49	51				
52	.78328	19	.18903	48	.79465	19	.21858	49	52				
53	.78347	19	.18951	49	.79484	19	.21908	49	53				
54	.78366	19	.19000	48	.79503	19	.21958	49	54				
55	9.78385	19	10.19049	48	9.79521	19	10.22008	49	55				
56	.78404	19	.19098	49	.79540	19	.22058	49	56				
57	.78423	19	.19146	48	.79559	19	.22108	49	57				
58	.78442	19	.19195	49	.79578	19	.22158	49	58				
59	.78462	19	.19244	48	.79596	19	.22208	49	59				
60	9.78481	19	10.19293	48	9.79615	19	10.22258	49	60				
	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D					P. P.

LOG. VERSED SINES AND EXTERNAL SECANTS 199

68°

69°

°	68°		69°		°	68°		69°		°	P. P.	
	Lg. Vers.	D	Log. Exs.	D		Lg. Vers.	D	Log. Exs.	D		Lg. Vers.	D
0	9.79615	18	10.22258	50	9.80728	18	10.25295	51	0			53 52
1	.79634	18	.22308	50	.80747	18	.25347	51	1			6 5.3 5.2
2	.79653	18	.22358	50	.80765	18	.25398	51	2			7 6.2 6.1
3	.79671	18	.22408	50	.80783	18	.25449	51	3			8 7.0 7.0
4	.79690	18	.22458	50	.80802	18	.25501	51	4			9 7.9 7.9
5	9.79709	18	10.22508	50	9.80820	18	10.25552	51	5			10 8.8 8.7
6	.79727	18	.22558	50	.80839	18	.25604	51	6			11 9.7 9.6
7	.79746	18	.22608	50	.80857	18	.25655	51	7			12 10.6 10.5
8	.79765	18	.22658	50	.80875	18	.25707	51	8			13 11.5 11.4
9	.79783	18	.22708	50	.80894	18	.25758	51	9			14 12.4 12.3
10	9.79802	18	10.22759	50	9.80912	18	10.25810	51	10			15 13.3 13.2
11	.79821	18	.22809	50	.80930	18	.25861	51	11			16 14.2 14.1
12	.79839	18	.22859	50	.80949	18	.25913	51	12			17 15.1 15.0
13	.79858	18	.22909	50	.80967	18	.25964	51	13			18 16.0 15.9
14	.79877	18	.22960	50	.80985	18	.26016	51	14			19 16.9 16.8
15	9.79895	18	10.23010	50	9.81003	18	10.26067	51	15			20 17.8 17.7
16	.79914	18	.23060	50	.81022	18	.26119	51	16			21 18.7 18.6
17	.79933	18	.23110	50	.81040	18	.26171	51	17			22 19.6 19.5
18	.79951	18	.23161	50	.81058	18	.26222	51	18			23 20.5 20.4
19	.79970	18	.23211	50	.81077	18	.26274	51	19			24 21.4 21.3
20	9.79988	18	10.23262	50	9.81095	18	10.26326	51	20			25 22.3 22.2
21	.80007	18	.23312	50	.81113	18	.26378	51	21			26 23.2 23.1
22	.80026	18	.23362	50	.81131	18	.26429	51	22			27 24.1 24.0
23	.80044	18	.23413	50	.81150	18	.26481	51	23			28 25.0 24.9
24	.80063	18	.23463	50	.81168	18	.26533	51	24			29 25.9 25.8
25	9.80081	18	10.23514	50	9.81186	18	10.26585	51	25			30 26.8 26.7
26	.80100	18	.23564	50	.81204	18	.26637	51	26			31 27.7 27.6
27	.80119	18	.23615	50	.81223	18	.26689	51	27			32 28.6 28.5
28	.80137	18	.23666	50	.81241	18	.26741	51	28			33 29.5 29.4
29	.80156	18	.23716	50	.81259	18	.26793	51	29			34 30.4 30.3
30	9.80174	18	10.23767	50	9.81277	18	10.26845	51	30			35 31.3 31.2
31	.80193	18	.23817	50	.81295	18	.26897	51	31			36 32.2 32.1
32	.80211	18	.23868	50	.81314	18	.26949	51	32			37 33.1 33.0
33	.80230	18	.23919	50	.81332	18	.27001	51	33			38 34.0 33.9
34	.80248	18	.23969	50	.81350	18	.27053	51	34			39 34.9 34.8
35	9.80267	18	10.24020	50	9.81368	18	10.27105	51	35			40 35.8 35.7
36	.80286	18	.24071	50	.81386	18	.27157	51	36			41 36.7 36.6
37	.80304	18	.24122	50	.81405	18	.27209	51	37			42 37.6 37.5
38	.80323	18	.24172	50	.81423	18	.27261	51	38			43 38.5 38.4
39	.80341	18	.24223	50	.81441	18	.27314	51	39			44 39.4 39.3
40	9.80360	18	10.24274	50	9.81459	18	10.27366	51	40			45 40.3 40.2
41	.80378	18	.24325	50	.81477	18	.27418	51	41			46 41.2 41.1
42	.80397	18	.24376	50	.81495	18	.27470	51	42			47 42.1 42.0
43	.80415	18	.24427	50	.81513	18	.27523	51	43			48 43.0 42.9
44	.80434	18	.24478	50	.81532	18	.27575	51	44			49 43.9 43.8
45	9.80452	18	10.24529	50	9.81550	18	10.27627	51	45			50 44.8 44.7
46	.80470	18	.24580	50	.81568	18	.27680	51	46			51 45.7 45.6
47	.80489	18	.24631	50	.81586	18	.27732	51	47			52 46.6 46.5
48	.80507	18	.24682	50	.81604	18	.27785	51	48			53 47.5 47.4
49	.80526	18	.24733	50	.81622	18	.27837	51	49			54 48.4 48.3
50	9.80544	18	10.24784	50	9.81640	18	10.27890	51	50			55 49.3 49.2
51	.80563	18	.24835	50	.81658	18	.27942	51	51			56 50.2 50.1
52	.80581	18	.24886	50	.81676	18	.27995	51	52			57 51.1 51.0
53	.80600	18	.24937	50	.81695	18	.28047	51	53			58 52.0 51.9
54	.80618	18	.24988	50	.81713	18	.28100	51	54			59 52.9 52.8
55	9.80636	18	10.25039	50	9.81731	18	10.28152	51	55			60 53.8 53.7
56	.80655	18	.25090	50	.81749	18	.28205	51	56			61 54.7 54.6
57	.80673	18	.25142	50	.81767	18	.28258	51	57			62 55.6 55.5
58	.80692	18	.25193	50	.81785	18	.28310	51	58			63 56.5 56.4
59	.80710	18	.25244	50	.81803	18	.28363	51	59			64 57.4 57.3
60	9.80728	18	10.25295	50	9.81821	18	10.28416	51	60			65 58.3 58.2
	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D				P. P.



200 LOG. VERSED SINES AND EXTERNAL SECANTS  
70° 71°

'	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	'	P. P.
0	9.81821	18	10.28416	53	9.82894	17	10.31629	54	0	56 56
1	.81859	18	.28469	53	.82911	17	.31684	54	1	6 5.6 5.6
2	.81857	18	.28521	53	.82929	18	.31738	54	2	7 6.6 6.6
3	.81875	18	.28574	53	.82947	17	.31793	54	3	8 7.5 7.4
4	.81893	18	.28627	53	.82964	17	.31847	54	4	9 8.5 8.4
5	9.81911	18	10.28680	52	9.82982	18	10.31902	54	5	10 9.4 9.3
6	.81929	18	.28733	53	.83000	17	.31956	54	6	20 18.8 18.6
7	.81947	18	.28786	53	.83017	17	.32011	54	7	30 28.2 28.0
8	.81965	18	.28839	53	.83035	18	.32066	54	8	40 37.6 37.3
9	.81983	18	.28892	53	.83053	17	.32120	54	9	50 47.1 46.6
10	9.82001	18	10.28945	53	9.83070	17	10.32175	54	10	55 55
11	.82019	18	.28998	53	.83088	17	.32230	54	11	6 5.5 5.5
12	.82037	18	.29051	53	.83106	17	.32284	54	12	7 6.5 6.4
13	.82055	18	.29104	53	.83123	17	.32339	54	13	8 7.4 7.3
14	.82073	18	.29157	53	.83141	17	.32394	54	14	9 8.3 8.2
15	9.82091	17	10.29210	53	9.83159	17	10.32449	55	15	10 9.2 9.1
16	.82109	18	.29263	53	.83176	17	.32504	54	16	20 18.5 18.3
17	.82127	18	.29316	53	.83194	17	.32558	54	17	30 27.7 27.6
18	.82145	18	.29370	53	.83211	18	.32613	55	18	40 37.0 36.9
19	.82163	18	.29423	53	.83229	17	.32668	55	19	50 46.2 45.8
20	9.82181	18	10.29476	53	9.83247	17	10.32723	55	20	54 54
21	.82199	18	.29529	53	.83264	17	.32778	55	21	6 5.4 5.4
22	.82217	18	.29583	53	.83282	17	.32833	55	22	7 6.3 6.3
23	.82235	17	.29636	53	.83299	18	.32888	55	23	8 7.2 7.2
24	.82252	17	.29689	53	.83317	17	.32944	55	24	9 8.2 8.1
25	9.82270	18	10.29743	53	9.83335	17	10.32999	55	25	10 9.1 9.0
26	.82288	18	.29796	53	.83352	17	.33054	55	26	20 18.1 18.0
27	.82306	18	.29850	53	.83370	17	.33109	55	27	30 27.1 27.0
28	.82324	17	.29903	53	.83387	17	.33164	55	28	40 36.3 36.0
29	.82342	18	.29957	53	.83405	17	.33220	55	29	50 45.4 45.0
30	9.82360	18	10.30010	53	9.83422	17	10.33275	55	30	55 53
31	.82378	18	.30064	53	.83440	18	.33330	55	31	6 5.3 5.3
32	.82396	17	.30117	54	.83458	17	.33385	55	32	7 6.2 6.2
33	.82413	18	.30171	54	.83475	17	.33441	55	33	8 7.1 7.0
34	.82431	18	.30225	53	.83493	17	.33496	55	34	9 8.0 7.9
35	9.82449	17	10.30278	54	9.83510	17	10.33552	55	35	10 8.9 8.8
36	.82467	18	.30332	54	.83528	17	.33607	55	36	20 17.1 17.0
37	.82485	18	.30386	54	.83545	17	.33663	55	37	30 26.7 26.5
38	.82503	17	.30440	53	.83563	17	.33718	55	38	40 35.6 35.3
39	.82520	17	.30493	53	.83580	17	.33774	55	39	50 44.8 44.1
40	9.82538	18	10.30547	54	9.83598	17	10.33829	55	40	55 52
41	.82556	17	.30601	54	.83615	17	.33885	55	41	6 5.2 5.2
42	.82574	18	.30655	54	.83633	17	.33941	55	42	7 6.1 6.1
43	.82592	17	.30709	54	.83650	17	.33996	55	43	8 7.0 7.0
44	.82609	17	.30763	54	.83668	17	.34052	55	44	9 7.9 7.9
45	9.82627	18	10.30817	54	9.83685	17	10.34108	55	45	10 8.7 8.7
46	.82645	17	.30871	54	.83703	17	.34164	55	46	20 17.5 17.5
47	.82663	17	.30925	54	.83720	17	.34220	55	47	30 26.3 26.3
48	.82681	18	.30979	54	.83737	17	.34275	55	48	40 35.0 35.0
49	.82698	17	.31033	54	.83755	17	.34331	55	49	50 43.7 43.7
50	9.82716	17	10.31087	54	9.83772	17	10.34387	55	50	55 50
51	.82734	18	.31141	54	.83790	17	.34443	55	51	6 1.8 1.7
52	.82752	18	.31195	54	.83807	17	.34499	55	52	7 2.1 2.0
53	.82769	17	.31249	54	.83825	17	.34555	55	53	8 2.4 2.3
54	.82787	17	.31303	54	.83842	17	.34611	55	54	9 2.7 2.6
55	9.82805	18	10.31358	54	9.83859	17	10.34667	55	55	10 3.0 2.9
56	.82823	17	.31412	54	.83877	17	.34723	55	56	20 6.0 5.8
57	.82840	18	.31466	54	.83894	17	.34778	55	57	30 9.0 8.7
58	.82858	17	.31521	54	.83912	17	.34833	55	58	40 12.0 11.6
59	.82876	18	.31575	54	.83929	17	.34889	55	59	50 15.0 14.6
60	9.82894	18	10.31629	54	9.83946	17	10.34944	55	60	55 15.0 14.6
	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D		P. P.

OG. VERSED SINES AND EXTERNAL SECANTS 201

72°

73°

72°		73°		P. P.					
rs.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	'	P. P.
146	17	10.34948	56	9.84980	17	10.38387	58	0	61 60
164	17	.35005	56	.84997	17	.38445	58	1	8 6.1 6.0
181	17	.35061	56	.85014	17	.38504	58	2	7 7.0 7.0
199	17	.35117	56	.85031	17	.38562	58	3	8 8.8 8.0
116	17	.35174	56	.85049	17	.38621	58	4	9 9.1 9.1
133	17	10.35230	56	9.85066	17	10.38679	58	5	10 10.1 10.1
151	17	.35286	56	.85083	17	.38738	58	6	20 20.3 20.2
168	17	.35343	56	.85100	17	.38796	58	7	30 30.5 30.2
185	17	.35399	56	.85117	17	.38855	59	8	40 40.6 40.3
03	17	.35456	57	.85134	17	.38914	58	9	50 50.8 50.4
20	17	10.35513	56	9.85151	17	10.38973	59	10	
37	17	.35569	56	.85168	17	.39031	59	11	6 6.0 5.9
55	17	.35626	57	.85185	17	.39090	59	12	7 7.0 6.9
72	17	.35683	56	.85202	17	.39149	59	13	8 8.0 7.9
89	17	.35739	56	.85219	17	.39208	58	14	9 9.0 8.9
107	17	10.35796	57	9.85236	17	10.39267	59	15	10 10.0 9.9
124	17	.35853	56	.85253	17	.39326	59	16	20 20.0 19.8
141	17	.35910	57	.85270	17	.39385	59	17	30 30.0 29.7
159	17	.35967	57	.85287	17	.39444	59	18	40 40.0 39.6
176	17	.36023	56	.85304	17	.39503	59	19	50 50.8 50.4
193	17	10.36080	57	9.85321	17	10.39562	59	20	
110	17	.36137	57	.85338	17	.39621	59	21	6 5.9 5.8
128	17	.36194	57	.85355	17	.39681	59	22	7 6.9 6.8
145	17	.36251	57	.85372	17	.39740	59	23	8 7.8 7.8
162	17	.36308	57	.85389	17	.39799	59	24	9 8.8 8.8
180	17	10.36366	57	9.85405	17	10.39859	59	25	10 9.8 9.7
197	17	.36423	57	.85422	17	.39918	59	26	20 19.6 19.5
114	17	.36480	57	.85439	17	.39977	59	27	30 29.5 29.2
131	17	.36537	57	.85456	17	.40037	59	28	40 39.3 39.0
149	17	.36594	57	.85473	17	.40096	59	29	50 49.1 48.7
166	17	10.36652	57	9.85490	17	10.40156	59	30	
183	17	.36709	57	.85507	16	.40216	60	31	6 5.8 5.7
100	17	.36766	57	.85524	17	.40275	59	32	7 6.7 6.7
117	17	.36824	57	.85541	17	.40335	59	33	8 7.7 7.6
135	17	.36881	57	.85558	17	.40395	60	34	9 8.7 8.6
152	17	10.36938	57	9.85575	17	10.40454	59	35	10 9.6 9.6
169	17	.36996	57	.85592	16	.40514	60	36	20 19.3 19.1
186	17	.37054	58	.85608	17	.40574	59	37	30 29.0 28.7
103	17	.37111	57	.85625	17	.40634	60	38	40 38.6 38.3
120	17	.37169	57	.85642	17	.40694	60	39	50 48.3 47.9
138	17	10.37226	57	9.85659	16	10.40754	60	40	
155	17	.37284	57	.85676	16	.40814	60	41	6 5.7 5.6
172	17	.37342	58	.85693	17	.40874	60	42	7 6.6 6.6
189	17	.37399	57	.85710	17	.40934	60	43	8 7.6 7.5
06	17	.37457	58	.85726	16	.40994	60	44	9 8.5 8.5
24	17	10.37515	58	9.85743	17	10.41054	60	45	10 9.5 9.4
41	17	.37573	58	.85760	16	.41114	60	46	20 19.0 18.8
58	17	.37631	58	.85777	17	.41174	60	47	30 28.7 28.2
75	17	.37689	58	.85794	17	.41235	60	48	40 38.0 37.6
92	17	.37747	58	.85811	17	.41295	60	49	50 47.5 47.1
109	17	10.37805	58	9.85827	17	10.41355	60	50	
126	17	.37863	58	.85844	17	.41416	60	51	6 5.7 5.6
144	17	.37921	58	.85861	16	.41476	60	52	7 6.6 6.6
161	17	.37979	58	.85878	17	.41537	60	53	8 7.5 7.5
178	17	.38037	58	.85895	16	.41597	60	54	9 8.5 8.5
195	17	10.38095	58	9.85911	17	10.41658	60	55	10 9.5 9.4
112	17	.38153	58	.85928	17	.41719	61	56	20 18.8 18.2
129	17	.38210	58	.85945	17	.41779	60	57	30 28.5 28.2
146	17	.38270	58	.85962	16	.41840	60	58	40 38.0 37.6
163	17	.38328	58	.85979	17	.41901	61	59	50 47.5 47.1
80	17	10.38387	58	9.85995	16	10.41962	61	60	6 5.6 5.5
rs.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	'	P. P.

202 LOG. VERSED SINES AND EXTERNAL SECANTS

74°

75°

74°				75°				P. P.				
Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D					
0	9.85995	17	10.41962	60	9.86992	16	10.45693	65	0			
1	.86012	16	.42022	61	.87009	16	.45756	63	8	67	66	66
2	.86029	16	.42083	61	.87025	16	.45820	64	7	7.8	7.7	7.7
3	.86046	17	.42144	61	.87042	16	.45884	64	8	8.9	8.8	8.8
4	.86062	16	.42205	61	.87058	16	.45947	63	9	10.0	10.0	9.9
5	9.86079	17	10.42266	61	9.87074	16	10.46011	64	5	10	11.1	11.1
6	.86096	16	.42327	61	.87091	16	.46075	64	6	20	22.3	22.3
7	.86113	16	.42388	61	.87107	16	.46139	64	7	30	33.5	33.5
8	.86129	16	.42450	61	.87124	16	.46203	64	8	40	44.6	44.6
9	.86146	17	.42511	61	.87140	16	.46267	64	9	50	55.8	55.8
10	9.86163	16	10.42572	61	9.87157	16	10.46331	64	10			
11	.86179	17	.42633	61	.87173	16	.46395	64	11	6	6.5	6.5
12	.86196	16	.42695	61	.87189	16	.46460	64	12	7	7.6	7.5
13	.86213	17	.42756	61	.87206	16	.46524	64	13	8	8.7	8.6
14	.86230	16	.42817	61	.87222	16	.46588	64	14	9	9.8	9.7
15	9.86246	16	10.42879	61	9.87239	16	10.46652	64	15	10	10.9	10.8
16	.86263	16	.42940	61	.87255	16	.46717	64	16	20	21.8	21.5
17	.86280	17	.43002	61	.87271	16	.46781	64	17	30	32.7	32.5
18	.86296	16	.43063	61	.87288	16	.46846	64	18	40	43.6	43.0
19	.86313	16	.43125	61	.87304	16	.46910	64	19	50	54.6	54.1
20	9.86330	17	10.43187	62	9.87320	16	10.46975	64	20			
21	.86346	16	.43249	62	.87337	16	.47040	64	21	6	6.4	6.3
22	.86363	16	.43310	62	.87353	16	.47104	64	22	7	7.4	7.3
23	.86380	17	.43372	62	.87370	16	.47169	64	23	8	8.4	8.4
24	.86396	16	.43434	62	.87386	16	.47234	64	24	9	9.6	9.4
25	9.86413	16	10.43496	62	9.87402	16	10.47299	65	25	10	10.6	10.5
26	.86430	16	.43558	62	.87419	16	.47364	65	26	20	21.3	21.0
27	.86446	16	.43620	62	.87435	16	.47429	65	27	30	32.0	31.5
28	.86463	16	.43682	62	.87451	16	.47494	65	28	40	42.6	42.0
29	.86479	16	.43744	62	.87468	16	.47559	65	29	50	53.3	52.5
30	9.86496	17	10.43806	62	9.87484	16	10.47624	65	30			
31	.86513	16	.43868	62	.87500	16	.47689	65	31	6	6.2	6.1
32	.86529	16	.43931	62	.87516	16	.47754	65	32	7	7.3	7.2
33	.86546	16	.43993	62	.87533	16	.47820	65	33	8	8.3	8.2
34	.86562	16	.44055	62	.87549	16	.47885	65	34	9	9.4	9.2
35	9.86579	17	10.44118	62	9.87565	16	10.47950	65	35	10	10.4	10.3
36	.86596	16	.44180	62	.87582	16	.48016	65	36	20	20.8	20.5
37	.86612	16	.44242	62	.87598	16	.48081	65	37	30	31.2	30.7
38	.86629	16	.44305	62	.87614	16	.48147	65	38	40	41.6	41.0
39	.86645	16	.44368	63	.87631	16	.48213	66	39	50	52.1	51.5
40	9.86662	16	10.44430	62	9.87647	16	10.48278	65	40			
41	.86678	17	.44493	62	.87663	16	.48344	65	41	6	6.1	6.0
42	.86695	16	.44556	62	.87679	16	.48410	66	42	7	7.1	7.0
43	.86712	16	.44618	62	.87696	16	.48476	66	43	8	8.1	8.0
44	.86728	16	.44681	63	.87712	16	.48542	66	44	9	9.1	9.1
45	9.86745	16	10.44744	63	9.87728	16	10.48607	66	45	10	10.1	10.1
46	.86761	16	.44807	63	.87744	16	.48674	66	46	20	20.3	20.1
47	.86778	16	.44870	63	.87761	16	.48740	66	47	30	30.5	30.2
48	.86794	16	.44933	63	.87777	16	.48806	66	48	40	40.6	40.3
49	.86811	16	.44996	63	.87793	16	.48872	66	49	50	50.8	50.4
50	9.86827	16	10.45059	63	9.87809	16	10.48936	66	50			
51	.86844	16	.45122	63	.87825	16	.49004	66	51	6	6.0	6.0
52	.86860	16	.45185	63	.87842	16	.49071	66	52	7	7.0	7.0
53	.86877	16	.45248	63	.87858	16	.49137	66	53	8	8.0	8.0
54	.86893	16	.45312	63	.87874	16	.49204	66	54	9	9.0	9.0
55	9.86910	16	10.45375	63	9.87890	16	10.49270	66	55	10	10.0	10.0
56	.86926	16	.45439	63	.87906	16	.49337	66	56	20	20.0	20.0
57	.86943	16	.45502	63	.87923	16	.49403	67	57	30	30.0	30.0
58	.86959	16	.45565	63	.87939	16	.49470	67	58	40	40.0	40.0
59	.86976	16	.45629	63	.87955	16	.49537	67	59	50	50.0	50.0
60	9.86992	16	10.45693	64	9.87971	16	10.49604	67	60			
	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	P. P.			

LOG. VERSED SINES AND EXTERNAL SECANTS 203

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	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D		P. P.
0	9.87971	16	10.49804	66	9.88933	16	10.53724	70	0	
1	.87987	16	.49670	67	.88949	15	.53794	71	1	
2	.88003	16	.49737	67	.88964	16	.53865	70	2	
3	.88020	16	.49804	67	.88980	16	.53936	71	3	
4	.88036	16	.49871	67	.88996	16	.54007	71	4	
5	9.88052	16	10.49939	67	9.89012	16	10.54078	71	5	6 7 5 7 4 7 3
6	.88068	16	.50006	67	.89028	16	.54149	71	6	7 8 7 8 6 8 5
7	.88084	16	.50073	67	.89044	16	.54220	71	7	8 10 0 9 8 9 9 7
8	.88100	16	.50140	67	.89060	16	.54291	71	8	9 11 2 11 1 10 9
9	.88116	16	.50208	67	.89075	15	.54362	71	9	10 12 5 12 3 12 1
10	9.88133	16	10.50275	67	9.89091	16	10.54433	71	10	20 25 0 24 6 24 3
11	.88149	16	.50342	67	.89107	15	.54505	71	11	30 37 5 37 0 38 5
12	.88165	16	.50410	67	.89123	16	.54576	71	12	40 50 0 49 3 48 6
13	.88181	16	.50477	68	.89139	16	.54647	72	13	50 62 5 61 6 60 8
14	.88197	16	.50545	68	.89155	15	.54719	71	14	
15	9.88213	16	10.50613	68	9.89170	16	10.54791	71	15	7 2 7 1 7 0
16	.88229	16	.50681	68	.89186	16	.54862	72	16	6 7 8 7 8 8
17	.88245	16	.50749	68	.89202	15	.54934	71	17	7 8 4 8 3 8 2
18	.88261	16	.50817	68	.89218	16	.55006	71	18	8 9 6 9 4 9 4
19	.88277	16	.50884	68	.89234	16	.55078	72	19	9 10 8 10 6 10 6
20	9.88294	16	10.50952	68	9.89249	15	10.55150	72	20	10 12 0 11 8 11 7
21	.88310	16	.51020	68	.89265	16	.55222	72	21	20 24 0 23 6 23 5
22	.88326	16	.51088	68	.89281	15	.55294	72	22	30 36 0 35 5 35 2
23	.88342	16	.51157	68	.89297	16	.55366	72	23	40 48 0 47 3 47 0
24	.88358	16	.51225	68	.89312	15	.55438	72	24	50 60 0 59 1 58 7
25	9.88374	16	10.51293	68	9.89328	16	10.55511	72	25	
26	.88390	16	.51361	68	.89344	15	.55583	72	26	6 6 9 6 8 6
27	.88406	16	.51430	68	.89360	16	.55655	73	27	7 8 0 7 9 7 8
28	.88422	16	.51498	68	.89376	16	.55727	73	28	8 9 2 9 0 8 9
29	.88438	16	.51567	69	.89391	15	.55801	72	29	9 10 3 10 2 10 0
30	9.88454	16	10.51636	68	9.89407	16	10.55873	73	30	10 11 5 11 3 11 1
31	.88470	16	.51704	68	.89423	15	.55946	73	31	20 23 0 22 6 22 3
32	.88486	16	.51773	69	.89438	16	.56019	73	32	30 34 5 34 0 33 5
33	.88502	16	.51842	69	.89454	15	.56092	73	33	40 46 0 45 4 44 6
34	.88518	16	.51911	69	.89470	16	.56165	73	34	50 57 5 56 8 55 8
35	9.88534	16	10.51980	69	9.89486	16	10.56238	73	35	
36	.88550	16	.52049	69	.89501	15	.56311	73	36	6 6 6 0 0
37	.88566	16	.52118	69	.89517	16	.56384	73	37	7 7 7 0 0
38	.88582	16	.52187	69	.89533	15	.56457	73	38	8 8 8 0 0
39	.88598	16	.52256	69	.89548	16	.56531	73	39	9 9 9 0 1
40	9.88614	16	10.52325	69	9.89564	16	10.56604	73	40	10 11 0 0 1
41	.88630	16	.52394	69	.89580	16	.56678	73	41	20 22 0 0 1
42	.88646	15	.52464	69	.89596	15	.56751	74	42	30 33 0 0 2
43	.88662	15	.52533	69	.89611	15	.56825	74	43	40 44 0 0 3
44	.88678	16	.52603	69	.89627	16	.56899	74	44	50 55 0 0 4
45	9.88694	16	10.52672	70	9.89643	16	10.56973	74	45	
46	.88710	16	.52742	69	.89658	15	.57047	74	46	
47	.88726	16	.52812	69	.89674	16	.57120	74	47	
48	.88742	16	.52881	70	.89690	15	.57195	74	48	
49	.88758	16	.52951	70	.89705	15	.57269	74	49	
50	9.88774	16	10.53021	70	9.89721	16	10.57343	74	50	6 1 6 1 6 1 5
51	.88790	16	.53091	70	.89737	15	.57417	74	51	7 1 9 1 8 1 8
52	.88805	15	.53161	70	.89752	15	.57491	74	52	8 2 2 2 1 2 0
53	.88821	16	.53231	70	.89768	15	.57566	74	53	9 9 9 0 1
54	.88837	16	.53301	70	.89783	15	.57640	74	54	10 2 7 2 6 2 6
55	9.88853	16	10.53372	70	9.89799	16	10.57715	75	55	20 5 5 5 3 5 1
56	.88869	15	.53442	70	.89815	15	.57790	74	56	30 8 2 8 0 7 7
57	.88885	15	.53512	70	.89830	15	.57864	74	57	40 11 0 10 6 10 3
58	.88901	16	.53583	70	.89846	16	.57939	75	58	50 13 7 13 3 12 9
59	.88917	16	.53653	70	.89862	15	.58014	75	59	
60	9.88933	16	10.53724	70	9.89877	15	10.58086	75	60	
	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D		P. P.

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	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D		P. P.		
0	9.89877	15	10.58089	75	9.90805	15	10.62745	80	0	86	85	84
1	89893	15	-58164	75	-90820	15	-62825	80	1	6 8.6	8.5	8.4
2	89908	15	-58239	75	-90835	15	-62906	80	2	7 10.0	9.9	9.8
3	89924	15	-58315	75	-90851	15	-62986	80	3	8 11.4	11.1	11.2
4	89939	15	-58390	75	-90866	15	-63067	81	4	9 12.9	12.7	12.6
5	9.89955	16	10.58465	75	9.90881	15	10.63148	81	5	10 14.3	14.1	14.0
6	89971	15	-58541	75	-90897	15	-63229	81	6	20 28.6	28.3	28.0
7	89986	15	-58616	75	-90912	15	-63310	81	7	30 43.0	42.5	42.0
8	9.90002	16	-58692	75	-90927	15	-63391	81	8	40 57.3	56.6	56.0
9	90017	15	-58768	75	-90943	15	-63472	81	9	50 71.6	70.8	70.0
10	9.90033	16	10.58844	76	9.90958	15	10.63553	81	10	83	82	81
11	90048	15	-58920	76	-90973	15	-63634	81	11	6 8.3	8.2	8.1
12	90064	15	-58995	75	-90988	15	-63716	81	12	7 9.7	9.7	9.4
13	90080	15	-59072	76	-91004	15	-63797	81	13	8 11.0	10.5	10.9
14	90095	15	-59148	76	-91019	15	-63879	81	14	9 12.4	12.3	12.1
15	9.90111	16	10.59224	76	9.91034	15	10.63961	82	15	10 13.8	13.1	13.5
16	90126	15	-59300	76	-91049	15	-64043	82	16	20 27.6	27.3	27.0
17	90142	15	-59377	76	-91065	15	-64125	82	17	30 41.5	41.0	40.5
18	90157	15	-59453	76	-91080	15	-64207	82	18	40 55.3	54.6	54.0
19	90173	15	-59530	76	-91095	15	-64289	82	19	50 69.1	68.3	67.5
20	9.90188	16	10.59606	76	9.91110	15	10.64371	82	20	80	79	78
21	90204	15	-59683	77	-91126	15	-64453	82	21	6 8.0	7.9	7.8
22	90219	15	-59760	76	-91141	15	-64536	82	22	7 9.5	9.2	9.1
23	90235	15	-59837	77	-91156	15	-64618	82	23	8 10.6	10.5	10.4
24	90250	15	-59914	77	-91171	15	-64701	82	24	9 12.0	11.8	11.7
25	9.90266	16	10.59991	77	9.91187	15	10.64784	82	25	10 13.3	13.1	13.0
26	90281	15	-60068	77	-91202	15	-64867	82	26	20 26.6	26.3	26.0
27	90297	15	-60145	77	-91217	15	-64950	82	27	30 40.0	39.5	39.0
28	90312	15	-60223	77	-91232	15	-65033	82	28	40 53.3	52.5	52.0
29	90328	15	-60300	77	-91247	15	-65116	82	29	50 66.6	65.8	65.0
30	9.90343	16	10.60378	77	9.91263	15	10.65199	82	30	80	77	76
31	90359	15	-60455	77	-91278	15	-65283	82	31	6 7.7	7.6	7.5
32	90374	15	-60533	78	-91293	15	-65366	82	32	7 9.0	8.6	8.7
33	90389	15	-60611	77	-91308	15	-65450	82	33	8 10.2	10.1	10.0
34	90405	15	-60688	77	-91323	15	-65534	82	34	9 11.5	11.4	11.2
35	9.90420	16	10.60766	78	9.91338	15	10.65617	83	35	10 12.8	12.6	12.5
36	90436	15	-60844	78	-91354	15	-65701	83	36	20 25.6	25.3	25.0
37	90451	15	-60923	78	-91369	15	-65785	83	37	30 38.5	38.0	37.5
38	90467	15	-61001	78	-91384	15	-65870	83	38	40 51.1	50.6	50.0
39	90482	15	-61079	78	-91399	15	-65954	83	39	50 64.1	63.3	62.5
40	9.90497	16	10.61158	78	9.91414	15	10.66038	83	40	80	77	76
41	90513	15	-61236	78	-91429	15	-66123	83	41	6 7.0	7.0	7.0
42	90528	15	-61315	78	-91445	15	-66207	83	42	7 8.1	8.0	8.0
43	90544	15	-61393	78	-91460	15	-66292	83	43	8 9.5	9.4	9.4
44	90559	15	-61472	79	-91475	15	-66377	84	44	9 11.0	11.4	11.2
45	9.90574	16	10.61551	78	9.91490	15	10.66462	85	45	10 12.8	12.6	12.5
46	90590	15	-61630	79	-91505	15	-66547	85	46	20 25.6	25.3	25.0
47	90605	15	-61709	79	-91520	15	-66632	85	47	30 38.5	38.0	37.5
48	90621	15	-61788	79	-91535	15	-66717	85	48	40 51.1	50.6	50.0
49	90636	15	-61867	79	-91550	15	-66803	85	49	50 64.1	63.3	62.5
50	9.90651	16	10.61947	79	9.91565	15	10.66888	85	50	80	77	76
51	90667	15	-62026	79	-91581	15	-66974	85	51	6 7.0	7.0	7.0
52	90682	15	-62105	80	-91596	15	-67059	86	52	7 8.1	8.1	8.1
53	90697	15	-62185	80	-91611	15	-67145	86	53	8 9.5	9.4	9.4
54	90713	15	-62265	79	-91626	15	-67231	86	54	9 11.0	11.4	11.2
55	9.90728	16	10.62345	80	9.91641	15	10.67317	86	55	10 12.8	12.6	12.5
56	90744	15	-62424	79	-91656	15	-67403	86	56	20 25.6	25.3	25.0
57	90759	15	-62504	80	-91671	15	-67490	86	57	30 38.5	38.0	37.5
58	90774	15	-62585	80	-91686	15	-67576	86	58	40 51.1	50.6	50.0
59	90790	15	-62665	80	-91701	15	-67663	86	59	50 64.1	63.3	62.5
60	9.90805	16	10.62745	80	9.91716	15	10.67749	86	60	80	77	76
	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D		P. P.		

LOG. VERSED SINES AND EXTERNAL SECANTS 205

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Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	P. P.
9.91716	15	10.67749	86	9.92612	14	10.73178	95	0
.91731	15	.67836	87	.92626	15	.73273	94	1
.91746	15	.67923	87	.92641	14	.73368	95	2
.91761	15	.68010	87	.92656	15	.73463	95	3
.91776	15	.68097	87	.92671	15	.73558	95	4
9.91791	5	10.68184	87	9.92686	15	10.73653	95	5
.91807	15	.68272	87	.92700	14	.73748	95	6
.91822	15	.68359	87	.92715	14	.73844	95	7
.91837	15	.68447	87	.92730	15	.73940	95	8
.91852	15	.68534	87	.92745	14	.74035	95	9
9.91867	15	10.68622	88	9.92759	14	10.74131	96	10
.91882	15	.68710	88	.92774	15	.74227	96	11
.91897	15	.68798	88	.92789	14	.74324	96	12
.91912	15	.68886	88	.92804	15	.74420	96	13
.91927	15	.68975	88	.92818	14	.74517	96	14
9.91942	15	10.69063	88	9.92833	14	10.74613	97	15
.91957	15	.69152	88	.92848	14	.74710	97	16
.91972	15	.69240	88	.92862	14	.74807	97	17
.91987	15	.69329	89	.92877	15	.74905	97	18
.92002	15	.69418	89	.92892	14	.75002	97	19
9.92016	14	10.69507	89	9.92907	14	10.75099	97	20
.92031	15	.69596	89	.92921	14	.75197	97	21
.92046	15	.69686	89	.92936	15	.75295	98	22
.92061	15	.69775	89	.92951	14	.75393	98	23
.92076	15	.69865	89	.92965	15	.75491	98	24
9.92091	15	10.69955	90	9.92980	14	10.75589	98	25
.92106	15	.70044	89	.92995	14	.75688	98	26
.92121	15	.70132	90	.93009	14	.75785	98	27
.92136	15	.70224	90	.93024	14	.75885	99	28
.92151	14	.70315	90	.93039	14	.75984	99	29
9.92166	15	10.70405	90	9.93053	14	10.76083	99	30
.92181	15	.70495	90	.93068	15	.76182	99	31
.92196	15	.70586	91	.93083	14	.76282	99	32
.92211	15	.70677	90	.93097	14	.76382	100	33
.92226	14	.70768	91	.93112	14	.76481	99	34
9.92240	15	10.70859	91	9.93127	14	10.76581	100	35
.92255	15	.70950	91	.93141	14	.76681	100	36
.92270	15	.71041	91	.93156	15	.76782	100	37
.92285	15	.71133	91	.93171	14	.76882	100	38
.92300	14	.71224	91	.93185	14	.76983	100	39
9.92315	15	10.71316	92	9.93200	14	10.77083	100	40
.92330	15	.71408	92	.93214	15	.77184	101	41
.92345	15	.71500	92	.93229	14	.77286	101	42
.92360	14	.71592	92	.93244	14	.77387	101	43
.92374	14	.71684	92	.93258	14	.77488	101	44
9.92389	15	10.71775	92	9.93273	14	10.77590	101	45
.92404	15	.71869	92	.93287	14	.77692	102	46
.92419	14	.71961	93	.93302	15	.77794	102	47
.92434	15	.72054	92	.93317	14	.77896	102	48
.92449	14	.72147	92	.93331	14	.77998	102	49
9.92463	15	10.72240	93	9.93346	14	10.78101	102	50
.92478	15	.72333	93	.93360	14	.78203	103	51
.92493	15	.72427	93	.93375	14	.78306	103	52
.92508	14	.72520	93	.93389	14	.78409	103	53
.92523	15	.72614	93	.93404	15	.78513	103	54
9.92538	14	10.72707	94	9.93419	14	10.78616	104	55
.92552	15	.72801	94	.93433	14	.78720	104	56
.92567	15	.72895	94	.93448	14	.78823	104	57
.92582	15	.72990	94	.93462	14	.78927	104	58
.92597	14	.73084	94	.93477	14	.79031	104	59
9.92612	15	10.73178	94	9.93491	14	10.79136	104	60
Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	P. P.

206 LOG. VERSED SINES AND EXTERNAL SECANTS

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'	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	'	P. P.
0	9.93491	14	10.79136	104	9.94356	14	10.85766	117	0	
1	.93506	14	.79240	105	.94370	14	.85884	117	1	
2	.93520	14	.79345	104	.94384	14	.86001	117	2	
3	.93535	14	.79450	105	.94398	14	.86119	118	3	
4	.93549	14	.79555	105	.94413	14	.86237	118	4	
5	9.93564	14	10.79660	105	9.94427	14	10.86355	118	5	
6	.93578	14	.79766	105	.94441	14	.86474	118	6	
7	.93593	14	.79871	105	.94456	14	.86592	118	7	
8	.93607	14	.79977	106	.94470	14	.86711	119	8	
9	.93622	14	.80083	106	.94484	14	.86831	119	9	
10	9.93636	14	10.80189	106	9.94498	14	10.86950	120	10	
11	.93651	14	.80296	106	.94512	14	.87070	120	11	
12	.93665	14	.80402	106	.94527	14	.87190	120	12	
13	.93680	14	.80509	107	.94541	14	.87310	120	13	
14	.93694	14	.80616	107	.94555	14	.87431	120	14	
15	9.93709	14	10.80723	107	9.94569	14	10.87552	121	15	
16	.93723	14	.80831	107	.94584	14	.87673	121	16	
17	.93738	14	.80938	108	.94598	14	.87794	121	17	
18	.93752	14	.81046	108	.94612	14	.87916	122	18	
19	.93767	14	.81154	108	.94626	14	.88038	122	19	
20	9.93781	14	10.81262	108	9.94640	14	10.88160	122	20	
21	.93796	14	.81371	108	.94655	14	.88282	122	21	
22	.93810	14	.81479	109	.94669	14	.88405	123	22	
23	.93824	14	.81588	109	.94683	14	.88528	123	23	
24	.93839	14	.81697	109	.94697	14	.88651	123	24	
25	9.93853	14	10.81806	109	9.94711	14	10.88775	123	25	
26	.93868	14	.81916	109	.94726	14	.88898	123	26	
27	.93882	14	.82025	109	.94740	14	.89022	124	27	
28	.93897	14	.82135	110	.94754	14	.89147	124	28	
29	.93911	14	.82245	110	.94768	14	.89271	124	29	
30	9.93925	14	10.82356	110	9.94782	14	10.89396	125	30	
31	.93940	14	.82466	110	.94796	14	.89521	125	31	
32	.93954	14	.82577	110	.94810	14	.89647	125	32	
33	.93969	14	.82688	111	.94825	14	.89773	126	33	
34	.93983	14	.82799	111	.94839	14	.89899	126	34	
35	9.93997	14	10.82910	111	9.94853	14	10.90025	126	35	
36	.94012	14	.83022	111	.94867	14	.90152	127	36	
37	.94026	14	.83133	112	.94881	14	.90279	127	37	
38	.94041	14	.83245	112	.94895	14	.90406	127	38	
39	.94055	14	.83358	112	.94909	14	.90533	127	39	
40	9.94069	14	10.83470	112	9.94923	14	10.90661	128	40	
41	.94084	14	.83583	112	.94938	14	.90789	128	41	
42	.94099	14	.83695	113	.94952	14	.90917	129	42	
43	.94112	14	.83809	113	.94966	14	.91046	129	43	
44	.94127	14	.83922	113	.94980	14	.91175	129	44	
45	9.94141	14	10.84035	113	9.94994	14	10.91304	129	45	
46	.94155	14	.84149	114	.95008	14	.91434	130	46	
47	.94170	14	.84263	114	.95022	14	.91564	129	47	
48	.94184	14	.84377	114	.95036	14	.91694	130	48	
49	.94198	14	.84492	115	.95050	14	.91825	130	49	
50	9.94213	14	10.84607	115	9.95064	14	10.91956	131	50	
51	.94227	14	.84721	115	.95078	14	.92087	131	51	
52	.94241	14	.84837	115	.95093	14	.92218	131	52	
53	.94256	14	.84952	115	.95107	14	.92350	131	53	
54	.94270	14	.85068	116	.95121	14	.92482	132	54	
55	9.94284	14	10.85183	116	9.95135	14	10.92614	132	55	
56	.94299	14	.85299	116	.95149	14	.92747	133	56	
57	.94313	14	.85416	116	.95163	14	.92880	133	57	
58	.94327	14	.85532	117	.95177	14	.93014	133	58	
59	.94341	14	.85649	117	.95191	14	.93147	133	59	
60	9.94356	14	10.85766	117	9.95205	14	10.93281	134	60	
Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	'	P. P.	

130 120  
6 13.0 12.0  
7 15.1 14.0  
8 17.3 16.0  
9 19.5 18.0  
10 21.6 20.0  
20 43.3 40.0  
30 65.0 60.0  
40 86.6 80.0  
50 108.3 100.0

110 100  
6 11.0 10.0  
7 12.6 11.6  
8 14.6 13.3  
9 18.5 15.0  
10 18.3 16.6  
20 36.6 33.3  
30 55.0 50.0  
40 73.3 66.6  
50 91.6 83.3

3 2  
6 0.3 0.2  
7 0.3 0.2  
8 0.4 0.2  
9 C.4 0.3  
10 0.5 0.3  
20 1.0 0.6  
30 1.5 1.0  
40 2.0 1.3  
50 2.5 1.6

1 0  
6 0.1 0.0  
7 0.1 0.0  
8 0.0 0.0  
9 0.0 0.1  
10 0.0 0.1  
20 0.5 0.2  
30 0.5 0.3  
40 0.8 0.4

13 14  
6 1.4 1.4  
7 1.7 1.6  
8 1.9 1.8  
9 2.2 2.1  
10 2.4 2.3  
20 4.4 4.6  
30 7.4 7.0  
40 9.6 9.3  
50 12.1 11.6

P. P.

OG. VERSED SINES AND EXTERNAL SECANTS 207

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rs.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	'	P. P.
105	14	10.93281	137	9.96039	14	11.02010	158	0	190 180
119	14	.93416	137	.96053	14	.02168	159	1	6 19.0 18.0
133	14	.93551	135	.96067	13	.02327	159	2	7 22.1 21.0
147	14	.93686	135	.96081	14	.02487	159	3	8 25.3 24.0
161	14	.93821	135	.96095	14	.02646	159	4	9 28.5 27.0
175	14	10.93957	135	9.96108	13	11.02807	160	5	10 31.6 30.0
189	14	.94093	136	.96122	13	.02868	161	6	20 63.3 60.0
303	14	.94229	137	.96136	13	.03129	161	7	30 95.0 90.0
317	14	.94366	137	.96150	14	.03291	161	8	40 126.6 120.0
331	14	.94503	137	.96163	13	.03453	162	9	50 158.3 150.0
345	14	10.94643	137	9.96177	14	11.03616	163	10	170 160
359	13	.94778	138	.96191	14	.03780	163	11	6 17.0 16.0
373	14	.94917	138	.96205	13	.03944	164	12	7 19.8 18.6
387	14	.95059	139	.96218	14	.04108	164	13	8 22.6 21.3
401	14	.95194	139	.96232	13	.04273	165	14	9 25.5 24.0
415	14	10.95333	139	9.96246	13	11.04438	165	15	10 28.3 26.6
429	14	.95473	140	.96259	14	.04604	166	16	20 56.6 53.3
443	14	.95613	140	.96273	13	.04771	167	17	30 85.0 80.0
457	14	.95753	140	.96287	14	.04938	167	18	40 113.3 106.6
471	14	.95894	141	.96301	13	.05106	168	19	50 141.6 133.3
485	14	10.96035	141	9.96314	14	11.05274	169	20	150 140
499	14	.96176	142	.96328	14	.05443	169	21	6 15.0 14.0
513	14	.96318	142	.96342	13	.05612	169	22	7 17.5 16.3
527	13	.96461	142	.96356	14	.05782	170	23	8 20.0 18.6
540	13	.96603	143	.96369	13	.05952	170	24	9 22.5 21.0
554	14	10.96746	143	9.96383	14	11.06123	171	25	10 25.0 23.3
568	14	.96889	144	.96397	14	.06295	172	26	20 50.0 46.6
582	14	.97033	144	.96410	13	.06467	173	27	30 75.0 70.0
596	14	.97177	144	.96424	14	.06640	173	28	40 100.0 93.3
610	14	.97322	144	.96438	13	.06813	173	29	50 125.0 116.6
624	14	10.97467	145	9.96451	13	11.06987	174	30	130 9 8
638	13	.97612	145	.96465	14	.07161	175	31	6 13.0 0.90 8
652	14	.97758	146	.96479	13	.07336	176	32	7 15.1 1.00 9
666	14	.97904	146	.96492	13	.07512	176	33	8 17.3 1.2 1.0
680	14	.98050	146	.96506	13	.07688	176	34	9 19.5 1.3 1.2
693	13	10.98197	147	9.96519	14	11.07865	177	35	10 21.6 1.5 1.1
707	14	.98345	147	.96533	13	.08043	178	36	20 43.3 0.2 6
721	14	.98492	148	.96547	13	.08221	179	37	30 65.0 4.5 4.0
735	14	.98640	149	.96560	14	.08400	179	38	40 86.6 6.0 5.3
749	14	.98789	149	.96574	13	.08579	179	39	50 108.3 7.5 6.6
763	13	10.98938	149	9.96588	13	11.08755	180	40	7 6 5
777	14	.99087	149	.96601	13	.08940	180	41	6 0.7 0.6 0.5
791	14	.99237	150	.96615	14	.09127	182	42	7 0.8 0.7 0.6
804	14	.99387	150	.96629	13	.09313	182	43	8 0.9 0.8 0.7
818	14	.99538	151	.96642	13	.09498	183	44	9 1.0 0.9 0.7
832	14	10.99689	151	9.96656	13	11.09685	184	45	10 1.1 1.0 0.8
846	13	.99841	152	.96669	13	.09873	185	46	20 2.3 2.0 1.6
860	13	.99993	152	.96683	13	.10063	185	47	30 3.5 3.0 2.5
874	14	11.00145	152	9.96697	14	11.10253	186	48	40 4.6 4.0 3.3
888	14	.00298	153	.96710	13	.10449	186	49	50 5.8 5.0 4.1
901	13	11.00451	153	9.96724	13	11.10595	187	50	14 14 13
915	13	.00605	154	.96737	13	.10783	187	51	6 1.4 1.4 1.3
929	14	.00759	155	.96751	13	.10971	188	52	7 1.7 1.6 1.6
943	14	.00914	155	.96764	14	.11160	189	53	8 1.9 1.8 1.8
957	14	.01069	155	.96778	13	.11349	189	54	9 2.2 2.1 2.0
970	13	11.01225	155	9.96792	13	11.11539	190	55	10 2.4 2.3 2.2
984	14	.01381	156	.96805	13	.11730	191	56	20 4.8 4.6 4.5
998	14	.01537	157	.96819	13	.11922	192	57	30 7.2 7.0 6.7
6012	13	.01694	157	.96832	13	.12114	193	58	40 9.6 9.3 9.0
6026	14	.01852	158	.96846	13	.12307	193	59	50 12.1 11.6 11.2
6039	13	11.02010	158	9.96859	14	11.12501	193	60	
Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	'	P. P.



206 LOG. VERSED SINES AND EXTERNAL SECANTS

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'	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	'	P. P.
0	9.93191	14	10.79136	104	9.94356	14	10.85766	117	0	
1	.93506	14	.79240	105	.94370	14	.85884	117	1	
2	9.93520	14	.79345	104	.94384	14	.86001	117	2	
3	9.93535	14	.79450	105	.94398	14	.86119	118	3	
4	9.93549	14	.79555	105	.94413	14	.86237	118	4	
5	9.93564	14	10.79660	105	9.94427	14	10.86355	118	5	
6	.93578	14	.79766	105	.94441	14	.86474	118	6	
7	9.93593	14	.79871	106	.94456	14	.86592	119	7	
8	9.93607	14	.79977	106	.94470	14	.86711	119	8	
9	9.93622	14	.80083	106	.94484	14	.86831	119	9	
10	9.93636	14	10.80189	106	9.94498	14	10.86950	119	10	
11	.93651	14	.80296	106	.94512	14	.87070	120	11	
12	9.93665	14	.80402	106	.94527	14	.87190	120	12	
13	9.93680	14	.80509	107	.94541	14	.87310	120	13	
14	9.93694	14	.80616	107	.94555	14	.87431	120	14	
15	9.93709	14	10.80723	107	9.94569	14	10.87552	121	15	
16	.93723	14	.80831	107	.94584	14	.87673	121	16	
17	9.93738	14	.80938	108	.94598	14	.87794	121	17	
18	9.93752	14	.81046	108	.94612	14	.87916	121	18	
19	9.93767	14	.81154	108	.94626	14	.88038	122	19	
20	9.93781	14	10.81262	108	9.94640	14	10.88160	122	20	
21	.93796	14	.81371	108	.94655	14	.88282	122	21	
22	9.93810	14	.81479	109	.94669	14	.88405	123	22	
23	9.93824	14	.81588	109	.94683	14	.88528	123	23	
24	9.93839	14	.81697	109	.94697	14	.88651	123	24	
25	9.93853	14	10.81806	109	9.94711	14	10.88775	124	25	
26	.93868	14	.81916	109	.94726	14	.88898	124	26	
27	9.93882	14	.82025	110	.94740	14	.89023	124	27	
28	9.93897	14	.82135	110	.94754	14	.89147	124	28	
29	9.93911	14	.82245	110	.94768	14	.89271	124	29	
30	9.93925	14	10.82356	110	9.94782	14	10.89395	125	30	
31	.93940	14	.82466	110	.94796	14	.89521	125	31	
32	9.93954	14	.82577	110	.94810	14	.89647	125	32	
33	9.93969	14	.82688	111	.94825	14	.89773	126	33	
34	9.93983	14	.82799	111	.94839	14	.89899	126	34	
35	9.93997	14	10.82910	111	9.94853	14	10.90025	126	35	
36	.94012	14	.83022	111	.94867	14	.90152	127	36	
37	9.94026	14	.83133	112	.94881	14	.90279	127	37	
38	9.94041	14	.83245	112	.94895	14	.90406	127	38	
39	9.94055	14	.83358	112	.94909	14	.90533	127	39	
40	9.94069	14	10.83470	112	9.94923	14	10.90661	128	40	
41	.94084	14	.83583	112	.94938	14	.90789	128	41	
42	9.94098	14	.83695	113	.94952	14	.90917	129	42	
43	9.94112	14	.83809	113	.94966	14	.91046	129	43	
44	9.94127	14	.83922	113	.94980	14	.91175	129	44	
45	9.94141	14	10.84035	113	9.94994	14	10.91304	129	45	
46	.94155	14	.84149	114	.95008	14	.91434	129	46	
47	9.94170	14	.84263	114	.95022	14	.91564	130	47	
48	9.94184	14	.84377	114	.95036	14	.91694	130	48	
49	9.94198	14	.84492	114	.95050	14	.91825	130	49	
50	9.94213	14	10.84607	115	9.95064	14	10.91956	131	50	
51	.94227	14	.84721	114	.95078	14	.92087	131	51	
52	9.94241	14	.84837	115	.95093	14	.92218	131	52	
53	9.94256	14	.84952	115	.95107	14	.92350	132	53	
54	9.94270	14	.85068	116	.95121	14	.92482	132	54	
55	9.94284	14	10.85183	115	9.95135	14	10.92614	132	55	
56	.94299	14	.85299	116	.95149	14	.92747	133	56	
57	9.94313	14	.85416	116	.95163	14	.92880	133	57	
58	9.94327	14	.85532	116	.95177	14	.93014	133	58	
59	9.94341	14	.85649	117	.95191	14	.93147	133	59	
60	9.94355	14	10.85766	117	9.95205	14	10.93281	134	60	
Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D		P. P.	

130 120  
6 13.0 12.0  
7 15.1 14.0  
8 17.3 16.0  
9 19.5 18.0  
10 21.6 20.0  
20 43.3 40.0  
30 65.0 60.0  
40 86.6 80.0  
50 108.3 100.0

110 100  
6 11.0 10.0  
7 12.8 11.6  
8 14.6 13.3  
9 16.5 15.0  
10 18.3 16.6  
20 36.6 33.3  
30 55.0 50.0  
40 73.3 66.6  
50 91.6 83.3

3 2  
6 0.3 0.2  
7 0.3 0.2  
8 0.4 0.2  
9 0.4 0.3  
10 0.5 0.3  
20 1.0 0.6  
30 1.5 0.9  
40 2.0 1.3  
50 2.5 1.6

1 0  
6 0.1 0.0  
7 0.1 0.0  
8 0.1 0.1  
9 0.1 0.1  
20 0.3 0.2  
30 0.5 0.3  
40 0.6 0.3  
50 0.8 0.4

1 14  
6 1.4 1.4  
7 1.7 1.6  
8 1.9 1.8  
9 2.2 2.1  
10 2.4 2.3  
20 4.8 4.6  
30 7.2 7.0  
40 9.6 9.3  
50 12.1 11.6

OG. VERSED SINES AND EXTERNAL SECANTS 207

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/vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	P. P.
1205	14	0.93281	134	9.96039	14	11.02010	158	0
1219	14	.93416	135	.96053	13	.02168	159	1
1233	14	.93551	135	.96067	13	.02327	159	2
1247	14	.93686	135	.96081	14	.02487	159	3
1261	14	.93821	135	.96095	13	.02646	159	4
1275	14	0.93957	135	9.96108	14	11.02807	160	5
1289	14	.94093	136	.96122	14	.02968	161	6
1303	14	.94228	136	.96136	13	.03129	161	7
1317	14	.94366	137	.96150	14	.03291	161	8
1331	14	.94503	137	.96163	13	.03453	162	9
1345	14	0.94641	137	9.96177	14	11.03616	163	10
1359	13	.94778	138	.96191	14	.03780	164	11
1373	14	.94917	138	.96205	13	.03944	164	12
1387	14	.95055	139	.96218	14	.04108	164	13
1401	14	.95194	139	.96232	13	.04273	165	14
1415	14	0.95333	139	9.96246	13	11.04436	165	15
1429	14	.95473	140	.96259	14	.04604	166	16
1443	14	.95613	140	.96273	13	.04771	167	17
1457	14	.95753	140	.96287	14	.04938	167	18
1471	14	.95894	141	.96301	13	.05106	168	19
1485	14	0.96035	141	9.96314	14	11.05274	169	20
1499	14	.96175	142	.96328	14	.05443	169	21
1513	14	.96318	142	.96342	13	.05612	169	22
1527	14	.96461	142	.96355	14	.05782	170	23
1540	13	.96603	142	.96369	13	.05952	170	24
1554	14	0.96746	143	9.96383	14	11.06123	171	25
1568	14	.96889	143	.96397	13	.06295	171	26
1582	14	.97033	144	.96410	13	.06467	172	27
1596	14	.97177	144	.96424	13	.06640	173	28
1610	14	.97322	144	.96438	14	.06813	173	29
1624	14	0.97467	145	9.96451	13	11.06987	174	30
1638	13	.97612	145	.96465	13	.07161	174	31
1652	14	.97758	145	.96479	14	.07336	175	32
1666	14	.97904	146	.96492	13	.07512	176	33
1680	14	.98050	146	.96506	13	.07688	176	34
1694	13	0.98197	147	9.96519	13	11.07865	177	35
1708	14	.98345	147	.96533	14	.08043	178	36
1722	14	.98492	148	.96547	13	.08221	179	37
1736	14	.98640	149	.96560	14	.08400	179	38
1750	14	.98788	149	.96574	13	.08579	179	39
1764	13	0.98938	149	9.96588	13	11.08759	180	40
1778	14	.99087	149	.96601	13	.08940	180	41
1792	14	.99237	150	.96615	13	.09121	182	42
1806	14	.99387	150	.96629	14	.09303	182	43
1820	14	.99538	151	.96642	13	.09486	182	44
1834	14	0.99689	151	9.96656	13	11.09668	183	45
1848	13	.99841	151	.96669	13	.09853	184	46
1862	13	0.99993	152	.96683	13	.10038	185	47
1876	14	11.00145	152	.96697	14	.10223	185	48
1890	14	.00298	153	.96710	13	.10409	186	49
1904	13	0.00451	153	9.96724	13	11.10595	187	50
1918	14	.00605	154	.96737	13	.10783	187	51
1932	14	.00759	154	.96751	13	.10971	188	52
1946	14	.00914	155	.96764	14	.11160	189	53
1960	14	.01069	155	.96778	13	.11349	189	54
1974	13	0.01225	155	9.96792	13	11.11539	190	55
1988	14	.01381	156	.96805	13	.11730	191	56
1992	13	.01537	157	.96819	13	.11922	192	57
2006	14	.01694	157	.96832	13	.12114	193	58
2020	14	.01852	158	.96846	13	.12307	193	59
2034	13	11.02010	158	9.96859	13	11.12501	193	60
2048	14	.02010	158	.96859	13	.12501	193	60
2062	14	.02168	158	.96859	13	.12501	193	60
2076	14	.02327	158	.96859	13	.12501	193	60
2090	14	.02487	158	.96859	13	.12501	193	60
2104	14	.02646	158	.96859	13	.12501	193	60
2118	14	.02807	158	.96859	13	.12501	193	60
2132	14	.02968	158	.96859	13	.12501	193	60
2146	14	.03129	158	.96859	13	.12501	193	60
2160	14	.03291	158	.96859	13	.12501	193	60
2174	14	.03453	158	.96859	13	.12501	193	60
2188	14	0.03616	158	9.96859	13	11.03616	183	10
2202	14	.03780	158	.96859	13	.03780	164	12
2216	14	.03944	158	.96859	13	.03944	164	12
2230	14	.04108	158	.96859	13	.04108	164	13
2244	14	.04273	158	.96859	13	.04273	165	14
2258	14	.04436	158	.96859	13	.04436	165	15
2272	14	.04604	158	.96859	13	.04604	166	16
2286	14	.04771	158	.96859	13	.04771	167	17
2300	14	.04938	158	.96859	13	.04938	167	18
2314	14	.05106	158	.96859	13	.05106	168	19
2328	14	0.05274	158	9.96314	14	11.05274	169	20
2342	14	.05443	158	.96314	14	.05443	169	21
2356	14	.05612	158	.96314	13	.05612	169	22
2370	14	.05782	158	.96314	13	.05782	169	23
2384	14	.05952	158	.96314	13	.05952	170	24
2398	14	.06123	158	.96314	13	.06123	171	25
2412	14	.06295	158	.96314	13	.06295	171	26
2426	14	.06467	158	.96314	13	.06467	172	27
2440	14	.06640	158	.96314	13	.06640	173	28
2454	14	.06813	158	.96314	13	.06813	173	29
2468	14	.06987	158	.96314	13	.06987	174	30
2482	14	.07161	158	.96314	13	.07161	174	31
2496	14	.07336	158	.96314	13	.07336	175	32
2510	14	.07512	158	.96314	13	.07512	176	33
2524	14	.07688	158	.96314	13	.07688	176	34
2538	14	.07865	158	.96314	13	.07865	177	35
2552	14	.08043	158	.96314	13	.08043	178	36
2566	14	.08221	158	.96314	13	.08221	179	37
2580	14	.08400	158	.96314	13	.08400	179	38
2594	14	.08579	158	.96314	13	.08579	179	39
2608	14	0.08759	158	9.96588	13	11.08759	180	40
2622	14	.08940	158	.96601	13	.08940	181	41
2636	14	.09121	158	.96615	13	.09121	182	42
2650	14	.09303	158	.96629	13	.09303	182	43
2664	14	.09486	158	.96642	13	.09486	182	44
2678	14	.09668	158	.96656	13	.09668	183	45
2692	14	.09853	158	.96669	13	.09853	184	46
2706	14	.10038	158	.96683	13	.10038	185	47
2720	14	.10223	158	.96697	13	.10223	185	48
2734	14	.10409	158	.96710	13	.10409	186	49
2748	14	0.10595	158	9.96724	13	11.10595	187	50
2762	14	.10783	158	.96737	13	.10783	187	51
2776	14	.10971	158	.96751	13	.10971	188	52
2790	14	.11160	158	.96764	14	.11160	189	53
2804	14	.11349	158	.96778	13	.11349	189	54
2818	14	.11539	158	.96792	13	.11539	190	55
2832	14	.11730	158	.96805	13	.11730	191	56
2846	14	.11922	158	.96819	13	.11922	192	57
2860	14	.12114	158	.96832	13	.12114	193	58
2874	14	.12307	158	.96846	13	.12307	193	59
2888	14	11.12501	158	9.96859	13	11.12501	193	60
2902	14	.12501	158	.96859	13	.12501	193	60
2916	14	.12501	158	.96859	13	.12501	193	60
2930	14	.12501	158	.96859	13	.12501	193	60
2944	14	.12501	158	.96859	13	.12501	193	60
2958	14	.12501	158	.96859	13	.12501	193	60
2972	14	.12501	158	.96859	13	.12501	193	60
2986	14	.12501	158	.96859	13	.12501	193	60
3000	14	.12501	158	.96859	13	.12501	193	60

208 LOG. VERSED SINES AND EXTERNAL SECANTS

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	Lg. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	P. P.
0	9.96859	13	11.12501	195	9.97665	13	11.25785	0	250 240
1	9.96837	13	12.696	195	9.97679	13	26040	1	6 25.0 24.0
2	9.96887	13	12.891	195	9.97692	13	26297	2	7 29.1 28.0
3	9.96900	13	13.087	196	9.97705	13	26554	3	8 33.3 32.0
4	9.96914	13	13.284	196	9.97718	13	26814	4	9 37.5 36.0
5	9.96927	13	11.13482	198	9.97732	13	27074	5	10 41.6 40.0
6	9.96941	13	13.680	198	9.97745	13	27336	6	20 83.3 80.0
7	9.96954	13	13.879	199	9.97758	13	27599	7	30 125.0 120.0
8	9.96968	13	14.079	200	9.97772	13	27864	8	40 166.6 160.0
9	9.96981	13	14.280	201	9.97785	13	28131	9	50 208.3 200.0
10	9.96995	13	11.14482	202	9.97799	13	28398	10	230 220
11	9.97008	13	14.684	203	9.97811	13	28668	11	6 23.0 22.0
12	9.97022	13	14.887	204	9.97825	13	28938	12	7 26.8 25.5
13	9.97035	13	15.092	205	9.97838	13	29211	13	8 30.6 29.3
14	9.97049	13	15.297	205	9.97851	13	29485	14	9 34.5 33.0
15	9.97063	13	11.15501	206	9.97864	13	29760	15	10 38.3 36.5
16	9.97076	13	15.709	208	9.97978	13	30037	16	20 76.6 73.3
17	9.97089	13	15.917	208	9.97991	13	30316	17	30 115.0 110.0
18	9.97103	13	16.125	208	9.97999	13	30599	18	40 153.3 146.6
19	9.97116	13	16.334	209	9.97999	13	30878	19	50 191.6 183.3
20	9.97130	13	11.16544	210	9.97999	13	31162	20	210 200
21	9.97143	13	16.545	211	9.97999	13	31447	21	6 21.0 20.0
22	9.97157	13	16.751	212	9.97999	13	31734	22	7 24.5 23.0
23	9.97171	13	16.958	214	9.97999	13	32023	23	8 28.0 26.6
24	9.97185	13	17.165	214	9.97999	13	32313	24	9 31.5 30.0
25	9.97199	13	11.17709	215	9.97999	13	32606	25	10 35.0 33.3
26	9.97213	13	17.376	216	9.97999	13	32900	26	20 70.0 66.6
27	9.97227	13	17.583	217	9.97999	13	33196	27	30 105.0 100.0
28	9.97241	13	17.790	218	9.97999	13	33494	28	40 140.0 133.3
29	9.97255	13	18.000	219	9.97999	13	33793	29	50 175.0 166.6
30	9.97269	13	11.18909	220	9.97999	13	34095	30	190 4 3
31	9.97283	13	18.206	221	9.97999	13	34398	31	6 19.0 10.4 0.3
32	9.97297	13	18.413	222	9.97999	13	34703	32	7 22.1 10.4 0.3
33	9.97311	13	18.620	223	9.97999	13	35011	33	8 25.1 0.4 0.4
34	9.97325	13	18.827	224	9.97999	13	35321	34	9 28.5 0.6 0.4
35	9.97339	13	19.034	225	9.97999	13	35633	35	10 31.0 0.8 0.5
36	9.97353	13	19.241	226	9.97999	13	35947	36	20 63.0 1.3 1.0
37	9.97367	13	19.448	227	9.97999	13	36263	37	30 95.0 2.0 1.5
38	9.97381	13	19.655	228	9.97999	13	36581	38	40 126.0 2.6 2.0
39	9.97395	13	19.862	229	9.97999	13	36901	39	50 158.0 3.2 2.5
40	9.97409	13	11.20011	230	9.97999	13	37223	40	60 1 0
41	9.97423	13	19.869	231	9.97999	13	37547	41	6 0.0 0.1 0.0
42	9.97437	13	19.869	232	9.97999	13	37873	42	7 0.0 0.1 0.0
43	9.97451	13	19.869	233	9.97999	13	38201	43	8 0.0 0.1 0.0
44	9.97465	13	19.869	234	9.97999	13	38531	44	9 0.0 0.1 0.0
45	9.97479	13	19.869	235	9.97999	13	38863	45	10 0.0 0.1 0.0
46	9.97493	13	19.869	236	9.97999	13	39197	46	20 0.0 0.0 0.0
47	9.97507	13	19.869	237	9.97999	13	39533	47	30 0.0 0.0 0.0
48	9.97521	13	19.869	238	9.97999	13	39871	48	40 0.0 0.0 0.0
49	9.97535	13	19.869	239	9.97999	13	40211	49	50 0.0 0.0 0.0
50	9.97549	13	19.869	240	9.97999	13	40553	50	1.0 0.0 0.4
51	9.97563	13	19.869	241	9.97999	13	40897	51	6 1.4 1.3 1.3
52	9.97577	13	19.869	242	9.97999	13	41243	52	7 1.1 1.3 1.5
53	9.97591	13	19.869	243	9.97999	13	41591	53	8 1.1 1.6 1.7
54	9.97605	13	19.869	244	9.97999	13	41941	54	9 2.1 1.9 2.1
55	9.97619	13	19.869	245	9.97999	13	42293	55	10 2.2 2.1 2.1
56	9.97633	13	19.869	246	9.97999	13	42647	56	11 2.4 2.4 2.4
57	9.97647	13	19.869	247	9.97999	13	43003	57	12 2.6 2.6 2.6
58	9.97661	13	19.869	248	9.97999	13	43361	58	13 2.8 2.8 2.8
59	9.97675	13	19.869	249	9.97999	13	43721	59	14 3.0 3.0 3.0
60	9.97689	13	19.869	250	9.97999	13	44083	60	15 3.2 3.2 3.2

LOG. VERSED SINES AND EXTERNAL SECANTS 209

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g. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	'	P. P.
98457	13	11.44175	376	9.99235	12	11.75050	742	0	
98470	13	.44551	379	.99248	13	.75792	755	1	
98483	13	.44931	382	.99261	13	.76547	768	2	
98496	13	.45313	386	.99274	13	.77316	781	3	
98509	13	.45699	389	.99287	13	.78097	795	4	
98522	13	11.46088	392	9.99299	12	11.78892	809	5	
98535	13	.46480	395	.99312	13	.79702	825	6	
98548	13	.46876	399	.99325	12	.80527	840	7	
98562	13	.47275	402	.99338	13	.81367	856	8	
98575	13	.47677	406	.99351	12	.82223	872	9	
98588	13	11.48083	409	9.99363	13	11.83095	890	10	
98601	13	.48493	413	.99376	13	.83986	908	11	
98614	13	.48906	417	.99389	12	.84894	927	12	
98627	13	.49323	420	.99402	13	.85821	947	13	
98640	13	.49743	425	.99415	13	.86768	967	14	
98653	13	11.50168	428	9.99428	12	11.87735	989	15	
98666	13	.50597	432	.99440	13	.88724	1009	16	
98679	13	.51029	436	.99453	12	.89735	1034	17	
98692	13	.51466	440	.99466	13	.90769	1059	18	
98705	13	.51906	445	.99479	12	.91829	1085	19	
98718	13	11.52351	449	9.99491	13	11.92914	1112	20	
98731	13	.52801	454	.99504	13	.94026	1140	21	
98744	13	.53255	458	.99517	12	.95167	1171	22	
98757	13	.53713	463	.99530	13	.96338	1203	23	
98770	13	.54176	467	.99543	12	.97541	1236	24	
98783	13	11.54643	472	9.99555	13	11.98777	1271	25	
98796	13	.55116	477	.99568	12	12.00048	1309	26	
98809	13	.55593	482	.99581	13	.01358	1349	27	
98822	13	.56076	487	.99594	12	.02707	1391	28	
98835	13	.56563	492	.99606	13	.04098	1436	29	
98848	13	11.57056	498	9.99619	12	12.05535	1485	30	
98861	13	.57554	504	.99632	13	.07020	1537	31	
98874	13	.58058	509	.99645	12	.08557	1592	32	
98887	13	.58567	515	.99657	13	.10149	1652	33	
98900	13	.59082	520	.99670	12	.11801	1716	34	
98913	12	11.59602	527	9.99683	13	12.13517	1785	35	
98925	13	.60129	533	.99695	13	.15302	1861	36	
98938	13	.60662	539	.99708	12	.17163	1943	37	
98951	13	.61202	545	.99721	13	.19106	2033	38	
98964	13	.61747	552	.99734	12	.21139	2131	39	
98977	13	11.62300	559	9.99746	13	12.23271	2240	40	
98990	13	.62859	566	.99759	12	.25511	2361	41	
99003	13	.63425	573	.99772	13	.27872	2495	42	
99016	12	.63998	581	.99784	12	.30367	2645	43	
99029	12	.64579	589	.99797	13	.33013	2815	44	
99042	13	11.65167	595	9.99810	12	12.35828	3009	45	
99055	13	.65752	604	.99823	12	.38837	3231	46	
99068	13	.66336	611	.99835	13	.42068	3489	47	
99081	13	.66978	620	.99848	12	.45557	3791	48	
99093	12	.67598	628	.99861	13	.49349	4152	49	
99106	13	11.68227	638	9.99873	12	12.53501	4586	50	
99119	13	.68865	646	.99886	12	.58089	5127	51	
99132	13	.69511	656	.99899	13	.63217	5812	52	
99145	13	.70168	666	.99911	12	.69029	6707	53	
99158	13	.70834	675	.99924	13	.75736	7931	54	
99171	13	11.71509	685	9.99937	12	12.83667	9704	55	
99184	12	.72196	695	.99949	13	.93371	12506	56	
99197	12	.72892	707	.99962	12	13.05877	17821	57	
99209	12	.73600	719	.99974	13	.23499	30116	58	
99222	13	.74319	730	.99987	12	.53615		59	
99235	13	11.75050	742	10.00000	12	Infinity		60	
g. Vers.	D	Log. Exs.	D	Lg. Vers.	D	Log. Exs.	D	'	P. P.

13 13  
6 1.3 1.3  
7 1.6 1.5  
8 1.8 1.7  
9 2.0 1.9  
10 2.2 2.1  
20 4.5 4.3  
30 6.7 6.5  
40 9.0 8.6  
50 11.2 10.8

12  
6 1.2  
7 1.4  
8 1.6  
9 1.9  
10 2.1  
20 4.1  
30 6.2  
40 8.3  
50 10.4

## FUNCTIONS OF A ONE-DEGREE CURVE

The Long Chords, Mid-Ordinates, Externals, and Tangent Distances of this table are for a curve of 5730 feet radius. To find the corresponding functions of any other curve divide the tabular values by the degree of curve.

For metric curves having a 20-meter chord, this is a table of the functions of a two-tenth degree curve. Multiply the *values in the table* by 0.2 to obtain the functions, in meters, of a one-degree metric curve.

	0°				1°				
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	0.00	0.000	0.000	0.00	100.00	0.218	0.218	50.00	0
2	3.33	0.000	0.000	1.67	103.33	0.233	0.233	51.67	2
4	6.67	0.001	0.001	3.33	106.66	0.248	0.248	53.33	4
6	10.00	0.002	0.002	5.00	110.00	0.264	0.264	55.00	6
8	13.33	0.004	0.004	6.67	113.33	0.280	0.280	56.67	8
10	16.67	0.006	0.006	8.33	116.66	0.297	0.297	58.33	10
12	20.00	0.009	0.009	10.00	120.00	0.314	0.314	60.00	12
14	23.33	0.012	0.012	11.67	123.33	0.332	0.332	61.67	14
16	26.67	0.015	0.015	13.33	126.66	0.350	0.350	63.33	16
18	30.00	0.019	0.019	15.00	130.00	0.368	0.368	65.00	18
20	33.33	0.024	0.024	16.67	133.33	0.388	0.388	66.67	20
22	36.67	0.029	0.029	18.33	136.66	0.407	0.407	68.33	22
24	40.00	0.035	0.035	20.00	140.00	0.427	0.427	70.00	24
26	43.33	0.041	0.041	21.67	143.33	0.448	0.448	71.67	26
28	46.67	0.048	0.048	23.33	146.66	0.469	0.469	73.33	28
30	50.00	0.054	0.054	25.00	150.00	0.491	0.491	75.00	30
32	53.33	0.062	0.062	26.67	153.33	0.513	0.513	76.67	32
34	56.67	0.070	0.070	28.33	156.66	0.536	0.536	78.33	34
36	60.00	0.079	0.079	30.00	160.00	0.559	0.559	80.00	36
38	63.33	0.088	0.088	31.67	163.33	0.582	0.582	81.67	38
40	66.67	0.097	0.097	33.33	166.66	0.606	0.606	83.33	40
42	70.00	0.107	0.107	35.00	170.00	0.630	0.630	85.00	42
44	73.33	0.117	0.117	36.67	173.33	0.655	0.655	86.67	44
46	76.67	0.128	0.128	38.33	176.66	0.681	0.681	88.33	46
48	80.00	0.140	0.140	40.00	180.00	0.706	0.706	90.00	48
50	83.33	0.151	0.151	41.67	183.33	0.732	0.732	91.67	50
52	86.67	0.164	0.164	43.33	186.66	0.760	0.760	93.33	52
54	90.00	0.178	0.178	45.00	190.00	0.788	0.788	95.00	54
56	93.33	0.190	0.190	46.67	193.33	0.815	0.815	96.67	56
58	96.67	0.204	0.204	48.33	196.66	0.844	0.844	98.33	58
60	100.00	0.218	0.218	50.00	199.99	0.873	0.873	100.00	60

FUNCTIONS OF A ONE-DEGREE CURVE 211

#	2°				3°				#
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	199.98	0.873	0.873	100.00	299.96	1.964	1.964	150.07	0
2	203.31	0.902	0.902	101.67	303.29	2.008	2.009	151.74	2
4	206.64	0.932	0.932	103.34	306.62	2.053	2.054	153.41	4
6	209.97	0.962	0.962	105.01	309.95	2.098	2.099	155.08	6
8	213.31	0.993	0.993	106.68	313.29	2.143	2.144	156.75	8
10	216.64	1.024	1.024	108.35	316.62	2.188	2.189	158.42	10
12	219.97	1.056	1.056	110.02	319.95	2.235	2.236	160.09	12
14	223.30	1.088	1.088	111.69	323.28	2.282	2.283	161.76	14
16	226.64	1.121	1.121	113.36	326.62	2.329	2.330	163.43	16
18	229.97	1.154	1.154	115.02	329.95	2.376	2.377	165.09	18
20	233.30	1.188	1.188	116.69	333.28	2.424	2.425	166.76	20
22	236.63	1.222	1.222	118.36	336.61	2.473	2.474	168.43	22
24	239.97	1.256	1.256	120.03	339.95	2.523	2.523	170.10	24
26	243.30	1.292	1.292	121.70	343.28	2.573	2.573	171.77	26
28	246.63	1.328	1.328	123.37	346.61	2.623	2.623	173.44	28
30	249.96	1.364	1.364	125.03	349.94	2.672	2.673	175.10	30
32	253.29	1.399	1.399	126.70	353.27	2.724	2.725	176.77	32
34	256.62	1.437	1.437	128.37	356.60	2.776	2.777	178.43	34
36	259.96	1.475	1.475	130.04	359.94	2.828	2.829	180.09	36
38	263.29	1.513	1.513	131.71	363.27	2.880	2.881	181.73	38
40	266.62	1.552	1.552	133.38	366.60	2.933	2.934	183.40	40
42	269.96	1.592	1.592	135.05	369.94	2.987	2.988	185.07	42
44	273.29	1.632	1.632	136.72	373.27	3.042	3.043	186.74	44
46	276.62	1.672	1.672	138.38	376.60	3.096	3.097	188.40	46
48	279.96	1.712	1.712	140.05	379.94	3.151	3.152	190.07	48
50	283.29	1.752	1.752	141.72	383.27	3.206	3.207	191.74	50
52	286.62	1.794	1.794	143.39	386.60	3.263	3.264	193.41	52
54	289.96	1.836	1.836	145.06	389.94	3.320	3.321	195.08	54
56	293.29	1.878	1.878	146.73	393.27	3.377	3.378	196.75	56
58	296.62	1.921	1.921	148.40	396.60	3.434	3.435	198.42	58
60	299.96	1.964	1.964	150.07	399.94	3.491	3.492	200.09	60

#	4°				5°				#
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	399.94	3.491	3.492	200.09	499.88	5.454	5.459	250.17	0
2	403.27	3.550	3.551	201.76	503.21	5.527	5.533	251.84	2
4	406.60	3.609	3.610	203.43	506.54	5.601	5.607	253.51	4
6	409.93	3.668	3.670	205.10	509.87	5.675	5.681	255.18	6
8	413.26	3.727	3.730	206.77	513.20	5.749	5.755	256.85	8
10	416.59	3.787	3.790	208.44	516.53	5.823	5.829	258.52	10
12	419.92	3.846	3.851	210.11	519.86	5.899	5.905	260.20	12
14	423.26	3.910	3.913	211.77	523.19	5.975	5.981	261.86	14
16	426.59	3.972	3.975	213.45	526.52	6.052	6.058	263.54	16
18	429.92	4.034	4.037	215.11	529.85	6.129	6.135	265.20	18
20	433.25	4.096	4.099	216.78	533.18	6.206	6.212	266.87	20
22	436.58	4.160	4.163	218.45	536.51	6.284	6.290	268.54	22
24	439.91	4.224	4.227	220.12	539.84	6.362	6.369	270.21	24
26	443.24	4.288	4.291	221.79	543.17	6.441	6.448	271.88	26
28	446.58	4.353	4.356	223.46	546.50	6.520	6.527	273.54	28
30	449.91	4.418	4.421	225.13	549.83	6.599	6.606	275.21	30
32	453.24	4.484	4.487	226.80	553.17	6.680	6.687	276.88	32
34	456.57	4.550	4.554	228.47	556.50	6.761	6.768	278.55	34
36	459.90	4.617	4.621	230.14	559.83	6.842	6.849	280.23	36
38	463.23	4.684	4.688	231.81	563.16	6.923	6.931	281.90	38
40	466.56	4.751	4.755	233.48	566.49	7.005	7.013	283.57	40
42	469.89	4.820	4.824	235.15	569.82	7.088	7.096	285.24	42
44	473.22	4.889	4.893	236.82	573.15	7.171	7.180	286.91	44
46	476.56	4.958	4.962	238.48	576.48	7.255	7.264	288.59	46
48	479.89	5.027	5.031	240.15	579.81	7.339	7.348	290.26	48
50	483.22	5.096	5.100	241.82	583.14	7.423	7.432	291.93	50
52	486.55	5.167	5.171	243.49	586.47	7.508	7.517	293.60	52
54	489.88	5.238	5.243	245.16	589.80	7.593	7.603	295.27	54
56	493.21	5.310	5.315	246.83	593.13	7.678	7.689	296.95	56
58	496.54	5.382	5.387	248.50	596.46	7.764	7.775	298.62	58
60	499.88	5.454	5.459	250.17	599.80	7.850	7.861	300.30	60

212 FUNCTIONS OF A ONE-DEGREE CURVE

'	6°				7°				'
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	599.80	7.850	7.861	800.30	699.60	10.69	10.71	850.44	0
2	608.13	7.940	7.951	801.97	702.93	10.79	10.81	852.11	2
4	606.46	8.030	8.041	808.64	706.26	10.80	10.82	853.79	4
6	609.78	8.120	8.131	805.31	709.58	11.00	11.02	855.46	6
8	613.11	8.210	8.221	806.98	712.91	11.11	11.13	857.13	8
10	616.44	8.300	8.311	808.65	716.24	11.21	11.23	858.81	10
12	619.76	8.390	8.401	810.32	719.56	11.31	11.33	860.48	12
14	623.09	8.480	8.491	811.99	722.89	11.42	11.44	862.15	14
16	626.42	8.570	8.581	813.66	726.21	11.52	11.54	863.83	16
18	629.74	8.660	8.671	815.33	729.53	11.63	11.65	865.50	18
20	633.07	8.750	8.761	817.00	732.86	11.73	11.75	867.17	20
22	636.40	8.844	8.856	818.67	736.19	11.84	11.86	868.85	22
24	639.72	8.939	8.951	820.34	739.51	11.95	11.97	870.52	24
26	643.05	9.033	9.046	822.01	742.84	12.06	12.08	872.19	26
28	646.38	9.128	9.141	823.68	746.17	12.17	12.19	873.86	28
30	649.70	9.222	9.236	825.35	749.49	12.27	12.30	875.54	30
32	653.03	9.317	9.331	827.02	752.82	12.38	12.41	877.22	32
34	656.36	9.411	9.426	828.69	756.15	12.49	12.52	878.90	34
36	659.69	9.506	9.521	830.37	759.47	12.60	12.63	880.57	36
38	663.02	9.600	9.616	832.04	762.80	12.71	12.74	882.24	38
40	666.34	9.695	9.712	833.71	766.13	12.82	12.85	883.92	40
42	669.67	9.794	9.812	835.38	769.45	12.93	12.96	885.60	42
44	673.00	9.894	9.912	837.05	772.78	13.04	13.08	887.27	44
46	676.32	9.993	10.01	838.73	776.11	13.15	13.19	888.95	46
48	679.65	10.09	10.11	840.40	779.43	13.26	13.31	890.62	48
50	682.98	10.19	10.21	842.07	782.76	13.37	13.42	892.30	50
52	686.30	10.29	10.31	843.74	786.09	13.48	13.53	893.98	52
54	689.63	10.39	10.41	845.41	789.41	13.59	13.65	895.65	54
56	692.96	10.49	10.51	847.08	792.74	13.70	13.76	897.33	56
58	696.28	10.59	10.61	848.76	796.07	13.81	13.88	899.01	58
60	699.60	10.69	10.71	850.44	799.40	13.96	13.99	900.70	60

'	8°				9°				'
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	799.40	13.96	13.99	400.70	899.10	17.66	17.71	450.95	0
2	802.72	14.07	14.10	402.37	902.42	17.79	17.84	452.63	2
4	806.04	14.19	14.22	404.05	905.74	17.92	17.98	454.31	4
6	809.37	14.31	14.34	405.72	909.07	18.06	18.11	455.98	6
8	812.69	14.43	14.46	407.39	912.39	18.19	18.25	457.66	8
10	816.01	14.55	14.58	409.06	915.71	18.32	18.38	459.34	10
12	819.34	14.66	14.70	410.74	919.04	18.46	18.52	461.02	12
14	822.66	14.78	14.82	412.41	922.36	18.59	18.65	462.70	14
16	825.98	14.90	14.94	414.08	925.68	18.72	18.79	464.37	16
18	829.31	15.02	15.06	415.75	929.01	18.86	18.92	466.05	18
20	832.63	15.14	15.18	417.43	932.33	18.99	19.06	467.73	20
22	835.95	15.26	15.30	419.10	935.65	19.12	19.19	469.41	22
24	839.28	15.38	15.43	420.77	938.98	19.26	19.33	471.08	24
26	842.60	15.51	15.55	422.45	942.30	19.40	19.47	472.76	26
28	845.92	15.63	15.68	424.12	945.62	19.54	19.61	474.43	28
30	849.25	15.75	15.80	425.79	948.95	19.68	19.75	476.10	30
32	852.57	15.88	15.93	427.47	952.27	19.82	19.89	477.78	32
34	855.89	16.00	16.05	429.15	955.59	19.96	20.03	479.46	34
36	859.22	16.12	16.18	430.82	958.92	20.10	20.17	481.14	36
38	862.54	16.25	16.30	432.50	962.24	20.24	20.31	482.83	38
40	865.86	16.38	16.43	434.18	965.56	20.38	20.45	484.51	40
42	869.19	16.50	16.55	435.86	968.89	20.52	20.59	486.19	42
44	872.51	16.63	16.68	437.54	972.21	20.66	20.74	487.87	44
46	875.83	16.76	16.81	439.21	975.53	20.80	20.88	489.55	46
48	879.16	16.89	16.94	440.89	978.86	20.94	21.03	491.23	48
50	882.48	17.02	17.07	442.57	982.18	21.09	21.17	492.92	50
52	885.80	17.14	17.19	444.25	985.50	21.23	21.31	494.60	52
54	889.13	17.27	17.32	445.93	988.83	21.37	21.46	496.28	54
56	892.45	17.40	17.45	447.60	992.15	21.51	21.60	497.96	56
58	895.77	17.53	17.58	449.28	995.47	21.65	21.75	499.65	58
60	899.10	17.66	17.71	450.95	998.80	21.80	21.89	501.33	60

FUNCTIONS OF A ONE-DEGREE CURVE 213

°	10°				11°				°
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	998.8	21.80	21.89	501.32	1098.4	26.38	26.50	551.74	0
2	1002.1	21.94	22.03	503.00	1101.7	26.54	26.66	553.42	2
4	1005.4	22.09	22.18	504.68	1105.0	26.70	26.83	555.10	4
6	1008.8	22.24	22.33	506.36	1108.3	26.86	26.99	556.78	6
8	1012.1	22.39	22.48	508.04	1111.7	27.02	27.16	558.46	8
10	1015.4	22.54	22.63	509.72	1115.0	27.19	27.32	560.14	10
12	1018.7	22.68	22.78	511.40	1118.3	27.35	27.48	561.82	12
14	1022.0	22.83	22.93	513.08	1121.6	27.51	27.65	563.50	14
16	1025.4	22.98	23.08	514.76	1124.9	27.67	27.81	565.18	16
18	1028.7	23.13	23.23	516.44	1128.2	27.83	27.98	566.86	18
20	1032.0	23.28	23.38	518.12	1131.6	28.00	28.14	568.54	20
22	1035.3	23.43	23.53	519.80	1134.9	28.17	28.30	570.22	22
24	1038.6	23.58	23.68	521.48	1138.2	28.34	28.47	571.90	24
26	1042.0	23.73	23.84	523.16	1141.5	28.50	28.64	573.58	26
28	1045.3	23.88	23.99	524.85	1144.8	28.67	28.81	575.27	28
30	1048.6	24.04	24.14	526.53	1148.1	28.84	28.98	576.95	30
32	1051.9	24.19	24.30	528.21	1151.5	29.00	29.14	578.63	32
34	1055.2	24.34	24.45	529.89	1154.8	29.17	29.31	580.32	34
36	1058.6	24.49	24.60	531.57	1158.1	29.34	29.48	582.00	36
38	1061.9	24.64	24.76	533.25	1161.4	29.50	29.65	583.69	38
40	1065.2	24.80	24.91	534.93	1164.7	29.67	29.82	585.37	40
42	1068.5	24.95	25.06	536.61	1168.0	29.84	29.99	587.05	42
44	1071.8	25.11	25.22	538.29	1171.4	30.01	30.17	588.74	44
46	1075.2	25.27	25.38	539.97	1174.7	30.18	30.34	590.42	46
48	1078.5	25.43	25.54	541.65	1178.0	30.35	30.52	592.11	48
50	1081.8	25.59	25.70	543.33	1181.3	30.53	30.69	593.79	50
52	1085.1	25.74	25.86	545.01	1184.6	30.70	30.86	595.47	52
54	1088.4	25.90	26.02	546.69	1187.9	30.87	31.04	597.16	54
56	1091.8	26.06	26.18	548.37	1191.3	31.04	31.21	598.84	56
58	1095.1	26.22	26.34	550.06	1194.6	31.21	31.39	600.53	58
60	1098.4	26.38	26.50	551.74	1197.9	31.39	31.56	602.22	60

°	12°				13°				°
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	1197.9	31.39	31.56	602.22	1297.3	36.83	37.07	652.87	0
2	1201.2	31.57	31.73	603.91	1300.6	37.02	37.26	654.56	2
4	1204.5	31.74	31.91	605.60	1303.9	37.21	37.46	656.25	4
6	1207.8	31.92	32.09	607.28	1307.2	37.40	37.65	657.93	6
8	1211.1	32.09	32.27	608.97	1310.5	37.59	37.85	659.62	8
10	1214.5	32.27	32.45	610.66	1313.8	37.79	38.04	661.31	10
12	1217.8	32.45	32.63	612.35	1317.2	37.98	38.23	663.00	12
14	1221.1	32.62	32.81	614.04	1320.5	38.17	38.43	664.69	14
16	1224.4	32.80	32.99	615.72	1323.8	38.36	38.62	666.37	16
18	1227.7	32.97	33.17	617.41	1327.1	38.55	38.82	668.06	18
20	1231.0	33.15	33.35	619.10	1330.4	38.75	39.01	669.75	20
22	1234.3	33.33	33.53	620.79	1333.7	38.95	39.20	671.44	22
24	1237.7	33.51	33.72	622.48	1337.0	39.15	39.40	673.13	24
26	1241.0	33.69	33.90	624.16	1340.3	39.35	39.60	674.81	26
28	1244.3	33.87	34.09	625.85	1343.6	39.54	39.80	676.51	28
30	1247.6	34.06	34.27	627.55	1346.9	39.74	40.00	678.20	30
32	1250.9	34.24	34.45	629.24	1350.3	39.94	40.19	679.89	32
34	1254.2	34.42	34.64	630.93	1353.6	40.13	40.39	681.58	34
36	1257.5	34.60	34.82	632.61	1356.9	40.33	40.59	683.26	36
38	1260.8	34.78	35.01	634.30	1360.2	40.52	40.79	684.95	38
40	1264.2	34.97	35.19	635.99	1363.5	40.71	40.99	686.64	40
42	1267.5	35.16	35.37	637.68	1366.8	40.91	41.19	688.33	42
44	1270.8	35.34	35.56	639.37	1370.1	41.11	41.40	690.02	44
46	1274.1	35.53	35.75	641.05	1373.4	41.31	41.60	691.70	46
48	1277.4	35.71	35.94	642.74	1376.7	41.51	41.81	693.39	48
50	1280.7	35.90	36.13	644.43	1380.0	41.71	42.01	695.08	50
52	1284.0	36.09	36.31	646.12	1383.4	41.91	42.21	696.77	52
54	1287.4	36.27	36.50	647.81	1386.7	42.11	42.42	698.46	54
56	1290.7	36.46	36.69	649.49	1390.0	42.31	42.62	700.14	56
58	1294.0	36.64	36.88	651.18	1393.3	42.51	42.83	701.83	58
60	1297.3	36.83	37.07	652.87	1396.6	42.71	43.03	703.53	60



214 FUNCTIONS OF A ONE-DEGREE CURVE

°	14°				15°				°
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	1306.6	42.71	43.03	703.53	1405.9	49.02	49.44	754.85	0
2	1399.9	42.92	43.23	705.23	1499.2	49.24	49.66	756.05	2
4	1403.2	43.12	43.44	706.92	1502.5	49.46	49.89	757.74	4
6	1406.5	43.33	43.65	708.62	1505.8	49.68	50.11	759.44	6
8	1409.8	43.53	43.86	710.31	1509.1	49.90	50.34	761.13	8
10	1413.1	43.74	44.07	712.01	1512.4	50.12	50.56	762.83	10
12	1416.5	43.94	44.28	713.71	1515.7	50.34	50.78	764.53	12
14	1419.8	44.15	44.49	715.40	1519.0	50.56	51.01	766.22	14
16	1423.1	44.35	44.70	717.10	1522.3	50.78	51.23	767.92	16
18	1426.4	44.56	44.91	718.79	1525.6	51.00	51.46	769.61	18
20	1429.7	44.77	45.12	720.49	1528.9	51.22	51.68	771.31	20
22	1433.0	44.98	45.33	722.20	1532.2	51.44	51.90	773.01	22
24	1436.3	45.19	45.54	723.89	1535.5	51.67	52.13	774.70	24
26	1439.6	45.40	45.76	725.59	1538.8	51.89	52.36	776.40	26
28	1442.9	45.61	45.97	727.28	1542.1	52.12	52.59	778.09	28
30	1446.2	45.82	46.18	728.97	1545.4	52.34	52.82	779.79	30
32	1449.6	46.03	46.40	730.66	1548.7	52.57	53.05	781.49	32
34	1452.9	46.24	46.61	732.35	1552.0	52.79	53.28	783.19	34
36	1456.2	46.45	46.82	734.05	1555.3	53.02	53.51	784.89	36
38	1459.5	46.66	47.04	735.74	1558.6	53.24	53.74	786.59	38
40	1462.8	46.87	47.25	737.43	1561.9	53.47	53.97	788.29	40
42	1466.1	47.08	47.46	739.12	1565.2	53.69	54.20	789.99	42
44	1469.4	47.30	47.68	740.81	1568.5	53.92	54.44	791.69	44
46	1472.7	47.51	47.90	742.51	1571.8	54.15	54.67	793.39	46
48	1476.0	47.73	48.12	744.20	1575.1	54.38	54.91	795.09	48
50	1479.3	47.94	48.34	745.89	1578.4	54.61	55.14	796.79	50
52	1482.7	48.16	48.56	747.58	1581.7	54.84	55.37	798.49	52
54	1486.0	48.37	48.78	749.27	1585.0	55.07	55.61	800.19	54
56	1489.3	48.59	49.00	750.97	1588.3	55.30	55.84	801.89	56
58	1492.6	48.80	49.22	752.66	1591.6	55.53	56.08	803.59	58
60	1495.9	49.02	49.44	754.35	1594.9	55.76	56.31	805.29	60

°	16°				17°				°
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	1591.9	55.76	56.31	805.29	1693.9	62.94	63.64	856.35	0
2	1595.2	55.99	56.54	806.99	1697.2	63.18	63.89	858.05	2
4	1601.5	56.23	56.78	808.64	1700.5	63.43	64.15	859.76	4
6	1604.8	56.46	57.02	810.39	1703.8	63.68	64.40	861.46	6
8	1608.1	56.70	57.26	812.09	1707.1	63.93	64.66	863.16	8
10	1611.4	56.93	57.50	813.79	1710.4	64.18	64.91	864.87	10
12	1614.7	57.17	57.74	815.49	1713.7	64.42	65.16	866.57	12
14	1618.0	57.40	57.98	817.19	1717.0	64.67	65.42	868.27	14
16	1621.3	57.64	58.22	818.89	1720.2	64.92	65.67	869.98	16
18	1624.6	57.87	58.46	820.59	1723.5	65.17	65.93	871.68	18
20	1627.9	58.11	58.70	822.29	1726.8	65.42	66.18	873.38	20
22	1631.2	58.34	58.94	823.99	1730.1	65.67	66.43	875.09	22
24	1634.5	58.58	59.19	825.69	1733.4	65.93	66.69	876.79	24
26	1637.8	58.82	59.43	827.39	1736.7	66.18	66.95	878.49	26
28	1641.1	59.06	59.68	829.09	1740.0	66.44	67.21	880.20	28
30	1644.4	59.30	59.92	830.79	1743.3	66.69	67.47	881.90	30
32	1647.7	59.54	60.16	832.49	1746.6	66.94	67.72	883.61	32
34	1651.0	59.78	60.41	834.20	1749.9	67.20	67.98	885.32	34
36	1654.3	60.02	60.65	835.90	1753.2	67.45	68.24	887.02	36
38	1657.6	60.26	60.90	837.61	1756.5	67.71	68.50	888.73	38
40	1660.9	60.50	61.14	839.31	1759.8	67.96	68.76	890.44	40
42	1664.2	60.74	61.39	841.01	1763.1	68.21	69.03	892.15	42
44	1667.5	60.99	61.64	842.72	1766.3	68.47	69.29	893.86	44
46	1670.8	61.23	61.89	844.42	1769.6	68.73	69.56	895.56	46
48	1674.1	61.48	62.14	846.13	1772.9	68.99	69.82	897.27	48
50	1677.4	61.72	62.39	847.83	1776.2	69.25	70.09	898.98	50
52	1680.7	61.96	62.64	849.53	1779.5	69.50	70.36	900.69	52
54	1684.0	62.21	62.89	851.24	1782.8	69.76	70.62	902.40	54
56	1687.3	62.45	63.14	852.94	1786.1	70.02	70.89	904.10	56
58	1690.6	62.70	63.39	854.65	1789.4	70.28	71.17	905.81	58
60	1693.9	62.94	63.64	856.35	1792.7	70.54	71.43	907.52	60

FUNCTIONS OF A ONE-DEGREE CURVE 215

	18°				19°				
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	1798.7	70.54	71.42	907.52	1891.5	78.58	79.65	958.86	0
2	1796.0	70.80	71.69	909.28	1894.8	78.86	79.94	960.67	2
4	1793.3	71.06	71.96	910.94	1898.1	79.13	80.22	962.50	4
6	1807.6	71.33	72.23	912.65	1901.3	79.41	80.51	964.00	6
8	1806.9	71.59	72.50	914.36	1904.6	79.68	80.79	965.72	8
10	1809.2	71.85	72.77	916.07	1907.9	79.96	81.08	967.43	10
12	1812.5	72.12	73.04	917.78	1911.2	80.24	81.37	969.15	12
14	1815.7	72.38	73.31	919.49	1914.5	80.51	81.65	970.86	14
16	1819.0	72.64	73.58	921.20	1917.8	80.79	81.94	972.58	16
18	1822.3	72.91	73.85	922.91	1921.0	81.07	82.22	974.29	18
20	1825.6	73.17	74.12	924.63	1924.3	81.35	82.51	976.01	20
22	1828.9	73.43	74.39	926.34	1927.6	81.63	82.80	977.72	22
24	1832.2	73.70	74.67	928.05	1930.9	81.91	83.09	979.44	24
26	1835.5	73.97	74.94	929.76	1934.2	82.20	83.38	981.15	26
28	1838.8	74.24	75.22	931.47	1937.5	82.48	83.67	982.86	28
30	1842.1	74.51	75.49	933.18	1940.7	82.76	83.97	984.58	30
32	1845.4	74.77	75.77	934.89	1944.0	83.05	84.26	986.30	32
34	1848.7	75.04	76.04	936.60	1947.3	83.33	84.55	988.02	34
36	1852.0	75.31	76.32	938.32	1950.6	83.61	84.84	989.74	36
38	1855.3	75.58	76.59	940.03	1953.9	83.90	85.13	991.46	38
40	1858.6	75.85	76.87	941.74	1957.2	84.18	85.43	993.18	40
42	1861.9	76.12	77.14	943.45	1960.4	84.47	85.73	994.90	42
44	1865.1	76.39	77.42	945.16	1963.7	84.75	86.02	996.62	44
46	1868.4	76.67	77.70	946.88	1967.0	85.04	86.32	998.34	46
48	1871.7	76.94	77.98	948.59	1970.3	85.32	86.61	1000.0	48
50	1875.0	77.21	78.26	950.30	1973.6	85.61	86.91	1001.8	50
52	1878.3	77.49	78.53	952.01	1976.9	85.90	87.21	1003.5	52
54	1881.6	77.76	78.81	953.72	1980.1	86.19	87.50	1005.2	54
56	1884.9	78.03	79.09	955.44	1983.4	86.47	87.80	1006.9	56
58	1888.2	78.31	79.37	957.15	1986.7	86.76	88.09	1008.6	58
60	1891.5	78.58	79.65	958.86	1990.0	87.05	88.39	1010.4	60

	20°				21°				
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	1990.0	87.05	88.39	1010.4	2088.5	95.95	97.58	1062.0	0
2	1993.3	87.34	88.69	1012.1	2091.8	96.26	97.90	1063.7	2
4	1996.6	87.63	88.99	1013.8	2095.0	96.56	98.21	1065.4	4
6	1999.9	87.92	89.29	1015.5	2098.3	96.87	98.53	1067.2	6
8	2003.1	88.21	89.59	1017.2	2101.6	97.17	98.84	1068.9	8
10	2006.4	88.50	89.89	1019.0	2104.9	97.48	99.16	1070.6	10
12	2009.7	88.79	90.19	1020.7	2108.1	97.79	99.48	1072.4	12
14	2013.0	89.08	90.49	1022.4	2111.4	98.09	99.79	1074.1	14
16	2016.3	89.37	90.79	1024.1	2114.7	98.40	100.1	1075.8	16
18	2019.5	89.66	91.09	1025.8	2118.0	98.70	100.4	1077.5	18
20	2022.8	89.96	91.40	1027.6	2121.2	99.00	100.7	1079.3	20
22	2026.1	90.25	91.71	1029.3	2124.5	99.30	101.1	1081.0	22
24	2029.4	90.55	92.01	1031.0	2127.8	99.60	101.4	1082.7	24
26	2032.7	90.85	92.32	1032.7	2131.0	99.90	101.7	1084.4	26
28	2036.0	91.15	92.62	1034.4	2134.3	100.2	102.0	1086.2	28
30	2039.2	91.45	92.93	1036.1	2137.6	100.5	102.3	1087.9	30
32	2042.5	91.74	93.24	1037.9	2140.9	100.8	102.7	1089.6	32
34	2045.8	92.04	93.54	1039.6	2144.1	101.1	103.0	1091.3	34
36	2049.1	92.34	93.85	1041.3	2147.4	101.4	103.3	1093.1	36
38	2052.4	92.64	94.15	1043.0	2150.7	101.7	103.6	1094.8	38
40	2055.7	92.94	94.46	1044.8	2154.0	102.1	104.0	1096.5	40
42	2058.9	93.24	94.76	1046.5	2157.2	102.4	104.3	1098.3	42
44	2062.2	93.54	95.09	1048.2	2160.5	102.7	104.6	1100.0	44
46	2065.5	93.84	95.40	1049.9	2163.8	103.0	104.9	1101.7	46
48	2068.8	94.14	95.71	1051.7	2167.1	103.3	105.3	1103.4	48
50	2072.1	94.44	96.03	1053.4	2170.3	103.6	105.6	1105.2	50
52	2075.4	94.74	96.34	1055.1	2173.6	103.9	105.9	1106.9	52
54	2078.6	95.04	96.65	1056.8	2176.9	104.2	106.3	1108.6	54
56	2081.9	95.34	96.96	1058.6	2180.1	104.5	106.6	1110.3	56
58	2085.2	95.64	97.27	1060.3	2183.4	104.8	106.9	1112.1	58
60	2088.5	95.95	97.58	1062.0	2186.7	105.2	107.2	1113.8	60

216 FUNCTIONS OF A ONE-DEGREE CURVE

	22°				23°				
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	2186.7	105.2	107.2	1113.8	2284.8	115.0	117.4	1165.8	0
2	2190.0	105.6	107.6	1115.5	2288.1	115.3	117.7	1167.5	2
4	2193.2	105.9	107.9	1117.3	2291.3	115.7	118.1	1169.2	4
6	2196.5	106.2	108.2	1119.0	2294.6	116.0	118.4	1171.0	6
8	2199.8	106.5	108.5	1120.7	2297.8	116.4	118.8	1172.7	8
10	2203.0	106.8	108.9	1122.4	2301.1	116.7	119.1	1174.4	10
12	2206.3	107.1	109.2	1124.2	2304.4	117.0	119.5	1176.2	12
14	2209.6	107.4	109.6	1125.9	2307.6	117.4	119.8	1177.9	14
16	2212.9	107.7	109.9	1127.6	2310.9	117.7	120.2	1179.7	16
18	2216.1	108.0	110.2	1129.4	2314.1	118.1	120.5	1181.4	18
20	2219.4	108.4	110.6	1131.1	2317.4	118.4	120.9	1183.1	20
22	2222.7	108.7	110.9	1132.8	2320.7	118.7	121.2	1184.9	22
24	2225.9	109.0	111.2	1134.6	2323.9	119.1	121.6	1186.6	24
26	2229.2	109.4	111.6	1136.3	2327.2	119.4	121.9	1188.4	26
28	2232.5	109.7	111.9	1138.0	2330.4	119.8	122.3	1190.1	28
30	2235.8	110.0	112.3	1139.7	2333.7	120.1	122.6	1191.8	30
32	2239.0	110.4	112.6	1141.5	2337.0	120.4	123.0	1193.6	32
34	2242.3	110.7	112.9	1143.2	2340.2	120.8	123.3	1195.3	34
36	2245.6	111.0	113.3	1144.9	2343.5	121.1	123.7	1197.1	36
38	2248.9	111.4	113.6	1146.7	2346.7	121.5	124.1	1198.8	38
40	2252.1	111.7	113.9	1148.4	2350.0	121.8	124.4	1200.5	40
42	2255.4	112.0	114.3	1150.1	2353.3	122.1	124.8	1202.3	42
44	2258.7	112.3	114.6	1151.9	2356.5	122.5	125.1	1204.0	44
46	2262.0	112.6	114.9	1153.6	2359.8	122.8	125.5	1205.8	46
48	2265.3	112.9	115.3	1155.3	2363.0	123.2	125.8	1207.5	48
50	2268.6	113.2	115.6	1157.0	2366.3	123.5	126.2	1209.3	50
52	2271.9	113.5	115.9	1158.7	2369.6	123.8	126.6	1211.0	52
54	2275.2	113.8	116.2	1160.4	2372.9	124.2	126.9	1212.7	54
56	2278.5	114.1	116.5	1162.1	2376.1	124.5	127.3	1214.5	56
58	2281.8	114.4	116.8	1163.8	2379.4	124.9	127.6	1216.2	58
60	2285.1	114.7	117.1	1165.5	2382.6	125.2	128.0	1218.0	60

	25°			
	M.	E.	T.	
0	139.1	1270.3		0
2	139.5	1272.0		2
4	139.9	1273.8		4
6	140.3	1275.5		6
8	140.6	1277.3		8
10	141.0	1279.0		10
12	141.4	1280.8		12
14	141.8	1282.5		14
16	142.2	1284.3		16
18	142.5	1286.1		18
20	142.9	1287.8		20
22	143.3	1289.6		22
24	143.7	1291.3		24
26	144.1	1293.1		26
28	144.5	1294.9		28
30	144.9	1296.6		30
32	145.3	1298.4		32
34	145.6	1300.1		34
36	146.0	1301.9		36
38	146.4	1303.6		38
40	146.8	1305.4		40
42	147.1	1307.1		42
44	147.5	1308.9		44
46	147.9	1310.6		46
48	148.3	1312.4		48
50	148.6	1314.1		50
52	149.0	1315.9		52
54	149.4	1317.6		54
56	149.8	1319.4		56
58	150.1	1321.1		58
60	150.5	1322.9		60

FUNCTIONS OF A ONE-DEGREE CURVE 217

'	26°				27°				'
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	2577.9	146.8	150.7	1322.9	2675.3	158.3	162.8	1375.6	0
2	2581.1	147.1	151.1	1324.6	2678.5	158.6	163.2	1377.4	2
4	2584.4	147.5	151.5	1326.4	2681.8	159.0	163.7	1379.2	4
6	2587.6	147.9	151.9	1328.1	2685.0	159.4	164.1	1380.9	6
8	2590.9	148.3	152.3	1329.9	2688.2	159.8	164.5	1382.7	8
10	2594.1	148.7	152.7	1331.6	2691.5	160.2	164.9	1384.5	10
12	2597.4	149.1	153.1	1333.4	2694.7	160.6	165.3	1386.2	12
14	2600.6	149.4	153.5	1335.2	2698.0	161.0	165.7	1388.0	14
16	2603.9	149.8	153.9	1336.9	2701.2	161.4	166.1	1389.8	16
18	2607.1	150.2	154.3	1338.7	2704.4	161.8	166.5	1391.5	18
20	2610.4	150.6	154.7	1340.4	2707.7	162.2	167.0	1393.3	20
22	2613.6	151.0	155.1	1342.2	2710.9	162.6	167.4	1395.0	22
24	2616.9	151.4	155.5	1343.9	2714.1	163.0	167.8	1396.8	24
26	2620.1	151.7	155.9	1345.7	2717.4	163.4	168.2	1398.6	26
28	2623.4	152.1	156.3	1347.4	2720.6	163.8	168.6	1400.3	28
30	2626.6	152.5	156.7	1349.2	2723.8	164.2	169.1	1402.1	30
32	2629.8	152.9	157.1	1351.0	2727.1	164.6	169.5	1403.9	32
34	2633.1	153.3	157.5	1352.7	2730.3	165.0	169.9	1405.6	34
36	2636.3	153.7	157.9	1354.5	2733.6	165.4	170.3	1407.4	36
38	2639.6	154.0	158.3	1356.2	2736.8	165.8	170.8	1409.2	38
40	2642.8	154.4	158.7	1358.0	2740.0	166.2	171.2	1410.9	40
42	2646.1	154.8	159.1	1359.8	2743.3	166.6	171.6	1412.7	42
44	2649.3	155.2	159.5	1361.5	2746.5	167.0	172.0	1414.5	44
46	2652.6	155.6	160.0	1363.3	2749.7	167.4	172.5	1416.3	46
48	2655.8	156.0	160.4	1365.1	2753.0	167.8	172.9	1418.0	48
50	2659.1	156.3	160.8	1366.8	2756.2	168.2	173.3	1419.8	50
52	2662.3	156.7	161.2	1368.6	2759.5	168.6	173.7	1421.6	52
54	2665.6	157.1	161.6	1370.4	2762.7	169.0	174.1	1423.3	54
56	2668.8	157.5	162.0	1372.1	2765.9	169.4	174.6	1425.1	56
58	2672.1	157.9	162.4	1373.9	2769.2	169.8	175.0	1426.9	58
60	2675.3	158.3	162.8	1375.6	2772.4	170.2	175.4	1428.6	60

'	28°				29°				'
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	2772.4	170.2	175.4	1428.6	2869.4	182.5	188.5	1481.9	0
2	2775.6	170.6	175.8	1430.4	2872.6	182.9	189.0	1483.7	2
4	2778.9	171.0	176.3	1432.2	2875.8	183.3	189.4	1485.4	4
6	2782.1	171.4	176.7	1434.0	2879.1	183.7	189.9	1487.2	6
8	2785.3	171.8	177.1	1435.7	2882.3	184.2	190.3	1489.0	8
10	2788.6	172.2	177.6	1437.5	2885.5	184.6	190.8	1490.8	10
12	2791.8	172.6	178.0	1439.3	2888.7	185.0	191.2	1492.6	12
14	2795.0	173.0	178.4	1441.1	2892.0	185.4	191.7	1494.3	14
16	2798.3	173.4	178.9	1442.8	2895.2	185.8	192.1	1496.1	16
18	2801.5	173.8	179.3	1444.6	2898.4	186.3	192.5	1497.9	18
20	2804.7	174.3	179.7	1446.4	2901.6	186.7	193.0	1499.7	20
22	2808.0	174.7	180.2	1448.2	2904.8	187.1	193.5	1501.5	22
24	2811.2	175.1	180.6	1449.9	2908.1	187.5	193.9	1503.2	24
26	2814.4	175.5	181.0	1451.7	2911.3	188.0	194.4	1505.0	26
28	2817.7	175.9	181.5	1453.5	2914.5	188.4	194.8	1506.8	28
30	2820.9	176.3	181.9	1455.2	2917.7	188.8	195.3	1508.6	30
32	2824.1	176.7	182.3	1457.0	2921.0	189.2	195.7	1510.4	32
34	2827.4	177.1	182.8	1458.8	2924.2	189.7	196.2	1512.1	34
36	2830.6	177.5	183.2	1460.6	2927.4	190.1	196.7	1513.9	36
38	2833.8	177.9	183.6	1462.3	2930.6	190.5	197.1	1515.7	38
40	2837.1	178.4	184.1	1464.1	2933.9	190.9	197.6	1517.5	40
42	2840.3	178.8	184.5	1465.9	2937.1	191.4	198.0	1519.3	42
44	2843.5	179.2	185.0	1467.7	2940.3	191.9	198.5	1521.0	44
46	2846.8	179.6	185.4	1469.5	2943.5	192.4	198.9	1522.8	46
48	2850.0	180.0	185.9	1471.2	2946.8	192.8	199.4	1524.6	48
50	2853.2	180.4	186.3	1473.0	2950.0	193.2	199.8	1526.4	50
52	2856.5	180.8	186.8	1474.8	2953.2	193.6	200.3	1528.2	52
54	2859.7	181.2	187.2	1476.6	2956.4	194.0	200.8	1530.0	54
56	2862.9	181.6	187.6	1478.3	2959.6	194.4	201.2	1531.7	56
58	2866.2	182.0	188.1	1480.1	2962.9	194.8	201.7	1533.5	58
60	2869.4	182.5	188.5	1481.9	2966.1	195.2	202.1	1535.3	60

## 218 FUNCTIONS OF A ONE-DEGREE CURVE

°	30°				31°				°
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	2966.1	195.2	202.1	1535.3	3062.6	208.4	216.3	1589.0	0
2	2969.3	195.6	202.6	1537.1	3065.8	208.8	216.8	1590.8	2
4	2972.5	196.1	203.1	1538.9	3069.0	209.3	217.3	1592.6	4
6	2975.7	196.5	203.5	1540.7	3072.2	209.7	217.7	1594.4	6
8	2979.0	197.0	204.0	1542.5	3075.4	210.2	218.2	1596.2	8
10	2982.2	197.4	204.5	1544.3	3078.6	210.6	218.7	1598.0	10
12	2985.4	197.8	204.9	1546.0	3081.8	211.1	219.2	1599.8	12
14	2988.6	198.2	205.4	1547.8	3085.0	211.5	219.6	1601.6	14
16	2991.8	198.6	205.9	1549.6	3088.3	212.0	220.1	1603.4	16
18	2995.0	199.1	206.3	1551.4	3091.5	212.4	220.6	1605.2	18
20	2998.3	199.5	206.8	1553.2	3094.7	212.9	221.1	1607.0	20
22	3001.5	199.9	207.3	1555.0	3097.9	213.3	221.6	1608.8	22
24	3004.7	200.4	207.7	1556.8	3101.1	213.8	222.1	1610.6	24
26	3007.9	200.8	208.2	1558.6	3104.3	214.2	222.6	1612.4	26
28	3011.1	201.3	208.7	1560.4	3107.5	214.7	223.0	1614.2	28
30	3014.3	201.7	209.1	1562.2	3110.7	215.1	223.5	1616.0	30
32	3017.6	202.1	209.6	1564.0	3113.9	215.6	224.0	1617.8	32
34	3020.8	202.6	210.1	1565.7	3117.1	216.0	224.5	1619.6	34
36	3024.0	203.0	210.5	1567.5	3120.3	216.5	225.0	1621.4	36
38	3027.2	203.5	211.0	1569.3	3123.5	216.9	225.5	1623.2	38
40	3030.4	203.9	211.5	1571.1	3126.7	217.4	226.0	1625.0	40
42	3033.6	204.3	212.0	1572.9	3129.9	217.8	226.5	1626.8	42
44	3036.9	204.8	212.4	1574.7	3133.1	218.3	227.0	1628.6	44
46	3040.1	205.2	212.9	1576.5	3136.4	218.7	227.5	1630.5	46
48	3043.3	205.7	213.4	1578.3	3139.6	219.2	228.0	1632.3	48
50	3046.5	206.1	213.9	1580.1	3142.8	219.6	228.4	1634.1	50
52	3049.7	206.5	214.4	1581.9	3146.0	220.1	228.9	1635.9	52
54	3052.9	207.0	214.8	1583.7	3149.2	220.5	229.4	1637.7	54
56	3056.2	207.4	215.3	1585.5	3152.4	221.0	229.9	1639.5	56
58	3059.4	207.9	215.8	1587.2	3155.6	221.5	230.4	1641.3	58
60	3062.6	208.4	216.3	1589.0	3158.8	222.0	230.9	1643.1	60

°	32°				33°				°
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	3158.8	222.0	230.9	1643.1	3254.9	236.0	246.1	1697.3	0
2	3162.0	222.5	231.4	1644.9	3258.1	236.4	246.6	1699.1	2
4	3165.2	222.9	231.9	1646.7	3261.3	236.9	247.1	1700.9	4
6	3168.4	223.4	232.4	1648.5	3264.5	237.4	247.7	1702.7	6
8	3171.6	223.8	232.9	1650.3	3267.7	237.9	248.2	1704.5	8
10	3174.8	224.3	233.4	1652.1	3270.8	238.4	248.7	1706.4	10
12	3178.0	224.8	233.9	1653.9	3274.0	238.9	249.2	1708.2	12
14	3181.2	225.2	234.4	1655.7	3277.2	239.3	249.7	1710.0	14
16	3184.4	225.7	234.9	1657.5	3280.4	239.8	250.2	1711.8	16
18	3187.6	226.1	235.4	1659.3	3283.6	240.3	250.8	1713.6	18
20	3190.8	226.6	235.9	1661.1	3286.8	240.8	251.3	1715.5	20
22	3194.0	227.1	236.4	1662.9	3290.0	241.2	251.8	1717.3	22
24	3197.2	227.5	236.9	1664.7	3293.2	241.7	252.3	1719.1	24
26	3200.4	228.0	237.4	1666.5	3296.4	242.2	252.9	1720.9	26
28	3203.6	228.4	237.9	1668.3	3299.6	242.7	253.4	1722.7	28
30	3206.8	228.9	238.4	1670.1	3302.8	243.2	253.9	1724.5	30
32	3210.0	229.4	238.9	1671.9	3305.9	243.6	254.4	1726.4	32
34	3213.2	229.8	239.5	1673.7	3309.1	244.1	255.0	1728.2	34
36	3216.5	230.3	240.0	1675.5	3312.3	244.6	255.5	1730.0	36
38	3219.7	230.7	240.5	1677.4	3315.5	245.1	256.0	1731.8	38
40	3222.9	231.2	241.0	1679.2	3318.7	245.6	256.5	1733.6	40
42	3226.1	231.7	241.5	1681.0	3321.9	246.0	257.1	1735.5	42
44	3229.3	232.2	242.0	1682.8	3325.1	246.5	257.6	1737.3	44
46	3232.5	232.6	242.5	1684.6	3328.3	247.0	258.1	1739.1	46
48	3235.7	233.1	243.0	1686.4	3331.5	247.5	258.6	1740.9	48
50	3238.9	233.5	243.5	1688.2	3334.6	248.0	259.2	1742.7	50
52	3242.1	234.0	244.0	1690.0	3337.8	248.4	259.7	1744.5	52
54	3245.3	234.5	244.5	1691.8	3341.0	248.9	260.2	1746.4	54
56	3248.5	235.0	245.0	1693.7	3344.2	249.4	260.8	1748.2	56
58	3251.7	235.5	245.5	1695.5	3347.4	249.9	261.3	1750.0	58
60	3254.9	236.0	246.0	1697.3	3350.6	250.4	261.8	1751.8	60

FUNCTIONS OF A ONE-DEGREE CURVE 219

°	34°				35°				°
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	3350.6	250.4	261.8	1751.9	3446.1	265.2	278.1	1806.7	0
2	3353.8	250.8	262.3	1753.7	3449.3	265.7	278.6	1808.5	2
4	3357.0	251.2	262.9	1755.5	3452.5	266.2	279.2	1810.3	4
6	3360.1	251.7	263.4	1757.3	3455.6	266.7	279.7	1812.2	6
8	3363.3	252.2	264.0	1759.1	3458.8	267.2	280.3	1814.0	8
10	3366.5	252.7	264.5	1761.0	3462.0	267.7	280.8	1815.8	10
12	3369.7	253.2	265.0	1762.8	3465.2	268.2	281.4	1817.7	12
14	3372.9	253.7	265.6	1764.6	3468.3	268.7	281.9	1819.5	14
16	3376.1	254.2	266.1	1766.4	3471.5	269.2	282.5	1821.3	16
18	3379.2	254.7	266.7	1768.3	3474.7	269.7	283.0	1823.2	18
20	3382.4	255.2	267.2	1770.1	3477.9	270.2	283.6	1825.0	20
22	3385.6	255.7	267.7	1771.9	3481.0	270.7	284.2	1826.8	22
24	3388.8	256.2	268.3	1773.7	3484.2	271.2	284.7	1828.7	24
26	3392.0	256.7	268.8	1775.6	3487.4	271.7	285.3	1830.5	26
28	3395.2	257.2	269.3	1777.4	3490.6	272.2	285.9	1832.3	28
30	3398.3	257.7	269.9	1779.2	3493.7	272.7	286.4	1834.2	30
32	3401.5	258.2	270.4	1781.0	3496.9	273.2	287.0	1836.0	32
34	3404.7	258.7	271.0	1782.9	3500.1	273.7	287.5	1837.8	34
36	3407.9	259.2	271.5	1784.7	3503.3	274.2	288.1	1839.7	36
38	3411.1	259.7	272.0	1786.5	3506.5	274.7	288.7	1841.5	38
40	3414.3	260.2	272.6	1788.4	3509.6	275.2	289.2	1843.4	40
42	3417.4	260.7	273.1	1790.2	3512.8	275.7	289.8	1845.2	42
44	3420.6	261.2	273.7	1792.0	3516.0	276.2	290.4	1847.1	44
46	3423.8	261.7	274.2	1793.9	3519.2	276.7	290.9	1848.9	46
48	3427.0	262.2	274.8	1795.7	3522.3	277.2	291.5	1850.7	48
50	3430.2	262.7	275.3	1797.5	3525.5	277.7	292.0	1852.6	50
52	3433.4	263.2	275.9	1799.3	3528.7	278.2	292.6	1854.4	52
54	3436.5	263.7	276.4	1801.2	3531.9	278.7	293.2	1856.3	54
56	3439.7	264.2	277.0	1803.0	3535.0	279.2	293.7	1858.1	56
58	3442.9	264.7	277.5	1804.8	3538.2	279.8	294.3	1859.9	58
60	3446.1	265.2	278.1	1806.7	3541.4	280.4	294.9	1861.8	60

°	36°				37°				°
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	3541.4	280.4	294.9	1861.8	3636.3	296.1	312.3	1917.3	0
2	3544.6	280.9	295.4	1863.6	3639.5	296.6	312.8	1919.1	2
4	3547.7	281.4	296.0	1865.5	3642.6	297.1	313.4	1921.0	4
6	3550.9	281.9	296.6	1867.3	3645.8	297.7	314.0	1922.8	6
8	3554.0	282.5	297.2	1869.2	3648.9	298.2	314.6	1924.7	8
10	3557.2	283.0	297.7	1871.0	3652.1	298.7	315.2	1926.5	10
12	3560.4	283.5	298.3	1872.9	3655.2	299.3	315.8	1928.4	12
14	3563.5	284.0	298.9	1874.7	3658.4	299.8	316.4	1930.2	14
16	3566.7	284.6	299.5	1876.5	3661.6	300.3	317.0	1932.1	16
18	3569.9	285.1	300.0	1878.4	3664.7	300.9	317.5	1933.9	18
20	3573.0	285.6	300.6	1880.2	3667.9	301.4	318.1	1935.8	20
22	3576.2	286.1	301.2	1882.1	3671.0	301.9	318.7	1937.6	22
24	3579.4	286.7	301.8	1883.9	3674.2	302.5	319.3	1939.5	24
26	3582.5	287.2	302.3	1885.8	3677.3	303.0	319.9	1941.3	26
28	3585.7	287.7	302.9	1887.6	3680.5	303.5	320.5	1943.2	28
30	3588.8	288.2	303.5	1889.5	3683.6	304.1	321.1	1945.0	30
32	3592.0	288.8	304.1	1891.3	3686.8	304.6	321.7	1946.9	32
34	3595.2	289.3	304.6	1893.2	3690.0	305.1	322.3	1948.8	34
36	3598.3	289.8	305.2	1895.0	3693.1	305.7	322.9	1950.6	36
38	3601.5	290.3	305.8	1896.9	3696.3	306.2	323.5	1952.5	38
40	3604.7	290.9	306.4	1898.7	3699.4	306.7	324.2	1954.4	40
42	3607.8	291.4	307.0	1900.6	3702.6	307.3	324.8	1956.2	42
44	3611.0	291.9	307.5	1902.4	3705.7	307.8	325.4	1958.1	44
46	3614.1	292.4	308.1	1904.3	3708.9	308.3	326.0	1960.0	46
48	3617.3	293.0	308.7	1906.1	3712.1	308.9	326.6	1961.8	48
50	3620.5	293.5	309.3	1908.0	3715.2	309.4	327.2	1963.7	50
52	3623.6	294.0	309.9	1909.8	3718.4	309.9	327.8	1965.5	52
54	3626.8	294.5	310.5	1911.7	3721.5	310.5	328.4	1967.4	54
56	3630.0	295.1	311.1	1913.5	3724.7	311.0	329.0	1969.3	56
58	3633.1	295.6	311.7	1915.4	3727.8	311.6	329.6	1971.1	58
60	3636.3	296.1	312.3	1917.3	3731.0	312.2	330.2	1973.0	60

## 220 FUNCTIONS OF A ONE-DEGREE CURVE

°	38°				39°				°
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	3731.0	312.2	330.2	1973.0	3825.5	328.7	348.7	2029.1	0
2	3734.1	312.7	330.8	1974.9	3828.6	329.2	349.3	2031.0	2
4	3737.3	313.3	331.4	1976.7	3831.8	329.8	349.9	2032.9	4
6	3740.4	313.8	332.0	1978.6	3834.9	330.3	350.5	2034.7	6
8	3743.6	314.4	332.6	1980.5	3838.0	330.9	351.2	2036.6	8
10	3746.7	314.9	333.2	1982.3	3841.2	331.5	351.8	2038.5	10
12	3749.9	315.5	333.8	1984.2	3844.3	332.0	352.4	2040.4	12
14	3753.0	316.0	334.5	1986.1	3847.4	332.6	353.1	2042.3	14
16	3756.2	316.6	335.1	1987.9	3850.6	333.2	353.7	2044.1	16
18	3759.3	317.1	335.7	1989.8	3853.7	333.7	354.3	2046.0	18
20	3762.5	317.7	336.3	1991.7	3856.8	334.3	354.9	2047.9	20
22	3765.6	318.2	336.9	1993.6	3860.0	334.9	355.6	2049.8	22
24	3768.8	318.8	337.5	1995.4	3863.1	335.4	356.2	2051.7	24
26	3771.9	319.3	338.1	1997.3	3866.2	336.0	356.9	2053.5	26
28	3775.1	319.9	338.7	1999.2	3869.4	336.6	357.5	2055.4	28
30	3778.2	320.4	339.4	2001.0	3872.5	337.1	358.1	2057.3	30
32	3781.4	321.0	340.0	2002.9	3875.6	337.7	358.8	2059.2	32
34	3784.5	321.5	340.6	2004.8	3878.8	338.3	359.4	2061.1	34
36	3787.7	322.1	341.2	2006.6	3881.9	338.8	360.1	2063.0	36
38	3790.8	322.6	341.8	2008.5	3885.0	339.4	360.7	2064.8	38
40	3794.0	323.2	342.4	2010.4	3888.2	340.0	361.3	2066.7	40
42	3797.1	323.7	343.1	2012.3	3891.3	340.5	362.0	2068.6	42
44	3800.3	324.3	343.7	2014.1	3894.4	341.1	362.6	2070.5	44
46	3803.4	324.8	344.3	2016.0	3897.6	341.7	363.3	2072.4	46
48	3806.6	325.4	344.9	2017.9	3900.7	342.2	363.9	2074.2	48
50	3809.7	325.9	345.6	2019.7	3903.8	342.8	364.5	2076.1	50
52	3812.9	326.5	346.2	2021.6	3907.0	343.4	365.2	2078.0	52
54	3816.0	327.0	346.8	2023.5	3910.1	343.9	365.8	2079.9	54
56	3819.2	327.6	347.4	2025.4	3913.2	344.5	366.5	2081.8	56
58	3822.3	328.1	348.1	2027.2	3916.4	345.1	367.1	2083.7	58
60	3825.5	328.7	348.7	2029.1	3919.5	345.6	367.7	2085.5	60

°	40°				41°				°
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	3919.5	345.6	367.7	2085.5	4013.4	362.9	387.4	2142.3	0
2	3922.6	346.1	368.4	2087.4	4016.5	363.4	388.1	2144.2	2
4	3925.8	346.7	369.0	2089.3	4019.6	364.0	388.8	2146.1	4
6	3928.9	347.2	369.7	2091.2	4022.7	364.5	389.4	2148.0	6
8	3932.0	347.8	370.3	2093.1	4025.9	365.1	390.1	2149.9	8
10	3935.1	348.4	371.0	2095.0	4029.0	365.6	390.7	2151.9	10
12	3938.3	348.9	371.6	2096.9	4032.1	366.2	391.4	2153.8	12
14	3941.4	349.5	372.3	2098.8	4035.2	366.8	392.1	2155.7	14
16	3944.5	350.1	372.9	2100.7	4038.3	367.4	392.7	2157.6	16
18	3947.7	350.7	373.6	2102.6	4041.4	368.0	393.4	2159.5	18
20	3950.8	351.3	374.3	2104.5	4044.6	368.6	394.1	2161.4	20
22	3953.9	351.8	374.9	2106.3	4047.7	369.2	394.7	2163.3	22
24	3957.1	352.4	375.6	2108.2	4050.8	369.8	395.4	2165.2	24
26	3960.2	353.0	376.2	2110.1	4053.9	370.4	396.1	2167.1	26
28	3963.3	353.6	376.9	2112.0	4057.0	371.0	396.8	2169.0	28
30	3966.4	354.2	377.5	2113.9	4060.1	371.6	397.5	2170.9	30
32	3969.6	354.7	378.2	2115.8	4063.2	372.2	398.1	2172.8	32
34	3972.7	355.3	378.8	2117.7	4066.4	372.8	398.8	2174.7	34
36	3975.8	355.9	379.5	2119.6	4069.5	373.4	399.5	2176.6	36
38	3979.0	356.5	380.1	2121.5	4072.6	374.0	400.2	2178.5	38
40	3982.1	357.1	380.8	2123.4	4075.7	374.6	400.9	2180.4	40
42	3985.2	357.6	381.4	2125.3	4078.8	375.2	401.5	2182.4	42
44	3988.4	358.2	382.1	2127.2	4082.0	375.8	402.2	2184.3	44
46	3991.5	358.8	382.8	2129.1	4085.1	376.4	402.9	2186.2	46
48	3994.6	359.4	383.4	2131.0	4088.2	377.0	403.6	2188.1	48
50	3997.7	360.0	384.1	2132.9	4091.3	377.6	404.3	2190.0	50
52	4000.9	360.5	384.8	2134.7	4094.4	378.2	404.9	2191.9	52
54	4004.0	361.1	385.4	2136.6	4097.5	378.8	405.6	2193.8	54
56	4007.1	361.7	386.1	2138.5	4100.7	379.4	406.3	2195.7	56
58	4010.3	362.3	386.8	2140.4	4103.8	380.0	407.0	2197.6	58
60	4013.4	362.9	387.4	2142.3	4106.9	380.6	407.7	2199.5	60

°	42°				43°				°
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	4106.9	380.6	407.7	2199.5	4200.1	398.7	428.6	2257.1	0
2	4110.0	381.2	408.3	2201.4	4203.2	399.3	429.3	2259.0	2
4	4113.1	381.8	409.0	2203.3	4206.3	399.9	430.0	2261.0	4
6	4116.2	382.4	409.7	2205.3	4209.4	400.5	430.7	2262.9	6
8	4119.3	383.0	410.4	2207.2	4212.5	401.1	431.4	2264.8	8
10	4122.4	383.6	411.1	2209.1	4215.6	401.7	432.1	2266.7	10
12	4125.5	384.2	411.8	2211.0	4218.7	402.4	432.8	2268.7	12
14	4128.6	384.8	412.5	2212.9	4221.8	403.0	433.5	2270.6	14
16	4131.8	385.4	413.2	2214.9	4224.9	403.6	434.2	2272.5	16
18	4134.9	386.0	413.9	2216.8	4228.0	404.2	434.9	2274.5	18
20	4138.0	386.6	414.6	2218.7	4231.1	404.8	435.6	2276.4	20
22	4141.1	387.2	415.3	2220.6	4234.2	405.4	436.3	2278.3	22
24	4144.2	387.8	416.0	2222.5	4237.3	406.1	437.0	2280.2	24
26	4147.3	388.4	416.6	2224.4	4240.4	406.7	437.8	2282.2	26
28	4150.4	389.0	417.3	2226.4	4243.5	407.3	438.5	2284.1	28
30	4153.5	389.6	418.0	2228.3	4246.5	407.9	439.2	2286.0	30
32	4156.6	390.2	418.7	2230.2	4249.6	408.5	439.9	2288.0	32
34	4159.7	390.8	419.4	2232.1	4252.7	409.1	440.6	2290.0	34
36	4162.8	391.4	420.1	2234.0	4255.8	409.8	441.4	2291.8	36
38	4165.9	392.0	420.8	2236.0	4258.9	410.4	442.1	2293.8	38
40	4169.0	392.6	421.5	2237.9	4262.0	411.0	442.8	2295.7	40
42	4172.1	393.2	422.2	2239.8	4265.1	411.6	443.5	2297.7	42
44	4175.2	393.8	422.9	2241.7	4268.2	412.2	444.2	2299.6	44
46	4178.4	394.4	423.6	2243.6	4271.3	412.8	445.0	2301.5	46
48	4181.5	395.0	424.3	2245.6	4274.4	413.5	445.7	2303.5	48
50	4184.6	395.6	425.0	2247.5	4277.5	414.1	446.4	2305.4	50
52	4187.7	396.2	425.7	2249.4	4280.6	414.7	447.1	2307.3	52
54	4190.8	396.8	426.4	2251.3	4283.7	415.3	447.8	2309.3	54
56	4193.9	397.4	427.1	2253.3	4286.8	415.9	448.6	2311.2	56
58	4197.0	398.0	427.8	2255.2	4289.9	416.5	449.3	2313.1	58
60	4200.1	398.7	428.6	2257.1	4293.0	417.2	450.0	2315.1	60

°	44°				45°				°
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	4293.0	417.2	450.0	2315.1	4383.5	436.2	472.1	2373.4	0
2	4296.1	417.8	450.7	2317.0	4386.6	436.8	472.9	2375.4	2
4	4299.2	418.4	451.5	2319.0	4389.7	437.5	473.6	2377.3	4
6	4302.2	419.1	452.2	2320.9	4392.7	438.1	474.4	2379.3	6
8	4305.3	419.7	452.9	2322.8	4395.8	438.8	475.1	2381.2	8
10	4308.4	420.3	453.7	2324.8	4400.9	439.4	475.9	2383.2	10
12	4311.5	421.0	454.4	2326.7	4404.0	440.0	476.6	2385.2	12
14	4314.6	421.6	455.1	2328.7	4407.0	440.7	477.4	2387.1	14
16	4317.7	422.2	455.9	2330.6	4410.1	441.3	478.1	2389.1	16
18	4320.7	422.9	456.6	2332.6	4413.2	442.0	478.9	2391.0	18
20	4323.8	423.5	457.3	2334.5	4416.3	442.6	479.6	2393.0	20
22	4326.9	424.1	458.1	2336.4	4419.3	443.2	480.4	2394.9	22
24	4330.0	424.8	458.8	2338.4	4422.4	443.9	481.1	2396.9	24
26	4333.1	425.4	459.5	2340.3	4425.5	444.5	481.9	2398.8	26
28	4336.2	426.0	460.3	2342.3	4428.6	445.2	482.6	2400.8	28
30	4339.2	426.7	461.0	2344.2	4431.6	445.8	483.4	2402.8	30
32	4342.3	427.3	461.7	2346.1	4434.7	446.4	484.2	2404.7	32
34	4345.4	427.9	462.5	2348.1	4437.8	447.1	484.9	2406.7	34
36	4348.5	428.6	463.2	2350.0	4440.9	447.7	485.7	2408.6	36
38	4351.6	429.2	463.9	2352.0	4444.0	448.3	486.5	2410.6	38
40	4354.7	429.8	464.7	2353.9	4447.0	448.9	487.2	2412.6	40
42	4357.7	430.5	465.4	2355.9	4450.1	449.5	488.0	2414.5	42
44	4360.8	431.1	466.2	2357.8	4453.2	450.2	488.7	2416.5	44
46	4363.9	431.7	466.9	2359.8	4456.3	450.8	489.5	2418.5	46
48	4367.0	432.4	467.7	2361.7	4459.3	451.5	490.3	2420.4	48
50	4370.1	433.0	468.4	2363.7	4462.4	452.1	491.0	2422.4	50
52	4373.2	433.6	469.1	2365.6	4465.5	452.7	491.8	2424.4	52
54	4376.2	434.3	469.9	2367.6	4468.6	453.4	492.5	2426.3	54
56	4379.3	434.9	470.6	2369.5	4471.6	454.1	493.3	2428.3	56
58	4382.4	435.6	471.4	2371.5	4474.7	454.8	494.1	2430.2	58
60	4385.5	436.2	472.1	2373.4	4477.8	455.5	494.8	2432.2	60



222 FUNCTIONS OF A ONE-DEGREE CURVE

'	46°				47°				'
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	4477.8	455.5	494.8	2432.2	4569.7	475.2	518.3	2491.5	0
2	4480.9	456.1	495.6	2434.2	4572.7	475.9	519.0	2493.4	2
4	4483.9	456.8	496.5	2436.1	4575.8	476.5	519.8	2495.4	4
6	4487.0	457.4	497.2	2438.1	4578.8	477.2	520.6	2497.4	6
8	4490.0	458.1	497.9	2440.1	4581.9	477.8	521.4	2499.4	8
10	4493.1	458.7	498.7	2442.1	4584.9	478.5	522.2	2501.4	10
12	4496.2	459.4	499.5	2444.0	4588.0	479.2	523.0	2503.4	12
14	4499.2	460.0	500.3	2446.0	4591.0	479.8	523.8	2505.4	14
16	4502.3	460.7	501.0	2448.0	4594.1	480.5	524.6	2507.3	16
18	4505.4	461.3	501.8	2449.9	4597.1	481.1	525.4	2509.3	18
20	4508.4	462.0	502.6	2451.9	4600.2	481.7	526.2	2511.3	20
22	4511.5	462.7	503.4	2453.9	4603.2	482.3	527.0	2513.3	22
24	4514.6	463.3	504.1	2455.9	4606.3	483.0	527.8	2515.3	24
26	4517.6	464.0	504.9	2457.8	4609.3	483.7	528.6	2517.3	26
28	4520.7	464.6	505.7	2459.8	4612.4	484.3	529.4	2519.3	28
30	4523.7	465.3	506.5	2461.8	4615.4	485.0	530.2	2521.2	30
32	4526.8	466.0	507.3	2463.8	4618.5	485.7	531.0	2523.2	32
34	4529.9	466.6	508.0	2465.7	4621.5	486.3	531.8	2525.2	34
36	4532.9	467.3	508.8	2467.7	4624.6	487.0	532.6	2527.2	36
38	4536.0	467.9	509.6	2469.7	4627.6	487.7	533.4	2529.2	38
40	4539.1	468.6	510.4	2471.7	4630.7	488.4	534.2	2531.2	40
42	4542.1	469.3	511.1	2473.6	4633.7	489.1	535.0	2533.2	42
44	4545.2	469.9	511.9	2475.6	4636.8	489.8	535.8	2535.2	44
46	4548.2	470.6	512.7	2477.6	4639.8	490.5	536.6	2537.2	46
48	4551.3	471.2	513.5	2479.6	4642.9	491.2	537.4	2539.2	48
50	4554.4	471.9	514.3	2481.6	4645.9	491.9	538.2	2541.2	50
52	4557.4	472.6	515.1	2483.5	4649.0	492.6	539.0	2543.1	52
54	4560.5	473.2	515.9	2485.5	4652.0	493.3	539.8	2545.1	54
56	4563.6	473.9	516.7	2487.5	4655.1	494.0	540.6	2547.1	56
58	4566.6	474.5	517.5	2489.5	4658.1	494.7	541.4	2549.1	58
60	4569.7	475.2	518.3	2491.5	4661.2	495.4	542.3	2551.1	60

'	48°				49°				'
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	4661.2	495.4	542.8	2551.1	4752.3	515.9	567.0	2611.3	0
2	4664.2	496.0	543.1	2553.1	4755.3	516.5	567.8	2613.3	2
4	4667.3	496.7	543.9	2555.1	4758.4	517.2	568.7	2615.3	4
6	4670.3	497.4	544.7	2557.1	4761.4	517.9	569.5	2617.3	6
8	4673.3	498.1	545.5	2559.1	4764.4	518.6	570.3	2619.3	8
10	4676.4	498.8	546.4	2561.1	4767.4	519.3	571.2	2621.4	10
12	4679.4	499.4	547.2	2563.1	4770.5	520.0	572.0	2623.4	12
14	4682.5	500.1	548.0	2565.1	4773.5	520.7	572.8	2625.4	14
16	4685.5	500.8	548.8	2567.1	4776.6	521.4	573.7	2627.4	16
18	4688.5	501.5	549.6	2569.1	4779.6	522.1	574.5	2629.4	18
20	4691.6	502.2	550.5	2571.1	4782.6	522.8	575.3	2631.4	20
22	4694.6	502.8	551.3	2573.1	4785.6	523.5	576.2	2633.5	22
24	4697.6	503.5	552.1	2575.1	4788.7	524.2	577.0	2635.5	24
26	4700.7	504.2	552.9	2577.1	4791.7	524.9	577.9	2637.5	26
28	4703.7	504.9	553.7	2579.1	4794.7	525.6	578.7	2639.5	28
30	4706.7	505.6	554.6	2581.1	4797.7	526.3	579.6	2641.5	30
32	4709.8	506.2	555.4	2583.1	4800.8	527.0	580.4	2643.5	32
34	4712.8	506.9	556.2	2585.1	4803.8	527.7	581.3	2645.6	34
36	4715.9	507.6	557.0	2587.2	4806.8	528.4	582.1	2647.6	36
38	4718.9	508.3	557.8	2589.2	4809.9	529.1	583.0	2649.6	38
40	4721.9	509.0	558.7	2591.2	4812.9	529.8	583.8	2651.6	40
42	4725.0	509.6	559.5	2593.2	4815.9	530.5	584.7	2653.7	42
44	4728.0	510.3	560.3	2595.2	4819.0	531.2	585.5	2655.7	44
46	4731.0	511.0	561.2	2597.2	4822.0	531.9	586.4	2657.7	46
48	4734.1	511.7	562.0	2599.2	4825.0	532.6	587.2	2659.7	48
50	4737.1	512.4	562.8	2601.2	4828.0	533.3	588.1	2661.8	50
52	4740.2	513.1	563.7	2603.2	4831.1	534.0	588.9	2663.8	52
54	4743.2	513.8	564.5	2605.2	4834.1	534.7	589.8	2665.8	54
56	4746.2	514.5	565.3	2607.2	4837.1	535.4	590.6	2667.8	56
58	4749.3	515.2	566.2	2609.3	4840.2	536.1	591.5	2669.9	58
60	4752.3	515.9	567.0	2611.3	4843.2	536.8	592.4	2671.9	60

FUNCTIONS OF A ONE-DEGREE CURVE 223

	50°				51°				
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	4843.2	586.8	592.4	2671.9	4933.6	558.2	618.5	2733.0	0
2	4846.2	537.5	593.2	2673.9	4936.6	558.9	619.3	2735.1	2
4	4849.2	538.2	594.1	2676.0	4939.6	559.7	620.2	2737.1	4
6	4852.2	538.9	594.9	2678.0	4942.6	560.4	621.1	2739.2	6
8	4855.2	539.6	595.8	2680.0	4945.6	561.1	622.0	2741.2	8
10	4858.3	540.3	596.7	2682.1	4948.6	561.8	622.9	2743.3	10
12	4861.3	541.0	597.5	2684.1	4951.6	562.5	623.7	2745.3	12
14	4864.3	541.7	598.4	2686.1	4954.6	563.3	624.6	2747.4	14
16	4867.3	542.4	599.3	2688.2	4957.6	564.0	625.5	2749.4	16
18	4870.3	543.1	600.1	2690.2	4960.6	564.7	626.4	2751.5	18
20	4873.3	543.9	601.0	2692.3	4963.6	565.4	627.3	2753.5	20
22	4876.3	544.6	601.9	2694.3	4966.6	566.2	628.2	2755.6	22
24	4879.4	545.3	602.7	2696.3	4969.6	566.9	629.9	2757.7	24
26	4882.4	546.0	603.6	2698.4	4972.6	567.6	630.0	2759.7	26
28	4885.4	546.7	604.5	2700.4	4975.6	568.3	630.9	2761.8	28
30	4888.4	547.4	605.3	2702.4	4978.6	569.1	631.8	2763.8	30
32	4891.4	548.1	606.2	2704.5	4981.6	569.8	632.7	2765.9	32
34	4894.4	548.8	607.0	2706.5	4984.6	570.5	633.0	2767.9	34
36	4897.4	549.5	607.9	2708.6	4987.7	571.2	634.5	2770.0	36
38	4900.4	550.2	608.8	2710.6	4990.7	572.0	635.3	2772.0	38
40	4903.5	551.0	609.7	2712.6	4993.7	572.7	636.2	2774.1	40
42	4906.5	551.7	610.5	2714.7	4996.7	573.4	637.1	2776.2	42
44	4909.5	552.4	611.4	2716.7	4999.7	574.1	638.0	2778.3	44
46	4912.5	553.1	612.3	2718.8	5002.7	574.9	638.9	2780.3	46
48	4915.5	553.8	613.2	2720.8	5005.7	575.6	639.8	2782.3	48
50	4918.5	554.5	614.1	2722.8	5008.7	576.3	640.7	2784.4	50
52	4921.5	555.2	614.9	2724.9	5011.7	577.0	641.6	2786.4	52
54	4924.5	555.9	615.8	2726.9	5014.7	577.8	642.5	2788.5	54
56	4927.5	556.6	616.7	2729.0	5017.7	578.5	643.4	2790.6	56
58	4930.5	557.4	617.6	2731.0	5020.7	579.2	644.3	2792.6	58
60	4933.5	558.2	618.5	2733.0	5023.7	579.9	645.2	2794.7	60

	52°				53°				
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	5028.7	579.9	645.2	2794.7	5113.5	602.0	672.7	2856.9	0
2	5026.7	580.6	646.1	2796.8	5116.5	602.8	673.7	2858.9	2
4	5029.7	581.8	647.0	2798.8	5119.4	603.5	674.6	2861.0	4
6	5032.7	582.1	647.9	2800.9	5122.4	604.3	675.5	2863.1	6
8	5035.7	582.8	648.9	2803.0	5125.4	605.0	676.4	2865.2	8
10	5038.7	583.5	649.8	2805.0	5128.4	605.8	677.4	2867.3	10
12	5041.7	584.3	650.7	2807.1	5131.3	606.5	678.3	2869.4	12
14	5044.7	585.0	651.6	2809.2	5134.3	607.3	679.2	2871.5	14
16	5047.7	585.7	652.5	2811.2	5137.3	608.0	680.2	2873.5	16
18	5050.7	586.5	653.4	2813.3	5140.3	608.8	681.1	2875.6	18
20	5053.6	587.2	654.3	2815.4	5143.2	609.5	682.0	2877.7	20
22	5056.6	587.9	655.2	2817.4	5146.2	610.3	683.0	2879.8	22
24	5059.6	588.7	656.2	2819.5	5149.2	611.0	683.9	2881.9	24
26	5062.6	589.4	657.1	2821.6	5152.1	611.8	684.9	2884.0	26
28	5065.6	590.1	658.0	2823.6	5155.1	612.5	685.8	2886.1	28
30	5068.6	590.9	658.9	2825.7	5158.1	613.3	686.7	2888.1	30
32	5071.6	591.6	659.8	2827.8	5161.1	614.0	687.7	2890.2	32
34	5074.6	592.3	660.7	2829.8	5164.0	614.8	688.6	2892.3	34
36	5077.6	593.1	661.6	2831.9	5167.0	615.5	689.6	2894.4	36
38	5080.6	593.8	662.5	2834.0	5170.0	616.3	690.5	2896.5	38
40	5083.6	594.5	663.5	2836.1	5173.0	617.0	691.5	2898.6	40
42	5086.6	595.3	664.4	2838.2	5175.9	617.8	692.4	2900.7	42
44	5089.6	596.0	665.3	2840.2	5178.9	618.5	693.4	2902.8	44
46	5092.6	596.7	666.2	2842.3	5181.9	619.3	694.3	2904.9	46
48	5095.6	597.5	667.2	2844.4	5184.9	620.1	695.3	2907.0	48
50	5098.6	598.2	668.1	2846.5	5187.8	620.8	696.2	2909.1	50
52	5101.6	598.9	669.0	2848.5	5190.8	621.5	697.1	2911.2	52
54	5104.6	599.7	669.9	2850.6	5193.8	622.3	698.1	2913.3	54
56	5107.6	600.4	670.9	2852.7	5196.7	623.0	699.0	2915.4	56
58	5110.6	601.2	671.8	2854.8	5199.7	623.8	700.0	2917.5	58
60	5113.5	602.0	672.7	2856.9	5202.7	624.6	700.9	2919.5	60

## 224 FUNCTIONS OF A ONE-DEGREE CURVE

°	54°				55°				°
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	5202.7	624.6	700.9	2919.5	5291.7	647.4	739.9	2982.8	0
2	5205.7	625.4	701.9	2921.6	5294.6	648.1	739.9	2984.9	2
4	5208.6	626.1	702.8	2923.8	5297.6	648.9	731.9	2987.1	4
6	5211.6	626.9	703.8	2925.9	5300.5	649.6	732.9	2989.2	6
8	5214.6	627.6	704.8	2928.0	5303.5	650.4	733.8	2991.3	8
10	5217.5	628.4	705.7	2930.1	5306.4	651.2	734.8	2993.4	10
12	5220.5	629.2	706.7	2932.2	5309.4	652.0	735.8	2995.5	12
14	5223.5	629.9	707.7	2934.3	5312.3	652.7	736.8	2997.7	14
16	5226.4	630.7	708.6	2936.4	5315.3	653.5	737.8	2999.8	16
18	5229.4	631.4	709.6	2938.5	5318.2	654.3	738.7	3001.9	18
20	5232.4	632.2	710.5	2940.6	5321.2	655.1	739.7	3004.0	20
22	5235.3	633.0	711.5	2942.7	5324.1	655.8	740.7	3006.2	22
24	5238.3	633.7	712.5	2944.8	5327.1	656.6	741.7	3008.3	24
26	5241.3	634.5	713.4	2946.9	5330.0	657.4	742.7	3010.4	26
28	5244.2	635.2	714.4	2949.0	5333.0	658.2	743.7	3012.5	28
30	5247.2	636.0	715.3	2951.1	5335.9	659.0	744.7	3014.7	30
32	5250.2	636.8	716.3	2953.2	5338.8	659.7	745.7	3016.8	32
34	5253.1	637.5	717.3	2955.3	5341.8	660.5	746.7	3018.9	34
36	5256.1	638.3	718.2	2957.5	5344.7	661.3	747.7	3021.1	36
38	5259.1	639.0	719.2	2959.6	5347.7	662.0	748.7	3023.2	38
40	5262.0	639.8	720.2	2961.7	5350.6	662.8	749.7	3025.3	40
42	5265.0	640.6	721.1	2963.8	5353.6	663.6	750.7	3027.5	42
44	5268.0	641.3	722.1	2965.9	5356.5	664.4	751.7	3029.6	44
46	5270.9	642.1	723.1	2968.0	5359.5	665.1	752.6	3031.7	46
48	5273.9	642.8	724.1	2970.1	5362.4	665.9	753.6	3033.8	48
50	5276.8	643.6	725.0	2972.2	5365.4	666.7	754.6	3036.0	50
52	5279.8	644.4	726.0	2974.4	5368.3	667.5	755.6	3038.1	52
54	5282.8	645.1	727.0	2976.5	5371.3	668.3	756.6	3040.2	54
56	5285.8	645.9	728.0	2978.6	5374.2	669.1	757.6	3042.4	56
58	5288.7	646.6	729.0	2980.7	5377.2	669.9	758.6	3044.5	58
60	5291.7	647.4	729.9	2982.8	5380.1	670.7	759.6	3046.6	60

°	56°				57°				°
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	5380.1	670.7	759.6	3016.6	5468.2	694.4	790.2	3111.1	0
2	5383.0	671.4	760.6	3048.8	5471.1	695.2	791.2	3113.3	2
4	5386.0	672.2	761.6	3050.9	5474.0	696.0	792.2	3115.4	4
6	5388.9	672.9	762.7	3053.1	5477.0	696.8	793.3	3117.6	6
8	5391.8	673.7	763.7	3055.2	5479.9	697.6	794.3	3119.7	8
10	5394.8	674.4	764.7	3057.4	5482.8	698.4	795.3	3121.9	10
12	5397.7	675.2	765.7	3059.5	5485.7	699.2	796.3	3124.1	12
14	5400.7	676.0	766.7	3061.6	5488.7	700.0	797.4	3126.2	14
16	5403.6	676.8	767.7	3063.8	5491.6	700.8	798.4	3128.4	16
18	5406.5	677.6	768.7	3065.9	5494.5	701.6	799.4	3130.6	18
20	5409.5	678.4	769.7	3068.1	5497.4	702.4	800.5	3132.7	20
22	5412.4	679.2	770.8	3070.2	5500.3	703.2	801.5	3134.9	22
24	5415.3	680.0	771.8	3072.4	5503.3	704.0	802.6	3137.0	24
26	5418.3	680.8	772.8	3074.5	5506.2	704.8	803.6	3139.2	26
28	5421.2	681.6	773.8	3076.6	5509.1	705.6	804.7	3141.4	28
30	5424.1	682.4	774.8	3078.8	5512.0	706.4	805.7	3143.5	30
32	5427.1	683.2	775.8	3080.9	5515.0	707.2	806.8	3145.7	32
34	5430.0	684.0	776.8	3083.1	5517.9	708.0	807.8	3147.9	34
36	5433.0	684.8	777.8	3085.2	5520.8	708.8	808.8	3150.0	36
38	5435.9	685.6	778.9	3087.4	5523.7	709.6	809.9	3152.2	38
40	5438.8	686.4	779.9	3089.6	5526.7	710.4	810.9	3154.4	40
42	5441.8	687.2	780.9	3091.7	5529.6	711.2	812.0	3156.6	42
44	5444.7	688.0	781.9	3093.9	5532.5	712.0	813.0	3158.7	44
46	5447.6	688.8	783.0	3096.0	5535.4	712.8	814.1	3160.9	46
48	5450.5	689.6	784.0	3098.2	5538.3	713.6	815.1	3163.1	48
50	5453.5	690.4	785.0	3100.3	5541.3	714.4	816.2	3165.3	50
52	5456.5	691.2	786.0	3102.5	5544.2	715.2	817.2	3167.4	52
54	5459.4	692.0	787.1	3104.6	5547.1	716.0	818.3	3169.6	54
56	5462.3	692.8	788.1	3106.8	5550.0	716.8	819.3	3171.8	56
58	5465.3	693.6	789.1	3108.9	5553.0	717.6	820.4	3174.0	58
60	5468.2	694.4	790.2	3111.1	5555.9	718.4	821.4	3176.1	60

FUNCTIONS OF A ONE-DEGREE CURVE 225

	58°				59°				
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	5555.9	718.4	821.4	3176.1	5643.1	742.8	853.5	3241.9	0
2	5558.8	719.2	822.5	3178.3	5646.0	743.6	854.6	3244.1	2
4	5561.7	720.0	823.5	3180.5	5648.9	744.4	855.7	3246.3	4
6	5564.6	720.8	824.6	3182.7	5651.8	745.3	856.8	3248.5	6
8	5567.5	721.6	825.7	3184.9	5654.7	746.1	857.9	3250.7	8
10	5570.4	722.4	826.7	3187.1	5657.6	746.9	859.0	3252.9	10
12	5573.3	723.2	827.8	3189.2	5660.5	747.7	860.0	3255.1	12
14	5576.2	724.0	828.9	3191.4	5663.4	748.6	861.1	3257.3	14
16	5579.2	724.8	829.9	3193.6	5666.3	749.4	862.2	3259.5	16
18	5582.1	725.6	831.0	3195.8	5669.2	750.2	863.3	3261.7	18
20	5585.0	726.5	832.1	3198.0	5672.1	751.1	864.4	3263.9	20
22	5587.9	727.3	833.1	3200.2	5675.0	751.9	865.5	3266.1	22
24	5590.8	728.1	834.2	3202.4	5677.9	752.7	866.6	3268.3	24
26	5593.7	728.9	835.3	3204.5	5680.8	753.5	867.7	3270.5	26
28	5596.6	729.7	836.3	3206.7	5683.7	754.4	868.8	3272.7	28
30	5599.5	730.5	837.4	3208.9	5686.5	755.2	869.9	3274.9	30
32	5602.4	731.3	838.4	3211.1	5689.4	756.0	871.0	3277.1	32
34	5605.3	732.1	839.5	3213.3	5692.3	756.9	872.1	3279.4	34
36	5608.2	732.9	840.6	3215.5	5695.2	757.7	873.2	3281.6	36
38	5611.1	733.7	841.6	3217.7	5698.1	758.5	874.3	3283.8	38
40	5614.0	734.5	842.7	3219.9	5701.0	759.4	875.4	3286.0	40
42	5616.9	735.4	843.8	3222.1	5703.9	760.2	876.5	3288.2	42
44	5619.8	736.2	844.9	3224.3	5706.8	761.0	877.6	3290.5	44
46	5622.7	737.0	846.0	3226.5	5709.7	761.9	878.7	3292.7	46
48	5625.6	737.8	847.0	3228.7	5712.6	762.7	879.8	3294.9	48
50	5628.5	738.6	848.1	3230.9	5715.5	763.5	880.9	3297.1	50
52	5631.4	739.4	849.2	3233.1	5718.4	764.4	882.0	3299.3	52
54	5634.3	740.2	850.3	3235.3	5721.3	765.2	883.1	3301.5	54
56	5637.2	741.0	851.4	3237.5	5724.2	766.0	884.2	3303.8	56
58	5640.1	741.9	852.5	3239.7	5727.1	766.8	885.3	3306.0	58
60	5643.0	742.8	853.5	3241.9	5730.0	767.7	886.4	3308.2	60

	60°				61°				
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	5730.0	767.7	886.4	3308.2	5816.4	792.9	920.2	3375.2	0
2	5732.9	768.5	887.5	3310.4	5819.3	793.7	921.4	3377.4	2
4	5735.8	769.4	888.7	3312.7	5822.1	794.6	922.5	3379.7	4
6	5738.6	770.2	889.8	3314.9	5825.0	795.4	923.6	3381.9	6
8	5741.5	771.1	890.9	3317.1	5827.9	796.3	924.8	3384.2	8
10	5744.4	771.9	892.0	3319.3	5830.7	797.1	925.9	3386.4	10
12	5747.3	772.7	893.1	3321.6	5833.6	798.0	927.1	3388.7	12
14	5750.2	773.6	894.3	3323.8	5836.5	798.8	928.2	3390.9	14
16	5753.0	774.4	895.4	3326.0	5839.3	799.7	929.3	3393.2	16
18	5755.9	775.3	896.5	3328.3	5842.2	800.5	930.5	3395.4	18
20	5758.8	776.1	897.6	3330.5	5845.1	801.4	931.6	3397.7	20
22	5761.7	776.9	898.8	3332.7	5847.9	802.2	932.8	3399.9	22
24	5764.6	777.8	899.9	3334.9	5850.8	803.1	933.9	3402.2	24
26	5767.4	778.6	901.0	3337.2	5853.7	803.9	935.1	3404.4	26
28	5770.3	779.5	902.1	3339.4	5856.5	804.8	936.3	3406.7	28
30	5773.2	780.3	903.2	3341.6	5859.4	805.6	937.4	3408.9	30
32	5776.1	781.1	904.4	3343.9	5862.3	806.5	938.6	3411.2	32
34	5779.0	782.0	905.5	3346.1	5865.1	807.3	939.7	3413.5	34
36	5781.8	782.8	906.6	3348.3	5868.0	808.2	940.9	3415.7	36
38	5784.7	783.7	907.7	3350.6	5870.9	809.0	942.1	3418.0	38
40	5787.6	784.5	908.8	3352.8	5873.7	809.9	943.2	3420.3	40
42	5790.5	785.3	910.0	3355.0	5876.6	810.7	944.4	3422.5	42
44	5793.4	786.2	911.1	3357.3	5879.5	811.6	945.5	3424.8	44
46	5796.2	787.0	912.3	3359.5	5882.3	812.4	946.7	3427.1	46
48	5799.1	787.9	913.4	3361.8	5885.2	813.3	947.8	3429.3	48
50	5802.0	788.7	914.5	3364.0	5888.1	814.1	949.0	3431.6	50
52	5804.9	789.5	915.7	3366.2	5890.9	815.0	950.2	3433.9	52
54	5807.8	790.4	916.8	3368.5	5893.8	815.8	951.3	3436.1	54
56	5810.6	791.2	918.0	3370.7	5896.7	816.7	952.5	3438.4	56
58	5813.5	792.1	919.1	3373.0	5899.5	817.5	953.6	3440.7	58
60	5816.4	792.9	920.2	3375.2	5902.4	818.4	954.8	3442.9	60

'	62°				63°				'
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	5902.4	818.4	954.8	3442.9	5987.8	844.4	990.3	3511.3	0
2	5905.2	819.8	956.0	3445.2	5990.6	845.3	991.5	3513.6	2
4	5908.1	820.1	957.2	3447.5	5993.5	846.2	992.7	3515.9	4
6	5910.9	821.0	958.3	3449.7	5996.3	847.1	993.9	3518.2	6
8	5913.8	821.8	959.5	3452.0	5999.1	847.9	995.1	3520.5	8
10	5916.6	822.7	960.7	3454.3	6002.0	848.8	996.3	3522.8	10
12	5919.5	823.6	961.9	3456.6	6004.8	849.7	997.5	3525.1	12
14	5922.3	824.4	963.0	3458.8	6007.7	850.6	998.7	3527.4	14
16	5925.2	825.3	964.2	3461.1	6010.5	851.4	999.9	3529.7	16
18	5928.0	826.1	965.4	3463.4	6013.3	852.3	1001.1	3532.0	18
20	5930.9	827.0	966.6	3465.7	6016.2	853.2	1002.3	3534.3	20
22	5933.7	827.9	967.8	3467.9	6019.0	854.1	1003.5	3536.6	22
24	5936.6	828.7	968.9	3470.2	6021.8	854.9	1004.7	3538.9	24
26	5939.4	829.6	970.1	3472.5	6024.7	855.8	1005.9	3541.2	26
28	5942.3	830.4	971.3	3474.7	6027.5	856.7	1007.1	3543.5	28
30	5945.1	831.3	972.5	3477.0	6030.3	857.6	1008.4	3545.8	30
32	5947.9	832.2	973.6	3479.3	6033.2	858.4	1009.6	3548.1	32
34	5950.8	833.0	974.8	3481.6	6036.0	859.3	1010.8	3550.4	34
36	5953.6	833.9	976.0	3483.9	6038.9	860.2	1012.0	3552.7	36
38	5956.5	834.7	977.2	3486.2	6041.7	861.1	1013.2	3555.0	38
40	5959.3	835.6	978.4	3488.5	6044.5	861.9	1014.5	3557.3	40
42	5962.2	836.5	979.6	3490.7	6047.4	862.8	1015.7	3559.6	42
44	5965.0	837.4	980.8	3493.0	6050.2	863.7	1016.9	3562.0	44
46	5967.9	838.3	982.0	3495.3	6053.0	864.6	1018.1	3564.3	46
48	5970.7	839.1	983.2	3497.6	6055.9	865.4	1019.3	3566.6	48
50	5973.6	840.0	984.4	3499.9	6058.7	866.3	1020.6	3568.9	50
52	5976.4	840.9	985.5	3502.2	6061.6	867.2	1021.8	3571.2	52
54	5979.3	841.7	986.7	3504.5	6064.4	868.1	1023.0	3573.5	54
56	5982.1	842.6	987.9	3506.8	6067.2	868.9	1024.2	3575.8	56
58	5985.0	843.5	989.1	3509.0	6070.1	869.8	1025.4	3578.1	58
60	5987.8	844.4	990.3	3511.3	6072.9	870.7	1026.7	3580.4	60

'	64°				65°				'
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	6072.9	870.7	1026.7	3580.4	6157.5	897.3	1064.0	3650.4	0
2	6075.7	871.5	1027.9	3582.8	6160.3	898.2	1065.2	3652.8	2
4	6078.5	872.4	1029.2	3585.1	6163.1	899.1	1066.5	3655.1	4
6	6081.4	873.3	1030.4	3587.4	6165.9	900.0	1067.7	3657.5	6
8	6084.2	874.2	1031.7	3589.7	6168.7	900.9	1069.0	3659.8	8
10	6087.0	875.1	1032.9	3592.1	6171.5	901.8	1070.2	3662.2	10
12	6089.8	875.9	1034.1	3594.4	6174.3	902.7	1071.5	3664.5	12
14	6092.6	876.8	1035.4	3596.7	6177.1	903.6	1072.7	3666.9	14
16	6095.5	877.7	1036.6	3599.1	6179.9	904.5	1074.0	3669.2	16
18	6098.3	878.6	1037.9	3601.4	6182.7	905.4	1075.2	3671.6	18
20	6101.1	879.5	1039.1	3603.7	6185.5	906.3	1076.6	3673.9	20
22	6103.9	880.3	1040.3	3606.0	6188.3	907.2	1077.8	3676.2	22
24	6106.7	881.2	1041.6	3608.4	6191.1	908.1	1079.1	3678.6	24
26	6109.6	882.1	1042.8	3610.7	6193.9	909.0	1080.4	3680.9	26
28	6112.4	883.0	1044.1	3613.0	6196.7	909.9	1081.7	3683.3	28
30	6115.2	883.9	1045.3	3615.3	6199.5	910.8	1083.0	3685.6	30
32	6118.0	884.7	1046.5	3617.7	6202.3	911.7	1084.2	3688.0	32
34	6120.8	885.6	1047.8	3620.0	6205.1	912.6	1085.5	3690.4	34
36	6123.7	886.5	1049.0	3622.3	6207.9	913.5	1086.8	3692.7	36
38	6126.5	887.4	1050.3	3624.7	6210.8	914.4	1088.1	3695.1	38
40	6129.3	888.3	1051.5	3627.0	6213.6	915.3	1089.4	3697.4	40
42	6132.1	889.2	1052.7	3629.4	6216.4	916.2	1090.6	3699.8	42
44	6134.9	890.1	1054.0	3631.7	6219.2	917.1	1091.9	3702.2	44
46	6137.8	891.0	1055.2	3634.0	6222.0	918.0	1093.2	3704.5	46
48	6140.6	891.9	1056.5	3636.4	6224.8	918.9	1094.5	3706.9	48
50	6143.4	892.8	1057.7	3638.7	6227.6	919.8	1095.8	3709.3	50
52	6146.2	893.7	1059.0	3641.1	6230.4	920.7	1097.0	3711.6	52
54	6149.0	894.6	1060.2	3643.4	6233.2	921.6	1098.3	3714.0	54
56	6151.9	895.5	1061.5	3645.7	6236.0	922.5	1099.6	3716.3	56
58	6154.7	896.4	1062.7	3648.1	6238.8	923.4	1100.9	3718.7	58
60	6157.5	897.3	1064.0	3650.4	6241.6	924.3	1102.2	3721.1	60

FUNCTIONS OF A ONE-DEGREE CURVE 227

	66°				67°				
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	6941.6	934.3	1102.2	3721.1	6325.2	951.8	1141.5	3792.6	0
2	6944.4	935.2	1103.5	3723.4	6328.0	952.7	1142.8	3795.0	2
4	6947.2	936.1	1104.8	3725.8	6330.7	953.6	1144.1	3797.4	4
6	6950.0	937.0	1106.1	3728.2	6333.5	954.5	1145.4	3799.8	6
8	6952.7	937.9	1107.4	3730.6	6336.3	955.5	1146.7	3802.2	8
10	6955.5	938.8	1108.7	3732.9	6339.0	956.4	1148.1	3804.6	10
12	6958.3	939.8	1110.0	3735.3	6341.8	957.3	1149.4	3807.0	12
14	6961.1	940.7	1111.3	3737.7	6344.6	958.2	1150.7	3809.4	14
16	6963.9	941.6	1112.6	3740.1	6347.4	959.2	1152.0	3811.8	16
18	6966.7	942.5	1113.9	3742.4	6350.1	960.1	1153.3	3814.2	18
20	6969.5	943.4	1115.2	3744.8	6352.9	961.0	1154.7	3816.6	20
22	6972.3	944.3	1116.5	3747.2	6355.7	961.9	1156.0	3819.0	22
24	6975.0	945.3	1117.8	3749.6	6358.4	962.9	1157.4	3821.4	24
26	6977.8	946.2	1119.1	3751.9	6361.2	963.8	1158.7	3823.8	26
28	6980.6	947.1	1120.4	3754.3	6364.0	964.7	1160.1	3826.2	28
30	6983.4	948.0	1121.7	3756.7	6366.7	965.6	1161.4	3828.6	30
32	6986.2	948.9	1123.0	3759.1	6369.5	966.6	1162.8	3831.0	32
34	6989.0	949.8	1124.3	3761.5	6372.3	967.5	1164.1	3833.4	34
36	6991.8	950.8	1125.6	3763.9	6375.1	968.4	1165.5	3835.8	36
38	6994.5	951.7	1126.9	3766.3	6377.8	969.3	1166.8	3838.2	38
40	6997.3	952.6	1128.2	3768.7	6380.6	970.3	1168.2	3840.6	40
42	6999.9	953.5	1129.5	3771.0	6383.4	971.2	1169.5	3843.0	42
44	7002.7	954.4	1130.9	3773.4	6386.1	972.1	1170.9	3845.4	44
46	7005.5	955.3	1132.2	3775.8	6388.9	973.0	1172.2	3847.8	46
48	7008.3	956.3	1133.5	3778.2	6391.7	974.0	1173.6	3850.2	48
50	7011.1	957.2	1134.9	3780.6	6394.4	974.9	1174.9	3852.6	50
52	7013.9	958.1	1136.2	3783.0	6397.2	975.8	1176.3	3855.0	52
54	7016.7	959.0	1137.5	3785.4	6400.0	976.8	1177.6	3857.4	54
56	7019.5	959.9	1138.8	3787.8	6402.8	977.7	1179.0	3860.0	56
58	7022.3	960.8	1140.1	3790.2	6405.5	978.6	1180.3	3862.5	58
60	7025.2	961.8	1141.5	3792.6	6408.3	979.6	1181.6	3864.9	60

	68°				69°				
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	6408.3	979.6	1181.6	3864.9	6491.1	1007.7	1222.9	3938.1	0
2	6411.1	980.5	1183.0	3867.3	6493.8	1008.7	1224.3	3940.6	2
4	6413.8	981.4	1184.4	3869.7	6496.6	1009.6	1225.7	3943.0	4
6	6416.6	982.4	1185.7	3872.2	6499.3	1010.6	1227.1	3945.5	6
8	6419.3	983.3	1187.1	3874.6	6502.1	1011.5	1228.5	3947.9	8
10	6422.1	984.2	1188.5	3877.0	6504.8	1012.5	1229.9	3950.4	10
12	6424.9	985.2	1189.8	3879.5	6507.5	1013.4	1231.3	3952.8	12
14	6427.6	986.1	1191.2	3881.9	6510.3	1014.4	1232.7	3955.3	14
16	6430.4	987.0	1192.6	3884.3	6513.0	1015.3	1234.1	3957.8	16
18	6433.1	988.0	1193.9	3886.8	6515.8	1016.3	1235.5	3960.2	18
20	6435.9	988.9	1195.3	3889.2	6518.5	1017.2	1236.9	3962.7	20
22	6438.7	989.8	1196.7	3891.6	6521.2	1018.2	1238.3	3965.2	22
24	6441.4	990.8	1198.0	3894.1	6524.0	1019.1	1239.7	3967.6	24
26	6444.2	991.7	1199.4	3896.5	6526.7	1020.1	1241.1	3970.1	26
28	6446.9	992.6	1200.8	3898.9	6529.5	1021.0	1242.5	3972.5	28
30	6449.7	993.6	1202.1	3901.4	6532.2	1022.0	1243.9	3975.0	30
32	6452.5	994.5	1203.5	3903.8	6534.9	1022.9	1245.3	3977.5	32
34	6455.2	995.4	1204.9	3906.3	6537.7	1023.9	1246.7	3980.0	34
36	6458.0	996.4	1206.2	3908.7	6540.4	1024.8	1248.1	3982.4	36
38	6460.7	997.3	1207.6	3911.2	6543.2	1025.8	1249.5	3984.9	38
40	6463.5	998.2	1209.0	3913.6	6545.9	1026.7	1250.9	3987.4	40
42	6466.3	999.2	1210.3	3916.1	6548.6	1027.7	1252.3	3989.8	42
44	6469.0	1000.1	1211.7	3918.5	6551.4	1028.6	1253.7	3992.3	44
46	6471.8	1001.0	1213.1	3921.0	6554.1	1029.6	1255.1	3994.8	46
48	6474.5	1002.0	1214.5	3923.4	6556.9	1030.5	1256.5	3997.3	48
50	6477.3	1002.9	1215.9	3925.9	6559.6	1031.5	1257.9	3999.8	50
52	6480.1	1003.8	1217.3	3928.3	6562.3	1032.4	1259.3	4002.2	52
54	6482.8	1004.8	1218.7	3930.8	6565.1	1033.4	1260.7	4004.7	54
56	6485.6	1005.7	1220.1	3933.2	6567.8	1034.3	1262.1	4007.2	56
58	6488.3	1006.7	1221.5	3935.7	6570.6	1035.3	1263.5	4009.7	58
60	6491.1	1007.7	1222.9	3938.1	6573.3	1036.3	1265.0	4012.1	60

71°				71°			
L	M	E	T	L	M	E	T
464	1367.1	1336.4	4087.1	0			
465	1368.1	1336.9	4089.7	2			
466	1369.0	1337.3	4092.2	4			
467	1369.8	1337.6	4094.7	6			
468	1370.6	1337.9	4097.2	8			
469	1371.4	1338.1	4099.8	10			
470	1372.1	1338.3	4102.3	12			
471	1372.8	1338.5	4104.8	14			
472	1373.5	1338.7	4107.3	16			
473	1374.2	1338.8	4109.8	18			
474	1374.9	1338.9	4112.4	20			
475	1375.5	1339.0	4114.9	22			
476	1376.2	1339.1	4117.4	24			
477	1376.8	1339.2	4119.9	26			
478	1377.4	1339.2	4122.4	28			
479	1378.0	1339.3	4125.0	30			
480	1378.6	1339.3	4127.5	32			
481	1379.1	1339.4	4130.1	34			
482	1379.7	1339.4	4132.6	36			
483	1380.2	1339.4	4135.1	38			
484	1380.7	1339.5	4137.7	40			
485	1381.2	1339.5	4140.2	42			
486	1381.7	1339.5	4142.7	44			
487	1382.2	1339.5	4145.3	46			
488	1382.7	1339.5	4147.8	48			
489	1383.2	1339.5	4150.4	50			
490	1383.7	1339.5	4152.9	52			
491	1384.2	1339.5	4155.4	54			
492	1384.7	1339.5	4157.9	56			
493	1385.2	1339.5	4160.5	58			
494	1385.7	1339.5	4163.1	60			

72°				72°			
L	M	E	T	L	M	E	T
495	1386.2	1339.5	4165.6	0			
496	1386.7	1339.5	4168.1	2			
497	1387.2	1339.5	4170.6	4			
498	1387.7	1339.5	4173.1	6			
499	1388.2	1339.5	4175.6	8			
500	1388.7	1339.5	4178.1	10			
501	1389.2	1339.5	4180.6	12			
502	1389.7	1339.5	4183.1	14			
503	1390.2	1339.5	4185.6	16			
504	1390.7	1339.5	4188.1	18			
505	1391.2	1339.5	4190.6	20			
506	1391.7	1339.5	4193.1	22			
507	1392.2	1339.5	4195.6	24			
508	1392.7	1339.5	4198.1	26			
509	1393.2	1339.5	4200.6	28			
510	1393.7	1339.5	4203.1	30			
511	1394.2	1339.5	4205.6	32			
512	1394.7	1339.5	4208.1	34			
513	1395.2	1339.5	4210.6	36			
514	1395.7	1339.5	4213.1	38			
515	1396.2	1339.5	4215.6	40			
516	1396.7	1339.5	4218.1	42			
517	1397.2	1339.5	4220.6	44			
518	1397.7	1339.5	4223.1	46			
519	1398.2	1339.5	4225.6	48			
520	1398.7	1339.5	4228.1	50			
521	1399.2	1339.5	4230.6	52			
522	1399.7	1339.5	4233.1	54			
523	1400.2	1339.5	4235.6	56			
524	1400.7	1339.5	4238.1	58			
525	1401.2	1339.5	4240.6	60			

FUNCTIONS OF A ONE-DEGREE CURVE 229

	74°				75°				
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	6896.8	1153.8	1441.7	4317.8	6976.4	1184.1	1492.5	4396.7	0
2	6899.4	1154.8	1446.2	4320.5	6979.0	1185.1	1494.1	4399.4	2
4	6902.1	1155.8	1447.8	4323.1	6981.7	1186.1	1495.7	4402.1	4
6	6904.8	1156.8	1449.4	4325.7	6984.3	1187.1	1497.3	4404.7	6
8	6907.4	1157.8	1451.0	4328.3	6986.9	1188.1	1499.0	4407.4	8
10	6910.1	1158.8	1452.6	4330.9	6989.6	1189.2	1500.6	4410.0	10
12	6912.7	1159.8	1454.1	4333.6	6992.2	1190.2	1502.3	4412.7	12
14	6915.4	1160.8	1455.7	4336.2	6994.9	1191.2	1503.8	4415.3	14
16	6918.0	1161.8	1457.3	4338.8	6997.5	1192.2	1505.4	4418.0	16
18	6920.7	1162.8	1458.9	4341.4	7000.1	1193.2	1507.0	4420.7	18
20	6923.3	1163.9	1460.5	4344.0	7002.8	1194.3	1508.7	4423.3	20
22	6926.0	1164.9	1462.0	4346.7	7005.4	1195.3	1510.3	4426.0	22
24	6928.6	1165.9	1463.6	4349.3	7008.0	1196.3	1512.0	4428.6	24
26	6931.3	1166.9	1465.2	4351.9	7010.7	1197.3	1513.6	4431.3	26
28	6933.9	1167.9	1466.8	4354.5	7013.3	1198.3	1515.3	4434.0	28
30	6936.6	1168.9	1468.4	4357.1	7015.9	1199.4	1516.9	4436.6	30
32	6939.2	1169.9	1469.9	4359.8	7018.6	1200.4	1518.5	4439.3	32
34	6941.9	1170.9	1471.5	4362.4	7021.2	1201.4	1520.2	4442.0	34
36	6944.6	1171.9	1473.1	4365.1	7023.9	1202.4	1521.8	4444.6	36
38	6947.2	1172.9	1474.7	4367.7	7026.5	1203.4	1523.5	4447.3	38
40	6949.9	1174.0	1476.4	4370.3	7029.1	1204.5	1525.1	4450.0	40
42	6952.5	1175.0	1478.0	4372.9	7031.8	1205.5	1526.7	4452.7	42
44	6955.2	1176.0	1479.6	4375.6	7034.4	1206.5	1528.4	4455.3	44
46	6957.8	1177.0	1481.2	4378.2	7037.0	1207.5	1530.0	4458.0	46
48	6960.5	1178.0	1482.8	4380.9	7039.7	1208.5	1531.7	4460.7	48
50	6963.1	1179.0	1484.4	4383.5	7042.3	1209.6	1533.3	4463.4	50
52	6965.8	1180.0	1486.0	4386.2	7045.0	1210.6	1534.9	4466.0	52
54	6968.4	1181.0	1487.7	4388.8	7047.6	1211.6	1536.6	4468.7	54
56	6971.1	1182.0	1489.3	4391.5	7050.2	1212.6	1538.2	4471.4	56
58	6973.7	1183.0	1490.9	4394.1	7052.9	1213.6	1539.9	4474.1	58
60	6976.4	1184.1	1492.5	4396.7	7055.5	1214.7	1541.5	4476.7	60

	76°				77°				
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	7055.5	1214.7	1541.5	4476.7	7134.0	1245.6	1591.7	4557.8	0
2	7058.1	1215.7	1543.2	4479.4	7136.6	1246.6	1593.4	4560.5	2
4	7060.7	1216.7	1544.9	4482.1	7139.2	1247.7	1595.1	4563.3	4
6	7063.3	1217.8	1546.5	4484.8	7141.8	1248.7	1596.8	4566.0	6
8	7066.0	1218.8	1548.2	4487.5	7144.4	1249.8	1598.5	4568.7	8
10	7068.6	1219.8	1549.9	4490.2	7147.0	1250.8	1600.2	4571.5	10
12	7071.2	1220.9	1551.5	4492.9	7149.6	1251.8	1601.9	4574.2	12
14	7073.8	1221.9	1553.2	4495.6	7152.2	1252.9	1603.6	4576.9	14
16	7076.4	1222.9	1554.9	4498.3	7154.8	1253.9	1605.3	4579.7	16
18	7079.0	1224.0	1556.5	4501.0	7157.4	1255.0	1607.0	4582.4	18
20	7081.7	1225.0	1558.2	4503.7	7160.0	1256.0	1608.7	4585.1	20
22	7084.3	1226.0	1559.9	4506.3	7162.6	1257.0	1610.4	4587.9	22
24	7086.9	1227.1	1561.5	4509.0	7165.2	1258.1	1612.1	4590.6	24
26	7089.5	1228.1	1563.2	4511.7	7167.8	1259.1	1613.8	4593.3	26
28	7092.1	1229.1	1564.9	4514.4	7170.4	1260.2	1615.5	4596.0	28
30	7094.7	1230.2	1566.5	4517.1	7173.0	1261.2	1617.3	4598.8	30
32	7097.4	1231.2	1568.2	4519.8	7175.6	1262.2	1619.0	4601.5	32
34	7100.0	1232.2	1569.9	4522.5	7178.2	1263.3	1620.7	4604.3	34
36	7102.6	1233.3	1571.5	4525.3	7180.8	1264.3	1622.4	4607.0	36
38	7105.2	1234.3	1573.2	4528.0	7183.4	1265.4	1624.1	4609.8	38
40	7107.8	1235.3	1574.8	4530.7	7186.0	1266.4	1625.9	4612.5	40
42	7110.4	1236.4	1576.4	4533.4	7188.6	1267.4	1627.6	4615.3	42
44	7113.1	1237.4	1578.1	4536.1	7191.2	1268.5	1629.3	4618.0	44
46	7115.7	1238.4	1579.8	4538.8	7193.8	1269.5	1631.0	4620.8	46
48	7118.3	1239.5	1581.5	4541.5	7196.4	1270.6	1632.7	4623.5	48
50	7120.9	1240.5	1583.2	4544.2	7199.0	1271.6	1634.5	4626.3	50
52	7123.5	1241.5	1584.9	4547.0	7201.6	1272.7	1636.2	4629.0	52
54	7126.1	1242.6	1586.6	4549.7	7204.2	1273.7	1637.9	4631.8	54
56	7128.8	1243.6	1588.3	4552.4	7206.8	1274.8	1639.6	4634.5	56
58	7131.4	1244.6	1590.0	4555.1	7209.4	1275.8	1641.3	4637.3	58
60	7134.0	1245.6	1591.7	4557.8	7212.0	1276.9	1643.1	4640.0	60



°	78°				79°				°
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	7212.0	1276.9	1643.1	4640.0	7289.5	1308.5	1696.0	4723.4	0
2	7314.6	1278.0	1644.8	4642.8	7322.1	1309.5	1697.7	4726.2	2
4	7317.2	1279.0	1646.6	4645.6	7324.6	1310.6	1699.5	4729.0	4
6	7319.7	1280.1	1648.3	4648.3	7327.2	1311.7	1701.3	4731.8	6
8	7322.3	1281.1	1650.1	4651.1	7329.7	1312.7	1703.1	4734.7	8
10	7324.9	1282.2	1651.8	4653.9	7332.3	1313.8	1704.9	4737.5	10
12	7327.5	1283.2	1653.6	4656.7	7334.9	1314.9	1706.6	4740.3	12
14	7330.1	1284.3	1655.3	4659.4	7337.4	1315.9	1708.4	4743.1	14
16	7332.7	1285.3	1657.1	4662.2	7340.0	1317.0	1710.2	4745.9	16
18	7335.2	1286.4	1658.8	4665.0	7342.6	1318.1	1712.0	4748.7	18
20	7337.8	1287.4	1660.6	4667.7	7345.1	1319.1	1713.8	4751.5	20
22	7340.4	1288.5	1662.3	4670.5	7347.7	1320.2	1715.6	4754.3	22
24	7343.0	1289.5	1664.1	4673.3	7350.3	1321.3	1717.4	4757.1	24
26	7345.6	1290.6	1665.8	4676.0	7352.8	1322.3	1719.2	4760.0	26
28	7348.2	1291.6	1667.6	4678.8	7355.4	1323.4	1721.0	4762.8	28
30	7350.7	1292.7	1669.3	4681.6	7357.9	1324.5	1722.8	4765.6	30
32	7353.3	1293.7	1671.1	4684.4	7360.5	1325.5	1724.6	4768.4	32
34	7355.9	1294.8	1672.8	4687.2	7363.1	1326.6	1726.4	4771.2	34
36	7358.5	1295.8	1674.6	4690.0	7365.6	1327.7	1728.2	4774.1	36
38	7361.1	1296.9	1676.3	4692.7	7368.2	1328.7	1730.0	4776.9	38
40	7363.7	1297.9	1678.2	4695.5	7370.8	1329.8	1731.9	4779.7	40
42	7366.2	1299.0	1679.9	4698.3	7373.3	1330.8	1733.7	4782.6	42
44	7368.8	1300.0	1681.7	4701.1	7375.9	1331.9	1735.5	4785.4	44
46	7371.4	1301.1	1683.5	4703.9	7378.4	1333.0	1737.3	4788.2	46
48	7374.0	1302.1	1685.3	4706.7	7381.0	1334.1	1739.1	4791.0	48
50	7376.6	1303.2	1687.1	4709.5	7383.5	1335.2	1740.9	4793.9	50
52	7379.2	1304.2	1688.8	4712.2	7386.1	1336.2	1742.7	4796.7	52
54	7381.7	1305.3	1690.6	4715.0	7388.7	1337.3	1744.5	4799.5	54
56	7384.3	1306.3	1692.4	4717.8	7391.3	1338.4	1746.3	4802.4	56
58	7386.9	1307.4	1694.2	4720.6	7393.8	1339.5	1748.1	4805.2	58
60	7389.5	1308.5	1696.0	4723.4	7396.4	1340.6	1750.0	4808.0	60

°	80°				81°				°
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	7366.4	1340.6	1750.0	4808.0	7442.7	1372.8	1805.5	4899.9	0
2	7368.9	1341.7	1751.8	4810.9	7445.2	1373.9	1807.3	4902.8	2
4	7371.5	1342.7	1753.7	4813.7	7447.7	1375.0	1809.2	4905.7	4
6	7374.0	1343.8	1755.5	4816.6	7450.3	1376.1	1811.1	4908.6	6
8	7376.6	1344.9	1757.4	4819.4	7452.8	1377.1	1813.0	4911.5	8
10	7379.1	1346.0	1759.2	4822.3	7455.3	1378.2	1814.9	4914.4	10
12	7381.7	1347.0	1761.0	4825.1	7457.8	1379.3	1816.8	4917.2	12
14	7384.2	1348.1	1762.9	4828.0	7460.4	1380.4	1818.6	4920.1	14
16	7386.7	1349.2	1764.7	4830.8	7462.9	1381.4	1820.5	4923.0	16
18	7389.3	1350.3	1766.6	4833.7	7465.4	1382.5	1822.4	4925.9	18
20	7391.8	1351.3	1768.4	4836.5	7467.9	1383.6	1824.2	4928.8	20
22	7394.4	1352.4	1770.2	4839.4	7470.4	1384.7	1826.1	4931.7	22
24	7396.9	1353.5	1772.1	4842.2	7473.0	1385.7	1828.0	4934.6	24
26	7399.5	1354.6	1773.9	4845.1	7475.5	1386.8	1829.9	4937.5	26
28	7402.0	1355.6	1775.8	4847.9	7478.0	1387.9	1831.8	4940.4	28
30	7404.5	1356.7	1777.6	4850.8	7480.5	1389.0	1833.7	4943.3	30
32	7407.1	1357.8	1779.4	4853.7	7483.1	1390.1	1835.6	4946.2	32
34	7409.6	1358.9	1781.3	4856.5	7485.6	1391.2	1837.5	4949.1	34
36	7412.2	1359.9	1783.1	4859.4	7488.1	1392.3	1839.4	4952.0	36
38	7414.7	1361.0	1785.0	4862.3	7490.6	1393.4	1841.3	4954.9	38
40	7417.3	1362.1	1786.8	4865.1	7493.2	1394.5	1843.2	4957.8	40
42	7419.8	1363.2	1788.6	4868.0	7495.7	1395.6	1845.1	4960.7	42
44	7422.3	1364.2	1790.5	4870.9	7498.2	1396.7	1847.0	4963.6	44
46	7424.9	1365.3	1792.4	4873.8	7500.7	1397.8	1848.9	4966.5	46
48	7427.4	1366.4	1794.3	4876.6	7503.3	1398.9	1850.8	4969.4	48
50	7430.0	1367.5	1796.2	4879.5	7505.8	1400.0	1852.7	4972.3	50
52	7432.5	1368.5	1798.0	4882.4	7508.3	1401.1	1854.6	4975.2	52
54	7435.1	1369.6	1799.9	4885.3	7510.8	1402.2	1856.5	4978.1	54
56	7437.6	1370.7	1801.8	4888.1	7513.3	1403.3	1858.4	4981.0	56
58	7440.1	1371.8	1803.7	4891.0	7515.9	1404.4	1860.3	4983.9	58
60	7442.7	1372.8	1805.5	4893.9	7518.4	1405.5	1862.3	4986.8	60

FUNCTIONS OF A ONE-DEGREE CURVE 231

°	82°				83°				°
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	7515.4	1405.5	1862.3	4981.0	7593.6	1438.5	1920.6	5069.4	0
2	7520.9	1406.6	1864.2	4983.9	7596.1	1439.6	1922.6	5072.4	2
4	7526.4	1407.7	1866.1	4986.8	7598.6	1440.7	1924.6	5075.4	4
6	7532.0	1408.8	1868.1	4989.8	7601.1	1441.8	1926.5	5078.4	6
8	7538.4	1409.9	1870.0	4992.7	7603.6	1442.9	1928.5	5081.4	8
10	7539.9	1411.0	1871.9	4995.7	7606.0	1444.0	1930.5	5084.4	10
12	7535.4	1412.1	1873.9	4998.6	7608.5	1445.1	1932.4	5087.3	12
14	7535.9	1413.2	1875.8	5001.5	7611.0	1446.2	1934.4	5090.3	14
16	7538.5	1414.3	1877.7	5004.5	7613.5	1447.3	1936.4	5093.3	16
18	7541.0	1415.4	1879.7	5007.4	7616.0	1448.4	1938.4	5096.3	18
20	7548.5	1416.5	1881.6	5010.3	7618.5	1449.6	1940.4	5099.3	20
22	7546.0	1417.6	1883.5	5013.3	7621.0	1450.7	1942.4	5102.3	22
24	7548.5	1418.7	1885.5	5016.2	7623.5	1451.8	1944.4	5105.2	24
26	7551.0	1419.8	1887.4	5019.2	7626.0	1452.9	1946.4	5108.2	26
28	7553.5	1420.9	1889.3	5022.1	7628.5	1454.0	1948.4	5111.2	28
30	7556.0	1422.0	1891.3	5025.0	7630.9	1455.1	1950.4	5114.2	30
32	7558.5	1423.1	1893.2	5028.0	7633.4	1456.2	1952.4	5117.2	32
34	7561.0	1424.2	1895.1	5031.0	7635.9	1457.3	1954.4	5120.2	34
36	7563.5	1425.3	1897.1	5033.9	7638.4	1458.4	1956.4	5123.2	36
38	7566.0	1426.4	1899.0	5036.9	7640.9	1459.5	1958.4	5126.2	38
40	7568.5	1427.5	1901.0	5039.8	7643.4	1460.7	1960.4	5129.2	40
42	7571.0	1428.6	1902.9	5042.8	7645.9	1461.8	1962.4	5132.2	42
44	7573.5	1429.7	1904.9	5045.8	7648.4	1462.9	1964.4	5135.2	44
46	7576.1	1430.8	1906.9	5048.7	7650.9	1464.0	1966.4	5138.2	46
48	7578.6	1431.9	1908.8	5051.7	7653.4	1465.1	1968.4	5141.2	48
50	7581.1	1433.0	1910.8	5054.6	7655.8	1466.2	1970.4	5144.2	50
52	7583.6	1434.1	1912.8	5057.6	7658.3	1467.3	1972.4	5147.2	52
54	7586.1	1435.2	1914.7	5060.6	7660.8	1468.4	1974.4	5150.2	54
56	7588.6	1436.3	1916.7	5063.5	7663.3	1469.5	1976.4	5153.2	56
58	7591.1	1437.4	1918.7	5066.5	7665.8	1470.6	1978.4	5156.2	58
60	7593.6	1438.5	1920.6	5069.4	7668.3	1471.8	1980.5	5159.3	60

°	84°				85°				°
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	7668.3	1471.8	1960.5	5159.3	7742.4	1505.4	2041.8	5250.6	0
2	7670.8	1472.9	1962.5	5162.3	7744.8	1506.5	2043.9	5253.6	2
4	7673.2	1474.0	1964.5	5165.3	7747.3	1507.6	2046.0	5256.7	4
6	7675.7	1475.1	1966.6	5168.4	7749.7	1508.8	2048.0	5259.8	6
8	7678.2	1476.2	1968.6	5171.4	7752.2	1509.9	2050.1	5262.9	8
10	7680.6	1477.4	1970.6	5174.4	7754.6	1511.0	2052.2	5266.0	10
12	7683.1	1478.5	1972.7	5177.5	7757.1	1512.2	2054.2	5269.0	12
14	7685.6	1479.6	1974.7	5180.5	7759.5	1513.3	2056.3	5272.1	14
16	7688.1	1480.7	1976.7	5183.5	7762.0	1514.4	2058.4	5275.2	16
18	7690.5	1481.8	1978.8	5186.6	7764.4	1515.6	2060.5	5278.3	18
20	7693.0	1483.0	1980.8	5189.6	7766.9	1516.7	2062.6	5281.4	20
22	7695.5	1484.1	1982.8	5192.6	7769.3	1517.8	2064.7	5284.4	22
24	7697.9	1485.2	1984.9	5195.6	7771.8	1519.0	2066.8	5287.5	24
26	7700.4	1486.3	1986.9	5198.7	7774.2	1520.1	2068.9	5290.6	26
28	7702.9	1487.4	1989.0	5201.7	7776.7	1521.2	2071.0	5293.7	28
30	7705.3	1488.6	1991.0	5204.7	7779.1	1522.4	2073.1	5296.7	30
32	7707.8	1489.7	1993.0	5207.8	7781.5	1523.5	2075.2	5299.8	32
34	7710.3	1490.8	1995.0	5210.8	7784.0	1524.6	2077.3	5302.9	34
36	7712.8	1491.9	1997.0	5213.9	7786.4	1525.8	2079.4	5306.0	36
38	7715.2	1493.0	1999.1	5216.9	7788.9	1526.9	2081.5	5309.2	38
40	7717.7	1494.2	2001.2	5220.0	7791.3	1528.0	2083.7	5312.3	40
42	7720.2	1495.3	2003.2	5223.1	7793.8	1529.2	2085.8	5315.4	42
44	7722.6	1496.4	2005.3	5226.1	7796.2	1530.3	2087.9	5318.5	44
46	7725.1	1497.5	2007.4	5229.2	7798.7	1531.4	2090.0	5321.6	46
48	7727.6	1498.6	2009.4	5232.2	7801.1	1532.6	2092.1	5324.7	48
50	7730.0	1499.8	2031.5	5235.3	7803.6	1533.7	2094.2	5327.8	50
52	7732.5	1500.9	2033.6	5238.3	7806.0	1534.8	2096.3	5330.9	52
54	7735.0	1502.0	2035.6	5241.4	7808.5	1536.0	2098.4	5334.0	54
56	7737.5	1503.1	2037.7	5244.5	7810.9	1537.1	2100.6	5337.1	56
58	7739.9	1504.2	2039.8	5247.5	7813.4	1538.2	2102.7	5340.2	58
60	7742.4	1505.4	2041.8	5250.6	7815.8	1539.3	2104.8	5343.3	60

## 232 FUNCTIONS OF A ONE-DEGREE CURVE

°	86°				87°				°
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	7815.8	1639.3	2104.8	5343.3	7888.5	1573.6	2169.5	5437.5	0
2	7818.2	1540.4	2106.9	5346.4	7890.9	1574.8	2171.6	5440.7	2
4	7820.6	1541.6	2109.1	5349.5	7893.3	1575.9	2173.8	5443.9	4
6	7823.1	1542.7	2111.2	5352.7	7895.7	1577.1	2176.0	5447.1	6
8	7825.5	1543.9	2113.4	5355.8	7898.1	1578.2	2178.2	5450.3	8
10	7827.9	1545.0	2115.5	5358.9	7900.5	1579.4	2180.4	5453.4	10
12	7830.3	1546.1	2117.6	5362.0	7903.0	1580.5	2182.5	5456.6	12
14	7832.8	1547.3	2119.8	5365.2	7905.4	1581.7	2184.7	5459.8	14
16	7835.2	1548.4	2121.9	5368.3	7907.8	1582.9	2186.9	5463.0	16
18	7837.6	1549.6	2124.1	5371.4	7910.2	1584.0	2189.1	5466.2	18
20	7840.0	1550.7	2126.2	5374.6	7912.6	1585.1	2191.3	5469.4	20
22	7842.4	1551.8	2128.3	5377.7	7915.0	1586.3	2193.5	5472.5	22
24	7844.9	1553.0	2130.5	5380.8	7917.4	1587.4	2195.7	5475.7	24
26	7847.3	1554.1	2132.6	5383.9	7919.8	1588.6	2197.9	5478.9	26
28	7849.7	1555.3	2134.8	5387.1	7922.2	1589.7	2200.1	5482.1	28
30	7852.1	1556.4	2136.9	5390.2	7924.6	1590.9	2202.3	5485.3	30
32	7854.6	1557.5	2139.0	5393.4	7927.1	1592.0	2204.5	5488.5	32
34	7857.0	1558.7	2141.2	5396.5	7929.5	1593.2	2206.8	5491.7	34
36	7859.4	1559.8	2143.3	5399.7	7931.9	1594.3	2209.0	5494.9	36
38	7861.8	1561.0	2145.5	5402.8	7934.3	1595.5	2211.2	5498.1	38
40	7864.3	1562.1	2147.7	5406.0	7936.7	1596.6	2213.4	5501.3	40
42	7866.7	1563.2	2149.8	5409.1	7939.1	1597.8	2215.6	5504.5	42
44	7869.1	1564.4	2152.0	5412.3	7941.5	1598.9	2217.8	5507.7	44
46	7871.5	1565.5	2154.2	5415.4	7943.9	1600.1	2220.0	5510.9	46
48	7874.0	1566.7	2156.4	5418.6	7946.3	1601.2	2222.2	5514.1	48
50	7876.4	1567.8	2158.6	5421.8	7948.7	1602.4	2224.5	5517.3	50
52	7878.8	1568.9	2160.7	5424.9	7951.2	1603.5	2226.7	5520.5	52
54	7881.2	1570.1	2162.9	5428.1	7953.6	1604.7	2228.9	5523.7	54
56	7883.6	1571.2	2165.1	5431.2	7956.0	1605.8	2231.1	5526.9	56
58	7886.1	1572.4	2167.3	5434.4	7958.4	1607.0	2233.3	5530.1	58
60	7888.5	1573.6	2169.5	5437.5	7960.8	1608.2	2235.6	5533.3	60

°	88°				89°				°
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	7960.8	1608.2	2235.6	5533.3	8039.2	1643.0	2308.6	5630.8	0
2	7963.2	1609.4	2237.8	5536.6	8041.8	1644.1	2305.9	5631.1	2
4	7965.6	1610.5	2240.1	5539.8	8037.1	1645.3	2308.2	5637.4	4
6	7968.0	1611.7	2242.3	5543.1	8039.5	1646.5	2310.5	5640.7	6
8	7970.3	1612.8	2244.6	5546.3	8041.9	1647.7	2312.8	5644.0	8
10	7972.7	1614.0	2246.8	5549.5	8044.2	1648.9	2315.1	5647.3	10
12	7975.1	1615.2	2249.1	5552.8	8046.6	1650.0	2317.4	5650.6	12
14	7977.5	1616.3	2251.3	5556.0	8049.0	1651.2	2319.7	5653.9	14
16	7979.9	1617.5	2253.6	5559.2	8051.4	1652.4	2322.0	5657.1	16
18	7982.3	1618.6	2255.8	5562.5	8053.7	1653.6	2324.3	5660.4	18
20	7984.7	1619.8	2258.1	5565.7	8056.1	1654.8	2326.7	5663.7	20
22	7987.1	1621.0	2260.4	5568.9	8058.5	1655.9	2329.0	5667.0	22
24	7989.4	1622.1	2262.7	5572.2	8060.8	1657.1	2331.3	5670.3	24
26	7991.8	1623.3	2264.9	5575.4	8063.2	1658.3	2333.7	5673.6	26
28	7994.2	1624.4	2267.2	5578.6	8065.6	1659.5	2336.0	5676.9	28
30	7996.6	1625.6	2269.5	5581.9	8067.9	1660.7	2338.3	5680.2	30
32	7999.0	1626.8	2271.7	5585.1	8070.3	1661.8	2340.7	5683.5	32
34	8001.4	1627.9	2273.9	5588.4	8072.7	1663.0	2343.0	5686.8	34
36	8003.8	1629.1	2276.2	5591.7	8075.1	1664.2	2345.3	5690.2	36
38	8006.1	1630.3	2278.5	5594.9	8077.4	1665.4	2347.7	5693.5	38
40	8008.5	1631.4	2280.8	5598.2	8079.8	1666.6	2350.0	5696.8	40
42	8010.9	1632.6	2283.0	5601.4	8082.2	1667.7	2352.3	5700.1	42
44	8013.3	1633.7	2285.3	5604.7	8084.5	1668.8	2354.7	5703.4	44
46	8015.7	1634.9	2287.6	5608.0	8086.9	1670.0	2357.0	5706.8	46
48	8018.1	1636.0	2289.9	5611.2	8089.3	1671.2	2359.3	5710.1	48
50	8020.5	1637.2	2292.2	5614.5	8091.6	1672.4	2361.7	5713.4	50
52	8022.9	1638.4	2294.4	5617.8	8094.0	1673.5	2364.0	5716.7	52
54	8025.2	1639.5	2296.7	5621.0	8096.4	1674.7	2366.3	5720.0	54
56	8027.6	1640.7	2299.0	5624.3	8098.8	1675.9	2368.7	5723.3	56
58	8030.0	1641.8	2301.3	5627.5	8101.1	1677.1	2371.0	5726.6	58
60	8032.4	1643.0	2303.6	5630.8	8103.5	1678.3	2373.4	5730.0	60

	90°				91°				
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	8108.5	1678.3	2373.4	5730.0	8173.9	1713.8	2445.1	5890.0	0
2	8105.8	1679.5	2375.8	5733.3	8176.2	1715.0	2447.5	5894.3	2
4	8108.2	1680.6	2378.2	5736.7	8178.5	1716.2	2450.0	5897.7	4
6	8110.5	1681.8	2380.5	5740.0	8180.9	1717.4	2452.4	5841.1	6
8	8112.9	1683.0	2382.9	5743.4	8183.2	1718.6	2454.8	5844.5	8
10	8115.2	1684.2	2385.3	5746.7	8185.5	1719.7	2457.2	5847.9	10
12	8117.6	1685.4	2387.6	5750.0	8187.9	1720.9	2459.7	5851.3	12
14	8119.9	1686.5	2390.0	5753.4	8190.2	1722.1	2462.1	5854.7	14
16	8122.3	1687.7	2392.4	5756.7	8192.5	1723.3	2464.5	5858.1	16
18	8124.6	1688.9	2394.7	5760.1	8194.8	1724.5	2467.0	5861.5	18
20	8127.0	1690.1	2397.1	5763.4	8197.2	1725.7	2469.4	5864.9	20
22	8129.3	1691.3	2399.5	5766.8	8199.5	1726.9	2471.9	5868.3	22
24	8131.7	1692.5	2401.9	5770.1	8201.8	1728.1	2474.3	5871.8	24
26	8134.0	1693.6	2404.3	5773.5	8204.2	1729.3	2476.7	5875.2	26
28	8136.4	1694.8	2406.6	5776.9	8206.5	1730.5	2479.2	5878.6	28
30	8138.7	1696.0	2409.0	5780.2	8208.8	1731.7	2481.6	5882.0	30
32	8141.1	1697.2	2411.4	5783.6	8211.1	1732.9	2484.1	5885.4	32
34	8143.4	1698.4	2413.8	5787.0	8213.5	1734.1	2486.5	5888.9	34
36	8145.8	1699.6	2416.2	5790.3	8215.9	1735.3	2489.0	5892.3	36
38	8148.1	1700.7	2418.6	5793.7	8218.1	1736.4	2491.5	5895.7	38
40	8150.4	1701.9	2421.0	5797.1	8220.4	1737.6	2493.9	5899.2	40
42	8152.8	1703.1	2423.4	5800.4	8222.8	1738.8	2496.4	5902.6	42
44	8155.1	1704.3	2425.8	5803.8	8225.1	1740.0	2498.9	5906.0	44
46	8157.5	1705.5	2428.2	5807.2	8227.4	1741.2	2501.3	5909.4	46
48	8159.8	1706.7	2430.6	5810.6	8229.7	1742.4	2503.8	5912.9	48
50	8162.2	1707.9	2433.0	5814.0	8232.0	1743.6	2506.3	5916.3	50
52	8164.5	1709.0	2435.4	5817.3	8234.3	1744.8	2508.7	5919.8	52
54	8166.8	1710.2	2437.9	5820.7	8236.7	1746.0	2511.2	5923.2	54
56	8169.2	1711.4	2440.3	5824.1	8239.0	1747.2	2513.7	5926.7	56
58	8171.5	1712.6	2442.7	5827.5	8241.3	1748.4	2516.2	5930.1	58
60	8173.9	1713.8	2445.1	5830.9	8243.6	1749.6	2518.7	5933.6	60

	92°				93°				
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	8243.6	1749.6	2518.7	5933.6	8312.8	1785.7	2594.2	6088.2	0
2	8245.9	1750.8	2521.2	5937.0	8315.1	1786.9	2596.8	6041.7	2
4	8248.2	1752.0	2523.6	5940.5	8317.4	1788.2	2599.3	6045.2	4
6	8250.6	1753.2	2526.1	5944.0	8319.7	1789.4	2601.9	6048.7	6
8	8252.9	1754.4	2528.6	5947.4	8322.0	1790.6	2604.4	6052.2	8
10	8255.2	1755.6	2531.1	5950.9	8324.3	1791.8	2607.0	6055.8	10
12	8257.5	1756.8	2533.6	5954.4	8326.6	1793.0	2609.6	6059.3	12
14	8259.8	1758.0	2536.1	5957.8	8328.8	1794.2	2612.1	6062.8	14
16	8262.2	1759.2	2538.6	5961.3	8331.1	1795.4	2614.7	6066.4	16
18	8264.5	1760.4	2541.1	5964.8	8333.3	1796.6	2617.3	6069.9	18
20	8266.8	1761.6	2543.6	5968.2	8335.6	1797.8	2619.8	6073.4	20
22	8269.1	1762.8	2546.1	5971.7	8337.9	1799.1	2622.4	6077.0	22
24	8271.4	1764.0	2548.6	5975.2	8340.2	1800.3	2625.0	6080.5	24
26	8273.7	1765.2	2551.2	5978.7	8342.5	1801.5	2627.6	6084.1	26
28	8276.0	1766.4	2553.7	5982.2	8344.8	1802.7	2630.2	6087.6	28
30	8278.3	1767.6	2556.2	5985.6	8347.1	1803.9	2632.7	6091.2	30
32	8280.6	1768.8	2558.7	5989.1	8349.4	1805.1	2635.3	6094.7	32
34	8282.9	1770.0	2561.2	5992.6	8351.7	1806.3	2637.9	6098.3	34
36	8285.2	1771.2	2563.8	5996.1	8354.0	1807.6	2640.5	6101.8	36
38	8287.5	1772.5	2566.3	5999.6	8356.3	1808.8	2643.1	6105.4	38
40	8289.8	1773.7	2568.8	6003.1	8358.5	1810.0	2645.7	6109.0	40
42	8292.1	1774.9	2571.3	6006.6	8360.8	1811.2	2648.3	6112.5	42
44	8294.4	1776.1	2573.9	6010.1	8363.1	1812.4	2650.9	6116.1	44
46	8296.7	1777.3	2576.4	6013.6	8365.4	1813.6	2653.5	6119.7	46
48	8299.0	1778.5	2578.9	6017.1	8367.7	1814.9	2656.1	6123.2	48
50	8301.3	1779.7	2581.5	6020.6	8369.9	1816.1	2658.7	6126.8	50
52	8303.6	1780.9	2584.0	6024.1	8372.2	1817.3	2661.3	6130.4	52
54	8305.9	1782.1	2586.6	6027.6	8374.5	1818.5	2663.9	6133.9	54
56	8308.2	1783.3	2589.1	6031.1	8376.8	1819.7	2666.6	6137.5	56
58	8310.5	1784.5	2591.7	6034.6	8379.1	1820.9	2669.2	6141.1	58
60	8312.8	1785.7	2594.2	6038.2	8381.3	1822.2	2671.8	6144.7	60

## 234 FUNCTIONS OF A ONE-DEGREE CURVE

°	94°				95°				°
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	8381.3	1822.2	2671.8	6144.7	8449.2	1858.9	2751.5	6253.2	0
2	8383.6	1823.4	2674.4	6148.3	8451.5	1860.1	2754.2	6256.9	2
4	8385.9	1824.6	2677.0	6151.9	8453.7	1861.3	2756.9	6260.5	4
6	8388.1	1825.8	2679.7	6155.4	8456.0	1862.6	2759.6	6264.2	6
8	8390.4	1827.0	2682.3	6159.0	8458.2	1863.8	2762.3	6267.8	8
10	8392.7	1828.3	2684.9	6162.6	8460.4	1865.0	2765.0	6271.5	10
12	8395.0	1829.5	2687.6	6166.2	8462.7	1866.3	2767.7	6275.2	12
14	8397.2	1830.7	2690.2	6169.8	8464.9	1867.5	2770.4	6278.8	14
16	8399.5	1831.9	2692.8	6173.4	8467.2	1868.7	2773.1	6282.5	16
18	8401.7	1833.1	2695.6	6177.0	8469.4	1869.9	2775.8	6286.2	18
20	8404.0	1834.4	2698.1	6180.6	8471.7	1871.2	2778.5	6289.8	20
22	8406.3	1835.6	2700.8	6184.2	8473.9	1872.4	2781.2	6293.5	22
24	8408.5	1836.8	2703.4	6187.8	8476.2	1873.6	2784.0	6297.2	24
26	8410.8	1838.0	2706.1	6191.5	8478.4	1874.9	2786.7	6300.9	26
28	8413.1	1839.3	2708.7	6195.1	8480.7	1876.1	2789.4	6304.6	28
30	8415.3	1840.5	2711.4	6198.7	8482.9	1877.3	2792.1	6308.2	30
32	8417.6	1841.7	2714.0	6202.3	8485.1	1878.6	2794.9	6311.9	32
34	8419.9	1842.9	2716.7	6205.9	8487.4	1879.8	2797.6	6315.6	34
36	8422.1	1844.2	2719.3	6209.5	8489.6	1881.0	2800.3	6319.3	36
38	8424.4	1845.4	2722.0	6213.2	8491.9	1882.3	2803.1	6323.0	38
40	8426.6	1846.6	2724.7	6216.8	8494.1	1883.5	2805.8	6326.7	40
42	8428.9	1847.8	2727.3	6220.4	8496.3	1884.8	2808.6	6330.4	42
44	8431.2	1849.0	2730.0	6224.1	8498.6	1886.0	2811.3	6334.1	44
46	8433.4	1850.3	2732.7	6227.7	8500.8	1887.2	2814.1	6337.8	46
48	8435.7	1851.5	2735.4	6231.3	8503.0	1888.5	2816.8	6341.5	48
50	8437.9	1852.7	2738.0	6235.0	8505.3	1889.7	2819.6	6345.2	50
52	8440.2	1854.0	2740.7	6238.6	8507.5	1890.9	2822.3	6348.9	52
54	8442.4	1855.2	2743.4	6242.3	8509.8	1892.2	2825.1	6352.7	54
56	8444.7	1856.4	2746.1	6245.9	8512.0	1893.4	2827.8	6356.4	56
58	8447.0	1857.6	2748.8	6249.6	8514.2	1894.6	2830.6	6360.1	58
60	8449.2	1858.9	2751.5	6253.2	8516.4	1895.9	2833.4	6363.8	60

°	96°				97°				°
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	8516.4	1895.9	2833.4	6363.8	8583.0	1933.2	2917.5	6476.6	0
2	8518.7	1897.1	2836.1	6367.5	8585.2	1934.4	2920.3	6480.4	2
4	8520.9	1898.4	2838.9	6371.3	8587.5	1935.7	2923.2	6484.2	4
6	8523.1	1899.6	2841.7	6375.0	8589.7	1936.9	2926.0	6488.0	6
8	8525.4	1900.8	2844.5	6378.7	8591.9	1938.2	2928.9	6491.8	8
10	8527.6	1902.1	2847.2	6382.5	8594.1	1939.4	2931.7	6495.6	10
12	8529.8	1903.3	2850.0	6386.2	8596.3	1940.7	2934.6	6499.4	12
14	8532.0	1904.6	2852.8	6389.9	8598.5	1941.9	2937.5	6503.2	14
16	8534.2	1905.8	2855.6	6393.7	8600.7	1943.2	2940.3	6507.1	16
18	8536.5	1907.0	2858.4	6397.4	8602.9	1944.4	2943.2	6510.9	18
20	8538.7	1908.3	2861.2	6401.2	8605.1	1945.7	2946.1	6514.7	20
22	8540.9	1909.5	2864.0	6404.9	8607.3	1946.9	2948.9	6518.5	22
24	8543.2	1910.8	2866.7	6408.7	8609.5	1948.2	2951.8	6522.3	24
26	8545.4	1912.0	2869.5	6412.4	8611.7	1949.4	2954.7	6526.2	26
28	8547.6	1913.3	2872.3	6416.2	8613.9	1950.7	2957.6	6530.0	28
30	8549.8	1914.5	2875.1	6419.9	8616.1	1952.0	2960.4	6533.8	30
32	8552.0	1915.7	2877.9	6423.7	8618.3	1953.2	2963.3	6537.7	32
34	8554.3	1917.0	2880.8	6427.5	8620.5	1954.5	2966.2	6541.5	34
36	8556.5	1918.2	2883.6	6431.2	8622.7	1955.7	2969.1	6545.3	36
38	8558.7	1919.5	2886.4	6435.0	8624.9	1957.0	2972.0	6549.2	38
40	8560.9	1920.7	2889.2	6438.8	8627.1	1958.2	2974.9	6553.0	40
42	8563.1	1922.0	2892.0	6442.5	8629.3	1959.5	2977.8	6556.9	42
44	8565.3	1923.2	2894.8	6446.3	8631.5	1960.7	2980.7	6560.7	44
46	8567.6	1924.5	2897.7	6450.1	8633.7	1962.0	2983.6	6564.6	46
48	8569.8	1925.7	2900.5	6453.9	8635.8	1963.2	2986.5	6568.4	48
50	8572.0	1927.0	2903.3	6457.7	8638.0	1964.5	2989.4	6572.3	50
52	8574.2	1928.2	2906.1	6461.4	8640.2	1965.8	2992.3	6576.2	52
54	8576.4	1929.4	2909.0	6465.2	8642.4	1967.0	2995.2	6580.0	54
56	8578.6	1930.7	2911.8	6469.0	8644.6	1968.3	2998.1	6583.9	56
58	8580.8	1931.9	2914.7	6472.8	8646.8	1969.5	3001.1	6587.7	58
60	8583.0	1933.2	2917.5	6476.6	8649.0	1970.8	3004.0	6591.6	60

FUNCTIONS OF A ONE-DEGREE CURVE 235

°	98°				99°				°
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	8649.0	1970.8	3004.0	6591.6	8714.3	2008.7	3092.9	6709.0	0
2	8651.2	1972.0	3006.9	6595.5	8716.4	2009.9	3095.9	6712.9	2
4	8653.3	1973.3	3009.8	6599.4	8718.5	2011.2	3098.9	6716.9	4
6	8655.5	1974.6	3012.8	6603.2	8720.7	2012.5	3101.9	6720.8	6
8	8657.7	1975.8	3015.7	6607.1	8722.9	2013.7	3104.9	6724.8	8
10	8659.9	1977.1	3018.6	6611.0	8725.1	2015.0	3107.9	6728.8	10
12	8662.1	1978.3	3021.6	6614.9	8727.2	2016.3	3111.0	6732.7	12
14	8664.3	1979.6	3024.5	6618.8	8729.4	2017.5	3114.0	6736.7	14
16	8666.4	1980.9	3027.5	6622.7	8731.5	2018.8	3117.0	6740.7	16
18	8668.6	1982.1	3030.4	6626.6	8733.7	2020.1	3120.0	6744.6	18
20	8670.8	1983.4	3033.3	6630.5	8735.9	2021.4	3123.1	6748.6	20
22	8673.0	1984.6	3036.3	6634.4	8738.0	2022.6	3126.1	6752.6	22
24	8675.2	1985.9	3039.3	6638.3	8740.2	2023.9	3129.1	6756.6	24
26	8677.3	1987.2	3042.2	6642.2	8742.3	2025.2	3132.2	6760.6	26
28	8679.5	1988.4	3045.2	6646.1	8744.5	2026.4	3135.2	6764.6	28
30	8681.7	1989.7	3048.1	6650.0	8746.6	2027.7	3138.3	6768.6	30
32	8683.9	1991.0	3051.1	6653.9	8748.8	2029.0	3141.3	6772.6	32
34	8686.0	1992.2	3054.1	6657.8	8750.9	2030.3	3144.4	6776.6	34
36	8688.2	1993.5	3057.0	6661.7	8753.1	2031.5	3147.4	6780.6	36
38	8690.4	1994.7	3060.0	6665.7	8755.3	2032.8	3150.5	6784.6	38
40	8692.6	1996.0	3063.0	6669.6	8757.4	2034.1	3153.5	6788.6	40
42	8694.7	1997.3	3066.0	6673.5	8759.5	2035.4	3156.6	6792.6	42
44	8696.9	1998.5	3068.9	6677.4	8761.7	2036.6	3159.7	6796.6	44
46	8699.1	1999.8	3071.9	6681.4	8763.8	2037.9	3162.7	6800.6	46
48	8701.2	2001.1	3074.9	6685.3	8766.0	2039.2	3165.8	6804.6	48
50	8703.4	2002.3	3077.9	6689.2	8768.1	2040.5	3168.9	6808.6	50
52	8705.6	2003.6	3080.9	6693.2	8770.3	2041.7	3172.0	6812.6	52
54	8707.8	2004.9	3083.9	6697.1	8772.4	2043.0	3175.1	6816.6	54
56	8709.9	2006.1	3086.9	6701.1	8774.6	2044.3	3178.1	6820.6	56
58	8712.1	2007.4	3089.9	6705.2	8776.7	2045.6	3181.2	6824.6	58
60	8714.3	2008.7	3092.9	6709.0	8778.9	2046.8	3184.3	6828.6	60

°	100°				101°				°
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	8778.9	2046.8	3184.3	6828.8	8842.8	2085.3	3278.3	6951.0	0
2	8781.0	2048.1	3187.4	6832.8	8844.9	2086.6	3281.5	6955.2	2
4	8783.1	2049.4	3190.5	6836.8	8847.0	2087.8	3284.7	6959.3	4
6	8785.3	2050.7	3193.6	6840.9	8849.2	2089.1	3287.9	6963.4	6
8	8787.4	2051.9	3196.7	6844.9	8851.3	2090.4	3291.1	6967.6	8
10	8789.6	2053.2	3199.8	6849.0	8853.4	2091.7	3294.3	6971.7	10
12	8791.7	2054.5	3202.9	6853.0	8855.5	2093.0	3297.5	6975.8	12
14	8793.9	2055.8	3206.0	6857.1	8857.6	2094.3	3300.7	6980.0	14
16	8796.0	2057.1	3209.1	6861.1	8859.8	2095.6	3303.9	6984.1	16
18	8798.2	2058.3	3212.3	6865.2	8861.9	2096.9	3307.1	6988.2	18
20	8800.3	2059.6	3215.4	6869.2	8864.0	2098.2	3310.3	6992.4	20
22	8802.4	2060.9	3218.5	6873.3	8866.1	2099.4	3313.5	6996.6	22
24	8804.5	2062.2	3221.6	6877.4	8868.2	2100.7	3316.7	7000.7	24
26	8806.7	2063.5	3224.7	6881.4	8870.3	2102.0	3319.9	7004.9	26
28	8808.8	2064.7	3227.9	6885.5	8872.4	2103.3	3323.1	7009.0	28
30	8810.9	2066.0	3231.0	6889.6	8874.5	2104.6	3326.4	7013.2	30
32	8813.1	2067.3	3234.1	6893.7	8876.7	2105.9	3329.6	7017.3	32
34	8815.2	2068.6	3237.3	6897.8	8878.8	2107.2	3332.8	7021.5	34
36	8817.3	2069.9	3240.4	6901.8	8880.9	2108.5	3336.0	7025.7	36
38	8819.5	2071.1	3243.5	6905.9	8883.0	2109.8	3339.3	7029.9	38
40	8821.6	2072.4	3246.7	6910.0	8885.1	2111.1	3342.5	7034.0	40
42	8823.7	2073.7	3249.8	6914.1	8887.2	2112.4	3345.8	7038.2	42
44	8825.8	2075.0	3253.0	6918.2	8889.3	2113.6	3349.0	7042.4	44
46	8828.0	2076.3	3256.2	6922.3	8891.4	2114.9	3352.3	7046.6	46
48	8830.1	2077.6	3259.3	6926.4	8893.5	2116.2	3355.5	7050.8	48
50	8832.2	2078.9	3262.5	6930.5	8895.6	2117.5	3358.8	7055.0	50
52	8834.3	2080.1	3265.7	6934.6	8897.7	2118.8	3362.0	7059.2	52
54	8836.4	2081.4	3268.8	6938.7	8899.8	2120.1	3365.3	7063.4	54
56	8838.6	2082.7	3272.0	6942.8	8901.9	2121.4	3368.7	7067.6	56
58	8840.7	2084.0	3275.3	6946.9	8904.0	2122.7	3372.0	7071.8	58
60	8842.8	2085.3	3278.3	6951.0	8906.1	2124.0	3375.1	7076.0	60

## 236 FUNCTIONS OF A ONE-DEGREE CURVE

x	102°				103°				x
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	8906.1	2124.0	3375.1	7076.0	8968.7	2163.0	3474.6	7308.6	0
2	8908.2	2125.3	3378.3	7080.2	8970.8	2164.3	3478.0	7307.9	2
4	8910.3	2126.6	3381.6	7084.4	8972.9	2165.6	3481.4	7312.2	4
6	8912.4	2127.9	3384.9	7088.6	8974.9	2166.9	3484.7	7316.5	6
8	8914.5	2129.2	3388.2	7092.8	8977.0	2168.2	3488.1	7320.8	8
10	8916.6	2130.5	3391.5	7097.1	8979.1	2169.5	3491.5	7325.1	10
12	8918.7	2131.8	3394.7	7101.3	8981.1	2170.8	3494.9	7329.5	12
14	8920.8	2133.1	3398.0	7105.5	8983.2	2172.1	3498.3	7333.8	14
16	8922.9	2134.4	3401.3	7109.7	8985.3	2173.4	3501.6	7338.1	16
18	8925.0	2135.7	3404.6	7114.0	8987.3	2174.7	3505.3	7342.4	18
20	8927.0	2137.0	3407.9	7118.2	8989.4	2176.1	3508.4	7346.8	20
22	8929.1	2138.3	3411.2	7122.4	8991.5	2177.4	3511.8	7351.1	22
24	8931.2	2139.6	3414.5	7126.7	8993.5	2178.7	3515.2	7355.4	24
26	8933.3	2140.9	3417.9	7130.9	8995.6	2180.0	3518.7	7359.8	26
28	8935.4	2142.2	3421.2	7135.2	8997.7	2181.3	3522.1	7364.1	28
30	8937.5	2143.5	3424.5	7139.4	8999.7	2182.6	3525.5	7368.5	30
32	8939.6	2144.8	3427.8	7143.7	9001.8	2183.9	3528.9	7372.8	32
34	8941.6	2146.1	3431.1	7148.0	9003.9	2185.2	3532.3	7377.2	34
36	8943.7	2147.4	3434.5	7152.2	9005.9	2186.5	3535.7	7381.5	36
38	8945.8	2148.7	3437.8	7156.5	9008.0	2187.8	3539.2	7385.9	38
40	8947.9	2150.0	3441.1	7160.7	9010.0	2189.1	3542.6	7390.3	40
42	8950.0	2151.3	3444.4	7165.0	9012.1	2190.5	3546.0	7394.6	42
44	8952.1	2152.6	3447.8	7169.3	9014.2	2191.8	3549.5	7399.0	44
46	8954.1	2153.9	3451.1	7173.6	9016.2	2193.1	3552.9	7403.4	46
48	8956.2	2155.2	3454.5	7177.9	9018.3	2194.4	3556.3	7407.7	48
50	8958.3	2156.5	3457.8	7182.1	9020.3	2195.7	3559.8	7412.1	50
52	8960.4	2157.8	3461.2	7186.4	9022.4	2197.0	3563.2	7416.5	52
54	8962.5	2159.1	3464.5	7190.7	9024.5	2198.3	3566.7	7420.9	54
56	8964.5	2160.4	3467.9	7195.0	9026.5	2199.6	3570.2	7425.3	56
58	8966.6	2161.7	3471.2	7199.3	9028.6	2200.9	3573.6	7429.7	58
60	8968.7	2163.0	3474.6	7203.6	9030.6	2202.3	3577.1	7434.1	60

x	104°				105°				x
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	9030.6	2202.3	3577.1	7334.1	9091.8	2241.8	3682.6	7467.5	0
2	9032.7	2203.6	3580.5	7338.5	9093.9	2243.1	3686.1	7472.0	2
4	9034.7	2204.9	3584.0	7342.9	9095.9	2244.4	3689.7	7476.5	4
6	9036.8	2206.2	3587.5	7347.3	9097.9	2245.8	3693.3	7481.0	6
8	9038.8	2207.5	3591.0	7351.7	9099.9	2247.1	3696.9	7485.5	8
10	9040.9	2208.8	3594.4	7356.1	9102.0	2248.4	3700.4	7490.0	10
12	9042.9	2210.2	3597.9	7360.5	9104.0	2249.7	3704.0	7494.5	12
14	9045.0	2211.5	3601.4	7364.9	9106.0	2251.1	3707.6	7499.1	14
16	9047.0	2212.8	3604.9	7369.4	9108.0	2252.4	3711.2	7503.6	16
18	9049.1	2214.1	3608.4	7373.8	9110.1	2253.7	3714.8	7508.1	18
20	9051.1	2215.4	3611.9	7378.2	9112.1	2255.0	3718.4	7512.6	20
22	9053.1	2216.7	3615.4	7382.6	9114.1	2256.4	3722.0	7517.2	22
24	9055.2	2218.0	3618.9	7387.1	9116.1	2257.7	3725.6	7521.7	24
26	9057.2	2219.4	3622.4	7391.5	9118.1	2259.0	3729.3	7526.3	26
28	9059.3	2220.7	3625.9	7396.0	9120.2	2260.3	3732.9	7530.8	28
30	9061.3	2222.0	3629.4	7400.4	9122.2	2261.7	3736.5	7535.3	30
32	9063.3	2223.3	3633.0	7404.8	9124.2	2263.0	3740.1	7539.9	32
34	9065.4	2224.6	3636.5	7409.3	9126.2	2264.3	3743.7	7544.4	34
36	9067.4	2226.0	3640.0	7413.8	9128.2	2265.7	3747.4	7549.0	36
38	9069.5	2227.3	3643.5	7418.2	9130.2	2267.0	3751.0	7553.6	38
40	9071.5	2228.6	3647.1	7422.7	9132.3	2268.3	3754.6	7558.1	40
42	9073.5	2229.9	3650.6	7427.1	9134.3	2269.6	3758.3	7562.7	42
44	9075.6	2231.2	3654.1	7431.6	9136.3	2271.0	3761.9	7567.3	44
46	9077.6	2232.6	3657.7	7436.1	9138.3	2272.3	3765.6	7571.8	46
48	9079.6	2233.9	3661.2	7440.6	9140.3	2273.6	3769.2	7576.4	48
50	9081.7	2235.2	3664.8	7445.0	9142.3	2275.0	3772.9	7581.0	50
52	9083.7	2236.5	3668.3	7449.5	9144.3	2276.3	3776.5	7585.6	52
54	9085.7	2237.8	3671.9	7454.0	9146.3	2277.6	3780.2	7590.2	54
56	9087.8	2239.2	3675.4	7458.5	9148.3	2278.9	3783.9	7594.8	56
58	9089.8	2240.5	3679.0	7463.0	9150.4	2280.3	3787.5	7599.4	58
60	9091.8	2241.8	3682.6	7467.5	9152.4	2281.6	3791.2	7604.0	60

FUNCTIONS OF A ONE-DEGREE CURVE 237

°	106°				107°				°
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	9158.4	2281.6	3791.2	7604.0	9212.9	2321.7	3903.1	7743.7	0
2	9154.4	2282.9	3794.9	7608.6	9214.2	2323.0	3906.9	7748.4	2
4	9150.4	2284.3	3798.6	7613.2	9216.2	2324.4	3910.7	7753.1	4
6	9148.4	2285.6	3802.3	7617.8	9218.1	2325.7	3914.5	7757.8	6
8	9146.4	2286.9	3805.9	7622.4	9220.1	2327.0	3918.3	7762.5	8
10	9142.4	2288.3	3809.6	7627.0	9222.1	2328.4	3922.1	7767.3	10
12	9144.4	2289.6	3813.3	7631.7	9224.1	2329.7	3925.9	7772.0	12
14	9146.4	2290.9	3817.0	7636.3	9226.1	2331.1	3929.7	7776.7	14
16	9148.4	2292.3	3820.7	7640.9	9228.1	2332.4	3933.6	7781.5	16
18	9170.4	2293.6	3824.4	7645.5	9230.0	2333.7	3937.4	7786.2	18
20	9172.4	2294.9	3828.1	7650.2	9232.0	2335.1	3941.2	7791.0	20
22	9174.4	2296.3	3831.9	7654.8	9234.0	2336.4	3945.0	7795.7	22
24	9176.4	2297.6	3835.6	7659.5	9235.9	2337.8	3948.8	7800.5	24
26	9178.4	2298.9	3839.3	7664.1	9237.9	2339.1	3952.7	7805.2	26
28	9180.4	2299.3	3843.0	7668.8	9239.9	2340.5	3956.5	7810.0	28
30	9182.4	2301.6	3846.7	7673.4	9241.9	2341.8	3960.4	7814.7	30
32	9184.4	2302.9	3850.5	7678.1	9243.8	2343.1	3964.2	7819.5	32
34	9186.4	2304.3	3854.2	7682.7	9245.8	2344.5	3968.1	7824.3	34
36	9188.4	2305.6	3858.0	7687.4	9247.8	2345.8	3971.9	7829.1	36
38	9190.4	2306.9	3861.7	7692.1	9249.7	2347.2	3975.8	7833.8	38
40	9192.4	2308.3	3865.4	7696.7	9251.7	2348.5	3979.6	7838.6	40
42	9194.4	2309.6	3869.2	7701.4	9253.7	2349.9	3983.5	7843.4	42
44	9196.3	2311.0	3873.0	7706.1	9255.6	2351.2	3987.4	7848.2	44
46	9198.3	2312.3	3876.7	7710.8	9257.6	2352.6	3991.3	7853.0	46
48	9200.2	2313.6	3880.5	7715.5	9259.6	2353.9	3995.1	7857.8	48
50	9202.3	2315.0	3884.2	7720.2	9261.5	2355.3	3999.0	7862.6	50
52	9204.3	2316.3	3888.0	7724.8	9263.5	2356.6	4002.9	7867.4	52
54	9206.3	2317.7	3891.8	7729.5	9265.4	2358.0	4006.8	7872.2	54
56	9208.2	2319.0	3895.6	7734.2	9267.4	2359.3	4010.7	7877.0	56
58	9210.2	2320.3	3899.3	7739.0	9269.4	2360.7	4014.6	7881.9	58
60	9212.2	2321.7	3903.1	7743.7	9271.3	2362.0	4018.5	7886.7	60

°	108°				109°				°
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	9271.3	2362.0	4019.5	7886.7	9329.8	2402.6	4137.4	8033.2	0
2	9273.3	2363.3	4023.4	7891.5	9331.7	2403.9	4141.4	8038.1	2
4	9275.3	2364.7	4026.3	7896.3	9333.6	2405.3	4145.4	8043.1	4
6	9277.2	2366.0	4030.2	7901.2	9335.6	2406.6	4149.5	8048.0	6
8	9279.2	2367.4	4034.1	7906.0	9337.5	2408.0	4153.5	8053.0	8
10	9281.1	2368.7	4038.0	7910.8	9339.4	2409.4	4157.5	8057.9	10
12	9283.1	2370.1	4042.0	7915.7	9341.4	2410.7	4161.6	8062.9	12
14	9285.0	2371.4	4045.9	7920.5	9343.3	2412.1	4165.6	8067.9	14
16	9287.0	2372.8	4049.8	7925.4	9345.2	2413.4	4169.7	8072.8	16
18	9288.9	2374.1	4053.8	7930.3	9347.2	2414.8	4173.8	8077.8	18
20	9290.9	2375.5	4057.7	7935.1	9349.1	2416.2	4177.8	8082.8	20
22	9292.8	2376.8	4061.6	7940.0	9351.0	2417.5	4181.9	8087.8	22
24	9294.8	2378.2	4065.6	7944.8	9352.9	2418.9	4186.0	8092.8	24
26	9296.7	2379.5	4069.5	7949.7	9354.9	2420.2	4190.0	8097.8	26
28	9298.7	2380.9	4073.5	7954.6	9356.8	2421.6	4193.1	8102.8	28
30	9300.6	2382.3	4077.5	7959.5	9358.7	2423.0	4198.2	8107.8	30
32	9302.6	2383.6	4081.4	7964.4	9360.6	2424.3	4202.3	8112.8	32
34	9304.5	2385.0	4085.4	7969.3	9362.6	2425.7	4206.4	8117.8	34
36	9306.5	2386.3	4089.4	7974.1	9364.5	2427.0	4210.5	8122.8	36
38	9308.4	2387.7	4093.4	7979.0	9366.4	2428.4	4214.6	8127.8	38
40	9310.4	2389.0	4097.3	7983.9	9368.3	2430.0	4218.7	8132.8	40
42	9312.3	2390.4	4101.3	7988.8	9370.2	2431.1	4222.8	8137.9	42
44	9314.2	2391.7	4105.3	7993.8	9372.2	2432.5	4226.9	8142.9	44
46	9316.2	2393.1	4109.3	7998.7	9374.1	2433.9	4231.0	8147.9	46
48	9318.1	2394.4	4113.3	8003.6	9376.0	2435.2	4235.1	8153.0	48
50	9320.1	2395.8	4117.3	8008.5	9377.9	2436.6	4239.3	8158.0	50
52	9322.0	2397.2	4121.3	8013.4	9379.8	2438.0	4243.4	8163.1	52
54	9323.9	2398.5	4125.3	8018.4	9381.7	2439.3	4247.5	8168.1	54
56	9325.9	2399.9	4129.3	8023.3	9383.7	2440.7	4251.7	8173.2	56
58	9327.8	2401.2	4133.4	8028.2	9385.6	2442.1	4255.8	8178.2	58
60	9329.8	2402.6	4137.4	8033.2	9387.5	2443.4	4260.0	8183.3	60



238 FUNCTIONS OF A ONE-DEGREE CURVE

°	110°				111°				°
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	9387.5	2443.4	4260.0	8183.3	9444.5	2484.5	4386.4	8337.2	0
2	9389.4	2444.8	4264.1	8188.4	9446.4	2485.9	4390.7	8342.4	2
4	9391.3	2446.1	4268.3	8193.4	9448.3	2487.2	4395.0	8347.6	4
6	9393.2	2447.5	4272.4	8198.5	9450.1	2488.6	4399.3	8352.8	6
8	9395.1	2448.9	4276.6	8203.6	9452.0	2490.0	4403.6	8358.0	8
10	9397.0	2450.2	4280.8	8208.7	9453.9	2491.4	4407.9	8363.2	10
12	9398.9	2451.6	4284.9	8213.8	9455.8	2492.7	4412.2	8368.5	12
14	9400.8	2453.0	4289.1	8218.9	9457.7	2494.1	4416.5	8373.7	14
16	9402.7	2454.3	4293.3	8224.0	9459.6	2495.5	4420.8	8378.9	16
18	9404.7	2455.7	4297.5	8229.1	9461.4	2496.9	4425.1	8384.1	18
20	9406.6	2457.1	4301.7	8234.2	9463.3	2498.2	4429.5	8389.4	20
22	9408.5	2458.4	4305.9	8239.3	9465.2	2499.6	4433.8	8394.6	22
24	9410.4	2459.8	4310.1	8244.4	9467.1	2501.0	4438.1	8399.9	24
26	9412.3	2461.2	4314.3	8249.5	9469.0	2502.4	4442.5	8405.1	26
28	9414.2	2462.6	4318.5	8254.6	9470.8	2503.8	4446.8	8410.4	28
30	9416.1	2463.9	4322.7	8259.8	9472.7	2505.1	4451.2	8415.6	30
32	9418.0	2465.3	4326.9	8264.9	9474.6	2506.5	4455.5	8420.9	32
34	9419.9	2466.7	4331.1	8270.0	9476.5	2507.9	4459.9	8426.2	34
36	9421.8	2468.0	4335.4	8275.2	9478.3	2509.3	4464.2	8431.4	36
38	9423.7	2469.4	4339.6	8280.3	9480.2	2510.6	4468.6	8436.7	38
40	9425.6	2470.8	4343.8	8285.5	9482.1	2512.0	4473.0	8442.0	40
42	9427.5	2472.1	4348.1	8290.6	9484.0	2513.4	4477.3	8447.3	42
44	9429.3	2473.5	4352.3	8295.8	9485.8	2514.8	4481.7	8452.6	44
46	9431.2	2474.9	4356.6	8300.9	9487.7	2516.2	4486.1	8457.9	46
48	9433.1	2476.3	4360.8	8306.1	9489.6	2517.5	4490.5	8463.2	48
50	9435.0	2477.6	4365.1	8311.3	9491.4	2518.9	4494.9	8468.5	50
52	9436.9	2479.0	4369.3	8316.5	9493.3	2520.3	4499.3	8473.8	52
54	9438.8	2480.4	4373.6	8321.6	9495.2	2521.7	4503.7	8479.1	54
56	9440.7	2481.7	4377.9	8326.8	9497.0	2523.1	4508.1	8484.4	56
58	9442.6	2483.1	4382.2	8332.0	9498.9	2524.5	4512.5	8489.7	58
60	9444.5	2484.5	4386.4	8337.2	9500.8	2525.8	4516.9	8495.1	60

°	112°				113°				°
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	9500.8	2525.8	4516.9	8495.1	9556.3	2567.4	4651.6	8657.1	0
2	9502.6	2527.2	4521.4	8500.4	9558.2	2568.8	4656.2	8662.6	2
4	9504.5	2528.6	4525.8	8505.8	9560.0	2570.2	4660.8	8668.0	4
6	9506.4	2530.0	4530.3	8511.1	9561.8	2571.6	4665.4	8673.5	6
8	9508.2	2531.4	4534.6	8516.4	9563.7	2573.0	4669.9	8679.0	8
10	9510.1	2532.7	4539.1	8521.8	9565.5	2574.4	4674.5	8684.5	10
12	9511.9	2534.1	4543.5	8527.1	9567.4	2575.8	4679.1	8690.0	12
14	9513.8	2535.5	4548.0	8532.5	9569.2	2577.1	4683.7	8695.5	14
16	9515.7	2536.9	4552.4	8537.9	9571.0	2578.5	4688.3	8701.0	16
18	9517.5	2538.3	4556.9	8543.2	9572.9	2579.9	4692.9	8706.5	18
20	9519.4	2539.7	4561.3	8548.6	9574.7	2581.3	4697.5	8712.0	20
22	9521.2	2541.0	4565.8	8554.0	9576.5	2582.7	4702.1	8717.6	22
24	9523.1	2542.4	4570.3	8559.4	9578.4	2584.1	4706.8	8723.1	24
26	9524.9	2543.8	4574.8	8564.8	9580.2	2585.5	4711.4	8728.6	26
28	9526.8	2545.2	4579.3	8570.2	9582.0	2586.9	4716.0	8734.2	28
30	9528.6	2546.6	4583.7	8575.6	9583.8	2588.3	4720.6	8739.7	30
32	9530.5	2548.0	4588.2	8581.0	9585.7	2589.7	4725.3	8745.3	32
34	9532.3	2549.4	4592.7	8586.4	9587.5	2591.1	4729.9	8750.8	34
36	9534.2	2550.7	4597.2	8591.8	9589.3	2592.5	4734.6	8756.4	36
38	9536.0	2552.1	4601.7	8597.2	9591.1	2593.9	4739.3	8761.9	38
40	9537.9	2553.5	4606.2	8602.6	9593.0	2595.3	4743.9	8767.5	40
42	9539.7	2554.9	4610.8	8608.0	9594.8	2596.7	4748.5	8773.1	42
44	9541.6	2556.3	4615.3	8613.5	9596.6	2598.1	4753.2	8778.6	44
46	9543.4	2557.7	4619.8	8618.9	9598.4	2599.4	4757.9	8784.2	46
48	9545.3	2559.1	4624.3	8624.3	9600.3	2600.8	4762.6	8789.8	48
50	9547.1	2560.5	4628.9	8629.8	9602.1	2602.2	4767.2	8795.4	50
52	9549.0	2561.8	4633.4	8635.2	9603.9	2603.6	4771.9	8801.0	52
54	9550.8	2563.2	4638.0	8640.7	9605.7	2605.0	4776.6	8806.6	54
56	9552.6	2564.6	4642.5	8646.2	9607.5	2606.4	4781.3	8812.2	56
58	9554.5	2566.0	4647.1	8651.6	9609.4	2607.8	4786.0	8817.8	58
60	9556.3	2567.4	4651.6	8657.1	9611.2	2609.2	4790.7	8823.4	60

	114°				115°				
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	9611.2	2609.2	4790.7	8823.4	9665.3	2651.3	4934.4	8994.3	0
2	9613.0	2610.6	4795.5	8829.1	9667.1	2652.7	4939.3	9000.1	2
4	9614.8	2612.0	4800.2	8834.7	9668.8	2654.1	4944.2	9005.9	4
6	9616.6	2613.4	4804.9	8840.3	9670.6	2655.5	4949.1	9011.6	6
8	9618.4	2614.8	4809.6	8846.0	9672.4	2656.9	4954.0	9017.4	8
10	9620.2	2616.2	4814.4	8851.6	9674.2	2658.3	4958.9	9023.2	10
12	9622.0	2617.6	4819.1	8857.2	9676.0	2659.7	4963.8	9029.0	12
14	9623.8	2619.0	4823.9	8862.9	9677.8	2661.1	4968.7	9034.8	14
16	9625.7	2620.4	4828.6	8868.5	9679.6	2662.5	4973.6	9040.7	16
18	9627.5	2621.8	4833.4	8874.2	9681.4	2663.9	4978.5	9046.5	18
20	9629.3	2623.2	4838.1	8879.9	9683.1	2665.4	4983.4	9052.3	20
22	9631.1	2624.6	4842.9	8885.5	9684.9	2666.8	4988.3	9058.1	22
24	9632.9	2626.0	4847.7	8891.2	9686.7	2668.2	4993.3	9064.0	24
26	9634.7	2627.4	4852.4	8896.9	9688.5	2669.6	4998.2	9069.8	26
28	9636.5	2628.8	4857.2	8902.6	9690.3	2671.0	5003.2	9075.7	28
30	9638.3	2630.2	4862.0	8908.3	9692.0	2672.4	5008.1	9081.5	30
32	9640.1	2631.6	4866.8	8914.0	9693.8	2673.8	5013.1	9087.4	32
34	9641.9	2633.0	4871.6	8919.7	9695.6	2675.2	5018.0	9093.2	34
36	9643.7	2634.4	4876.4	8925.4	9697.4	2676.6	5023.0	9099.1	36
38	9645.5	2635.8	4881.2	8931.1	9699.1	2678.0	5028.0	9105.0	38
40	9647.3	2637.2	4885.0	8936.8	9700.9	2679.5	5032.9	9110.8	40
42	9649.1	2638.6	4890.9	8942.6	9702.7	2680.9	5037.9	9116.7	42
44	9650.9	2640.0	4895.7	8948.3	9704.5	2682.3	5042.9	9122.6	44
46	9652.7	2641.4	4900.5	8954.0	9706.3	2683.7	5047.9	9128.5	46
48	9654.5	2642.9	4905.3	8959.8	9708.0	2685.1	5052.9	9134.4	48
50	9656.3	2644.3	4910.2	8965.5	9709.8	2686.5	5057.9	9140.3	50
52	9658.1	2645.7	4915.0	8971.3	9711.6	2687.9	5062.9	9146.2	52
54	9659.9	2647.1	4919.9	8977.0	9713.3	2689.3	5067.9	9152.1	54
56	9661.7	2648.5	4924.7	8982.8	9715.1	2690.7	5072.9	9158.1	56
58	9663.5	2649.9	4929.6	8988.5	9716.9	2692.2	5078.0	9164.0	58
60	9665.3	2651.3	4934.4	8994.3	9718.6	2693.6	5083.0	9169.9	60

	116°				117°				
	L. C.	M.	E.	T.	L. C.	M.	E.	T.	
0	9718.6	2693.6	5088.0	9169.9	9771.3	2736.1	5236.6	9350.5	0
2	9720.4	2695.0	5093.8	9175.9	9773.0	2737.5	5241.8	9356.6	2
4	9722.2	2696.4	5099.1	9181.8	9774.7	2738.9	5247.0	9362.7	4
6	9723.9	2697.8	5104.1	9188.8	9776.5	2740.4	5252.2	9368.9	6
8	9725.7	2699.2	5109.2	9193.7	9778.2	2741.8	5257.4	9375.0	8
10	9727.4	2700.6	5114.2	9199.7	9779.9	2743.2	5262.6	9381.1	10
12	9729.2	2702.1	5119.3	9205.6	9781.7	2744.6	5267.9	9387.3	12
14	9731.0	2703.5	5124.4	9211.6	9783.4	2746.0	5273.1	9393.4	14
16	9732.7	2704.9	5129.4	9217.6	9785.2	2747.5	5278.4	9399.5	16
18	9734.5	2706.3	5134.5	9223.6	9786.9	2748.9	5283.6	9405.7	18
20	9736.3	2707.7	5139.6	9229.6	9788.6	2750.3	5288.9	9411.9	20
22	9738.0	2709.1	5144.7	9235.5	9790.4	2751.7	5294.2	9418.0	22
24	9739.8	2710.6	5149.8	9241.5	9792.1	2753.2	5299.5	9424.2	24
26	9741.5	2712.0	5154.9	9247.6	9793.8	2754.6	5304.7	9430.4	26
28	9743.3	2713.4	5160.0	9253.6	9795.6	2756.0	5310.0	9436.6	28
30	9745.0	2714.8	5165.1	9259.6	9797.3	2757.4	5315.3	9442.8	30
32	9746.8	2716.2	5170.2	9265.6	9799.0	2758.9	5320.6	9449.0	32
34	9748.5	2717.6	5175.4	9271.6	9800.7	2760.3	5325.9	9455.2	34
36	9750.3	2719.1	5180.5	9277.7	9802.5	2761.7	5331.2	9461.4	36
38	9752.0	2720.5	5185.7	9283.7	9804.2	2763.1	5336.5	9467.6	38
40	9753.8	2721.9	5190.8	9289.8	9805.9	2764.6	5341.8	9473.8	40
42	9755.6	2723.3	5196.0	9295.8	9807.7	2766.0	5347.2	9480.0	42
44	9757.3	2724.7	5201.1	9301.9	9809.4	2767.4	5352.5	9486.3	44
46	9759.0	2726.2	5206.3	9307.9	9811.1	2768.8	5357.9	9492.5	46
48	9760.8	2727.6	5211.4	9314.0	9812.8	2770.3	5363.2	9498.7	48
50	9762.5	2729.0	5216.5	9320.1	9814.5	2771.7	5368.5	9505.0	50
52	9764.3	2730.4	5221.6	9326.1	9816.3	2773.1	5373.9	9511.2	52
54	9766.0	2731.8	5226.7	9332.2	9818.0	2774.6	5379.3	9517.5	54
56	9767.8	2733.3	5231.8	9338.3	9819.7	2776.0	5384.7	9523.8	56
58	9769.5	2734.7	5236.9	9344.4	9821.4	2777.4	5390.0	9530.0	58
60	9771.3	2736.1	5242.0	9350.5	9823.1	2778.8	5395.4	9536.3	60

240 NATURAL SINES, COSINES, TANGENTS, COTAN.

	0°				1°				
	Sin.	Cos.	Tan.	Cot.	Sin.	Cos.	Tan.	Cot.	'
0	.00000	One	.00000	Infinite	.01745	.99985	.01746	57.2900	60
1	.00029	One	.00029	3437.75	.01774	.99984	.01775	56.3506	59
2	.00058	One	.00058	1718.87	.01803	.99984	.01804	55.4415	58
3	.00087	One	.00087	1145.92	.01832	.99983	.01833	54.5613	57
4	.00116	One	.00116	859.436	.01862	.99983	.01862	53.7086	56
5	.00145	One	.00145	687.549	.01891	.99982	.01891	52.8821	55
6	.00175	One	.00175	572.957	.01920	.99982	.01920	52.0807	54
7	.00204	One	.00204	491.106	.01949	.99981	.01949	51.3032	53
8	.00233	One	.00233	429.718	.01978	.99980	.01978	50.5485	52
9	.00262	One	.00262	381.971	.02007	.99980	.02007	49.8157	51
10	.00291	One	.00291	343.774	.02036	.99979	.02036	49.1039	50
11	.00320	.99999	.00320	312.521	.02065	.99979	.02065	48.4121	49
12	.00349	.99999	.00349	286.478	.02094	.99978	.02095	47.7395	48
13	.00378	.99999	.00378	264.441	.02123	.99977	.02124	47.0853	47
14	.00407	.99999	.00407	245.552	.02152	.99977	.02153	46.4489	46
15	.00436	.99999	.00436	229.182	.02181	.99976	.02182	45.8294	45
16	.00465	.99999	.00465	214.858	.02211	.99976	.02211	45.2261	44
17	.00495	.99999	.00495	202.219	.02240	.99975	.02240	44.6386	43
18	.00524	.99999	.00524	190.984	.02269	.99974	.02269	44.0661	42
19	.00553	.99998	.00553	180.932	.02298	.99974	.02298	43.5081	41
20	.00582	.99998	.00582	171.885	.02327	.99973	.02328	42.9641	40
21	.00611	.99998	.00611	163.700	.02356	.99972	.02357	42.4335	39
22	.00640	.99998	.00640	156.259	.02385	.99972	.02386	41.9158	38
23	.00669	.99998	.00669	149.465	.02414	.99971	.02415	41.4106	37
24	.00698	.99998	.00698	143.237	.02443	.99970	.02444	40.9174	36
25	.00727	.99997	.00727	137.507	.02472	.99969	.02473	40.4358	35
26	.00756	.99997	.00756	132.219	.02501	.99969	.02502	39.9655	34
27	.00785	.99997	.00785	127.321	.02530	.99968	.02531	39.5059	33
28	.00814	.99997	.00814	122.774	.02560	.99967	.02560	39.0568	32
29	.00844	.99996	.00844	118.540	.02589	.99966	.02589	38.6177	31
30	.00873	.99996	.00873	114.589	.02618	.99966	.02619	38.1885	30
31	.00902	.99996	.00902	110.892	.02647	.99965	.02648	37.7688	29
32	.00931	.99996	.00931	107.426	.02676	.99964	.02677	37.3579	28
33	.00960	.99995	.00960	104.171	.02705	.99963	.02706	36.9560	27
34	.00989	.99995	.00989	101.107	.02734	.99963	.02735	36.5627	26
35	.01018	.99995	.01018	98.2179	.02763	.99962	.02764	36.1776	25
36	.01047	.99995	.01047	95.4895	.02792	.99961	.02793	35.8006	24
37	.01076	.99994	.01076	92.9085	.02821	.99960	.02822	35.4313	23
38	.01105	.99994	.01105	90.4833	.02850	.99959	.02851	35.0695	22
39	.01134	.99994	.01135	88.1436	.02879	.99959	.02881	34.7151	21
40	.01164	.99993	.01164	85.9398	.02908	.99958	.02910	34.3678	20
41	.01193	.99993	.01193	83.8435	.02938	.99957	.02939	34.0273	19
42	.01222	.99993	.01222	81.8470	.02967	.99956	.02968	33.6935	18
43	.01251	.99992	.01251	79.9434	.02996	.99955	.02997	33.3662	17
44	.01280	.99992	.01280	78.1263	.03025	.99954	.03026	33.0452	16
45	.01309	.99991	.01309	76.3900	.03054	.99953	.03055	32.7303	15
46	.01338	.99991	.01338	74.7292	.03083	.99952	.03084	32.4213	14
47	.01367	.99991	.01367	73.1390	.03112	.99952	.03114	32.1181	13
48	.01396	.99990	.01396	71.6151	.03141	.99951	.03143	31.8205	12
49	.01425	.99990	.01425	70.1533	.03170	.99950	.03172	31.5284	11
50	.01454	.99989	.01455	68.7501	.03199	.99949	.03201	31.2416	10
51	.01483	.99989	.01484	67.4019	.03228	.99948	.03230	30.9599	9
52	.01513	.99989	.01513	66.1055	.03257	.99947	.03259	30.6832	8
53	.01542	.99988	.01542	64.8580	.03286	.99946	.03288	30.4116	7
54	.01571	.99988	.01571	63.6567	.03316	.99945	.03317	30.1446	6
55	.01600	.99987	.01600	62.4992	.03345	.99944	.03346	29.8823	5
56	.01629	.99987	.01629	61.3829	.03374	.99943	.03376	29.6245	4
57	.01658	.99986	.01658	60.3058	.03403	.99942	.03405	29.3711	3
58	.01687	.99986	.01687	59.2659	.03432	.99941	.03434	29.1220	2
59	.01716	.99985	.01716	58.2612	.03461	.99940	.03463	28.8771	1
60	.01745	.99985	.01746	57.2900	.03490	.99939	.03492	28.6363	0
	Cos.	Sin.	Cot.	Tan.	Cos.	Sin.	Cot.	Tan.	

NATURAL SINES, COSINES, TANGENTS, COTAN. 241

2°

3°

	Sin.	Cos.	Tan.	Cot.	Sin.	Cos.	Tan.	Cot.	
0	.03490	.99939	.03492	28.6363	.05234	.99863	.05241	19.0811	60
1	.03519	.99938	.03521	28.3994	.05263	.99861	.05270	18.9755	59
2	.03548	.99937	.03550	28.1664	.05292	.99860	.05299	18.8711	58
3	.03577	.99936	.03579	27.9372	.05321	.99858	.05328	18.7678	57
4	.03606	.99935	.03609	27.7117	.05350	.99857	.05357	18.6656	56
5	.03635	.99934	.03638	27.4899	.05379	.99855	.05387	18.5645	55
6	.03664	.99933	.03667	27.2715	.05408	.99854	.05416	18.4645	54
7	.03693	.99932	.03696	27.0566	.05437	.99852	.05445	18.3656	53
8	.03723	.99931	.03725	26.8450	.05466	.99851	.05474	18.2677	52
9	.03752	.99930	.03754	26.6367	.05495	.99849	.05503	18.1708	51
10	.03781	.99929	.03783	26.4316	.05524	.99847	.05533	18.0750	50
11	.03810	.99927	.03812	26.2296	.05553	.99846	.05562	17.9802	49
12	.03839	.99926	.03842	26.0307	.05582	.99844	.05591	17.8863	48
13	.03868	.99925	.03871	25.8348	.05611	.99842	.05620	17.7934	47
14	.03897	.99924	.03900	25.6418	.05640	.99841	.05649	17.7015	46
15	.03926	.99923	.03929	25.4517	.05669	.99839	.05678	17.6106	45
16	.03955	.99922	.03958	25.2644	.05698	.99838	.05707	17.5205	44
17	.03984	.99921	.03987	25.0798	.05727	.99836	.05737	17.4314	43
8	.04013	.99919	.04016	24.8978	.05756	.99834	.05766	17.3432	42
9	.04042	.99918	.04046	24.7185	.05785	.99833	.05795	17.2558	41
0	.04071	.99917	.04075	24.5418	.05814	.99831	.05824	17.1693	40
1	.04100	.99916	.04104	24.3675	.05844	.99829	.05854	17.0837	39
2	.04129	.99915	.04133	24.1957	.05873	.99827	.05883	16.9990	38
3	.04158	.99913	.04162	24.0263	.05902	.99826	.05912	16.9150	37
4	.04188	.99912	.04191	23.8593	.05931	.99824	.05941	16.8319	36
5	.04217	.99911	.04220	23.6945	.05960	.99822	.05970	16.7496	35
6	.04246	.99910	.04250	23.5321	.05989	.99821	.05999	16.6681	34
7	.04275	.99909	.04279	23.3718	.06018	.99819	.06029	16.5874	33
8	.04304	.99907	.04308	23.2137	.06047	.99817	.06058	16.5075	32
9	.04333	.99906	.04337	23.0577	.06076	.99815	.06087	16.4283	31
10	.04362	.99905	.04366	22.9038	.06105	.99813	.06116	16.3499	30
1	.04391	.99904	.04395	22.7519	.06134	.99812	.06145	16.2722	29
2	.04420	.99902	.04424	22.6020	.06163	.99810	.06175	16.1952	28
3	.04449	.99901	.04454	22.4541	.06192	.99808	.06204	16.1190	27
4	.04478	.99900	.04483	22.3081	.06221	.99806	.06233	16.0435	26
5	.04507	.99898	.04512	22.1640	.06250	.99804	.06262	15.9687	25
6	.04536	.99897	.04541	22.0217	.06279	.99803	.06291	15.8945	24
7	.04565	.99896	.04570	21.8813	.06308	.99801	.06321	15.8211	23
8	.04594	.99894	.04599	21.7426	.06337	.99799	.06350	15.7483	22
9	.04623	.99893	.04628	21.6056	.06366	.99797	.06379	15.6762	21
10	.04653	.99892	.04658	21.4704	.06395	.99795	.06408	15.6048	20
11	.04682	.99890	.04687	21.3369	.06424	.99793	.06437	15.5340	19
12	.04711	.99889	.04716	21.2049	.06453	.99792	.06467	15.4638	18
13	.04740	.99888	.04745	21.0747	.06482	.99790	.06496	15.3943	17
14	.04769	.99886	.04774	20.9460	.06511	.99788	.06525	15.3254	16
15	.04798	.99885	.04803	20.8188	.06540	.99786	.06554	15.2571	15
16	.04827	.99883	.04833	20.6932	.06569	.99784	.06584	15.1893	14
17	.04856	.99882	.04862	20.5691	.06598	.99782	.06613	15.1222	13
18	.04885	.99881	.04891	20.4465	.06627	.99780	.06642	15.0557	12
19	.04914	.99879	.04920	20.3253	.06656	.99778	.06671	14.9898	11
50	.04943	.99878	.04949	20.2056	.06685	.99776	.06700	14.9244	10
51	.04972	.99876	.04978	20.0872	.06714	.99774	.06730	14.8596	9
52	.05001	.99875	.05007	19.9702	.06743	.99772	.06759	14.7954	8
53	.05030	.99873	.05037	19.8546	.06773	.99770	.06788	14.7317	7
54	.05059	.99872	.05066	19.7403	.06802	.99768	.06817	14.6685	6
55	.05088	.99870	.05095	19.6273	.06831	.99766	.06847	14.6059	5
56	.05117	.99869	.05124	19.5156	.06860	.99764	.06876	14.5438	4
57	.05146	.99867	.05153	19.4051	.06889	.99762	.06905	14.4823	3
58	.05175	.99866	.05182	19.2959	.06918	.99760	.06934	14.4212	2
59	.05205	.99864	.05212	19.1879	.06947	.99758	.06963	14.3607	1
60	.05234	.99863	.05241	19.0811	.06976	.99756	.06993	14.3007	0
	Cos.	Sin.	Cot.	Tan.	Cos.	Sin.	Cot.	Tan.	

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86°

242 NATURAL SINES, COSINES, TANGENTS, COTAN.

	4°				5°				
'	Sin.	Cos.	Tan.	Cot.	Sin.	Cos.	Tan.	Cot.	'
0	.06976	.99756	.06993	14.3007	.08716	.98619	.08749	11.4301	60
1	.07005	.99754	.07022	14.2411	.08745	.98617	.08778	11.3919	59
2	.07034	.99752	.07051	14.1821	.08774	.98614	.08807	11.3540	58
3	.07063	.99750	.07080	14.1235	.08803	.98612	.08837	11.3163	57
4	.07092	.99748	.07110	14.0655	.08831	.98609	.08866	11.2789	56
5	.07121	.99746	.07139	14.0079	.08860	.98607	.08895	11.2417	55
6	.07150	.99744	.07168	13.9507	.08889	.98604	.08925	11.2048	54
7	.07179	.99742	.07197	13.8940	.08918	.98602	.08954	11.1681	53
8	.07208	.99740	.07227	13.8378	.08947	.98599	.08983	11.1316	52
9	.07237	.99738	.07256	13.7821	.08976	.98596	.09012	11.0954	51
10	.07266	.99736	.07285	13.7267	.09005	.98594	.09042	11.0594	50
11	.07295	.99734	.07314	13.6719	.09034	.98591	.09071	11.0237	49
12	.07324	.99731	.07344	13.6174	.09063	.98588	.09101	10.9882	48
13	.07353	.99729	.07373	13.5634	.09092	.98586	.09130	10.9529	47
14	.07382	.99727	.07402	13.5098	.09121	.98583	.09159	10.9178	46
15	.07411	.99725	.07431	13.4566	.09150	.98580	.09189	10.8829	45
16	.07440	.99723	.07461	13.4039	.09179	.98578	.09218	10.8483	44
17	.07469	.99721	.07490	13.3515	.09208	.98575	.09247	10.8139	43
18	.07498	.99719	.07519	13.2994	.09237	.98572	.09277	10.7797	42
19	.07527	.99716	.07548	13.2480	.09266	.98570	.09306	10.7457	41
20	.07556	.99714	.07578	13.1969	.09295	.98567	.09335	10.7119	40
21	.07585	.99712	.07607	13.1461	.09324	.98564	.09365	10.6783	39
22	.07614	.99710	.07636	13.0958	.09353	.98562	.09394	10.6450	38
23	.07643	.99708	.07665	13.0458	.09382	.98559	.09423	10.6118	37
24	.07672	.99705	.07695	12.9962	.09411	.98556	.09453	10.5789	36
25	.07701	.99703	.07724	12.9469	.09440	.98553	.09482	10.5462	35
26	.07730	.99701	.07753	12.8981	.09469	.98551	.09511	10.5136	34
27	.07759	.99699	.07782	12.8496	.09498	.98548	.09541	10.4813	33
28	.07788	.99696	.07812	12.8014	.09527	.98545	.09570	10.4491	32
29	.07817	.99694	.07841	12.7536	.09556	.98542	.09600	10.4172	31
30	.07846	.99692	.07870	12.7062	.09585	.98540	.09629	10.3854	30
31	.07875	.99689	.07899	12.6591	.09614	.98537	.09658	10.3538	29
32	.07904	.99687	.07929	12.6124	.09643	.98534	.09688	10.3224	28
33	.07933	.99685	.07958	12.5660	.09671	.98531	.09717	10.2913	27
34	.07962	.99683	.07987	12.5199	.09700	.98528	.09746	10.2602	26
35	.07991	.99680	.08017	12.4742	.09729	.98526	.09776	10.2294	25
36	.08020	.99678	.08046	12.4288	.09758	.98523	.09805	10.1988	24
37	.08049	.99676	.08075	12.3838	.09787	.98520	.09834	10.1683	23
38	.08078	.99673	.08104	12.3390	.09816	.98517	.09864	10.1381	22
39	.08107	.99671	.08134	12.2946	.09845	.98514	.09893	10.1080	21
40	.08136	.99668	.08163	12.2505	.09874	.98511	.09923	10.0780	20
41	.08165	.99666	.08192	12.2067	.09903	.98508	.09952	10.0482	19
42	.08194	.99664	.08221	12.1632	.09932	.98506	.09981	10.0187	18
43	.08223	.99661	.08251	12.1201	.09961	.98503	.10011	9.9893	17
44	.08252	.99659	.08280	12.0772	.09990	.98500	.10040	9.9600	16
45	.08281	.99657	.08309	12.0346	.10019	.98497	.10069	9.9310	15
46	.08310	.99654	.08339	11.9923	.10048	.98494	.10099	9.9021	14
47	.08339	.99652	.08368	11.9504	.10077	.98491	.10128	9.8733	13
48	.08368	.99649	.08397	11.9087	.10106	.98488	.10158	9.8448	12
49	.08397	.99647	.08427	11.8673	.10135	.98485	.10187	9.8164	11
50	.08426	.99644	.08456	11.8262	.10164	.98482	.10216	9.7881	10
51	.08455	.99642	.08485	11.7853	.10192	.98479	.10245	9.7600	9
52	.08484	.99639	.08514	11.7448	.10221	.98476	.10275	9.7321	8
53	.08513	.99637	.08544	11.7045	.10250	.98473	.10305	9.7044	7
54	.08542	.99635	.08573	11.6645	.10279	.98470	.10334	9.6769	6
55	.08571	.99632	.08602	11.6248	.10308	.98467	.10363	9.6495	5
56	.08600	.99630	.08632	11.5853	.10337	.98464	.10393	9.6223	4
57	.08629	.99627	.08661	11.5461	.10366	.98461	.10422	9.5953	3
58	.08658	.99625	.08690	11.5072	.10395	.98458	.10452	9.5684	2
59	.08687	.99622	.08720	11.4686	.10424	.98455	.10481	9.5416	1
60	.08716	.99619	.08749	11.4301	.10453	.98452	.10510	9.5149	0
	Cos.	Sin.	Cot.	Tan.	Cos.	Sin.	Cot.	Tan.	

NATURAL SINES, COSINES, TANGENTS, COTAN. 243

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7°

Sin.	Cos.	Tan.	Cot.	Sin.	Cos.	Tan.	Cot.	'
.10453	.89452	.10510	9.51436	.12187	.99255	.12278	8.14435	60
.10482	.89449	.10540	9.48781	.12216	.99251	.12308	8.12481	59
.10511	.89446	.10569	9.46141	.12245	.99248	.12338	8.10536	58
.10540	.89443	.10599	9.43515	.12274	.99244	.12367	8.08600	57
.10569	.89440	.10628	9.40904	.12302	.99240	.12397	8.06674	56
.10597	.89437	.10657	9.38307	.12331	.99237	.12426	8.04756	55
.10626	.89434	.10687	9.35724	.12360	.99233	.12456	8.02848	54
.10655	.89431	.10716	9.33155	.12389	.99230	.12485	8.00948	53
.10684	.89428	.10746	9.30599	.12418	.99226	.12515	7.99058	52
.10713	.89424	.10775	9.28058	.12447	.99222	.12544	7.97176	51
.10742	.89421	.10805	9.25530	.12476	.99219	.12574	7.95302	50
.10771	.89418	.10834	9.23016	.12504	.99215	.12603	7.93438	49
.10800	.89415	.10863	9.20516	.12533	.99211	.12633	7.91582	48
.10829	.89412	.10893	9.18028	.12562	.99208	.12662	7.89734	47
.10858	.89409	.10922	9.15554	.12591	.99204	.12692	7.87895	46
.10887	.89406	.10952	9.13093	.12620	.99200	.12722	7.86064	45
.10916	.89402	.10981	9.10648	.12649	.99197	.12751	7.84242	44
.10945	.89399	.11011	9.08211	.12678	.99193	.12781	7.82428	43
.10973	.89396	.11040	9.05789	.12706	.99189	.12810	7.80622	42
.11002	.89393	.11070	9.03379	.12735	.99186	.12840	7.78825	41
.11031	.89390	.11099	9.00983	.12764	.99182	.12869	7.77035	40
.11060	.89386	.11128	8.98598	.12793	.99178	.12899	7.75254	39
.11089	.89383	.11158	8.96227	.12822	.99175	.12929	7.73480	38
.11118	.89380	.11187	8.93867	.12851	.99171	.12958	7.71715	37
.11147	.89377	.11217	8.91520	.12880	.99167	.12988	7.69957	36
.11176	.89374	.11246	8.89185	.12908	.99163	.13017	7.68208	35
.11205	.89370	.11276	8.86862	.12937	.99160	.13047	7.66466	34
.11234	.89367	.11305	8.84551	.12966	.99156	.13076	7.64732	33
.11263	.89364	.11335	8.82252	.12995	.99152	.13106	7.63005	32
.11291	.89360	.11364	8.79964	.13024	.99148	.13136	7.61287	31
.11320	.89357	.11394	8.77689	.13053	.99144	.13165	7.59575	30
.11349	.89354	.11423	8.75425	.13081	.99141	.13195	7.57872	29
.11378	.89351	.11452	8.73172	.13110	.99137	.13224	7.56176	28
.11407	.89347	.11482	8.70931	.13139	.99133	.13254	7.54487	27
.11436	.89344	.11511	8.68701	.13168	.99129	.13284	7.52806	26
.11465	.89341	.11541	8.66482	.13197	.99125	.13313	7.51132	25
.11494	.89337	.11570	8.64275	.13226	.99122	.13343	7.49465	24
.11523	.89334	.11600	8.62078	.13254	.99118	.13372	7.47806	23
.11552	.89331	.11629	8.59893	.13283	.99114	.13402	7.46156	22
.11580	.89327	.11659	8.57718	.13312	.99110	.13432	7.44509	21
.11609	.89324	.11688	8.55555	.13341	.99106	.13461	7.42871	20
.11638	.89320	.11718	8.53402	.13370	.99102	.13491	7.41240	19
.11667	.89317	.11747	8.51259	.13399	.99098	.13521	7.39616	18
.11696	.89314	.11777	8.49128	.13427	.99094	.13550	7.37999	17
.11725	.89310	.11806	8.47007	.13456	.99091	.13580	7.36389	16
.11754	.89307	.11836	8.44896	.13485	.99087	.13609	7.34786	15
.11783	.89303	.11865	8.42795	.13514	.99083	.13639	7.33190	14
.11812	.89300	.11895	8.40705	.13543	.99079	.13669	7.31600	13
.11840	.89297	.11924	8.38625	.13572	.99075	.13698	7.30018	12
.11869	.89293	.11954	8.36555	.13600	.99071	.13728	7.28442	11
.11898	.89290	.11983	8.34496	.13629	.99067	.13758	7.26873	10
.11927	.89286	.12013	8.32446	.13658	.99063	.13787	7.25310	9
.11956	.89283	.12042	8.30406	.13687	.99059	.13817	7.23754	8
.11985	.89279	.12072	8.28376	.13716	.99055	.13846	7.22204	7
.12014	.89276	.12101	8.26355	.13744	.99051	.13876	7.20661	6
.12043	.89272	.12131	8.24345	.13773	.99047	.13906	7.19125	5
.12071	.89269	.12160	8.22344	.13802	.99043	.13935	7.17594	4
.12100	.89265	.12190	8.20352	.13831	.99039	.13965	7.16071	3
.12129	.89262	.12219	8.18370	.13860	.99035	.13995	7.14553	2
.12158	.89258	.12249	8.16398	.13889	.99031	.14024	7.13042	1
.12187	.89255	.12278	8.14435	.13917	.99027	.14054	7.11537	0
Cos.	Sin.	Cot.	Tan.	Cos.	Sin.	Cot.	Tan.	'

85°

83°

## 244 NATURAL SINES, COSINES, TANGENTS, COTAN.

$8^{\circ}$				$9^{\circ}$					
	Sin.	Cos.	Tan.	Cot.	Sin.	Cos.	Tan.	Cot.	
0	.13917	.99027	.14054	7.11537	.15643	.98769	.15838	6.31375	60
1	.13946	.99023	.14084	7.10038	.15672	.98764	.15868	6.30189	59
2	.13975	.99019	.14113	7.08546	.15701	.98760	.15898	6.29007	58
3	.14004	.99015	.14143	7.07059	.15730	.98755	.15928	6.27829	57
4	.14033	.99011	.14173	7.05579	.15758	.98751	.15958	6.26655	56
5	.14061	.99006	.14202	7.04105	.15787	.98746	.15988	6.25486	55
6	.14090	.99002	.14232	7.02637	.15816	.98741	.16017	6.24321	54
7	.14119	.98998	.14262	7.01174	.15845	.98737	.16047	6.23160	53
8	.14148	.98994	.14291	6.99718	.15873	.98732	.16077	6.22003	52
9	.14177	.98990	.14321	6.98268	.15902	.98728	.16107	6.20851	51
10	.14205	.98986	.14351	6.96823	.15931	.98723	.16137	6.19708	50
11	.14234	.98982	.14381	6.95385	.15959	.98718	.16167	6.18559	49
12	.14263	.98978	.14410	6.93952	.15988	.98714	.16196	6.17419	48
13	.14292	.98973	.14440	6.92525	.16017	.98709	.16226	6.16283	47
14	.14320	.98969	.14470	6.91104	.16046	.98704	.16256	6.15151	46
15	.14349	.98965	.14499	6.89688	.16074	.98700	.16286	6.14023	45
16	.14378	.98961	.14529	6.88278	.16103	.98695	.16316	6.12899	44
17	.14407	.98957	.14559	6.86874	.16132	.98690	.16346	6.11779	43
18	.14436	.98953	.14588	6.85475	.16160	.98686	.16376	6.10664	42
19	.14464	.98948	.14618	6.84082	.16189	.98681	.16405	6.09552	41
20	.14493	.98944	.14648	6.82694	.16218	.98676	.16435	6.08444	40
21	.14522	.98940	.14678	6.81312	.16246	.98671	.16465	6.07340	39
22	.14551	.98936	.14707	6.79936	.16275	.98667	.16495	6.06240	38
23	.14580	.98931	.14737	6.78564	.16304	.98662	.16525	6.05143	37
24	.14608	.98927	.14767	6.77199	.16333	.98657	.16555	6.04051	36
25	.14637	.98923	.14796	6.75838	.16361	.98652	.16585	6.02962	35
26	.14666	.98919	.14826	6.74483	.16390	.98648	.16615	6.01878	34
27	.14695	.98914	.14856	6.73133	.16419	.98643	.16645	6.00797	33
28	.14723	.98910	.14886	6.71789	.16447	.98638	.16674	5.99720	32
29	.14752	.98906	.14915	6.70450	.16476	.98633	.16704	5.98646	31
30	.14781	.98902	.14945	6.69116	.16505	.98629	.16734	5.97576	30
31	.14810	.98897	.14975	6.67787	.16533	.98624	.16764	5.96510	29
32	.14838	.98893	.15005	6.66463	.16562	.98619	.16794	5.95448	28
33	.14867	.98889	.15034	6.65144	.16591	.98614	.16824	5.94390	27
34	.14896	.98884	.15064	6.63831	.16620	.98609	.16854	5.93335	26
35	.14925	.98880	.15094	6.62523	.16648	.98604	.16884	5.92283	25
36	.14954	.98876	.15124	6.61219	.16677	.98600	.16914	5.91236	24
37	.14982	.98871	.15153	6.59921	.16706	.98595	.16944	5.90191	23
38	.15011	.98867	.15183	6.58627	.16734	.98590	.16974	5.89151	22
39	.15040	.98863	.15213	6.57339	.16763	.98585	.17004	5.88114	21
40	.15069	.98858	.15243	6.56055	.16792	.98580	.17033	5.87080	20
41	.15097	.98854	.15272	6.54777	.16820	.98575	.17063	5.86051	19
42	.15126	.98850	.15302	6.53503	.16849	.98570	.17093	5.85024	18
43	.15155	.98845	.15332	6.52234	.16878	.98565	.17123	5.84001	17
44	.15184	.98841	.15362	6.50970	.16906	.98561	.17153	5.82982	16
45	.15212	.98836	.15391	6.49710	.16935	.98556	.17183	5.81966	15
46	.15241	.98832	.15421	6.48456	.16964	.98551	.17213	5.80953	14
47	.15270	.98827	.15451	6.47206	.16992	.98546	.17243	5.79944	13
48	.15299	.98823	.15481	6.45961	.17021	.98541	.17273	5.78938	12
49	.15327	.98818	.15511	6.44720	.17050	.98536	.17303	5.77936	11
50	.15356	.98814	.15540	6.43484	.17078	.98531	.17333	5.76937	10
51	.15385	.98809	.15570	6.42253	.17107	.98526	.17363	5.75941	9
52	.15414	.98805	.15600	6.41026	.17136	.98521	.17393	5.74949	8
53	.15442	.98800	.15630	6.39804	.17164	.98516	.17423	5.73960	7
54	.15471	.98796	.15660	6.38587	.17193	.98511	.17453	5.72974	6
55	.15500	.98791	.15689	6.37374	.17222	.98506	.17483	5.71992	5
56	.15529	.98787	.15719	6.36165	.17250	.98501	.17513	5.71013	4
57	.15557	.98782	.15749	6.34961	.17279	.98496	.17543	5.70037	3
58	.15586	.98778	.15779	6.33761	.17308	.98491	.17573	5.69064	2
59	.15615	.98773	.15809	6.32566	.17336	.98486	.17603	5.68094	1
60	.15643	.98769	.15838	6.31375	.17365	.98481	.17633	5.67128	0
	Cos.	Sin.	Cot.	Tan.	Cos.	Sin.	Cot.	Tan.	

NATURAL SINES, COSINES, TANGENTS, COTAN. 245

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11°

#	Sin.	Cos.	Tan.	Cot.	Sin.	Cos.	Tan.	Cot.	#
0	.17365	.98481	.17633	5.67128	.19081	.98163	.19438	5.14455	60
1	.17393	.98476	.17663	5.66165	.19109	.98157	.19468	5.13658	59
2	.17422	.98471	.17693	5.65205	.19138	.98152	.19498	5.12862	58
3	.17451	.98466	.17723	5.64245	.19167	.98146	.19529	5.12069	57
4	.17479	.98461	.17753	5.63295	.19195	.98140	.19559	5.11279	56
5	.17508	.98455	.17783	5.62344	.19224	.98135	.19589	5.10490	55
6	.17537	.98450	.17813	5.61397	.19252	.98129	.19619	5.09704	54
7	.17565	.98445	.17843	5.60452	.19281	.98124	.19649	5.08921	53
8	.17594	.98440	.17873	5.59511	.19309	.98118	.19680	5.08139	52
9	.17623	.98435	.17903	5.58573	.19338	.98112	.19710	5.07360	51
0	.17651	.98430	.17933	5.57638	.19366	.98107	.19740	5.06584	50
1	.17680	.98425	.17963	5.56708	.19395	.98101	.19770	5.05809	49
2	.17708	.98420	.17993	5.55777	.19423	.98096	.19801	5.05037	48
3	.17737	.98414	.18023	5.54851	.19452	.98090	.19831	5.04267	47
4	.17766	.98409	.18053	5.53927	.19481	.98084	.19861	5.03499	46
5	.17794	.98404	.18083	5.53007	.19509	.98079	.19891	5.02734	45
6	.17823	.98399	.18113	5.52090	.19538	.98073	.19921	5.01971	44
7	.17852	.98394	.18143	5.51176	.19566	.98067	.19952	5.01210	43
8	.17880	.98389	.18173	5.50264	.19595	.98061	.19982	5.00451	42
9	.17909	.98383	.18203	5.49356	.19623	.98056	.20012	4.99695	41
0	.17937	.98378	.18233	5.48451	.19652	.98050	.20042	4.98940	40
1	.17966	.98373	.18263	5.47548	.19680	.98044	.20073	4.98188	39
2	.17995	.98368	.18293	5.46648	.19709	.98039	.20103	4.97438	38
3	.18023	.98362	.18323	5.45751	.19737	.98033	.20133	4.96690	37
4	.18052	.98357	.18353	5.44857	.19766	.98027	.20164	4.95945	36
5	.18081	.98352	.18384	5.43966	.19794	.98021	.20194	4.95201	35
6	.18109	.98347	.18414	5.43077	.19823	.98016	.20224	4.94460	34
7	.18138	.98341	.18444	5.42192	.19851	.98010	.20254	4.93721	33
8	.18166	.98336	.18474	5.41309	.19880	.98004	.20285	4.92984	32
9	.18195	.98331	.18504	5.40429	.19908	.97998	.20315	4.92249	31
0	.18224	.98325	.18534	5.39552	.19937	.97992	.20345	4.91516	30
1	.18252	.98320	.18564	5.38677	.19965	.97987	.20376	4.90785	29
2	.18281	.98315	.18594	5.37805	.19994	.97981	.20406	4.90056	28
3	.18309	.98310	.18624	5.36936	.20022	.97975	.20436	4.89330	27
4	.18338	.98304	.18654	5.36070	.20051	.97969	.20466	4.88605	26
5	.18367	.98299	.18684	5.35206	.20079	.97963	.20497	4.87882	25
6	.18395	.98294	.18714	5.34345	.20108	.97958	.20527	4.87162	24
7	.18424	.98288	.18745	5.33487	.20136	.97952	.20557	4.86444	23
8	.18452	.98283	.18775	5.32631	.20165	.97946	.20588	4.85727	22
9	.18481	.98277	.18805	5.31778	.20193	.97940	.20618	4.85013	21
0	.18509	.98272	.18835	5.30928	.20222	.97934	.20648	4.84300	20
1	.18538	.98267	.18865	5.30080	.20250	.97928	.20679	4.83590	19
2	.18567	.98261	.18895	5.29235	.20279	.97922	.20709	4.82882	18
3	.18595	.98256	.18925	5.28393	.20307	.97916	.20739	4.82175	17
4	.18624	.98250	.18955	5.27553	.20336	.97910	.20770	4.81471	16
5	.18652	.98245	.18986	5.26715	.20364	.97905	.20800	4.80769	15
6	.18681	.98240	.19016	5.25880	.20393	.97899	.20830	4.80068	14
7	.18710	.98234	.19046	5.25048	.20421	.97893	.20861	4.79370	13
8	.18738	.98229	.19076	5.24218	.20450	.97887	.20891	4.78673	12
9	.18767	.98223	.19106	5.23391	.20478	.97881	.20921	4.77978	11
0	.18795	.98218	.19136	5.22568	.20507	.97875	.20952	4.77286	10
1	.18824	.98212	.19166	5.21744	.20535	.97869	.20982	4.76595	9
2	.18852	.98207	.19197	5.20925	.20563	.97863	.21013	4.75906	8
3	.18881	.98201	.19227	5.20107	.20592	.97857	.21043	4.75219	7
4	.18910	.98196	.19257	5.19293	.20620	.97851	.21073	4.74534	6
5	.18938	.98190	.19287	5.18480	.20649	.97845	.21104	4.73851	5
6	.18967	.98185	.19317	5.17671	.20677	.97839	.21134	4.73170	4
7	.18995	.98179	.19347	5.16863	.20706	.97833	.21164	4.72490	3
8	.19024	.98174	.19378	5.16058	.20734	.97827	.21195	4.71813	2
9	.19052	.98168	.19408	5.15256	.20763	.97821	.21225	4.71137	1
0	.19081	.98163	.19438	5.14455	.20791	.97815	.21256	4.70463	0
	Cos.	Sin.	Cot.	Tan.	Cos.	Sin.	Cot.	Tan.	

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	Sin.	Cos.	Tan.	Cot.	Sin.	Cos.	Tan.	Cot.	
0	.20791	.97815	.21256	4.70463	.22495	.97437	.23087	4.33148	60
1	.20820	.97809	.21288	4.69791	.22523	.97430	.23117	4.32573	59
2	.20848	.97803	.21316	4.69121	.22552	.97424	.23148	4.32001	58
3	.20877	.97797	.21347	4.68452	.22580	.97417	.23179	4.31430	57
4	.20905	.97791	.21377	4.67786	.22608	.97411	.23209	4.30860	56
5	.20933	.97784	.21408	4.67121	.22637	.97404	.23240	4.30291	55
6	.20962	.97778	.21438	4.66458	.22665	.97398	.23271	4.29724	54
7	.20990	.97772	.21469	4.65797	.22693	.97391	.23301	4.29158	53
8	.21019	.97766	.21499	4.65138	.22722	.97384	.23332	4.28595	52
9	.21047	.97760	.21529	4.64480	.22750	.97378	.23363	4.28032	51
10	.21076	.97754	.21560	4.63825	.22778	.97371	.23393	4.27471	50
11	.21104	.97748	.21590	4.63171	.22807	.97365	.23424	4.26911	49
12	.21132	.97742	.21621	4.62518	.22835	.97358	.23455	4.26352	48
13	.21161	.97735	.21651	4.61868	.22863	.97351	.23485	4.25795	47
14	.21189	.97729	.21682	4.61219	.22892	.97345	.23516	4.25239	46
15	.21218	.97723	.21712	4.60572	.22920	.97338	.23547	4.24685	45
16	.21246	.97717	.21743	4.59927	.22948	.97331	.23578	4.24132	44
17	.21275	.97711	.21773	4.59283	.22977	.97325	.23608	4.23580	43
18	.21303	.97705	.21804	4.58641	.23005	.97318	.23639	4.23030	42
19	.21331	.97698	.21834	4.58001	.23033	.97311	.23670	4.22481	41
20	.21360	.97692	.21864	4.57363	.23062	.97304	.23700	4.21933	40
21	.21388	.97686	.21895	4.56726	.23090	.97298	.23731	4.21387	39
22	.21417	.97680	.21925	4.56091	.23118	.97291	.23762	4.20842	38
23	.21445	.97673	.21956	4.55458	.23146	.97284	.23793	4.20298	37
24	.21474	.97667	.21986	4.54826	.23175	.97278	.23823	4.19756	36
25	.21502	.97661	.22017	4.54196	.23203	.97271	.23854	4.19215	35
26	.21530	.97655	.22047	4.53568	.23231	.97264	.23885	4.18675	34
27	.21559	.97648	.22078	4.52941	.23260	.97257	.23916	4.18137	33
28	.21587	.97642	.22108	4.52316	.23288	.97251	.23946	4.17600	32
29	.21616	.97636	.22139	4.51693	.23316	.97244	.23977	4.17064	31
30	.21644	.97630	.22169	4.51071	.23345	.97237	.24008	4.16530	30
31	.21672	.97623	.22200	4.50451	.23373	.97230	.24039	4.15997	29
32	.21701	.97617	.22231	4.49832	.23401	.97223	.24069	4.15465	28
33	.21729	.97611	.22261	4.49215	.23429	.97217	.24100	4.14934	27
34	.21758	.97604	.22292	4.48600	.23458	.97210	.24131	4.14405	26
35	.21786	.97598	.22322	4.47986	.23486	.97203	.24162	4.13877	25
36	.21814	.97592	.22353	4.47374	.23514	.97196	.24193	4.13350	24
37	.21843	.97585	.22383	4.46764	.23542	.97189	.24223	4.12825	23
38	.21871	.97579	.22414	4.46155	.23571	.97182	.24254	4.12301	22
39	.21899	.97573	.22444	4.45548	.23599	.97176	.24285	4.11778	21
40	.21928	.97566	.22475	4.44942	.23627	.97169	.24316	4.11256	20
41	.21956	.97560	.22505	4.44338	.23656	.97162	.24347	4.10736	19
42	.21985	.97553	.22536	4.43735	.23684	.97155	.24377	4.10216	18
43	.22013	.97547	.22567	4.43134	.23712	.97148	.24408	4.09699	17
44	.22041	.97541	.22597	4.42534	.23740	.97141	.24439	4.09182	16
45	.22070	.97534	.22628	4.41936	.23769	.97134	.24470	4.08666	15
46	.22098	.97528	.22658	4.41340	.23797	.97127	.24501	4.08152	14
47	.22126	.97521	.22689	4.40745	.23825	.97120	.24532	4.07639	13
48	.22155	.97515	.22719	4.40152	.23853	.97113	.24562	4.07127	12
49	.22183	.97508	.22750	4.39560	.23882	.97106	.24593	4.06616	11
50	.22212	.97502	.22781	4.38969	.23910	.97100	.24624	4.06107	10
51	.22240	.97496	.22811	4.38381	.23938	.97093	.24655	4.05599	9
52	.22268	.97489	.22842	4.37793	.23966	.97086	.24686	4.05092	8
53	.22297	.97483	.22872	4.37207	.23995	.97079	.24717	4.04586	7
54	.22325	.97476	.22905	4.36623	.24023	.97072	.24747	4.04081	6
55	.22353	.97470	.22934	4.36040	.24051	.97065	.24778	4.03578	5
56	.22382	.97463	.22964	4.35459	.24079	.97058	.24809	4.03076	4
57	.22410	.97457	.22995	4.34879	.24108	.97051	.24840	4.02574	3
58	.22438	.97450	.23026	4.34300	.24136	.97044	.24871	4.02074	2
59	.22467	.97444	.23056	4.33723	.24164	.97037	.24902	4.01576	1
60	.22495	.97437	.23087	4.33148	.24192	.97030	.24933	4.01078	0
	Cos.	Sin.	Cot.	Tan.	Cos.	Sin.	Cot.	Tan.	

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NATURAL SINES, COSINES, TANGENTS, COTAN. 247

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15°

	Sin.	Cos.	Tan.	Cot.	Sin.	Cos.	Tan.	Cot.	
0	.24192	.97030	.24933	4.01078	.25882	.96593	.26795	3.73205	60
1	.24220	.97023	.24964	4.00582	.25910	.96585	.26826	3.72771	59
2	.24249	.97015	.24995	4.00086	.25938	.96578	.26857	3.72338	58
3	.24277	.97008	.25026	3.99592	.25966	.96570	.26888	3.71907	57
4	.24305	.97001	.25056	3.99099	.25994	.96562	.26920	3.71476	56
5	.24333	.96994	.25087	3.98607	.26022	.96555	.26951	3.71046	55
6	.24362	.96987	.25118	3.98117	.26050	.96547	.26982	3.70616	54
7	.24390	.96980	.25149	3.97627	.26079	.96540	.27013	3.70188	53
8	.24418	.96973	.25180	3.97139	.26107	.96532	.27044	3.69761	52
9	.24446	.96966	.25211	3.96651	.26135	.96524	.27076	3.69335	51
10	.24474	.96959	.25242	3.96165	.26163	.96517	.27107	3.68909	50
11	.24503	.96952	.25273	3.95680	.26191	.96510	.27138	3.68485	49
12	.24531	.96945	.25304	3.95196	.26219	.96502	.27169	3.68061	48
13	.24559	.96937	.25335	3.94713	.26247	.96494	.27201	3.67638	47
14	.24587	.96930	.25366	3.94232	.26275	.96486	.27232	3.67217	46
15	.24615	.96923	.25397	3.93751	.26303	.96479	.27263	3.66796	45
16	.24644	.96916	.25428	3.93271	.26331	.96471	.27294	3.66376	44
17	.24672	.96909	.25459	3.92793	.26359	.96463	.27326	3.65957	43
18	.24700	.96902	.25490	3.92316	.26387	.96456	.27357	3.65538	42
9	.24728	.96894	.25521	3.91839	.26415	.96448	.27388	3.65121	41
10	.24756	.96887	.25552	3.91364	.26443	.96440	.27419	3.64705	40
11	.24784	.96880	.25583	3.90890	.26471	.96433	.27451	3.64289	39
12	.24813	.96873	.25614	3.90417	.26500	.96425	.27482	3.63874	38
13	.24841	.96866	.25645	3.89945	.26528	.96417	.27513	3.63461	37
14	.24869	.96858	.25676	3.89474	.26556	.96410	.27545	3.63048	36
15	.24897	.96851	.25707	3.89004	.26584	.96402	.27576	3.62636	35
16	.24925	.96844	.25738	3.88536	.26612	.96394	.27607	3.62224	34
17	.24954	.96837	.25769	3.88068	.26640	.96386	.27638	3.61814	33
18	.24982	.96830	.25800	3.87601	.26668	.96379	.27670	3.61405	32
9	.25010	.96822	.25831	3.87136	.26696	.96371	.27701	3.60996	31
10	.25038	.96815	.25862	3.86671	.26724	.96363	.27732	3.60588	30
11	.25066	.96807	.25893	3.86208	.26752	.96355	.27764	3.60181	29
12	.25094	.96800	.25924	3.85745	.26780	.96347	.27795	3.59775	28
3	.25122	.96793	.25955	3.85284	.26808	.96340	.27826	3.59370	27
4	.25151	.96786	.25986	3.84824	.26836	.96332	.27858	3.58966	26
5	.25179	.96779	.26017	3.84364	.26864	.96324	.27889	3.58562	25
6	.25207	.96771	.26048	3.83906	.26892	.96316	.27921	3.58160	24
7	.25235	.96764	.26079	3.83449	.26920	.96308	.27952	3.57758	23
8	.25263	.96756	.26110	3.82992	.26948	.96301	.27983	3.57357	22
9	.25291	.96749	.26141	3.82537	.26976	.96293	.28015	3.56957	21
0	.25320	.96742	.26172	3.82083	.27004	.96285	.28046	3.56557	20
1	.25348	.96734	.26203	3.81630	.27032	.96277	.28077	3.56159	19
2	.25376	.96727	.26235	3.81177	.27060	.96269	.28109	3.55761	18
3	.25404	.96719	.26266	3.80726	.27088	.96261	.28140	3.55364	17
4	.25432	.96712	.26297	3.80276	.27116	.96253	.28172	3.54968	16
5	.25460	.96705	.26328	3.79827	.27144	.96246	.28203	3.54573	15
6	.25488	.96697	.26359	3.79377	.27172	.96238	.28234	3.54179	14
7	.25516	.96690	.26390	3.78931	.27200	.96230	.28266	3.53785	13
8	.25545	.96682	.26421	3.78485	.27228	.96222	.28297	3.53393	12
9	.25573	.96675	.26452	3.78040	.27256	.96214	.28329	3.53001	11
0	.25601	.96667	.26483	3.77595	.27284	.96206	.28360	3.52609	10
1	.25629	.96660	.26515	3.77152	.27312	.96198	.28391	3.52219	9
2	.25657	.96653	.26546	3.76709	.27340	.96190	.28423	3.51829	8
3	.25685	.96645	.26577	3.76268	.27368	.96182	.28454	3.51441	7
4	.25713	.96638	.26608	3.75828	.27396	.96174	.28486	3.51053	6
5	.25741	.96630	.26639	3.75388	.27424	.96166	.28517	3.50666	5
6	.25769	.96623	.26670	3.74950	.27452	.96158	.28549	3.50279	4
7	.25798	.96615	.26701	3.74512	.27480	.96150	.28580	3.49894	3
8	.25826	.96608	.26733	3.74075	.27508	.96142	.28612	3.49509	2
9	.25854	.96600	.26764	3.73640	.27536	.96134	.28643	3.49125	1
0	.25882	.96593	.26795	3.73205	.27564	.96126	.28675	3.48741	0
	Cos.	Sin.	Cot.	Tan.	Cos.	Sin.	Cot.	Tan.	

76°

74°

218 NATURAL SINES, COSINES, TANGENTS, COTAN.

10°

17°

	Sin.	Cos.	Tan.	Cot.	Sin.	Cos.	Tan.	Cot.
0	27564	99128	28675	3.48741	29237	95680	30573	3.27085
1	27592	99118	28708	3.48359	29265	95622	30605	3.26745
2	27620	99110	28738	3.47977	29293	95563	30637	3.26406
3	27648	99102	28769	3.47596	29321	95505	30669	3.26067
4	27676	99094	28800	3.47216	29348	95446	30700	3.25729
5	27704	99086	28832	3.46837	29376	95388	30732	3.25392
6	27731	99078	28864	3.46458	29404	95329	30764	3.25055
7	27759	99070	28895	3.46079	29432	95271	30796	3.24719
8	27787	99062	28927	3.45700	29460	95212	30828	3.24383
9	27815	99054	28958	3.45322	29487	95154	30860	3.24049
10	27843	99046	28990	3.44945	29515	95095	30891	3.23714
11	27871	99037	29021	3.44568	29543	95036	30923	3.23381
12	27899	99029	29053	3.44192	29571	94978	30955	3.23048
13	27927	99021	29084	3.43817	29599	94919	30987	3.22715
14	27955	99013	29116	3.43442	29626	94861	31019	3.22384
15	27983	99005	29147	3.43068	29654	94802	31051	3.22053
16	28011	98997	29179	3.42693	29682	94743	31083	3.21722
17	28039	98989	29210	3.42319	29710	94685	31115	3.21392
18	28067	98981	29242	3.41945	29737	94626	31147	3.21063
19	28095	98973	29274	3.41571	29765	94567	31178	3.20734
20	28123	98964	29305	3.41198	29793	94508	31210	3.20406
21	28150	98956	29337	3.40824	29821	94449	31242	3.20079
22	28178	98948	29368	3.40451	29849	94390	31274	3.19752
23	28206	98940	29400	3.40078	29876	94331	31306	3.19426
24	28234	98932	29432	3.39705	29904	94272	31338	3.19100
25	28262	98923	29464	3.39332	29932	94213	31370	3.18775
26	28290	98915	29495	3.38959	29960	94154	31402	3.18451
27	28318	98907	29527	3.38586	29987	94095	31434	3.18127
28	28346	98899	29558	3.38213	30015	94036	31466	3.17804
29	28374	98891	29590	3.37840	30043	93977	31498	3.17481
30	28402	98883	29622	3.37467	30071	93918	31530	3.17159
31	28430	98875	29653	3.37094	30099	93859	31562	3.16838
32	28458	98867	29685	3.36721	30126	93800	31594	3.16517
33	28486	98859	29717	3.36348	30154	93741	31626	3.16197
34	28514	98851	29748	3.35975	30182	93682	31658	3.15877
35	28542	98843	29780	3.35602	30209	93623	31690	3.15558
36	28570	98835	29812	3.35229	30237	93564	31722	3.15240
37	28598	98827	29843	3.34856	30265	93505	31754	3.14922
38	28626	98819	29875	3.34483	30293	93446	31786	3.14605
39	28654	98811	29907	3.34110	30320	93387	31818	3.14288
40	28682	98803	29938	3.33737	30348	93328	31850	3.13972
41	28710	98795	29970	3.33364	30376	93269	31882	3.13656
42	28738	98787	29999	3.32991	30403	93210	31914	3.13341
43	28766	98779	30030	3.32618	30431	93151	31946	3.13027
44	28794	98771	30061	3.32245	30459	93092	31978	3.12713
45	28822	98763	30092	3.31872	30486	93033	32010	3.12400
46	28850	98755	30123	3.31499	30514	92974	32042	3.12087
47	28878	98747	30154	3.31126	30542	92915	32074	3.11775
48	28906	98739	30185	3.30753	30570	92856	32106	3.11464
49	28934	98731	30216	3.30380	30597	92797	32138	3.11153
50	28962	98723	30247	3.30007	30625	92738	32171	3.10842
51	28990	98715	30278	3.29634	30653	92679	32203	3.10532
52	29018	98707	30309	3.29261	30680	92620	32235	3.10223
53	29046	98700	30340	3.28888	30708	92561	32267	3.09914
54	29074	98692	30371	3.28515	30736	92502	32299	3.09606
55	29102	98684	30402	3.28142	30763	92443	32331	3.09298
56	29130	98676	30433	3.27769	30791	92384	32363	3.08991
57	29158	98668	30464	3.27396	30819	92325	32395	3.08685
58	29186	98660	30495	3.27023	30846	92266	32428	3.08379
59	29214	98652	30526	3.26650	30874	92207	32460	3.08073
60	29242	98644	30557	3.26277	30902	92148	32492	3.07768
					Cos.	Sin.	Cot.	Tan.

NATURAL SINES, COSINES, TANGENTS, COTAN. 249

18°				19°					
	Sin.	Cos.	Tan.	Cot.	Sin.	Cos.	Tan.	Cot.	
0	.30902	.95106	.32492	3.07768	.32557	.94552	.34433	2.90421	60
1	.30929	.95097	.32524	3.07464	.32584	.94542	.34465	2.90147	59
2	.30957	.95088	.32556	3.07160	.32612	.94533	.34498	2.89873	58
3	.30985	.95079	.32588	3.06857	.32639	.94523	.34530	2.89600	57
4	.31012	.95070	.32621	3.06554	.32667	.94514	.34563	2.89327	56
5	.31040	.95061	.32653	3.06252	.32694	.94504	.34596	2.89055	55
6	.31068	.95052	.32685	3.05950	.32722	.94495	.34628	2.88783	54
7	.31095	.95043	.32717	3.05649	.32749	.94486	.34661	2.88511	53
8	.31123	.95033	.32749	3.05349	.32777	.94476	.34693	2.88240	52
9	.31151	.95024	.32782	3.05049	.32804	.94466	.34726	2.87970	51
10	.31178	.95015	.32814	3.04749	.32832	.94457	.34758	2.87700	50
11	.31206	.95006	.32846	3.04450	.32859	.94447	.34791	2.87430	49
12	.31233	.94997	.32878	3.04152	.32887	.94438	.34824	2.87161	48
13	.31261	.94988	.32911	3.03854	.32914	.94428	.34856	2.86892	47
14	.31289	.94979	.32943	3.03556	.32942	.94418	.34889	2.86624	46
15	.31316	.94970	.32975	3.03260	.32969	.94409	.34922	2.86356	45
16	.31344	.94961	.33007	3.02963	.32997	.94399	.34954	2.86089	44
17	.31372	.94952	.33040	3.02667	.33024	.94390	.34987	2.85822	43
18	.31399	.94943	.33072	3.02372	.33051	.94380	.35020	2.85555	42
19	.31427	.94933	.33104	3.02077	.33079	.94370	.35052	2.85289	41
20	.31454	.94924	.33136	3.01783	.33106	.94361	.35085	2.85023	40
21	.31482	.94915	.33169	3.01489	.33134	.94351	.35118	2.84758	39
22	.31510	.94906	.33201	3.01196	.33161	.94342	.35150	2.84494	38
23	.31537	.94897	.33233	3.00903	.33189	.94332	.35183	2.84229	37
24	.31565	.94888	.33266	3.00611	.33216	.94322	.35216	2.83965	36
25	.31593	.94878	.33298	3.00319	.33244	.94313	.35248	2.83702	35
26	.31620	.94869	.33330	3.00028	.33271	.94303	.35281	2.83439	34
27	.31648	.94860	.33363	2.99738	.33298	.94293	.35314	2.83176	33
28	.31675	.94851	.33395	2.99447	.33326	.94284	.35346	2.82914	32
29	.31703	.94842	.33427	2.99158	.33353	.94274	.35379	2.82653	31
30	.31730	.94833	.33460	2.98868	.33381	.94264	.35412	2.82391	30
31	.31758	.94823	.33492	2.98580	.33408	.94254	.35445	2.82130	29
32	.31786	.94814	.33524	2.98292	.33436	.94245	.35477	2.81870	28
33	.31813	.94805	.33557	2.98004	.33463	.94235	.35510	2.81610	27
34	.31841	.94795	.33589	2.97717	.33490	.94225	.35543	2.81350	26
35	.31868	.94786	.33621	2.97430	.33518	.94215	.35576	2.81091	25
36	.31896	.94777	.33654	2.97144	.33545	.94206	.35608	2.80833	24
37	.31923	.94768	.33686	2.96858	.33573	.94196	.35641	2.80574	23
38	.31951	.94758	.33718	2.96573	.33600	.94186	.35674	2.80316	22
39	.31979	.94749	.33751	2.96288	.33627	.94176	.35707	2.80059	21
40	.32006	.94740	.33783	2.96004	.33655	.94167	.35740	2.79802	20
41	.32034	.94730	.33816	2.95721	.33682	.94157	.35772	2.79545	19
42	.32061	.94721	.33848	2.95437	.33710	.94147	.35805	2.79289	18
43	.32089	.94712	.33881	2.95155	.33737	.94137	.35838	2.79033	17
44	.32116	.94702	.33913	2.94872	.33764	.94127	.35871	2.78778	16
45	.32144	.94693	.33945	2.94591	.33792	.94118	.35904	2.78523	15
46	.32171	.94684	.33978	2.94309	.33819	.94108	.35937	2.78269	14
47	.32199	.94674	.34010	2.94028	.33846	.94098	.35969	2.78014	13
48	.32227	.94665	.34043	2.93748	.33874	.94088	.36002	2.77761	12
49	.32254	.94656	.34075	2.93468	.33901	.94078	.36035	2.77507	11
50	.32282	.94646	.34108	2.93189	.33929	.94068	.36068	2.77254	10
51	.32309	.94637	.34140	2.92910	.33956	.94058	.36101	2.77002	9
52	.32337	.94627	.34173	2.92632	.33983	.94049	.36134	2.76750	8
53	.32364	.94618	.34205	2.92354	.34011	.94039	.36167	2.76498	7
54	.32392	.94609	.34238	2.92076	.34038	.94029	.36199	2.76247	6
55	.32419	.94599	.34270	2.91799	.34065	.94019	.36232	2.75996	5
56	.32447	.94590	.34303	2.91523	.34093	.94009	.36265	2.75744	4
57	.32474	.94580	.34335	2.91246	.34120	.93999	.36298	2.75493	3
58	.32502	.94571	.34368	2.90971	.34147	.93989	.36331	2.75242	2
59	.32529	.94561	.34400	2.90696	.34175	.93979	.36364	2.74991	1
60	.32557	.94552	.34433	2.90421	.34202	.93969	.36397	2.74740	0
	Cos.	Sin.	Cot.	Tan.	Cos.	Sin.	Cot.	Tan.	

71°

70°

## 250 NATURAL SINES, COSINES, TANGENTS, COTAN.

20°

21°

	Sin.	Cos.	Tan.	Cot.	Sin.	Cos.	Tan.	Cot.	
0	.34202	.93969	.36397	2.74748	.35837	.93358	.38386	2.60509	60
1	.34229	.93959	.36430	2.74499	.35864	.93348	.38420	2.60283	59
2	.34257	.93949	.36463	2.74251	.35891	.93337	.38453	2.60057	58
3	.34284	.93939	.36496	2.74004	.35918	.93327	.38487	2.59831	57
4	.34311	.93929	.36529	2.73756	.35945	.93316	.38520	2.59606	56
5	.34339	.93919	.36562	2.73509	.35973	.93306	.38553	2.59381	55
6	.34366	.93909	.36595	2.73263	.36000	.93295	.38587	2.59156	54
7	.34393	.93899	.36628	2.73017	.36027	.93285	.38620	2.58932	53
8	.34421	.93889	.36661	2.72771	.36054	.93274	.38654	2.58708	52
9	.34448	.93879	.36694	2.72526	.36081	.93264	.38687	2.58484	51
10	.34475	.93869	.36727	2.72281	.36108	.93253	.38721	2.58261	50
11	.34503	.93859	.36760	2.72036	.36135	.93243	.38754	2.58038	49
12	.34530	.93849	.36793	2.71792	.36162	.93232	.38787	2.57815	48
13	.34557	.93839	.36826	2.71548	.36190	.93222	.38821	2.57593	47
14	.34584	.93829	.36859	2.71305	.36217	.93211	.38854	2.57371	46
15	.34612	.93819	.36892	2.71062	.36244	.93201	.38888	2.57150	45
16	.34639	.93809	.36925	2.70819	.36271	.93190	.38921	2.56928	44
17	.34666	.93799	.36958	2.70577	.36298	.93180	.38955	2.56707	43
18	.34694	.93789	.36991	2.70335	.36325	.93169	.38988	2.56487	42
19	.34721	.93779	.37024	2.70094	.36352	.93159	.39022	2.56266	41
20	.34748	.93769	.37057	2.69853	.36379	.93148	.39055	2.56046	40
21	.34775	.93759	.37090	2.69612	.36406	.93137	.39089	2.55827	39
22	.34803	.93749	.37123	2.69371	.36434	.93127	.39122	2.55608	38
23	.34830	.93738	.37157	2.69131	.36461	.93116	.39156	2.55389	37
24	.34857	.93728	.37190	2.68892	.36488	.93106	.39190	2.55170	36
25	.34884	.93718	.37223	2.68653	.36515	.93095	.39223	2.54952	35
26	.34912	.93708	.37256	2.68414	.36542	.93084	.39257	2.54734	34
27	.34939	.93698	.37289	2.68175	.36569	.93074	.39290	2.54516	33
28	.34966	.93688	.37322	2.67937	.36596	.93063	.39324	2.54299	32
29	.34993	.93677	.37355	2.67700	.36623	.93052	.39357	2.54082	31
30	.35021	.93667	.37388	2.67462	.36650	.93042	.39391	2.53865	30
31	.35048	.93657	.37422	2.67225	.36677	.93031	.39425	2.53648	29
32	.35075	.93647	.37455	2.66989	.36704	.93020	.39458	2.53432	28
33	.35102	.93637	.37488	2.66752	.36731	.93010	.39492	2.53217	27
34	.35130	.93626	.37521	2.66516	.36758	.92999	.39526	2.53001	26
35	.35157	.93616	.37554	2.66281	.36785	.92988	.39559	2.52786	25
36	.35184	.93606	.37588	2.66046	.36812	.92978	.39593	2.52571	24
37	.35211	.93596	.37621	2.65811	.36839	.92967	.39626	2.52357	23
38	.35238	.93585	.37654	2.65576	.36867	.92956	.39660	2.52143	22
39	.35266	.93575	.37687	2.65342	.36894	.92945	.39694	2.51929	21
40	.35293	.93565	.37720	2.65109	.36921	.92935	.39727	2.51715	20
41	.35320	.93555	.37754	2.64875	.36948	.92924	.39761	2.51502	19
42	.35347	.93544	.37787	2.64642	.36975	.92913	.39795	2.51289	18
43	.35375	.93534	.37820	2.64410	.37002	.92902	.39829	2.51076	17
44	.35402	.93524	.37853	2.64177	.37029	.92892	.39862	2.50864	16
45	.35429	.93514	.37887	2.63945	.37056	.92881	.39896	2.50652	15
46	.35456	.93503	.37920	2.63714	.37083	.92870	.39930	2.50440	14
47	.35484	.93493	.37953	2.63483	.37110	.92859	.39963	2.50229	13
48	.35511	.93483	.37986	2.63252	.37137	.92849	.39997	2.50018	12
49	.35538	.93472	.38020	2.63021	.37164	.92838	.40031	2.49807	11
50	.35565	.93462	.38053	2.62791	.37191	.92827	.40065	2.49597	10
51	.35592	.93452	.38086	2.62561	.37218	.92816	.40099	2.49386	9
52	.35619	.93441	.38120	2.62332	.37245	.92805	.40132	2.49177	8
53	.35647	.93431	.38153	2.62103	.37272	.92794	.40166	2.48967	7
54	.35674	.93420	.38186	2.61874	.37299	.92784	.40200	2.48758	6
55	.35701	.93410	.38220	2.61646	.37326	.92773	.40234	2.48549	5
56	.35728	.93400	.38253	2.61418	.37353	.92762	.40267	2.48340	4
57	.35755	.93389	.38286	2.61190	.37380	.92751	.40301	2.48132	3
58	.35782	.93379	.38320	2.60963	.37407	.92740	.40335	2.47924	2
59	.35810	.93368	.38353	2.60736	.37434	.92729	.40369	2.47716	1
60	.35837	.93358	.38386	2.60509	.37461	.92718	.40403	2.47509	0
	Cos.	Sin.	Cot.	Tan.	Cos.	Sin.	Cot.	Tan.	

69°

68°

NATURAL SINES, COSINES, TANGENTS, COTAN. 251

22°

23°

'	Sin.	Cos.	Tan.	Cot.	Sin.	Cos.	Tan.	Cot.	'
0	.37461	.92718	.40408	2.47509	.39073	.92050	.42447	2.35585	60
1	.37493	.92707	.40436	2.47302	.39100	.92039	.42482	2.35395	59
2	.37515	.92697	.40470	2.47095	.39127	.92028	.42516	2.35205	58
3	.37542	.92686	.40504	2.46888	.39153	.92016	.42551	2.35015	57
4	.37569	.92675	.40538	2.46682	.39180	.92005	.42586	2.34825	56
5	.37595	.92664	.40572	2.46476	.39207	.91994	.42619	2.34638	55
6	.37622	.92653	.40606	2.46270	.39234	.91982	.42654	2.34447	54
7	.37649	.92642	.40640	2.46065	.39260	.91971	.42688	2.34258	53
8	.37676	.92631	.40674	2.45860	.39287	.91959	.42722	2.34069	52
9	.37703	.92620	.40707	2.45655	.39314	.91948	.42757	2.33881	51
10	.37730	.92609	.40741	2.45451	.39341	.91936	.42791	2.33693	50
11	.37757	.92598	.40775	2.45246	.39367	.91925	.42826	2.33505	49
12	.37784	.92587	.40809	2.45043	.39394	.91914	.42860	2.33317	48
13	.37811	.92576	.40843	2.44839	.39421	.91902	.42894	2.33130	47
14	.37838	.92565	.40877	2.44636	.39448	.91891	.42929	2.32943	46
15	.37865	.92554	.40911	2.44433	.39474	.91879	.42963	2.32756	45
16	.37892	.92543	.40945	2.44230	.39501	.91868	.42998	2.32570	44
17	.37919	.92532	.40979	2.44027	.39528	.91856	.43032	2.32383	43
18	.37946	.92521	.41013	2.43825	.39555	.91845	.43067	2.32197	42
19	.37973	.92510	.41047	2.43623	.39581	.91833	.43101	2.32012	41
20	.37999	.92499	.41081	2.43422	.39608	.91822	.43136	2.31826	40
21	.38026	.92488	.41115	2.43220	.39635	.91810	.43170	2.31641	39
22	.38053	.92477	.41149	2.43019	.39661	.91799	.43205	2.31456	38
23	.38080	.92466	.41183	2.42819	.39688	.91787	.43239	2.31271	37
24	.38107	.92455	.41217	2.42618	.39715	.91776	.43274	2.31086	36
25	.38134	.92444	.41251	2.42418	.39741	.91764	.43308	2.30902	35
26	.38161	.92432	.41285	2.42218	.39768	.91752	.43343	2.30718	34
27	.38188	.92421	.41319	2.42019	.39795	.91741	.43378	2.30534	33
28	.38215	.92410	.41353	2.41819	.39822	.91729	.43412	2.30351	32
29	.38241	.92399	.41387	2.41620	.39848	.91718	.43447	2.30167	31
30	.38268	.92388	.41421	2.41421	.39875	.91706	.43481	2.29984	30
31	.38295	.92377	.41455	2.41223	.39902	.91694	.43516	2.29801	29
32	.38322	.92366	.41490	2.41025	.39928	.91683	.43550	2.29619	28
33	.38349	.92355	.41524	2.40827	.39955	.91671	.43585	2.29437	27
34	.38376	.92343	.41558	2.40629	.39982	.91660	.43620	2.29254	26
35	.38403	.92332	.41592	2.40432	.40008	.91648	.43654	2.29073	25
36	.38430	.92321	.41626	2.40235	.40035	.91636	.43689	2.28891	24
37	.38456	.92310	.41660	2.40038	.40062	.91625	.43724	2.28710	23
38	.38483	.92299	.41694	2.39841	.40088	.91613	.43758	2.28528	22
39	.38510	.92287	.41728	2.39645	.40115	.91601	.43793	2.28348	21
40	.38537	.92276	.41763	2.39449	.40141	.91590	.43828	2.28167	20
41	.38564	.92265	.41797	2.39253	.40168	.91578	.43862	2.27987	19
42	.38591	.92254	.41831	2.39058	.40195	.91566	.43897	2.27806	18
43	.38617	.92243	.41865	2.38863	.40221	.91555	.43932	2.27626	17
44	.38644	.92231	.41899	2.38668	.40248	.91543	.43966	2.27447	16
45	.38671	.92220	.41933	2.38473	.40275	.91531	.44001	2.27267	15
46	.38698	.92209	.41968	2.38279	.40301	.91519	.44036	2.27088	14
47	.38725	.92198	.42002	2.38084	.40328	.91508	.44071	2.26909	13
48	.38752	.92186	.42036	2.37891	.40355	.91496	.44105	2.26730	12
49	.38778	.92175	.42070	2.37697	.40381	.91484	.44140	2.26552	11
50	.38805	.92164	.42105	2.37504	.40408	.91472	.44175	2.26374	10
51	.38832	.92152	.42139	2.37311	.40434	.91461	.44210	2.26196	9
52	.38859	.92141	.42173	2.37118	.40461	.91449	.44244	2.26018	8
53	.38886	.92130	.42207	2.36925	.40488	.91437	.44279	2.25840	7
54	.38912	.92119	.42242	2.36733	.40514	.91425	.44314	2.25663	6
55	.38939	.92107	.42276	2.36541	.40541	.91414	.44349	2.25486	5
56	.38966	.92096	.42310	2.36349	.40567	.91402	.44384	2.25309	4
57	.38993	.92085	.42345	2.36158	.40594	.91390	.44418	2.25132	3
58	.39020	.92073	.42379	2.35967	.40621	.91378	.44453	2.24956	2
59	.39046	.92062	.42413	2.35776	.40647	.91366	.44488	2.24780	1
60	.39073	.92050	.42447	2.35585	.40674	.91355	.44523	2.24604	0
	Cos.	Sin.	Cot.	Tan.	Cos.	Sin.	Cot.	Tan.	

67°

68°

252 NATURAL SINES, COSINES, TANGENTS, COTAN.

24°

25°

	Sin.	Cos.	Tan.	Cot.	Sin.	Cos.	Tan.	Cot.	
0	.40674	.91355	.44528	2.24604	.42262	.90631	.46631	2.14451	60
1	.40700	.91343	.44558	2.24428	.42288	.90618	.46666	2.14288	59
2	.40727	.91331	.44593	2.24252	.42315	.90606	.46702	2.14125	58
3	.40753	.91319	.44627	2.24077	.42341	.90594	.46737	2.13963	57
4	.40780	.91307	.44662	2.23902	.42367	.90582	.46772	2.13801	56
5	.40806	.91295	.44697	2.23727	.42394	.90569	.46808	2.13639	55
6	.40833	.91283	.44732	2.23553	.42420	.90557	.46843	2.13477	54
7	.40860	.91272	.44767	2.23378	.42446	.90545	.46879	2.13316	53
8	.40886	.91260	.44802	2.23204	.42473	.90532	.46914	2.13154	52
9	.40913	.91248	.44837	2.23030	.42499	.90520	.46950	2.12993	51
10	.40939	.91236	.44872	2.22857	.42525	.90507	.46985	2.12832	50
11	.40966	.91224	.44907	2.22683	.42552	.90495	.47021	2.12671	49
12	.40992	.91212	.44942	2.22510	.42578	.90483	.47056	2.12511	48
13	.41019	.91200	.44977	2.22337	.42604	.90470	.47092	2.12350	47
14	.41045	.91188	.45012	2.22164	.42631	.90458	.47128	2.12190	46
15	.41072	.91176	.45047	2.21992	.42657	.90446	.47163	2.12030	45
16	.41098	.91164	.45082	2.21819	.42683	.90433	.47199	2.11871	44
17	.41125	.91152	.45117	2.21647	.42709	.90421	.47234	2.11711	43
18	.41151	.91140	.45152	2.21475	.42736	.90408	.47270	2.11552	42
19	.41178	.91128	.45187	2.21304	.42762	.90396	.47305	2.11392	41
20	.41204	.91116	.45222	2.21132	.42788	.90383	.47341	2.11233	40
21	.41231	.91104	.45257	2.20961	.42815	.90371	.47377	2.11075	39
22	.41257	.91092	.45292	2.20790	.42841	.90358	.47412	2.10916	38
23	.41284	.91080	.45327	2.20619	.42867	.90346	.47448	2.10758	37
24	.41310	.91068	.45362	2.20449	.42894	.90334	.47483	2.10600	36
25	.41337	.91056	.45397	2.20278	.42920	.90321	.47519	2.10442	35
26	.41363	.91044	.45432	2.20108	.42946	.90309	.47555	2.10284	34
27	.41390	.91032	.45467	2.19938	.42972	.90296	.47590	2.10126	33
28	.41416	.91020	.45502	2.19769	.42999	.90284	.47626	2.09969	32
29	.41443	.91008	.45538	2.19599	.43025	.90271	.47662	2.09811	31
30	.41469	.90996	.45573	2.19430	.43051	.90259	.47698	2.09654	30
31	.41496	.90984	.45608	2.19261	.43077	.90246	.47733	2.09498	29
32	.41522	.90972	.45643	2.19092	.43104	.90233	.47769	2.09341	28
33	.41549	.90960	.45678	2.18923	.43130	.90221	.47805	2.09184	27
34	.41575	.90948	.45713	2.18755	.43156	.90208	.47840	2.09028	26
35	.41602	.90936	.45748	2.18587	.43182	.90196	.47876	2.08872	25
36	.41628	.90924	.45784	2.18419	.43209	.90183	.47912	2.08716	24
37	.41655	.90911	.45819	2.18251	.43235	.90171	.47948	2.08560	23
38	.41681	.90899	.45854	2.18084	.43261	.90158	.47984	2.08405	22
39	.41707	.90887	.45889	2.17916	.43287	.90146	.48019	2.08250	21
40	.41734	.90875	.45924	2.17749	.43313	.90133	.48055	2.08094	20
41	.41760	.90863	.45960	2.17582	.43340	.90120	.48091	2.07939	19
42	.41787	.90851	.45995	2.17416	.43366	.90108	.48127	2.07785	18
43	.41813	.90839	.46030	2.17249	.43392	.90095	.48163	2.07630	17
44	.41840	.90826	.46065	2.17083	.43418	.90082	.48198	2.07476	16
45	.41866	.90814	.46101	2.16917	.43445	.90070	.48234	2.07321	15
46	.41892	.90802	.46136	2.16751	.43471	.90057	.48270	2.07167	14
47	.41919	.90790	.46171	2.16585	.43497	.90045	.48306	2.07014	13
48	.41945	.90778	.46206	2.16420	.43523	.90032	.48342	2.06860	12
49	.41972	.90766	.46242	2.16255	.43549	.90019	.48378	2.06706	11
50	.41998	.90753	.46277	2.16090	.43575	.90007	.48414	2.06553	10
51	.42024	.90741	.46312	2.15925	.43602	.89994	.48450	2.06400	9
52	.42051	.90729	.46348	2.15760	.43628	.89981	.48486	2.06247	8
53	.42077	.90717	.46383	2.15596	.43654	.89968	.48521	2.06094	7
54	.42104	.90704	.46418	2.15432	.43680	.89956	.48557	2.05942	6
55	.42130	.90692	.46454	2.15268	.43706	.89943	.48593	2.05790	5
56	.42156	.90680	.46489	2.15104	.43733	.89930	.48629	2.05637	4
57	.42183	.90668	.46525	2.14940	.43759	.89918	.48665	2.05485	3
58	.42209	.90655	.46560	2.14777	.43785	.89905	.48701	2.05333	2
59	.42235	.90643	.46595	2.14614	.43811	.89892	.48737	2.05182	1
60	.42262	.90631	.46631	2.14451	.43837	.89879	.48773	2.05030	0
	Cos.	Sin.	Cot.	Tan.	Cos.	Sin.	Cot.	Tan.	

65°

64°

NATURAL SINES, COSINES, TANGENTS, COTAN. 253

26°					27°				
'	Sin.	Cos.	Tan.	Cot.	Sin.	Cos.	Tan.	Cot.	'
0	.43837	.89879	.48773	2.05030	.45399	.89101	.50953	1.96261	60
1	.43863	.89867	.48809	2.04879	.45425	.89087	.50989	1.96120	59
2	.43889	.89854	.48845	2.04723	.45451	.89074	.51026	1.95979	58
3	.43916	.89841	.48881	2.04577	.45477	.89061	.51063	1.95838	57
4	.43942	.89828	.48917	2.04426	.45503	.89048	.51099	1.95698	56
5	.43968	.89816	.48953	2.04276	.45529	.89035	.51136	1.95557	55
6	.43994	.89803	.48989	2.04125	.45554	.89021	.51173	1.95417	54
7	.44020	.89790	.49026	2.03975	.45580	.89008	.51209	1.95277	53
8	.44046	.89777	.49062	2.03825	.45606	.88995	.51246	1.95137	52
9	.44072	.89764	.49098	2.03675	.45632	.88981	.51283	1.94997	51
10	.44098	.89752	.49134	2.03526	.45658	.88968	.51319	1.94858	50
11	.44124	.89739	.49170	2.03376	.45684	.88955	.51356	1.94718	49
12	.44151	.89726	.49206	2.03227	.45710	.88942	.51393	1.94579	48
13	.44177	.89713	.49242	2.03078	.45736	.88928	.51430	1.94440	47
14	.44203	.89700	.49278	2.02929	.45762	.88915	.51467	1.94301	46
15	.44229	.89687	.49315	2.02780	.45787	.88902	.51503	1.94162	45
16	.44255	.89674	.49351	2.02631	.45813	.88888	.51540	1.94023	44
17	.44281	.89662	.49387	2.02483	.45839	.88875	.51577	1.93885	43
18	.44307	.89649	.49423	2.02335	.45865	.88862	.51614	1.93746	42
19	.44333	.89636	.49459	2.02187	.45891	.88848	.51651	1.93608	41
20	.44359	.89623	.49495	2.02039	.45917	.88835	.51688	1.93470	40
21	.44385	.89610	.49532	2.01891	.45942	.88822	.51724	1.93332	39
22	.44411	.89597	.49568	2.01743	.45968	.88808	.51761	1.93195	38
23	.44437	.89584	.49604	2.01596	.45994	.88795	.51798	1.93057	37
24	.44464	.89571	.49640	2.01449	.46020	.88782	.51835	1.92920	36
25	.44490	.89558	.49677	2.01302	.46046	.88768	.51872	1.92782	35
26	.44516	.89545	.49713	2.01155	.46072	.88755	.51909	1.92645	34
27	.44542	.89532	.49749	2.01008	.46097	.88741	.51946	1.92508	33
28	.44568	.89519	.49786	2.00862	.46123	.88728	.51983	1.92371	32
29	.44594	.89506	.49822	2.00715	.46149	.88715	.52020	1.92235	31
30	.44620	.89493	.49858	2.00569	.46175	.88701	.52057	1.92098	30
31	.44646	.89480	.49894	2.00423	.46201	.88688	.52094	1.91962	29
32	.44672	.89467	.49931	2.00277	.46226	.88674	.52131	1.91826	28
33	.44698	.89454	.49967	2.00131	.46252	.88661	.52168	1.91690	27
34	.44724	.89441	.50004	1.99986	.46278	.88647	.52205	1.91554	26
35	.44750	.89428	.50040	1.99841	.46304	.88634	.52242	1.91418	25
36	.44776	.89415	.50076	1.99695	.46330	.88620	.52279	1.91282	24
37	.44802	.89402	.50113	1.99550	.46355	.88607	.52316	1.91147	23
38	.44828	.89389	.50149	1.99406	.46381	.88593	.52353	1.91012	22
39	.44854	.89376	.50185	1.99261	.46407	.88580	.52390	1.90876	21
40	.44880	.89363	.50222	1.99116	.46433	.88566	.52427	1.90741	20
41	.44906	.89350	.50258	1.98972	.46458	.88553	.52464	1.90607	19
42	.44932	.89337	.50295	1.98828	.46484	.88539	.52501	1.90472	18
43	.44958	.89324	.50331	1.98684	.46510	.88526	.52538	1.90337	17
44	.44984	.89311	.50368	1.98540	.46536	.88512	.52575	1.90203	16
45	.45010	.89298	.50404	1.98396	.46561	.88499	.52613	1.90069	15
46	.45036	.89285	.50441	1.98253	.46587	.88485	.52650	1.89935	14
47	.45062	.89272	.50477	1.98110	.46613	.88472	.52687	1.89801	13
48	.45088	.89259	.50514	1.97966	.46639	.88458	.52724	1.89667	12
49	.45114	.89245	.50550	1.97823	.46664	.88445	.52761	1.89533	11
50	.45140	.89232	.50587	1.97681	.46690	.88431	.52798	1.89400	10
51	.45166	.89219	.50623	1.97538	.46716	.88417	.52836	1.89266	9
52	.45192	.89206	.50660	1.97395	.46742	.88404	.52873	1.89133	8
53	.45218	.89193	.50696	1.97253	.46767	.88390	.52910	1.89000	7
54	.45243	.89180	.50733	1.97111	.46793	.88377	.52947	1.88867	6
55	.45269	.89167	.50769	1.96969	.46819	.88363	.52985	1.88734	5
56	.45295	.89153	.50806	1.96827	.46844	.88349	.53022	1.88602	4
57	.45321	.89140	.50843	1.96685	.46870	.88336	.53059	1.88469	3
58	.45347	.89127	.50879	1.96544	.46896	.88322	.53096	1.88337	2
59	.45373	.89114	.50916	1.96402	.46921	.88308	.53134	1.88205	1
60	.45399	.89101	.50953	1.96261	.46947	.88295	.53171	1.88073	0
'	Cos.	Sin.	Cot.	Tan.	Cos.	Sin.	Cot.	Tan.	'



254 NATURAL SINES, COSINES, TANGENTS, COTAN.

28°				29°					
	Sin.	Cos.	Tan.	Cot.	Sin.	Cos.	Tan.	Cot.	
0	.46947	.88295	.53171	1.88073	.48481	.87462	.55431	1.80405	60
1	.46973	.88281	.53208	1.87941	.48506	.87448	.55469	1.80281	59
2	.46999	.88267	.53246	1.87809	.48532	.87434	.55507	1.80158	58
3	.47024	.88254	.53283	1.87677	.48557	.87420	.55545	1.80034	57
4	.47050	.88240	.53320	1.87546	.48583	.87406	.55583	1.79911	56
5	.47076	.88226	.53358	1.87415	.48608	.87391	.55621	1.79788	55
6	.47101	.88213	.53395	1.87283	.48634	.87377	.55659	1.79665	54
7	.47127	.88199	.53432	1.87152	.48659	.87363	.55697	1.79542	53
8	.47153	.88185	.53470	1.87021	.48684	.87349	.55736	1.79419	52
9	.47178	.88172	.53507	1.86891	.48710	.87335	.55774	1.79296	51
10	.47204	.88158	.53545	1.86760	.48735	.87321	.55812	1.79174	50
11	.47229	.88144	.53582	1.86630	.48761	.87306	.55850	1.79051	49
12	.47255	.88130	.53620	1.86499	.48786	.87292	.55888	1.78929	48
13	.47281	.88117	.53657	1.86369	.48811	.87278	.55926	1.78807	47
14	.47306	.88103	.53694	1.86239	.48837	.87264	.55964	1.78685	46
15	.47332	.88089	.53732	1.86109	.48862	.87250	.56003	1.78563	45
16	.47358	.88075	.53769	1.85979	.48888	.87235	.56041	1.78441	44
17	.47383	.88062	.53807	1.85850	.48913	.87221	.56079	1.78319	43
18	.47409	.88048	.53844	1.85720	.48938	.87207	.56117	1.78198	42
19	.47434	.88034	.53882	1.85591	.48964	.87193	.56156	1.78077	41
20	.47460	.88020	.53920	1.85462	.48989	.87178	.56194	1.77955	40
21	.47486	.88006	.53957	1.85333	.49014	.87164	.56232	1.77834	39
22	.47511	.87993	.53995	1.85204	.49040	.87150	.56270	1.77713	38
23	.47537	.87979	.54032	1.85075	.49065	.87136	.56309	1.77592	37
24	.47562	.87965	.54070	1.84946	.49090	.87122	.56347	1.77471	36
25	.47588	.87951	.54107	1.84818	.49116	.87107	.56385	1.77351	35
26	.47614	.87937	.54145	1.84689	.49141	.87093	.56424	1.77230	34
27	.47639	.87923	.54183	1.84561	.49166	.87079	.56462	1.77110	33
28	.47665	.87909	.54220	1.84433	.49192	.87064	.56501	1.76990	32
29	.47690	.87896	.54258	1.84305	.49217	.87050	.56539	1.76869	31
30	.47716	.87882	.54296	1.84177	.49242	.87036	.56577	1.76749	30
31	.47741	.87868	.54333	1.84049	.49268	.87021	.56616	1.76629	29
32	.47767	.87854	.54371	1.83922	.49293	.87007	.56654	1.76510	28
33	.47793	.87840	.54409	1.83794	.49318	.86993	.56693	1.76390	27
34	.47818	.87826	.54446	1.83667	.49344	.86978	.56731	1.76271	26
35	.47844	.87812	.54484	1.83540	.49369	.86964	.56769	1.76151	25
36	.47869	.87798	.54522	1.83413	.49394	.86949	.56808	1.76032	24
37	.47895	.87784	.54560	1.83286	.49419	.86935	.56846	1.75913	23
38	.47920	.87770	.54597	1.83159	.49445	.86921	.56885	1.75794	22
39	.47946	.87756	.54635	1.83033	.49470	.86906	.56923	1.75675	21
40	.47971	.87743	.54673	1.82906	.49495	.86892	.56962	1.75556	20
41	.47997	.87729	.54711	1.82780	.49521	.86878	.57000	1.75437	19
42	.48022	.87715	.54748	1.82654	.49546	.86863	.57039	1.75319	18
43	.48048	.87701	.54786	1.82528	.49571	.86849	.57078	1.75200	17
44	.48073	.87687	.54824	1.82402	.49596	.86834	.57116	1.75082	16
45	.48099	.87673	.54862	1.82276	.49622	.86820	.57155	1.74964	15
46	.48124	.87659	.54900	1.82150	.49647	.86805	.57193	1.74846	14
47	.48150	.87645	.54938	1.82025	.49672	.86791	.57232	1.74728	13
48	.48175	.87631	.54975	1.81899	.49697	.86777	.57271	1.74610	12
49	.48201	.87617	.55013	1.81774	.49723	.86762	.57309	1.74492	11
50	.48226	.87603	.55051	1.81649	.49748	.86748	.57348	1.74375	10
51	.48252	.87589	.55089	1.81524	.49773	.86733	.57386	1.74257	9
52	.48277	.87575	.55127	1.81399	.49798	.86719	.57425	1.74140	8
53	.48303	.87561	.55165	1.81274	.49824	.86704	.57464	1.74022	7
54	.48328	.87546	.55203	1.81150	.49849	.86690	.57503	1.73905	6
55	.48354	.87532	.55241	1.81025	.49874	.86675	.57541	1.73788	5
56	.48379	.87518	.55279	1.80901	.49899	.86661	.57580	1.73671	4
57	.48405	.87504	.55317	1.80777	.49924	.86646	.57619	1.73553	3
58	.48430	.87490	.55355	1.80653	.49950	.86632	.57657	1.73438	2
59	.48456	.87476	.55393	1.80529	.49975	.86617	.57696	1.73321	1
60	.48481	.87462	.55431	1.80405	.50000	.86603	.57735	1.73205	0
	Cos.	Sin.	Cot.	Tan.	Cos.	Sin.	Cot.	Tan.	

61°

60°

NATURAL SINES, COSINES, TANGENTS, COTAN. 255

30°

31°

	Sin.	Cos.	Tan.	Cot.	Sin.	Cos.	Tan.	Cot.	
0	.50000	.86603	.57735	1.73205	.51504	.85717	.60086	1.66428	60
1	.50025	.86588	.57774	1.73089	.51529	.85702	.60126	1.66318	59
2	.50050	.86573	.57813	1.72973	.51554	.85687	.60165	1.66209	58
3	.50076	.86559	.57851	1.72857	.51579	.85672	.60205	1.66099	57
4	.50101	.86544	.57890	1.72741	.51604	.85657	.60245	1.65990	56
5	.50126	.86530	.57929	1.72625	.51628	.85642	.60284	1.65881	55
6	.50151	.86515	.57968	1.72509	.51653	.85627	.60324	1.65772	54
7	.50176	.86501	.58007	1.72393	.51678	.85612	.60364	1.65663	53
8	.50201	.86486	.58046	1.72277	.51703	.85597	.60403	1.65554	52
9	.50227	.86471	.58085	1.72163	.51728	.85582	.60443	1.65445	51
10	.50252	.86457	.58124	1.72047	.51753	.85567	.60483	1.65337	50
11	.50277	.86442	.58162	1.71932	.51778	.85551	.60522	1.65228	49
12	.50302	.86427	.58201	1.71817	.51803	.85536	.60562	1.65120	48
13	.50327	.86413	.58240	1.71702	.51828	.85521	.60602	1.65011	47
14	.50352	.86398	.58279	1.71588	.51852	.85506	.60642	1.64903	46
15	.50377	.86384	.58318	1.71473	.51877	.85491	.60681	1.64795	45
16	.50403	.86369	.58357	1.71358	.51902	.85476	.60721	1.64687	44
17	.50428	.86354	.58396	1.71244	.51927	.85461	.60761	1.64579	43
18	.50453	.86340	.58435	1.71129	.51952	.85446	.60801	1.64471	42
19	.50478	.86325	.58474	1.71015	.51977	.85431	.60841	1.64363	41
20	.50503	.86310	.58513	1.70901	.52002	.85416	.60881	1.64255	40
21	.50528	.86295	.58552	1.70787	.52026	.85401	.60921	1.64148	39
22	.50553	.86281	.58591	1.70673	.52051	.85385	.60960	1.64041	38
23	.50578	.86266	.58631	1.70560	.52076	.85370	.61000	1.63934	37
24	.50603	.86251	.58670	1.70446	.52101	.85355	.61040	1.63826	36
25	.50628	.86237	.58709	1.70332	.52126	.85340	.61080	1.63719	35
26	.50654	.86222	.58748	1.70219	.52151	.85325	.61120	1.63612	34
27	.50679	.86207	.58787	1.70106	.52175	.85310	.61160	1.63505	33
28	.50704	.86192	.58826	1.69992	.52200	.85294	.61200	1.63398	32
29	.50729	.86178	.58865	1.69879	.52225	.85279	.61240	1.63292	31
30	.50754	.86163	.58905	1.69766	.52250	.85264	.61280	1.63185	30
31	.50779	.86148	.58944	1.69653	.52275	.85249	.61320	1.63079	29
32	.50804	.86133	.58983	1.69541	.52299	.85234	.61360	1.62972	28
33	.50829	.86119	.59022	1.69428	.52324	.85218	.61400	1.62866	27
34	.50854	.86104	.59061	1.69316	.52349	.85203	.61440	1.62760	26
35	.50879	.86089	.59101	1.69203	.52374	.85188	.61480	1.62654	25
36	.50904	.86074	.59140	1.69091	.52399	.85173	.61520	1.62548	24
37	.50929	.86059	.59179	1.68979	.52423	.85157	.61561	1.62442	23
38	.50954	.86045	.59218	1.68866	.52448	.85142	.61601	1.62336	22
39	.50979	.86030	.59258	1.68754	.52473	.85127	.61641	1.62230	21
40	.51004	.86015	.59297	1.68643	.52498	.85112	.61681	1.62125	20
41	.51029	.86000	.59336	1.68531	.52522	.85096	.61721	1.62019	19
42	.51054	.85985	.59376	1.68419	.52547	.85081	.61761	1.61914	18
43	.51079	.85970	.59415	1.68308	.52572	.85066	.61801	1.61808	17
44	.51104	.85956	.59454	1.68196	.52597	.85051	.61842	1.61703	16
45	.51129	.85941	.59494	1.68085	.52621	.85035	.61882	1.61598	15
46	.51154	.85926	.59533	1.67974	.52646	.85020	.61922	1.61493	14
47	.51179	.85911	.59573	1.67863	.52671	.85005	.61962	1.61388	13
48	.51204	.85896	.59612	1.67752	.52696	.84989	.62003	1.61283	12
49	.51229	.85881	.59651	1.67641	.52720	.84974	.62043	1.61179	11
50	.51254	.85866	.59691	1.67530	.52745	.84959	.62083	1.61074	10
51	.51279	.85851	.59730	1.67419	.52770	.84943	.62124	1.60970	9
52	.51304	.85836	.59770	1.67309	.52794	.84928	.62164	1.60865	8
53	.51329	.85821	.59809	1.67198	.52819	.84913	.62204	1.60761	7
54	.51354	.85806	.59849	1.67088	.52844	.84897	.62245	1.60657	6
55	.51379	.85792	.59888	1.66978	.52869	.84882	.62285	1.60553	5
56	.51404	.85777	.59928	1.66867	.52893	.84866	.62325	1.60449	4
57	.51429	.85762	.59967	1.66757	.52918	.84851	.62366	1.60345	3
58	.51454	.85747	.60007	1.66647	.52943	.84836	.62406	1.60241	2
59	.51479	.85732	.60046	1.66538	.52967	.84820	.62446	1.60137	1
60	.51504	.85717	.60086	1.66428	.52992	.84805	.62487	1.60033	0
	Cos.	Sin.	Cot.	Tan.	Cos.	Sin.	Cot.	Tan.	

59°

58°

256 NATURAL SINES, COSINES, TANGENTS, COTAN.

32°

33°

°	Sin.	Cos	Tan.	Cot	Sin.	Cos.	Tan.	Cot.	°
0	.52992	.84805	.62487	1.60033	.54464	.83867	.64941	1.53986	60
1	.53017	.84789	.62527	1.59930	.54488	.83851	.64982	1.53888	59
2	.53041	.84774	.62568	1.59826	.54513	.83835	.65024	1.53791	58
3	.53066	.84759	.62608	1.59723	.54537	.83819	.65065	1.53693	57
4	.53091	.84743	.62649	1.59620	.54561	.83804	.65106	1.53595	56
5	.53115	.84728	.62689	1.59517	.54585	.83788	.65148	1.53497	55
6	.53140	.84712	.62730	1.59414	.54610	.83772	.65189	1.53400	54
7	.53164	.84697	.62770	1.59311	.54635	.83756	.65231	1.53302	53
8	.53189	.84681	.62811	1.59208	.54659	.83740	.65272	1.53205	52
9	.53214	.84666	.62852	1.59105	.54683	.83724	.65314	1.53107	51
10	.53238	.84650	.62892	1.59002	.54708	.83708	.65355	1.53010	50
11	.53263	.84635	.62933	1.58900	.54732	.83692	.65397	1.52913	49
12	.53288	.84619	.62973	1.58797	.54756	.83676	.65438	1.52816	48
13	.53312	.84604	.63014	1.58695	.54781	.83660	.65480	1.52719	47
14	.53337	.84588	.63055	1.58593	.54805	.83645	.65521	1.52622	46
15	.53361	.84573	.63095	1.58490	.54829	.83629	.65563	1.52525	45
16	.53386	.84557	.63136	1.58388	.54854	.83613	.65604	1.52429	44
17	.53411	.84542	.63177	1.58286	.54878	.83597	.65646	1.52332	43
18	.53435	.84526	.63217	1.58184	.54902	.83581	.65688	1.52235	42
19	.53460	.84511	.63258	1.58083	.54927	.83565	.65729	1.52139	41
20	.53484	.84495	.63299	1.57981	.54951	.83549	.65771	1.52043	40
21	.53509	.84480	.63340	1.57879	.54975	.83533	.65813	1.51946	39
22	.53534	.84464	.63380	1.57778	.54999	.83517	.65854	1.51850	38
23	.53558	.84448	.63421	1.57676	.55024	.83501	.65896	1.51754	37
24	.53583	.84433	.63462	1.57575	.55048	.83485	.65938	1.51658	36
25	.53607	.84417	.63503	1.57474	.55072	.83469	.65980	1.51562	35
26	.53632	.84402	.63544	1.57372	.55097	.83453	.66021	1.51466	34
27	.53656	.84386	.63584	1.57271	.55121	.83437	.66063	1.51370	33
28	.53681	.84370	.63625	1.57170	.55145	.83421	.66105	1.51275	32
29	.53705	.84355	.63666	1.57069	.55169	.83405	.66147	1.51179	31
30	.53730	.84339	.63707	1.56969	.55194	.83389	.66189	1.51084	30
31	.53754	.84324	.63748	1.56868	.55218	.83373	.66230	1.50988	29
32	.53779	.84308	.63789	1.56767	.55242	.83357	.66272	1.50893	28
33	.53804	.84292	.63830	1.56666	.55266	.83341	.66314	1.50797	27
34	.53828	.84277	.63871	1.56566	.55291	.83324	.66356	1.50702	26
35	.53853	.84261	.63912	1.56466	.55315	.83308	.66398	1.50607	25
36	.53877	.84245	.63953	1.56366	.55339	.83292	.66440	1.50512	24
37	.53902	.84230	.63994	1.56265	.55363	.83276	.66482	1.50417	23
38	.53926	.84214	.64035	1.56165	.55388	.83260	.66524	1.50322	22
39	.53951	.84198	.64076	1.56065	.55412	.83244	.66566	1.50228	21
40	.53975	.84182	.64117	1.55966	.55436	.83228	.66608	1.50133	20
41	.54000	.84167	.64158	1.55866	.55460	.83212	.66650	1.50038	19
42	.54024	.84151	.64199	1.55766	.55484	.83196	.66692	1.49944	18
43	.54049	.84135	.64240	1.55666	.55509	.83179	.66734	1.49849	17
44	.54073	.84120	.64281	1.55567	.55533	.83163	.66776	1.49755	16
45	.54097	.84104	.64322	1.55467	.55557	.83147	.66818	1.49661	15
46	.54122	.84088	.64363	1.55368	.55581	.83131	.66860	1.49566	14
47	.54146	.84072	.64404	1.55269	.55605	.83115	.66902	1.49472	13
48	.54171	.84057	.64446	1.55170	.55630	.83099	.66944	1.49378	12
49	.54195	.84041	.64487	1.55071	.55654	.83083	.66986	1.49284	11
50	.54220	.84025	.64528	1.54972	.55678	.83067	.67028	1.49190	10
51	.54244	.84009	.64569	1.54873	.55702	.83051	.67071	1.49097	9
52	.54269	.83994	.64610	1.54774	.55726	.83034	.67113	1.49003	8
53	.54293	.83978	.64652	1.54675	.55750	.83017	.67155	1.48909	7
54	.54317	.83963	.64693	1.54576	.55775	.83001	.67197	1.48816	6
55	.54342	.83946	.64734	1.54478	.55799	.82985	.67239	1.48722	5
56	.54366	.83930	.64775	1.54379	.55823	.82969	.67282	1.48629	4
57	.54391	.83915	.64817	1.54281	.55847	.82953	.67324	1.48536	3
58	.54415	.83899	.64858	1.54183	.55871	.82936	.67366	1.48442	2
59	.54440	.83883	.64899	1.54085	.55895	.82920	.67409	1.48349	1
60	.54464	.83867	.64941	1.53986	.55919	.82904	.67451	1.48256	0
	Cos.	Sin.	Cot.	Tan.	Cos.	Sin.	Cot.	Tan.	

47°

56°

NATURAL SINES, COSINES, TANGENTS, COTAN. 257

34°

35°

	Sin.	Cos.	Tan.	Cot.	Sin.	Cos.	Tan.	Cot.	'
0	.55919	.82904	.67451	1.48256	.57358	.81915	.70021	1.42815	60
1	.55943	.82887	.67493	1.48163	.57381	.81899	.70064	1.42726	59
2	.55968	.82871	.67536	1.48070	.57405	.81882	.70107	1.42638	58
3	.55992	.82855	.67578	1.47977	.57429	.81865	.70151	1.42550	57
4	.56016	.82839	.67620	1.47885	.57453	.81848	.70194	1.42462	56
5	.56040	.82822	.67663	1.47792	.57477	.81832	.70238	1.42374	55
6	.56064	.82806	.67705	1.47699	.57501	.81815	.70281	1.42286	54
7	.56088	.82790	.67748	1.47607	.57524	.81798	.70325	1.42198	53
8	.56112	.82773	.67790	1.47514	.57548	.81782	.70368	1.42110	52
9	.56136	.82757	.67832	1.47422	.57572	.81765	.70412	1.42022	51
10	.56160	.82741	.67875	1.47330	.57596	.81748	.70455	1.41934	50
11	.56184	.82724	.67917	1.47238	.57619	.81731	.70499	1.41847	49
12	.56208	.82708	.67960	1.47146	.57643	.81714	.70542	1.41759	48
13	.56232	.82692	.68002	1.47053	.57667	.81698	.70586	1.41672	47
14	.56256	.82675	.68045	1.46962	.57691	.81681	.70629	1.41584	46
15	.56280	.82659	.68088	1.46870	.57715	.81664	.70673	1.41497	45
16	.56305	.82643	.68130	1.46778	.57738	.81647	.70717	1.41409	44
17	.56329	.82626	.68173	1.46686	.57762	.81631	.70760	1.41322	43
18	.56353	.82610	.68215	1.46595	.57786	.81614	.70804	1.41235	42
19	.56377	.82593	.68258	1.46503	.57810	.81597	.70848	1.41148	41
20	.56401	.82577	.68301	1.46411	.57833	.81580	.70891	1.41061	40
21	.56425	.82561	.68343	1.46320	.57857	.81563	.70935	1.40974	39
22	.56449	.82544	.68386	1.46229	.57881	.81546	.70979	1.40887	38
23	.56473	.82528	.68429	1.46137	.57904	.81530	.71023	1.40800	37
24	.56497	.82511	.68471	1.46046	.57928	.81513	.71066	1.40714	36
25	.56521	.82495	.68514	1.45955	.57952	.81496	.71110	1.40627	35
26	.56545	.82478	.68557	1.45864	.57976	.81479	.71154	1.40540	34
27	.56569	.82462	.68600	1.45773	.57999	.81462	.71198	1.40454	33
28	.56593	.82446	.68642	1.45682	.58023	.81445	.71242	1.40367	32
29	.56617	.82429	.68685	1.45592	.58047	.81428	.71285	1.40281	31
30	.56641	.82413	.68728	1.45501	.58070	.81412	.71329	1.40195	30
31	.56665	.82396	.68771	1.45410	.58094	.81395	.71373	1.40109	29
32	.56689	.82380	.68814	1.45320	.58118	.81378	.71417	1.40022	28
33	.56713	.82363	.68857	1.45229	.58141	.81361	.71461	1.39936	27
34	.56738	.82347	.68900	1.45139	.58165	.81344	.71505	1.39850	26
35	.56760	.82330	.68942	1.45049	.58189	.81327	.71549	1.39764	25
36	.56784	.82314	.68985	1.44958	.58212	.81310	.71593	1.39679	24
37	.56808	.82297	.69028	1.44868	.58236	.81293	.71637	1.39593	23
38	.56832	.82281	.69071	1.44777	.58260	.81276	.71681	1.39507	22
39	.56856	.82264	.69114	1.44688	.58283	.81259	.71725	1.39421	21
40	.56880	.82248	.69157	1.44598	.58307	.81242	.71769	1.39336	20
41	.56904	.82231	.69200	1.44508	.58330	.81225	.71813	1.39250	19
42	.56928	.82214	.69243	1.44418	.58354	.81208	.71857	1.39165	18
43	.56952	.82198	.69286	1.44329	.58378	.81191	.71901	1.39079	17
44	.56976	.82181	.69329	1.44239	.58401	.81174	.71946	1.38994	16
45	.57000	.82165	.69372	1.44149	.58425	.81157	.71990	1.38909	15
46	.57024	.82148	.69416	1.44060	.58449	.81140	.72034	1.38824	14
47	.57047	.82132	.69459	1.43970	.58472	.81123	.72078	1.38738	13
48	.57071	.82115	.69502	1.43881	.58496	.81106	.72122	1.38653	12
49	.57095	.82098	.69545	1.43792	.58519	.81089	.72167	1.38568	11
50	.57119	.82082	.69588	1.43703	.58543	.81072	.72211	1.38484	10
51	.57143	.82065	.69631	1.43614	.58567	.81055	.72255	1.38399	9
52	.57167	.82048	.69675	1.43525	.58590	.81038	.72299	1.38314	8
53	.57191	.82032	.69718	1.43436	.58614	.81021	.72344	1.38229	7
54	.57215	.82015	.69761	1.43347	.58637	.81004	.72388	1.38145	6
55	.57238	.81999	.69804	1.43258	.58661	.80987	.72432	1.38060	5
56	.57262	.81982	.69847	1.43169	.58684	.80970	.72477	1.37976	4
57	.57286	.81965	.69891	1.43080	.58708	.80953	.72521	1.37891	3
58	.57310	.81949	.69934	1.42992	.58731	.80936	.72565	1.37807	2
59	.57334	.81932	.69977	1.42903	.58755	.80919	.72610	1.37722	1
60	.57358	.81915	.70021	1.42815	.58779	.80902	.72654	1.37638	0
	Cos.	Sin.	Cot.	Tan.	Cos.	Sin.	Cot.	Tan.	'

55°

54°

258 NATURAL SINES, COSINES, TANGENTS, COTAN.

36°

37°

	Sin.	Cos.	Tan.	Cot.	Sin.	Cos.	Tan.	Cot.	
0	.58779	.80902	.72654	1.37638	.60182	.79864	.75355	1.32704	60
1	.58802	.80885	.72699	1.37554	.60205	.79846	.75401	1.32624	59
2	.58826	.80867	.72743	1.37470	.60228	.79829	.75447	1.32544	58
3	.58849	.80850	.72788	1.37386	.60251	.79811	.75492	1.32464	57
4	.58873	.80833	.72832	1.37302	.60274	.79793	.75538	1.32384	56
5	.58896	.80816	.72877	1.37218	.60298	.79776	.75584	1.32304	55
6	.58920	.80799	.72921	1.37134	.60321	.79758	.75629	1.32224	54
7	.58943	.80782	.72966	1.37050	.60344	.79741	.75675	1.32144	53
8	.58967	.80765	.73010	1.36967	.60367	.79723	.75721	1.32064	52
9	.58990	.80748	.73055	1.36883	.60390	.79706	.75767	1.31984	51
10	.59014	.80730	.73100	1.36800	.60414	.79688	.75812	1.31904	50
11	.59037	.80713	.73144	1.36716	.60437	.79671	.75858	1.31825	49
12	.59061	.80696	.73189	1.36633	.60460	.79653	.75904	1.31745	48
13	.59084	.80679	.73234	1.36549	.60483	.79635	.75950	1.31666	47
14	.59108	.80662	.73278	1.36466	.60506	.79618	.75996	1.31586	46
15	.59131	.80644	.73323	1.36383	.60529	.79600	.76042	1.31507	45
16	.59154	.80627	.73368	1.36300	.60553	.79583	.76088	1.31427	44
17	.59178	.80610	.73413	1.36217	.60576	.79565	.76134	1.31348	43
18	.59201	.80593	.73457	1.36134	.60599	.79547	.76180	1.31269	42
19	.59225	.80576	.73502	1.36051	.60622	.79530	.76226	1.31190	41
20	.59248	.80558	.73547	1.35968	.60645	.79512	.76272	1.31110	40
21	.59272	.80541	.73592	1.35885	.60668	.79494	.76318	1.31031	39
22	.59295	.80524	.73637	1.35802	.60691	.79477	.76364	1.30952	38
23	.59318	.80507	.73681	1.35719	.60714	.79459	.76410	1.30873	37
24	.59342	.80489	.73726	1.35637	.60738	.79441	.76456	1.30795	36
25	.59365	.80472	.73771	1.35554	.60761	.79424	.76502	1.30716	35
26	.59389	.80455	.73816	1.35472	.60784	.79406	.76548	1.30637	34
27	.59412	.80438	.73861	1.35389	.60807	.79388	.76594	1.30558	33
28	.59436	.80420	.73906	1.35307	.60830	.79371	.76640	1.30480	32
29	.59459	.80403	.73951	1.35224	.60853	.79353	.76686	1.30401	31
30	.59482	.80386	.73996	1.35142	.60876	.79335	.76733	1.30323	30
31	.59506	.80369	.74041	1.35060	.60899	.79318	.76779	1.30244	29
32	.59529	.80351	.74086	1.34978	.60922	.79300	.76825	1.30166	28
33	.59552	.80334	.74131	1.34896	.60945	.79282	.76871	1.30087	27
34	.59576	.80316	.74176	1.34814	.60968	.79264	.76918	1.30009	26
35	.59599	.80299	.74221	1.34732	.60991	.79247	.76964	1.29931	25
36	.59622	.80282	.74267	1.34650	.61015	.79229	.77010	1.29853	24
37	.59646	.80264	.74312	1.34568	.61038	.79211	.77057	1.29775	23
38	.59669	.80247	.74357	1.34487	.61061	.79193	.77103	1.29696	22
39	.59693	.80230	.74402	1.34405	.61084	.79176	.77149	1.29618	21
40	.59716	.80212	.74447	1.34323	.61107	.79158	.77196	1.29541	20
41	.59739	.80195	.74492	1.34242	.61130	.79140	.77242	1.29463	19
42	.59763	.80178	.74538	1.34160	.61153	.79122	.77289	1.29385	18
43	.59786	.80160	.74583	1.34079	.61176	.79105	.77335	1.29307	17
44	.59809	.80143	.74628	1.33998	.61199	.79087	.77382	1.29229	16
45	.59832	.80125	.74674	1.33916	.61222	.79069	.77428	1.29152	15
46	.59856	.80108	.74719	1.33835	.61245	.79051	.77475	1.29074	14
47	.59879	.80091	.74764	1.33754	.61268	.79033	.77521	1.28997	13
48	.59902	.80073	.74810	1.33673	.61291	.79016	.77568	1.28919	12
49	.59926	.80056	.74855	1.33592	.61314	.78998	.77615	1.28842	11
50	.59949	.80038	.74900	1.33511	.61337	.78980	.77661	1.28764	10
51	.59972	.80021	.74946	1.33430	.61360	.78962	.77708	1.28687	9
52	.59995	.80003	.74991	1.33349	.61383	.78944	.77754	1.28610	8
53	.60019	.79986	.75037	1.33268	.61406	.78926	.77801	1.28533	7
54	.60042	.79968	.75082	1.33187	.61429	.78908	.77848	1.28456	6
55	.60065	.79951	.75128	1.33107	.61451	.78891	.77895	1.28379	5
56	.60089	.79934	.75173	1.33026	.61474	.78873	.77941	1.28302	4
57	.60112	.79916	.75219	1.32946	.61497	.78855	.77988	1.28225	3
58	.60135	.79899	.75264	1.32865	.61520	.78837	.78035	1.28148	2
59	.60158	.79881	.75310	1.32785	.61543	.78819	.78082	1.28071	1
60	.60182	.79864	.75355	1.32704	.61566	.78801	.78129	1.27994	0
	Cos.	Sin.	Cot.	Tan.	Cos.	Sin.	Cot.	Tan.	

38°

39°

NATURAL SINES, COSINES, TANGENTS, COTAN. 259

39°

39°

'	Sin.	Cos.	Tan.	Cot.	Sin.	Cos.	Tan.	Cot.	'
0	.61566	.78801	.78129	1.27994	.62932	.77715	.80978	1.23490	60
1	.61589	.78783	.78175	1.27917	.62955	.77696	.81027	1.23416	59
2	.61612	.78765	.78222	1.27841	.62977	.77678	.81075	1.23343	58
3	.61635	.78747	.78269	1.27764	.63000	.77660	.81123	1.23270	57
4	.61658	.78729	.78316	1.27688	.63022	.77641	.81171	1.23196	56
5	.61681	.78711	.78363	1.27611	.63045	.77623	.81220	1.23123	55
6	.61704	.78694	.78410	1.27535	.63068	.77605	.81268	1.23050	54
7	.61728	.78676	.78457	1.27458	.63090	.77588	.81316	1.22977	53
8	.61749	.78658	.78504	1.27382	.63113	.77568	.81364	1.22904	52
9	.61772	.78640	.78551	1.27306	.63135	.77550	.81413	1.22831	51
10	.61795	.78622	.78598	1.27230	.63158	.77531	.81461	1.22758	50
1	.61818	.78604	.78645	1.27153	.63180	.77513	.81510	1.22685	49
2	.61841	.78586	.78692	1.27077	.63203	.77494	.81558	1.22612	48
3	.61864	.78568	.78739	1.27001	.63225	.77476	.81606	1.22539	47
4	.61887	.78550	.78786	1.26925	.63248	.77458	.81655	1.22467	46
5	.61909	.78532	.78834	1.26849	.63271	.77439	.81703	1.22394	45
6	.61932	.78514	.78881	1.26774	.63293	.77421	.81752	1.22321	44
7	.61955	.78496	.78928	1.26698	.63316	.77402	.81800	1.22249	43
8	.61978	.78478	.78975	1.26622	.63338	.77384	.81849	1.22176	42
9	.62001	.78460	.79022	1.26546	.63361	.77366	.81898	1.22104	41
10	.62024	.78442	.79070	1.26471	.63383	.77347	.81946	1.22031	40
11	.62046	.78424	.79117	1.26395	.63406	.77329	.81995	1.21959	39
12	.62069	.78405	.79164	1.26319	.63428	.77310	.82044	1.21886	38
13	.62092	.78387	.79212	1.26244	.63451	.77292	.82092	1.21814	37
14	.62115	.78369	.79259	1.26169	.63473	.77273	.82141	1.21742	36
15	.62138	.78351	.79306	1.26093	.63496	.77255	.82190	1.21670	35
16	.62160	.78333	.79354	1.26018	.63518	.77236	.82238	1.21598	34
17	.62183	.78315	.79401	1.25943	.63540	.77218	.82287	1.21526	33
18	.62206	.78297	.79449	1.25867	.63563	.77199	.82336	1.21454	32
19	.62229	.78279	.79496	1.25792	.63585	.77181	.82385	1.21382	31
30	.62251	.78261	.79544	1.25717	.63608	.77162	.82434	1.21310	30
11	.62274	.78243	.79591	1.25642	.63630	.77144	.82483	1.21238	29
12	.62297	.78225	.79639	1.25567	.63653	.77125	.82531	1.21166	28
13	.62320	.78207	.79686	1.25492	.63675	.77107	.82580	1.21094	27
14	.62342	.78188	.79734	1.25417	.63698	.77088	.82629	1.21022	26
15	.62365	.78170	.79781	1.25343	.63720	.77070	.82678	1.20951	25
16	.62388	.78152	.79829	1.25268	.63742	.77051	.82727	1.20879	24
17	.62411	.78134	.79877	1.25193	.63765	.77033	.82776	1.20808	23
18	.62433	.78116	.79924	1.25118	.63787	.77014	.82825	1.20736	22
19	.62456	.78098	.79972	1.25044	.63810	.76996	.82874	1.20665	21
10	.62479	.78079	.80020	1.24969	.63832	.76977	.82923	1.20593	20
11	.62502	.78061	.80067	1.24895	.63854	.76959	.82972	1.20522	19
12	.62524	.78043	.80115	1.24820	.63877	.76940	.83022	1.20451	18
13	.62547	.78025	.80163	1.24746	.63899	.76921	.83071	1.20379	17
14	.62570	.78007	.80211	1.24672	.63922	.76903	.83120	1.20308	16
15	.62592	.77988	.80258	1.24597	.63944	.76884	.83169	1.20237	15
16	.62615	.77970	.80306	1.24523	.63966	.76866	.83218	1.20166	14
17	.62638	.77952	.80354	1.24449	.63989	.76847	.83268	1.20095	13
18	.62660	.77934	.80402	1.24375	.64011	.76828	.83317	1.20024	12
19	.62683	.77916	.80450	1.24301	.64033	.76810	.83366	1.19953	11
30	.62706	.77897	.80498	1.24227	.64056	.76791	.83415	1.19882	10
11	.62728	.77879	.80546	1.24153	.64078	.76772	.83465	1.19811	9
12	.62751	.77861	.80594	1.24079	.64100	.76754	.83514	1.19740	8
13	.62774	.77843	.80642	1.24005	.64123	.76735	.83564	1.19669	7
14	.62796	.77824	.80690	1.23931	.64145	.76717	.83613	1.19599	6
15	.62819	.77806	.80738	1.23858	.64167	.76698	.83662	1.19528	5
16	.62842	.77788	.80786	1.23784	.64190	.76679	.83712	1.19457	4
17	.62864	.77769	.80834	1.23710	.64212	.76661	.83761	1.19387	3
18	.62887	.77751	.80882	1.23637	.64234	.76642	.83811	1.19316	2
19	.62909	.77733	.80930	1.23563	.64256	.76623	.83860	1.19246	1
30	.62932	.77715	.80978	1.23490	.64279	.76604	.83910	1.19175	0
'	Cos.	Sin.	Cot.	Tan.	Cos.	Sin.	Cot.	Tan.	'

51°

50°

## 260 NATURAL SINES, COSINES, TANGENTS, COTAN.

40°

41°

	Sin.	Cos.	Tan.	Cot.	Sin.	Cos.	Tan.	Cot.	
0	.64279	.76804	.83910	1.19175	.65606	.75471	.86929	1.15037	60
1	.64301	.76588	.83960	1.19105	.65628	.75452	.86980	1.14969	59
2	.64323	.76567	.84009	1.19035	.65650	.75433	.87031	1.14902	58
3	.64346	.76548	.84059	1.18964	.65672	.75414	.87082	1.14834	57
4	.64368	.76530	.84108	1.18894	.65694	.75395	.87133	1.14767	56
5	.64390	.76511	.84158	1.18824	.65716	.75375	.87184	1.14699	55
6	.64412	.76492	.84208	1.18754	.65738	.75356	.87236	1.14632	54
7	.64435	.76473	.84258	1.18684	.65759	.75337	.87287	1.14565	53
8	.64457	.76455	.84307	1.18614	.65781	.75318	.87338	1.14498	52
9	.64479	.76436	.84357	1.18544	.65803	.75299	.87389	1.14430	51
10	.64501	.76417	.84407	1.18474	.65825	.75280	.87441	1.14363	50
11	.64524	.76398	.84457	1.18404	.65847	.75261	.87492	1.14296	49
12	.64546	.76380	.84507	1.18334	.65869	.75242	.87543	1.14229	48
13	.64568	.76361	.84556	1.18264	.65891	.75222	.87595	1.14162	47
14	.64590	.76342	.84606	1.18194	.65913	.75203	.87646	1.14095	46
15	.64612	.76323	.84656	1.18125	.65935	.75184	.87698	1.14028	45
16	.64635	.76304	.84706	1.18055	.65956	.75165	.87749	1.13961	44
17	.64657	.76286	.84756	1.17986	.65978	.75146	.87801	1.13894	43
18	.64679	.76267	.84806	1.17916	.66000	.75126	.87852	1.13827	42
19	.64701	.76248	.84856	1.17846	.66022	.75107	.87904	1.13761	41
20	.64723	.76229	.84906	1.17777	.66044	.75088	.87955	1.13694	40
21	.64746	.76210	.84956	1.17708	.66066	.75069	.88007	1.13627	39
22	.64768	.76192	.85006	1.17638	.66088	.75050	.88059	1.13561	38
23	.64790	.76173	.85057	1.17569	.66109	.75030	.88110	1.13494	37
24	.64812	.76154	.85107	1.17500	.66131	.75011	.88162	1.13428	36
25	.64834	.76135	.85157	1.17430	.66153	.74992	.88214	1.13361	35
26	.64856	.76116	.85207	1.17361	.66175	.74973	.88265	1.13295	34
27	.64878	.76097	.85257	1.17292	.66197	.74953	.88317	1.13228	33
28	.64901	.76078	.85308	1.17223	.66218	.74934	.88369	1.13162	32
29	.64923	.76059	.85358	1.17154	.66240	.74915	.88421	1.13096	31
30	.64945	.76041	.85408	1.17085	.66262	.74896	.88473	1.13029	30
31	.64967	.76022	.85458	1.17016	.66284	.74877	.88524	1.12963	29
32	.64989	.76003	.85509	1.16947	.66306	.74857	.88576	1.12897	28
33	.65011	.75984	.85559	1.16878	.66327	.74838	.88628	1.12831	27
34	.65033	.75965	.85609	1.16809	.66349	.74818	.88680	1.12765	26
35	.65055	.75946	.85660	1.16741	.66371	.74799	.88732	1.12699	25
36	.65077	.75927	.85710	1.16672	.66393	.74780	.88784	1.12633	24
37	.65100	.75908	.85761	1.16603	.66414	.74760	.88836	1.12567	23
38	.65122	.75889	.85811	1.16535	.66436	.74741	.88888	1.12501	22
39	.65144	.75870	.85862	1.16466	.66458	.74722	.88940	1.12435	21
40	.65166	.75851	.85912	1.16398	.66480	.74703	.88992	1.12369	20
41	.65188	.75832	.85963	1.16329	.66501	.74683	.89045	1.12303	19
42	.65210	.75813	.86014	1.16261	.66523	.74664	.89097	1.12238	18
43	.65232	.75794	.86064	1.16192	.66545	.74644	.89149	1.12172	17
44	.65254	.75775	.86115	1.16124	.66566	.74625	.89201	1.12106	16
45	.65276	.75756	.86166	1.16056	.66588	.74606	.89253	1.12041	15
46	.65298	.75737	.86216	1.15987	.66610	.74586	.89306	1.11975	14
47	.65320	.75719	.86267	1.15919	.66632	.74567	.89358	1.11909	13
48	.65342	.75700	.86318	1.15851	.66653	.74548	.89410	1.11844	12
49	.65364	.75681	.86368	1.15783	.66675	.74529	.89463	1.11778	11
50	.65386	.75661	.86419	1.15715	.66697	.74509	.89515	1.11713	10
51	.65408	.75642	.86470	1.15647	.66718	.74489	.89567	1.11648	9
52	.65430	.75623	.86521	1.15579	.66740	.74470	.89620	1.11582	8
53	.65452	.75604	.86572	1.15511	.66762	.74451	.89672	1.11517	7
54	.65474	.75585	.86623	1.15443	.66783	.74431	.89725	1.11452	6
55	.65496	.75566	.86674	1.15375	.66805	.74412	.89777	1.11387	5
56	.65518	.75547	.86725	1.15308	.66827	.74392	.89830	1.11321	4
57	.65540	.75528	.86776	1.15240	.66848	.74373	.89883	1.11256	3
58	.65562	.75509	.86827	1.15172	.66870	.74353	.89935	1.11191	2
59	.65584	.75490	.86878	1.15104	.66891	.74334	.89988	1.11126	1
60	.65606	.75471	.86929	1.15037	.66913	.74314	.90040	1.11061	0
	Cos.	Sin.	Cot.	Tan.	Cos.	Sin.	Cot.	Tan.	

40°

40°

NATURAL SINES, COSINES, TANGENTS, COTAN. 261

42°

43°

	Sin.	Cos.	Tan.	Cot.	Sin.	Cos.	Tan.	Cot.	
0	.66913	.74314	.90040	1.11061	.68200	.73135	.93252	1.07237	60
1	.66935	.74295	.90093	1.10996	.68221	.73116	.93306	1.07174	59
2	.66956	.74276	.90146	1.10931	.68242	.73096	.93360	1.07112	58
3	.66978	.74256	.90199	1.10867	.68264	.73076	.93415	1.07049	57
4	.66999	.74237	.90251	1.10802	.68285	.73056	.93469	1.06987	56
5	.67021	.74217	.90304	1.10737	.68306	.73036	.93524	1.06925	55
6	.67043	.74198	.90357	1.10672	.68327	.73016	.93578	1.06862	54
7	.67064	.74178	.90410	1.10607	.68349	.72996	.93633	1.06800	53
8	.67086	.74159	.90463	1.10543	.68370	.72976	.93688	1.06738	52
9	.67107	.74139	.90516	1.10478	.68391	.72957	.93742	1.06676	51
0	.67129	.74120	.90569	1.10414	.68412	.72937	.93797	1.06613	50
1	.67151	.74100	.90621	1.10349	.68434	.72917	.93852	1.06551	49
2	.67172	.74080	.90674	1.10285	.68455	.72897	.93906	1.06489	48
3	.67194	.74061	.90727	1.10220	.68476	.72877	.93961	1.06427	47
4	.67215	.74041	.90781	1.10156	.68497	.72857	.94016	1.06365	46
5	.67237	.74022	.90834	1.10091	.68518	.72837	.94071	1.06303	45
6	.67258	.74002	.90887	1.10027	.68539	.72817	.94125	1.06241	44
7	.67280	.73983	.90940	1.09963	.68561	.72797	.94180	1.06179	43
8	.67301	.73964	.90993	1.09899	.68582	.72777	.94235	1.06117	42
9	.67323	.73944	.91046	1.09834	.68603	.72757	.94290	1.06056	41
0	.67344	.73924	.91099	1.09770	.68624	.72737	.94345	1.05994	40
1	.67366	.73904	.91153	1.09706	.68645	.72717	.94400	1.05932	39
2	.67387	.73885	.91206	1.09642	.68666	.72697	.94455	1.05870	38
3	.67409	.73865	.91259	1.09578	.68688	.72677	.94510	1.05809	37
4	.67430	.73846	.91313	1.09514	.68709	.72657	.94565	1.05747	36
5	.67452	.73826	.91366	1.09450	.68730	.72637	.94620	1.05685	35
6	.67473	.73806	.91419	1.09386	.68751	.72617	.94675	1.05624	34
7	.67495	.73787	.91473	1.09322	.68772	.72597	.94731	1.05562	33
8	.67516	.73767	.91526	1.09258	.68793	.72577	.94786	1.05501	32
9	.67538	.73747	.91580	1.09195	.68814	.72557	.94841	1.05439	31
0	.67559	.73728	.91633	1.09131	.68835	.72537	.94896	1.05378	30
1	.67580	.73708	.91687	1.09067	.68857	.72517	.94952	1.05317	29
2	.67602	.73688	.91740	1.09003	.68878	.72497	.95007	1.05255	28
3	.67623	.73669	.91794	1.08940	.68899	.72477	.95062	1.05194	27
4	.67645	.73649	.91847	1.08876	.68920	.72457	.95118	1.05133	26
5	.67666	.73629	.91901	1.08813	.68941	.72437	.95173	1.05072	25
6	.67688	.73610	.91955	1.08749	.68962	.72417	.95229	1.05010	24
7	.67709	.73590	.92008	1.08686	.68983	.72397	.95284	1.04949	23
8	.67730	.73570	.92062	1.08622	.69004	.72377	.95340	1.04888	22
9	.67752	.73551	.92116	1.08559	.69025	.72357	.95395	1.04827	21
0	.67773	.73531	.92170	1.08496	.69046	.72337	.95451	1.04766	20
1	.67795	.73511	.92224	1.08432	.69067	.72317	.95506	1.04705	19
2	.67816	.73491	.92277	1.08369	.69088	.72297	.95562	1.04644	18
3	.67837	.73472	.92331	1.08306	.69109	.72277	.95618	1.04583	17
4	.67859	.73452	.92385	1.08243	.69130	.72257	.95673	1.04522	16
5	.67880	.73432	.92439	1.08179	.69151	.72236	.95729	1.04461	15
6	.67901	.73413	.92493	1.08116	.69172	.72216	.95785	1.04401	14
7	.67923	.73393	.92547	1.08053	.69193	.72196	.95841	1.04340	13
8	.67944	.73373	.92601	1.07990	.69214	.72176	.95897	1.04279	12
9	.67965	.73353	.92655	1.07927	.69235	.72156	.95952	1.04218	11
0	.67987	.73333	.92709	1.07864	.69256	.72136	.96008	1.04158	10
1	.68008	.73314	.92763	1.07801	.69277	.72116	.96064	1.04097	9
2	.68029	.73294	.92817	1.07738	.69298	.72096	.96120	1.04036	8
3	.68051	.73274	.92872	1.07676	.69319	.72075	.96176	1.03976	7
4	.68072	.73254	.92926	1.07613	.69340	.72055	.96232	1.03915	6
5	.68093	.73234	.92980	1.07550	.69361	.72035	.96288	1.03855	5
6	.68115	.73215	.93034	1.07487	.69382	.72015	.96344	1.03794	4
7	.68136	.73195	.93088	1.07425	.69403	.71995	.96400	1.03734	3
8	.68157	.73175	.93143	1.07362	.69424	.71974	.96457	1.03674	2
9	.68179	.73155	.93197	1.07299	.69445	.71954	.96513	1.03613	1
0	.68200	.73135	.93252	1.07237	.69466	.71934	.96569	1.03553	0
	Cos.	Sin.	Cot.	Tan.	Cos.	Sin.	Cot.	Tan.	

47°

46°



## 262 NATURAL SINES, COSINES, TANGENTS, COTAN.

44°

44°

'	Sin.	Cos.	Tan.	Cot.	'	'	Sin.	Cos.	Tan.	Cot.	'
0	.69486	.71934	.98569	1.03553	60	30	.70091	.71325	.98270	1.01761	30
1	.69487	.71914	.98625	1.03493	59	31	.70112	.71305	.98327	1.01702	29
2	.69508	.71894	.98681	1.03433	58	32	.70132	.71284	.98384	1.01642	28
3	.69529	.71873	.98738	1.03372	57	33	.70153	.71264	.98441	1.01583	27
4	.69549	.71853	.98794	1.03312	56	34	.70174	.71243	.98499	1.01524	26
5	.69570	.71833	.98850	1.03252	55	35	.70195	.71223	.98556	1.01465	25
6	.69591	.71813	.98907	1.03192	54	36	.70215	.71203	.98613	1.01406	24
7	.69612	.71792	.98963	1.03132	53	37	.70236	.71182	.98671	1.01347	23
8	.69633	.71772	.99020	1.03072	52	38	.70257	.71162	.98728	1.01288	22
9	.69654	.71752	.99076	1.03012	51	39	.70277	.71141	.98786	1.01229	21
10	.69675	.71732	.97133	1.02952	50	40	.70298	.71121	.98843	1.01170	20
11	.69696	.71711	.97189	1.02892	49	41	.70319	.71100	.98901	1.01112	19
12	.69717	.71691	.97246	1.02832	48	42	.70339	.71080	.98958	1.01053	18
13	.69737	.71671	.97302	1.02772	47	43	.70360	.71059	.99016	1.00994	17
14	.69758	.71650	.97359	1.02713	46	44	.70381	.71039	.99073	1.00935	16
15	.69779	.71630	.97416	1.02653	45	45	.70401	.71019	.99131	1.00876	15
16	.69800	.71610	.97472	1.02593	44	46	.70422	.70998	.99189	1.00818	14
17	.69821	.71590	.97529	1.02533	43	47	.70443	.70978	.99247	1.00759	13
18	.69842	.71569	.97586	1.02474	42	48	.70463	.70957	.99304	1.00701	12
19	.69862	.71549	.97643	1.02414	41	49	.70484	.70937	.99362	1.00642	11
20	.69883	.71529	.97700	1.02355	40	50	.70505	.70916	.99420	1.00583	10
21	.69904	.71508	.97756	1.02295	39	51	.70525	.70896	.99478	1.00525	9
22	.69925	.71488	.97813	1.02236	38	52	.70546	.70875	.99536	1.00467	8
23	.69946	.71468	.97870	1.02176	37	53	.70567	.70855	.99594	1.00408	7
24	.69966	.71447	.97927	1.02117	36	54	.70587	.70834	.99652	1.00350	6
25	.69987	.71427	.97984	1.02057	35	55	.70608	.70813	.99710	1.00291	5
26	.70008	.71407	.98041	1.01998	34	56	.70628	.70793	.99768	1.00233	4
27	.70029	.71386	.98098	1.01939	33	57	.70649	.70772	.99826	1.00175	3
28	.70049	.71366	.98155	1.01879	32	58	.70670	.70752	.99884	1.00116	2
29	.70070	.71345	.98213	1.01820	31	59	.70690	.70731	.99942	1.00058	1
30	.70091	.71325	.98270	1.01761	30	60	.70711	.70711	1.00000	1.00000	0
	Cos.	Sin.	Cot.	Tan.			Cos.	Sin.	Cot.	Tan.	

45°

45°

°	SECANTS.						°	
	0°	1°	2°	3°	4°	5°		6°
0	1.0000	1.00015	1.00061	1.00137	1.00244	1.00382	1.00551	60
1	0000	00016	00062	00139	00246	00385	00554	59
2	0000	00016	00063	00140	00248	00387	00557	58
3	0000	00017	00064	00142	00250	00390	00560	57
4	0000	00017	00065	00143	00252	00392	00563	56
5	0000	00018	00066	00145	00254	00395	00566	55
6	0000	00018	00067	00147	00257	00397	00569	54
7	0000	00019	00068	00148	00259	00400	00573	53
8	0000	00020	00069	00150	00261	00403	00576	52
9	0000	00020	00070	00151	00263	00405	00579	51
0	0000	00021	00072	00153	00265	00408	00582	50
1	1.0001	1.00021	1.00073	1.00155	1.00267	1.00411	1.00585	49
2	0001	00022	00074	00156	00269	00413	00588	48
3	0001	00023	00075	00158	00271	00416	00592	47
4	0001	00023	00076	00159	00274	00419	00595	46
5	0001	00024	00077	00161	00276	00421	00598	45
6	0001	00024	00078	00163	00278	00424	00601	44
7	0001	00025	00079	00164	00280	00427	00604	43
8	0001	00026	00081	00166	00282	00429	00608	42
9	0002	00026	00082	00168	00284	00432	00611	41
0	0002	00027	00083	00169	00287	00435	00614	40
1	1.0002	1.00028	1.00084	1.00171	1.00289	1.00438	1.00617	39
2	0002	00028	00085	00173	00291	00440	00621	38
3	0002	00029	00087	00175	00293	00443	00624	37
4	0002	00030	00088	00176	00296	00446	00627	36
5	0003	00031	00089	00178	00298	00449	00630	35
6	0003	00031	00090	00180	00300	00451	00634	34
7	0003	00032	00091	00182	00302	00454	00637	33
8	0003	00033	00093	00183	00305	00457	00640	32
9	0004	00034	00094	00185	00307	00460	00644	31
0	0004	00034	00095	00187	00309	00463	00647	30
11	1.0004	1.00035	1.00097	1.00189	1.00312	1.00465	1.00650	29
12	0004	00036	00098	00190	00314	00468	00654	28
13	0005	00037	00099	00192	00316	00471	00657	27
14	0005	00037	00100	00194	00318	00474	00660	26
15	0005	00038	00102	00196	00321	00477	00664	25
16	0005	00039	00103	00198	00323	00480	00667	24
17	0006	00040	00104	00200	00326	00482	00671	23
18	0006	00041	00106	00201	00328	00485	00674	22
19	0006	00041	00107	00203	00330	00488	00677	21
10	0007	00042	00108	00205	00333	00491	00681	20
11	1.0007	1.00043	1.00110	1.00207	1.00335	1.00494	1.00684	19
12	0007	00044	00111	00209	00337	00497	00688	18
13	0008	00045	00113	00211	00340	00500	00691	17
14	0008	00046	00114	00213	00342	00503	00695	16
15	0009	00047	00115	00215	00345	00506	00698	15
16	0009	00048	00117	00216	00347	00509	00701	14
17	0009	00048	00118	00218	00350	00512	00705	13
18	0010	00049	00120	00220	00352	00515	00708	12
19	0010	00050	00121	00222	00354	00518	00712	11
0	0011	00051	00122	00224	00357	00521	00715	10
1	1.0011	1.00052	1.00134	1.00226	1.00359	1.00524	1.00719	9
2	0011	00053	00125	00228	00362	00527	00722	8
3	0012	00054	00127	00230	00364	00530	00726	7
4	0012	00055	00128	00232	00367	00533	00730	6
5	0013	00056	00130	00234	00369	00536	00733	5
6	0013	00057	00131	00236	00372	00539	00737	4
7	0014	00058	00133	00238	00374	00542	00740	3
8	0014	00059	00134	00240	00377	00545	00744	2
9	0015	00060	00136	00242	00379	00548	00747	1
0	0015	00061	00137	00244	00382	00551	00751	0
	89°	88°	87°	86°	85°	84°	83°	
COSECANTS.								

°	SECANTS.							°
	7°	8°	9°	10°	11°	12°	13°	
0	1.00751	1.00983	1.01347	1.01543	1.01872	1.02384	1.02630	60
1	00755	00987	01351	01548	01877	02340	02637	59
2	00758	00991	01356	01553	01883	02347	02644	58
3	00762	00995	01361	01558	01889	02353	02651	57
4	00765	00999	01365	01564	01895	02359	02658	56
5	00769	01004	01370	01569	01901	02365	02665	55
6	00773	01008	01375	01574	01906	02372	02672	54
7	00776	01012	01379	01579	01912	02379	02679	53
8	00780	01016	01384	01585	01918	02385	02686	52
9	00784	01020	01389	01590	01924	02391	02693	51
10	00787	01024	01394	01595	01930	02398	02700	50
11	1.00791	1.01029	1.01298	1.01601	1.01936	1.02304	1.02707	49
12	00795	01033	01303	01606	01941	02311	02714	48
13	00799	01037	01308	01611	01947	02317	02721	47
14	00802	01041	01313	01616	01953	02323	02728	46
15	00806	01046	01318	01622	01959	02330	02735	45
16	00810	01050	01322	01627	01965	02336	02742	44
17	00813	01054	01327	01633	01971	02343	02749	43
18	00817	01059	01332	01638	01977	02349	02756	42
19	00821	01063	01337	01643	01983	02356	02763	41
20	00825	01067	01342	01649	01989	02362	02770	40
21	1.00828	1.01071	1.01346	1.01654	1.01995	1.02369	1.02777	39
22	00832	01076	01351	01659	02001	02375	02784	38
23	00836	01080	01356	01665	02007	02382	02791	37
24	00840	01084	01361	01670	02013	02388	02799	36
25	00844	01089	01366	01676	02019	02395	02806	35
26	00848	01093	01371	01681	02025	02402	02813	34
27	00851	01097	01376	01687	02031	02408	02820	33
28	00855	01102	01381	01692	02037	02415	02827	32
29	00859	01106	01386	01698	02043	02421	02834	31
30	00863	01111	01391	01703	02049	02428	02842	30
31	1.00867	1.01115	1.01395	1.01709	1.02055	1.02435	1.02849	29
32	00871	01119	01400	01714	02061	02441	02856	28
33	00875	01124	01405	01720	02067	02448	02863	27
34	00878	01128	01410	01725	02073	02454	02870	26
35	00882	01133	01415	01731	02079	02461	02878	25
36	00886	01137	01420	01736	02085	02468	02885	24
37	00890	01142	01425	01742	02091	02474	02892	23
38	00894	01146	01430	01747	02097	02481	02899	22
39	00898	01151	01435	01753	02103	02488	02907	21
40	00902	01155	01440	01758	02110	02494	02914	20
41	1.00906	1.01160	1.01445	1.01764	1.02116	1.02501	1.02921	19
42	00910	01164	01450	01769	02122	02508	02928	18
43	00914	01169	01455	01775	02128	02515	02936	17
44	00918	01173	01461	01781	02134	02521	02943	16
45	00922	01178	01466	01786	02140	02528	02950	15
46	00926	01182	01471	01792	02146	02535	02958	14
47	00930	01187	01476	01798	02153	02542	02965	13
48	00934	01191	01481	01803	02159	02548	02972	12
49	00938	01196	01486	01809	02165	02555	02980	11
50	00942	01200	01491	01815	02171	02562	02987	10
51	1.00946	1.01205	1.01496	1.01820	1.02178	1.02569	1.02994	9
52	00950	01209	01501	01826	02184	02576	03002	8
53	00954	01213	01506	01832	02190	02582	03009	7
54	00958	01219	01512	01837	02196	02589	03017	6
55	00962	01223	01517	01843	02203	02596	03024	5
56	00966	01228	01522	01849	02209	02603	03032	4
57	00970	01233	01527	01854	02215	02610	03039	3
58	00975	01237	01532	01860	02221	02617	03046	2
59	00979	01242	01537	01866	02228	02624	03054	1
60	00983	01247	01543	01872	02234	02630	03061	0
°	82°	81°	80°	79°	78°	77°	76°	°
	COSECANTS.							

NATURAL SECANTS AND COSECANTS

		SECANTS.							
		14°	15°	16°	17°	18°	19°	20°	
0	1.03061	1.03528	1.04030	1.04569	1.05146	1.05762	1.06418	60	
1	03069	03536	04039	04578	05159	05773	06429	59	
2	03076	03544	04047	04588	05166	05783	06440	58	
3	03084	03552	04056	04597	05176	05794	06452	57	
4	03091	03560	04065	04606	05186	05805	06463	56	
5	03099	03568	04073	04616	05196	05815	06474	55	
6	03106	03576	04082	04625	05206	05826	06486	54	
7	03114	03584	04091	04635	05216	05836	06497	53	
8	03121	03592	04100	04644	05226	05847	06508	52	
9	03129	03601	04108	04653	05236	05858	06520	51	
10	03137	03609	04117	04663	05246	05869	06531	50	
11	1.03144	1.03617	1.04126	1.04673	1.05256	1.05879	1.06542	49	
12	03152	03625	04135	04682	05266	05890	06554	48	
13	03159	03633	04144	04691	05276	05901	06565	47	
14	03167	03642	04152	04700	05286	05911	06577	46	
15	03175	03650	04161	04710	05297	05922	06588	45	
16	03182	03658	04170	04719	05307	05933	06600	44	
17	03190	03666	04179	04729	05317	05944	06611	43	
18	03198	03674	04188	04738	05327	05955	06622	42	
19	03205	03683	04197	04748	05337	05965	06634	41	
20	03213	03691	04206	04757	05347	05976	06645	40	
21	1.03221	1.03699	1.04214	1.04767	1.05357	1.05987	1.06657	39	
22	03228	03708	04223	04776	05367	05998	06668	38	
23	03236	03716	04232	04786	05378	06009	06680	37	
24	03244	03724	04241	04795	05388	06020	06691	36	
25	03251	03732	04250	04805	05398	06030	06703	35	
26	03259	03741	04259	04815	05408	06041	06715	34	
27	03267	03749	04268	04824	05418	06052	06726	33	
28	03275	03758	04277	04834	05429	06063	06738	32	
29	03282	03766	04286	04843	05439	06074	06749	31	
30	03290	03774	04295	04853	05449	06085	06761	30	
31	1.03298	1.03783	1.04304	1.04863	1.05460	1.06096	1.06773	29	
32	03306	03791	04313	04872	05450	06107	06784	28	
33	03313	03799	04322	04882	05460	06118	06796	27	
34	03321	03808	04331	04891	05470	06129	06807	26	
35	03329	03816	04340	04901	05501	06140	06819	25	
36	03337	03825	04349	04911	05511	06151	06831	24	
37	03345	03833	04358	04920	05521	06162	06843	23	
38	03353	03842	04367	04930	05532	06173	06854	22	
39	03360	03850	04376	04940	05542	06184	06866	21	
40	03368	03858	04385	04950	05552	06195	06878	20	
41	1.03376	1.03867	1.04394	1.04959	1.05563	1.06206	1.06889	19	
42	03384	03875	04403	04969	05573	06217	06901	18	
43	03392	03884	04413	04979	05584	06228	06913	17	
44	03400	03892	04422	04989	05594	06239	06925	16	
45	03408	03901	04431	04998	05604	06250	06936	15	
46	03416	03909	04440	05008	05615	06261	06948	14	
47	03424	03918	04449	05018	05625	06272	06960	13	
48	03432	03927	04458	05028	05636	06283	06972	12	
49	03439	03935	04468	05038	05646	06295	06984	11	
50	03447	03944	04477	05047	05657	06306	06995	10	
51	1.03455	1.03952	1.04486	1.05057	1.05667	1.06317	1.07007	9	
52	03463	03961	04495	05067	05678	06328	07019	8	
53	03471	03969	04504	05077	05688	06339	07031	7	
54	03479	03978	04514	05087	05699	06350	07043	6	
55	03487	03987	04523	05097	05709	06362	07055	5	
56	03495	03995	04532	05107	05720	06373	07067	4	
57	03503	04004	04541	05116	05730	06384	07079	3	
58	03512	04013	04551	05126	05741	06395	07091	2	
59	03520	04021	04560	05136	05751	06407	07103	1	
60	03528	04030	04569	05146	05762	06418	07115	0	
	75°	74°	73°	72°	71°	70°	69°		
COSECANTS.									

		SECANTS.						
	21°	22°	23°	24°	25°	26°	27°	
0	1.07115	1.07853	1.08636	1.09464	1.10338	1.11260	1.12233	60
1	07126	07866	08649	09478	10353	11276	12249	59
2	07138	07879	08663	09492	10368	11292	12266	58
3	07150	07892	08676	09506	10383	11308	12283	57
4	07162	07904	08690	09520	10398	11323	12299	56
5	07174	07917	08703	09535	10413	11339	12316	55
6	07186	07930	08717	09549	10428	11355	12333	54
7	07199	07943	08730	09563	10443	11371	12349	53
8	07211	07955	08744	09577	10458	11387	12366	52
9	07223	07968	08757	09592	10473	11403	12383	51
10	07235	07981	08771	09606	10488	11419	12400	50
11	1.07247	1.07994	1.08784	1.09620	1.10503	1.11435	1.12416	49
12	07259	08006	08798	09635	10518	11451	12433	48
13	07271	08019	08811	09649	10533	11467	12450	47
14	07283	08032	08825	09663	10549	11483	12467	46
15	07295	08045	08839	09678	10564	11499	12484	45
16	07307	08058	08852	09692	10579	11515	12501	44
17	07320	08071	08866	09707	10594	11531	12518	43
18	07332	08084	08880	09721	10609	11547	12534	42
19	07344	08097	08893	09735	10625	11563	12551	41
20	07356	08109	08907	09750	10640	11579	12568	40
21	1.07368	1.08122	1.08921	1.09764	1.10655	1.11595	1.12585	39
22	07380	08135	08934	09779	10670	11611	12602	38
23	07393	08148	08948	09793	10686	11627	12619	37
24	07405	08161	08962	09808	10701	11643	12636	36
25	07417	08174	08975	09822	10716	11659	12653	35
26	07429	08187	08989	09837	10731	11675	12670	34
27	07442	08200	09003	09851	10747	11691	12687	33
28	07454	08213	09017	09866	10762	11708	12704	32
29	07466	08226	09030	09880	10777	11724	12721	31
30	07479	08239	09044	09895	10793	11740	12738	30
31	1.07491	1.08252	1.09058	1.09909	1.10808	1.11756	1.12755	29
32	07508	08265	09072	09924	10824	11772	12772	28
33	07516	08278	09086	09939	10839	11789	12789	27
34	07528	08291	09099	09953	10854	11805	12807	26
35	07540	08305	09113	09968	10870	11821	12824	25
36	07553	08318	09127	09982	10885	11838	12841	24
37	07565	08331	09141	09997	10901	11854	12858	23
38	07578	08344	09155	10012	10916	11870	12875	22
39	07590	08357	09169	10026	10932	11886	12892	21
40	07602	08370	09183	10041	10947	11903	12910	20
41	1.07615	1.08383	1.09197	1.10055	1.10963	1.11919	1.12927	19
42	07627	08397	09211	10071	10978	11936	12944	18
43	07640	08410	09224	10085	10994	11952	12961	17
44	07652	08423	09238	10100	11009	11968	12979	16
45	07665	08436	09252	10115	11025	11985	12996	15
46	07677	08449	09266	10130	11041	12001	13013	14
47	07690	08463	09280	10144	11056	12018	13031	13
48	07702	08476	09294	10159	11072	12034	13048	12
49	07715	08489	09308	10174	11087	12051	13065	11
50	07727	08503	09323	10189	11103	12067	13083	10
51	1.07740	1.08516	1.09337	1.10204	1.11119	1.12084	1.13100	9
52	07752	08529	09351	10218	11134	12100	13117	8
53	07765	08542	09365	10233	11150	12117	13135	7
54	07778	08556	09379	10248	11166	12133	13152	6
55	07790	08569	09393	10263	11181	12150	13170	5
56	07803	08582	09407	10278	11197	12166	13187	4
57	07816	08596	09421	10293	11213	12183	13205	3
58	07828	08609	09435	10308	11229	12199	13222	2
59	07841	08623	09449	10323	11244	12216	13240	1
60	07853	08636	09464	10338	11260	12233	13257	0
	68°	67°	66°	65°	64°	63°	62°	
COSECANTS.								

		SECANTS.							
		28°	29°	30°	31°	32°	33°	34°	
0	1.13257	1.14335	1.15470	1.16663	1.17918	1.19236	1.20622	60	
1	13275	14354	15489	16684	17939	19259	20647	59	
2	13292	14372	15509	16704	17961	19281	20669	58	
3	13310	14391	15528	16725	17982	19304	20693	57	
4	13327	14409	15548	16745	18004	19327	20717	56	
5	13345	14428	15567	16766	18025	19349	20740	55	
6	13362	14446	15587	16786	18047	19372	20764	54	
7	13380	14465	15606	16806	18068	19394	20788	53	
8	13398	14483	15626	16827	18090	19417	20812	52	
9	13415	14502	15645	16848	18111	19440	20836	51	
10	13433	14521	15665	16868	18133	19463	20859	50	
11	1.13451	1.14539	1.15684	1.16889	1.18155	1.19455	1.20883	49	
12	13468	14558	15704	16909	18176	19508	20907	48	
13	13486	14576	15724	16930	18198	19531	20931	47	
14	13504	14595	15743	16950	18220	19554	20955	46	
15	13521	14614	15763	16971	18241	19576	20979	45	
16	13539	14632	15782	16992	18263	19599	21003	44	
17	13557	14651	15802	17012	18285	19622	21027	43	
18	13575	14670	15822	17033	18307	19645	21051	42	
19	13593	14689	15841	17054	18328	19668	21075	41	
20	13610	14707	15861	17075	18350	19691	21099	40	
21	1.13628	1.14726	1.15881	1.17095	1.18372	1.19718	1.21123	39	
22	13646	14745	15901	17116	18394	19736	21147	38	
23	13664	14764	15920	17137	18416	19759	21171	37	
24	13682	14782	15940	17158	18437	19782	21195	36	
25	13700	14801	15960	17178	18459	19805	21220	35	
26	13718	14820	15980	17199	18481	19828	21244	34	
27	13735	14839	16000	17220	18503	19851	21268	33	
28	13753	14858	16019	17241	18525	19874	21292	32	
29	13771	14877	16039	17262	18547	19897	21316	31	
30	13789	14896	16059	17283	18569	19920	21341	30	
31	1.13807	1.14914	1.16079	1.17304	1.18591	1.19944	1.21365	29	
32	13825	14933	16099	17325	18613	19967	21389	28	
33	13843	14952	16119	17346	18635	19990	21414	27	
34	13861	14971	16139	17367	18657	20013	21438	26	
35	13879	14990	16159	17388	18679	20036	21462	25	
36	13897	15009	16179	17409	18701	20059	21487	24	
37	13916	15028	16199	17430	18723	20083	21511	23	
38	13934	15047	16219	17451	18745	20106	21535	22	
39	13952	15066	16239	17472	18767	20129	21560	21	
40	13970	15085	16259	17493	18790	20152	21584	20	
41	1.13988	1.15105	1.16279	1.17514	1.18812	1.20176	1.21609	19	
42	14006	15124	16299	17535	18834	20199	21633	18	
43	14024	15143	16319	17556	18856	20222	21658	17	
44	14042	15162	16339	17577	18878	20246	21682	16	
45	14061	15181	16359	17598	18901	20269	21707	15	
46	14079	15200	16380	17620	18923	20292	21731	14	
47	14097	15219	16400	17641	18945	20316	21756	13	
48	14115	15239	16420	17662	18967	20339	21781	12	
49	14134	15258	16440	17683	18990	20363	21805	11	
50	14152	15277	16460	17704	19012	20386	21830	10	
51	1.14170	1.15296	1.16481	1.17726	1.19034	1.20410	1.21855	9	
52	14188	15315	16501	17747	19057	20433	21879	8	
53	14207	15335	16521	17768	19079	20457	21904	7	
54	14225	15354	16541	17790	19102	20480	21929	6	
55	14243	15373	16562	17811	19124	20504	21953	5	
56	14262	15393	16582	17832	19146	20527	21978	4	
57	14280	15412	16602	17854	19169	20551	22003	3	
58	14299	15431	16623	17875	19191	20575	22028	2	
59	14317	15451	16643	17896	19214	20598	22053	1	
60	14335	15470	16663	17918	19236	20622	22077	0	
	61°	60°	59°	58°	57°	56°	55°		
COSECANTS.									

	SECANTS.								
	35°	36°	37°	38°	39°	40°	41°		
0	1.22077	1.22607	1.25214	1.26002	1.26076	1.26541	1.26501	60	
1	22102	22638	25241	26091	26706	26573	25255	59	
2	22127	22659	25269	26090	26737	26605	25268	58	
3	22152	22685	25296	26088	26767	26636	25292	57	
4	22177	22711	25324	27017	26797	26668	25316	56	
5	22202	22738	25351	27046	26828	26700	25340	55	
6	22227	22764	25379	27075	26858	26732	25364	54	
7	22252	22790	25406	27104	26889	26764	25387	53	
8	22277	22816	25434	27133	26919	26796	25411	52	
9	22302	22843	25462	27162	26950	26829	25434	51	
10	22327	22869	25489	27191	26980	26861	25458	50	
11	1.22352	1.22995	1.25517	1.27221	1.29011	1.30893	1.32872	49	
12	22377	22922	25545	27250	29042	30925	32905	48	
13	22402	22948	25572	27279	29072	30957	32939	47	
14	22428	22975	25600	27308	29103	30989	32973	46	
15	22453	24001	25628	27337	29133	31022	33007	45	
16	22478	24028	25656	27366	29164	31054	33041	44	
17	22503	24054	25683	27396	29195	31086	33075	43	
18	22528	24081	25711	27425	29226	31119	33109	42	
19	22554	24107	25739	27454	29256	31151	33143	41	
20	22579	24134	25767	27483	29287	31183	33177	40	
21	1.22604	1.24160	1.25795	1.27513	1.29318	1.31216	1.33211	39	
22	22629	24187	25823	27542	29349	31248	33245	38	
23	22655	24213	25851	27572	29380	31281	33279	37	
24	22680	24240	25879	27601	29411	31313	33314	36	
25	22706	24267	25907	27630	29442	31346	33348	35	
26	22731	24293	25935	27660	29473	31378	33382	34	
27	22756	24320	25963	27689	29504	31411	33416	33	
28	22782	24347	25991	27719	29535	31443	33451	32	
29	22807	24373	26019	27748	29566	31476	33485	31	
30	22833	24400	26047	27778	29597	31509	33519	30	
31	1.22858	1.24427	1.26075	1.27807	1.29628	1.31541	1.33554	29	
32	22884	24454	26104	27837	29659	31574	33588	28	
33	22909	24481	26132	27867	29690	31607	33622	27	
34	22935	24508	26160	27896	29721	31640	33657	26	
35	22960	24534	26188	27926	29752	31672	33691	25	
36	22986	24561	26216	27956	29784	31705	33726	24	
37	23012	24588	26245	27985	29815	31738	33760	23	
38	23037	24615	26273	28015	29846	31771	33795	22	
39	23063	24642	26301	28045	29877	31804	33830	21	
40	23089	24669	26330	28075	29909	31837	33864	20	
41	1.23114	1.24696	1.26358	1.28105	1.29910	1.31870	1.33899	19	
42	23140	24723	26387	28134	29941	31908	33934	18	
43	23166	24750	26415	28164	30003	31936	33968	17	
44	23192	24777	26443	28194	30034	31969	34008	16	
45	23217	24804	26472	28224	30066	32002	34088	15	
46	23243	24832	26500	28254	30097	32035	34078	14	
47	23269	24859	26529	28284	30129	32068	34108	13	
48	23295	24886	26557	28314	30160	32101	34143	12	
49	23321	24913	26586	28344	30192	32134	34177	11	
50	23347	24940	26615	28374	30223	32168	34212	10	
51	1.23373	1.24967	1.26643	1.28404	1.30255	1.32201	1.34247	9	
52	23399	24995	26672	28434	30287	32234	34282	8	
53	23424	25022	26701	28464	30318	32267	34317	7	
54	23450	25049	26729	28495	30350	32301	34359	6	
55	23476	25077	26758	28525	30382	32334	34397	5	
56	23502	25104	26787	28555	30413	32368	34423	4	
57	23529	25131	26815	28585	30445	32401	34458	3	
58	23555	25159	26844	28615	30477	32434	34498	2	
59	23581	25186	26873	28646	30509	32468	34523	1	
60	23607	25214	26902	28676	30541	32501	34568	0	
	54°	58°	52°	51°	50°	49°	48°		
	COSECANTS.								

SECANTS.							
42°	43°	44°	45°	46°	47°	48°	
1.34563	1.36733	1.39016	1.41421	1.43956	1.46628	1.49448	60
34599	36770	39055	41463	43999	46674	49496	59
34634	36807	39095	41504	44042	46719	49544	58
34669	36844	39134	41545	44086	46765	49593	57
34704	36881	39173	41586	44129	46811	49641	56
34740	36919	39212	41627	44173	46857	49690	55
34775	36956	39251	41669	44217	46903	49738	54
34811	36993	39291	41710	44260	46949	49787	53
34846	37030	39330	41752	44304	46995	49835	52
34882	37068	39369	41793	44347	47041	49884	51
34917	37105	39409	41835	44391	47087	49933	50
1.34953	1.37143	1.39448	1.41876	1.44435	1.47134	1.49981	49
34988	37180	39487	41918	44479	47180	50030	48
35024	37218	39527	41959	44523	47226	50079	47
35060	37255	39566	42001	44567	47272	50128	46
35095	37293	39606	42042	44610	47319	50177	45
35131	37330	39646	42084	44654	47365	50226	44
35167	37368	39685	42126	44698	47411	50275	43
35203	37406	39725	42168	44742	47458	50324	42
35238	37443	39764	42210	44787	47504	50373	41
35274	37481	39804	42251	44831	47551	50422	40
1.35310	1.37519	1.39844	1.42298	1.44875	1.47598	1.50471	39
35346	37556	39884	42335	44919	47644	50521	38
35382	37594	39924	42377	44963	47691	50570	37
35418	37632	39963	42419	45007	47738	50619	36
35454	37670	40003	42461	45052	47784	50669	35
35490	37708	40043	42503	45096	47831	50718	34
35526	37746	40083	42545	45141	47878	50767	33
35562	37784	40123	42587	45185	47925	50817	32
35598	37822	40163	42630	45229	47972	50866	31
35634	37860	40203	42672	45274	48019	50916	30
1.35670	1.37898	1.40243	1.42714	1.45319	1.48066	1.50966	29
35707	37936	40283	42756	45363	48113	51015	28
35743	37974	40324	42799	45408	48160	51065	27
35779	38012	40364	42841	45452	48207	51115	26
35815	38051	40404	42883	45497	48254	51165	25
35852	38089	40444	42926	45542	48301	51215	24
35888	38127	40485	42968	45587	48349	51265	23
35924	38165	40525	43011	45631	48396	51314	22
35961	38204	40565	43053	45676	48443	51364	21
35997	38242	40606	43096	45721	48491	51415	20
1.36034	1.38220	1.40646	1.43139	1.45766	48538	1.51465	19
36070	38319	40687	43181	45811	48586	51515	18
36107	38357	40727	43224	45856	48633	51565	17
36143	38396	40768	43267	45901	48681	51615	16
36180	38434	40808	43310	45946	48728	51665	15
36217	38473	40849	43352	45992	48776	51716	14
36253	38512	40890	43395	46037	48824	51766	13
36290	38550	40930	43438	46082	48871	51817	12
36327	38589	40971	43481	46127	48919	51867	11
36363	38628	41012	43524	46176	48967	51918	10
1.36400	1.38666	1.41053	1.43567	1.46218	1.49015	1.51968	9
36437	38705	41093	43610	46263	49063	52019	8
36474	38744	41134	43653	46309	49111	52069	7
36511	38783	41175	43696	46354	49159	52120	6
36548	38822	41216	43739	46400	49207	52171	5
36585	38860	41257	43783	46445	49255	52222	4
36622	38899	41298	43826	46491	49303	52273	3
36659	38938	41339	43869	46537	49351	52323	2
36696	38977	41380	43912	46582	49399	52374	1
36733	39016	41421	43956	46628	49448	52425	0
47°	46°	45°	44°	43°	42°	41°	
COSECANTS.							



	SECANTS.							
	49°	50°	51°	52°	53°	54°	55°	
0	1.52425	1.55572	1.58902	1.62427	1.66164	1.70130	1.74345	60
1	52476	55626	58959	62487	66228	70198	74417	59
2	52527	55680	59016	62548	66292	70267	74490	58
3	52579	55734	59073	62609	66357	70335	74562	57
4	52630	55789	59130	62669	66421	70403	74635	56
5	52681	55843	59188	62730	66486	70472	74708	55
6	52732	55897	59245	62791	66550	70540	74781	54
7	52784	55951	59302	62852	66615	70609	74854	53
8	52835	56005	59360	62913	66679	70677	74927	52
9	52886	56060	59418	62974	66744	70746	75000	51
10	52938	56114	59475	63035	66809	70815	75073	50
11	1.52989	1.56169	1.59533	1.63096	1.66873	1.70884	1.75146	49
12	53041	56223	59590	63157	66938	70953	75219	48
13	53092	56278	59648	63218	67003	71022	75293	47
14	53144	56332	59706	63279	67068	71091	75366	46
15	53196	56387	59764	63341	67133	71160	75440	45
16	53247	56442	59822	63402	67199	71229	75513	44
17	53299	56497	59880	63464	67264	71298	75587	43
18	53351	56551	59938	63525	67329	71368	75661	42
19	53403	56606	59996	63587	67394	71437	75734	41
20	53455	56661	60054	63648	67460	71506	75808	40
21	1.53507	1.56716	1.60112	1.63710	1.67525	1.71576	1.75882	39
22	53559	56771	60171	63772	67591	71646	75956	38
23	53611	56826	60229	63834	67656	71715	76031	37
24	53663	56881	60287	63895	67722	71785	76105	36
25	53715	56937	60346	63957	67788	71855	76179	35
26	53768	56992	60404	64019	67853	71925	76253	34
27	53820	57047	60463	64081	67919	71995	76328	33
28	53872	57103	60521	64144	67985	72065	76402	32
29	53924	57158	60580	64206	68051	72135	76477	31
30	53977	57213	60639	64268	68117	72205	76552	30
31	1.54029	1.57269	1.60668	1.64330	1.68183	1.72275	1.76626	29
32	54082	57324	60726	64393	68250	72346	76701	28
33	54134	57380	60785	64455	68316	72416	76776	27
34	54187	57436	60844	64518	68382	72487	76851	26
35	54240	57491	60903	64580	68449	72557	76926	25
36	54292	57547	60962	64643	68515	72628	77001	24
37	54345	57603	61021	64705	68582	72698	77077	23
38	54398	57659	61081	64768	68648	72769	77152	22
39	54451	57715	61140	64831	68715	72840	77227	21
40	54504	57771	61200	64894	68782	72911	77303	20
41	1.54557	1.57827	1.61288	1.64957	1.68848	1.72962	1.77379	19
42	54610	57883	61348	65020	68915	72938	77454	18
43	54663	57939	61407	65083	68982	73014	77529	17
44	54716	57995	61467	65146	69049	73090	77604	16
45	54769	58051	61526	65209	69116	73167	77679	15
46	54822	58106	61586	65272	69183	73243	77754	14
47	54876	58164	61646	65336	69250	73320	77829	13
48	54929	58221	61705	65399	69318	73397	77904	12
49	54982	58277	61765	65462	69385	73474	77979	11
50	55036	58333	61825	65526	69452	73552	78053	10
51	1.55089	1.58390	1.61885	1.65589	1.69520	1.73696	1.78128	9
52	55143	58447	61945	65653	69587	73773	78203	8
53	55196	58503	62005	65717	69655	73850	78278	7
54	55250	58560	62065	65780	69723	73927	78353	6
55	55303	58617	62125	65844	69790	74004	78428	5
56	55357	58674	62185	65908	69858	74081	78503	4
57	55411	58731	62246	65972	69926	74158	78578	3
58	55465	58788	62306	66036	69994	74235	78653	2
59	55518	58845	62366	66100	70062	74312	78728	1
60	55572	58902	62427	66164	70130	74389	78803	0
	40°	39°	38°	37°	36°	35°	34°	
COSECANTS.								

NATURAL SECANTS AND COSECANTS

		SECANTS.									
		56°	57°	58°	59°	60°	61°	62°			
0	1.78829	1.88608	1.88708	1.94160	2.00000	2.06267	2.13005			60	
1	78906	88690	88796	94254	00101	06375	13122			59	
2	79894	88773	88884	94349	00202	06483	13239			58	
3	79061	88855	88972	94443	00303	06592	13356			57	
4	79188	88988	89060	94537	00404	06701	13473			56	
5	79216	84020	89148	94632	00505	06809	13590			55	
6	79298	84103	89237	94726	00607	06918	13707			54	
7	79371	84186	89325	94821	00708	07027	13825			53	
8	79449	84269	89414	94916	00810	07137	13942			52	
9	79527	84352	89503	95011	00912	07246	14060			51	
10	79604	84435	89591	95106	01014	07356	14178			50	
11	7.79682	1.84518	1.89680	1.95201	2.01116	2.07465	2.14296			49	
12	79761	84601	89769	95296	01218	07575	14414			48	
13	79839	84685	89858	95392	01320	07685	14533			47	
14	79917	84768	89948	95487	01422	07795	14651			46	
15	79995	84852	90037	95583	01525	07905	14770			45	
16	80074	84935	90126	95678	01628	08015	14889			44	
17	80152	85019	90216	95774	01730	08126	15008			43	
18	80231	85103	90305	95870	01833	08236	15127			42	
19	80309	85187	90395	95966	01936	08347	15246			41	
20	80388	85271	90485	96062	02039	08458	15366			40	
21	1.80467	1.85355	1.90575	1.96158	2.02143	2.08569	2.15485			39	
22	80546	85439	90565	96255	02246	08580	15605			38	
23	80625	85523	90755	96351	02349	08791	15725			37	
24	80704	85608	90845	96448	02453	08903	15845			36	
25	80783	85692	90935	96544	02557	09014	15965			35	
26	80862	85777	91026	96641	02661	09126	16085			34	
27	80942	85861	91116	96738	02765	09238	16206			33	
28	81021	85946	91207	96835	02869	09350	16326			32	
29	81101	86031	91297	96932	02973	09462	16447			31	
30	81180	86116	91388	97029	03077	09574	16568			30	
31	1.81260	1.86201	1.91479	1.97127	2.03182	2.09686	2.16680			29	
32	81340	86286	91570	97224	03286	09799	16810			28	
33	81419	86371	91661	97322	03391	09911	16932			27	
34	81499	86457	91752	97420	03496	10024	17053			26	
35	81579	86542	91844	97517	03601	10137	17175			25	
36	81659	86627	91935	97615	03706	10250	17297			24	
37	81740	86713	92027	97713	03811	10363	17419			23	
38	81820	86799	92118	97811	03916	10477	17541			22	
39	81900	86885	92210	97910	04022	10590	17663			21	
40	81981	86970	92302	98008	04128	10704	17786			20	
41	1.82061	1.87056	1.92394	1.98107	2.04283	2.10817	2.17909			19	
42	82142	87142	92486	98205	04339	10931	18031			18	
43	82222	87229	92578	98304	04445	11045	18154			17	
44	82303	87315	92670	98403	04551	11159	18277			16	
45	82384	87401	92762	98502	04658	11274	18401			15	
46	82465	87488	92855	98601	04764	11388	18524			14	
47	82546	87574	92947	98700	04870	11503	18648			13	
48	82627	87661	93040	98799	04977	11617	18772			12	
49	82709	87748	93133	98899	05084	11732	18895			11	
50	82790	87834	93226	98998	05191	11847	19019			10	
51	1.82871	1.87921	1.93319	1.99098	2.05298	2.11963	2.19144			9	
52	82953	88008	93412	99198	05405	12078	19268			8	
53	83034	88095	93505	99298	05512	12193	19393			7	
54	83116	88183	93598	99398	05619	12309	19517			6	
55	83198	88270	93692	99498	05727	12425	19642			5	
56	83280	88357	93785	99598	05835	12540	19767			4	
57	83362	88445	93879	99698	05942	12657	19892			3	
58	83444	88532	93973	99799	06050	12773	20018			2	
59	83526	88620	94066	99899	06158	12889	20143			1	
60	83608	88708	94160	2.00000	06267	13005	20269			0	
		33°	32°	31°	30°	29°	28°	27°			
		COSECANTS.									

	SECANTS.							
	63°	64°	65°	66°	67°	68°	69°	
0	2.20269	2.28117	2.36620	2.45859	2.55930	2.66947	2.79043	60
1	20395	28253	36768	46020	56106	67139	79254	59
2	20521	28390	36916	46181	56282	67382	79466	58
3	20647	28526	37064	46342	56458	67525	79679	57
4	20773	28663	37212	46504	56634	67718	79891	56
5	20900	28800	37361	46665	56811	67911	80104	55
6	21026	28937	37509	46827	56988	68105	80318	54
7	21153	29074	37658	46989	57165	68299	80531	53
8	21280	29211	37808	47152	57342	68494	80746	52
9	21407	29349	37957	47314	57520	68689	80960	51
10	21535	29487	38107	47477	57698	68884	81175	50
11	2.21662	2.29625	2.38256	2.47640	2.57876	2.69079	2.81390	49
12	21790	29763	38406	47804	58054	69275	81605	48
13	21918	29901	38556	47967	58233	69471	81821	47
14	22045	30040	38707	48131	58412	69667	82037	46
15	22172	30179	38857	48295	58591	69864	82254	45
16	22300	30318	39008	48459	58771	70061	82471	44
17	22428	30457	39159	48624	58950	70258	82688	43
18	22556	30596	39311	48789	59130	70455	82906	42
19	22684	30735	39462	48954	59311	70653	83124	41
20	22812	30875	39614	49119	59491	70851	83342	40
21	2.22940	2.31015	2.39766	2.49284	2.59672	2.71050	2.83561	39
22	23075	31155	39918	49350	59853	71249	83780	38
23	23205	31295	40070	49516	60035	71448	83999	37
24	23334	31436	40222	49682	60217	71647	84219	36
25	23464	31576	40375	49848	60399	71847	84439	35
26	23594	31717	40528	50115	60581	72047	84659	34
27	23724	31858	40681	50282	60763	72247	84880	33
28	23855	31999	40835	50449	60946	72448	85102	32
29	23985	32140	40988	50617	61129	72649	85323	31
30	24116	32282	41142	50784	61313	72850	85545	30
31	2.24247	2.32424	2.41296	2.50952	2.61496	2.73052	2.85767	29
32	24378	32566	41450	51120	61680	73254	85990	28
33	24509	32708	41605	51289	61864	73456	86213	27
34	24640	32850	41760	51457	62049	73659	86437	26
35	24772	32993	41914	51626	62234	73862	86661	25
36	24903	33135	42070	51795	62419	74065	86885	24
37	25035	33278	42225	51965	62604	74269	87109	23
38	25167	33422	42380	52134	62790	74473	87334	22
39	25300	33565	42536	52304	62976	74677	87560	21
40	25432	33708	42692	52474	63162	74881	87785	20
41	2.25565	2.33852	2.42848	2.52645	2.63348	2.75086	2.88011	19
42	25607	33996	43005	52815	63535	75292	88238	18
43	25830	34140	43162	52986	63722	75497	88465	17
44	25963	34284	43318	53157	63909	75703	88692	16
45	26097	34429	43476	53329	64097	75909	88920	15
46	26230	34573	43633	53500	64285	76116	89148	14
47	26364	34718	43790	53672	64473	76323	89376	13
48	26498	34863	43948	53845	64662	76530	89605	12
49	26632	35009	44106	54017	64851	76737	89834	11
50	26766	35154	44264	54190	65040	76945	90063	10
51	2.26900	2.35300	2.44423	2.54363	2.65229	2.77154	2.90293	9
52	27035	35446	44582	54536	65419	77362	90524	8
53	27169	35592	44741	54709	65609	77571	90754	7
54	27304	35738	44900	54883	65799	77780	90986	6
55	27439	35885	45059	55057	65989	77990	91217	5
56	27574	36031	45219	55231	66180	78200	91449	4
57	27710	36178	45378	55405	66371	78410	91681	3
58	27845	36325	45539	55580	66563	78621	91914	2
59	27981	36473	45699	55755	66755	78832	92147	1
60	28117	36620	45859	55930	66947	79043	92380	0
	26°	25°	24°	23°	22°	21°	20°	
	COSECANTS.							

		SECANTS.							
		70°	71°	72°	73°	74°	75°	76°	
0	2.92880	3.07155	3.23607	3.42090	3.62796	3.86970	4.13357	60	
1	92614	07415	23897	42856	63164	86790	13839	59	
2	92849	07675	24187	42683	63533	87211	14323	58	
3	93083	07936	24478	42010	63903	87633	14809	57	
4	93318	08197	24770	43337	64274	88056	15295	56	
5	93554	08459	25062	43666	64645	88479	15782	55	
6	93790	08721	25355	43995	65018	88904	16271	54	
7	94026	08983	25648	44324	65391	89330	16761	53	
8	94263	09246	25942	44655	65765	89756	17252	52	
9	94500	09510	26237	44986	66140	90181	17744	51	
10	94737	09774	26531	45317	66515	90603	18238	50	
11	2.94975	3.10088	3.26827	3.45650	3.66892	3.9142	4.18733	49	
12	95213	10303	27123	45983	67269	91473	19228	48	
13	95452	10568	27420	46316	67647	91904	19725	47	
14	95691	10834	27717	46651	68025	92337	20224	46	
15	95931	11101	28015	46989	68405	92770	20723	45	
16	96171	11367	28313	47321	68785	93204	21224	44	
17	96411	11635	28612	47658	69167	93640	21726	43	
18	96652	11903	28912	47995	69549	94076	22229	42	
19	96893	12171	29212	48333	69931	94514	22734	41	
20	97135	12440	29512	48671	70315	94952	23239	40	
21	2.97377	3.12709	3.29814	3.49010	3.70700	3.95392	4.23746	39	
22	97619	12979	30115	49350	71085	95832	24255	38	
23	97862	13249	30418	49691	71471	96274	24764	37	
24	98106	13520	30721	50032	71858	96716	25275	36	
25	98349	13791	31024	50374	72246	97160	25787	35	
26	98594	14063	31328	50716	72635	97604	26300	34	
27	98838	14335	31633	51060	73024	98050	26814	33	
28	99083	14608	31939	51404	73414	98497	27330	32	
29	99329	14881	32244	51748	73806	98944	27847	31	
30	99574	15155	32551	52094	74198	99393	28366	30	
31	2.99821	3.15429	3.32858	3.52440	3.74591	3.99843	4.28885	29	
32	3.00067	15704	33166	52787	74984	4.00293	29406	28	
33	00315	15979	33474	53134	75379	00745	29929	27	
34	00562	16255	33783	53482	75775	01198	30452	26	
35	00810	16531	34092	53831	76171	01652	30977	25	
36	01059	16808	34403	54181	76568	02107	31503	24	
37	01308	17085	34713	54531	76966	02563	32031	23	
38	01557	17363	35025	54883	77365	03020	32560	22	
39	01807	17641	35336	55235	77765	03479	33090	21	
40	02057	17920	35649	55587	78166	03938	33622	20	
41	3.02308	3.18199	3.35962	3.55940	3.78568	4.04398	4.34154	19	
42	02559	18479	36276	56294	78970	04860	34689	18	
43	02810	18759	36590	56649	79374	05322	35224	17	
44	03062	19040	36905	57005	79778	05786	35761	16	
45	03315	19322	37221	57361	80183	06251	36299	15	
46	03568	19604	37537	57718	80589	06717	36839	14	
47	03821	19886	37854	58076	80996	07184	37380	13	
48	04075	20169	38171	58434	81404	07652	37923	12	
49	04329	20453	38489	58794	81813	08121	38466	11	
50	04584	20737	38808	59154	82223	08591	39012	10	
51	3.04839	3.21021	3.39128	3.59514	3.82638	4.09068	4.39558	9	
52	05094	21306	39448	59876	82645	09035	40106	8	
53	05350	21592	39768	60238	83057	09500	40656	7	
54	05607	21878	40089	60601	83471	09967	41206	6	
55	05864	22165	40411	60965	83885	10434	41759	5	
56	06121	22452	40734	61330	84300	10901	42312	4	
57	06379	22740	41057	61695	84716	11368	42867	3	
58	06637	23028	41381	62061	85133	11836	43424	2	
59	06896	23317	41705	62428	85551	12305	43982	1	
60	07155	23607	42030	62796	85970	12775	44541	0	
	19°	18°	17°	16°	15°	14°	13°		
COSECANTS.									

		SECANTS.								
		77°	78°	79°	80°	81°	82°	83°		
0	4.44541	4.80973	5.24084	5.75877	6.39245	7.18530	8.20551		60	
1	45102	81683	24870	76829	40422	20020	22500		59	
2	45684	82294	25658	77794	41602	21517	24457		58	
3	46228	82956	26448	78742	42787	23019	26425		57	
4	46798	83621	27241	79703	43977	24529	28402		56	
5	47360	84288	28036	80667	45171	26044	30388		55	
6	47928	84956	28833	81635	46309	27566	32384		54	
7	48498	85627	29634	82606	47572	29095	34390		53	
8	49069	86299	30436	83581	48779	30630	36405		52	
9	49642	86973	31241	84558	49991	32171	38431		51	
10	50216	87649	32049	85539	51208	33719	40466		50	
11	4.50791	4.88327	5.32859	5.86524	6.52429	7.35274	8.42511		49	
12	51368	89007	32871	87511	52655	35285	44566		48	
13	51947	89649	33486	88502	54886	35403	46632		47	
14	52527	90373	35304	89497	56121	39978	48707		46	
15	53109	91058	36124	90495	57361	41560	50793		45	
16	53692	91746	36947	91496	58606	43148	52880		44	
17	54277	92436	37772	92501	59855	44743	54996		43	
18	54863	93128	38600	93509	61110	46346	57113		42	
19	55451	93821	39430	94521	62369	47955	59241		41	
20	56041	94517	40263	95536	63633	49571	61379		40	
21	4.56632	4.95215	5.41099	5.96555	6.64902	7.51194	8.63578		39	
22	57224	95914	41937	97577	66176	52825	65688		38	
23	57819	96616	42778	98603	67454	54462	67859		37	
24	58414	97320	43622	99633	68738	56107	70041		36	
25	59012	98025	44468	6.00666	70027	57759	72234		35	
26	59611	98733	45317	01708	71321	59418	74438		34	
27	60211	99443	46169	02748	72620	61085	76653		33	
28	60813	5.00155	47023	03787	73924	62759	78880		32	
29	61417	00809	47881	04834	75233	64441	81118		31	
30	62023	01535	48740	05886	76547	66180	83367		30	
31	4.62630	5.02303	5.49603	6.06941	6.77866	7.67896	8.85628		29	
32	63238	03024	50468	08000	79191	69580	87901		28	
33	63849	03746	51337	09062	80521	71242	90126		27	
34	64461	04471	52208	10129	81856	72962	92482		26	
35	65074	05197	53081	11199	83196	74689	94791		25	
36	65690	05926	53958	12273	84542	76424	97111		24	
37	66307	06657	54837	13350	85893	78167	99444		23	
38	66925	07390	55720	14432	87250	79918	9.01788		22	
39	67545	08125	56605	15517	88612	81677	04146		21	
40	68167	08863	57493	16607	89979	83443	06515		20	
41	4.68791	5.09602	5.58383	6.17700	6.91352	7.85218	9.06897		19	
42	69417	10344	59277	18797	92731	87001	11292		18	
43	70044	11088	60174	19898	94115	88792	13699		17	
44	70673	11835	61073	21004	95505	90592	16120		16	
45	71303	12582	61976	22113	96900	92400	18558		15	
46	71935	13334	62881	23226	98301	94216	20999		14	
47	72569	14097	63790	24343	99708	96040	23459		13	
48	73205	14842	64701	25464	7.01120	97873	25931		12	
49	73843	15599	65616	26590	02538	99714	28417		11	
50	74482	16359	66533	27719	03962	8.01566	30917		10	
51	4.75123	5.17121	5.67454	6.28853	7.05392	8.09428	9.33430		9	
52	75766	17880	68377	29901	06828	05291	35467		8	
53	76411	18652	69304	31193	08269	07167	38497		7	
54	77067	19421	70234	32579	09717	09052	41052		6	
55	77705	20193	71166	33949	11171	10946	43680		5	
56	78355	20966	72102	34584	12630	12849	46303		4	
57	79007	21742	73041	35743	14066	14760	48900		3	
58	79661	22521	73983	36906	15568	16681	51411		2	
59	80316	23301	74929	38073	17046	18612	54037		1	
60	80973	24084	75877	39245	18530	20551	56677		0	
		12°	11°	10°	9°	8°	7°	6°		
		COSECANTS.								

		SECANTS.						
		84°	85°	86°	87°	88°	89°	
0	9.56677	11.47371	14.33559	19.10732	28.65371	57.29869	60	
1	59332	51199	39547	21397	89440	58.26976	59	
2	62002	55052	45586	32182	29.13917	59.27431	58	
3	64687	58932	51676	43088	38812	60.31411	57	
4	67387	62837	57817	54119	64137	61.39105	56	
5	70108	66769	64011	65275	89903	62.50715	55	
6	72833	70728	70258	76560	30.16120	63.66460	54	
7	75579	74714	76558	87976	42802	64.86572	53	
8	78341	78727	82913	99524	69960	66.11304	52	
9	81119	82768	89323	20.11308	97607	67.40927	51	
10	83912	86837	95788	23028	31.25758	68.75736	50	
11	0.86722	11.90934	15.02310	20.31089	31.54425	70.16047	49	
12	89547	95060	08890	47093	83623	71.62207	48	
13	92389	99214	15527	59341	32.13366	73.14583	47	
14	95248	12.08397	22223	71737	43671	74.73586	46	
15	98122	07610	28979	84283	74554	76.39655	45	
16	10.01015	11852	35705	96982	33.06090	78.13274	44	
17	03923	16125	42672	21.09838	38118	79.91968	43	
18	06849	20427	49611	22852	70835	81.85315	42	
19	09722	24761	56614	36027	34.01199	83.84947	41	
20	12752	29125	63679	49368	38232	85.94561	40	
21	10.15730	12.33521	15.70810	21.62876	34.72952	88.14924	39	
22	18725	37018	78005	76555	35.08380	90.46886	38	
23	21739	42408	85288	90409	44539	92.91387	37	
24	24770	46900	92597	22.01440	81452	95.49471	36	
25	27819	51424	99995	18653	36.19141	98.22303	35	
26	30887	55982	16.07402	33050	57633	101.11185	34	
27	33973	60572	14909	47635	96953	104.17574	33	
28	37077	65197	22607	62413	37.37127	107.48111	32	
29	40201	69856	30287	77386	78185	110.89656	31	
30	43343	74550	38041	92559	38.20155	114.59301	30	
31	10.46505	12.79278	16.45869	23.07935	38.63068	118.54440	29	
32	49685	84042	53772	23520	39.06957	122.77808	28	
33	52886	88841	61751	39316	51855	127.32526	27	
34	56106	93677	69808	55329	97797	132.22229	26	
35	59346	98519	77944	71563	40.44820	137.51108	25	
36	62605	13.03458	86159	88022	92963	142.24061	24	
37	65885	08404	94456	24.04712	41.42226	149.46837	23	
38	69186	13358	17.02835	21637	92772	156.26228	22	
39	72507	18411	11297	38802	42.44525	163.70325	21	
40	75849	23472	19843	56212	97571	171.88831	20	
41	10.79212	13.28572	17.28476	24.73873	43.51961	180.92496	19	
42	82596	33712	37196	91790	44.07746	190.98680	18	
43	86001	38891	46005	25.09969	64980	202.22122	17	
44	89428	44112	54903	28414	45.23720	214.85995	16	
45	92877	49373	63893	47134	84026	229.18385	15	
46	96348	54676	72975	66132	46.45963	245.55402	14	
47	99841	60021	82152	85417	47.05966	264.44269	13	
48	11.03356	65408	91424	26.04994	74997	286.47948	12	
49	06594	70838	18.09794	24869	48.42241	312.52297	11	
50	10455	76312	10262	45051	49.11406	343.77516	10	
51	11.14089	13.81829	18.19830	26.65546	49.82576	381.97230	9	
52	17646	87391	29501	86360	50.55840	429.71873	8	
53	21277	92999	39274	27.07503	51.31290	491.10702	7	
54	24932	98051	49153	28981	52.09027	572.95800	6	
55	28610	14.04350	59139	50804	89156	687.54960	5	
56	32313	10096	69233	72978	53.71790	859.43689	4	
57	36040	15889	79438	95513	54.57046	1145.9157	3	
58	39792	21730	89755	28.18417	55.45053	1718.8785	2	
59	43569	27620	10.00185	41700	56.35946	3437.7468	1	
60	47371	33559	10732	65371	57.29869	∞	0	
		5°	4°	3°	2°	1°	0°	
		COSECANTS.						

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	0°		1°		2°		3°		
'	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	'
0	.00000	.00000	.00015	.00015	.00061	.00061	.00137	.00137	0
1	.00000	.00000	.00016	.00016	.00062	.00062	.00139	.00139	1
2	.00000	.00000	.00016	.00016	.00063	.00063	.00140	.00140	2
3	.00000	.00000	.00017	.00017	.00064	.00064	.00142	.00142	3
4	.00000	.00000	.00017	.00017	.00065	.00065	.00143	.00143	4
5	.00000	.00000	.00018	.00018	.00066	.00066	.00145	.00145	5
6	.00000	.00000	.00018	.00018	.00067	.00067	.00146	.00146	6
7	.00000	.00000	.00019	.00019	.00068	.00068	.00148	.00148	7
8	.00000	.00000	.00020	.00020	.00069	.00069	.00150	.00150	8
9	.00000	.00000	.00020	.00020	.00070	.00070	.00151	.00151	9
10	.00000	.00000	.00021	.00021	.00071	.00072	.00153	.00153	10
11	.00001	.00001	.00021	.00021	.00073	.00073	.00154	.00155	11
12	.00001	.00001	.00022	.00022	.00074	.00074	.00156	.00156	12
13	.00001	.00001	.00023	.00023	.00075	.00075	.00158	.00158	13
14	.00001	.00001	.00023	.00023	.00076	.00076	.00159	.00159	14
15	.00001	.00001	.00024	.00024	.00077	.00077	.00161	.00161	15
16	.00001	.00001	.00024	.00024	.00078	.00078	.00162	.00163	16
17	.00001	.00001	.00025	.00025	.00079	.00079	.00164	.00164	17
18	.00001	.00001	.00026	.00026	.00081	.00081	.00166	.00166	18
19	.00002	.00002	.00026	.00026	.00082	.00082	.00168	.00168	19
20	.00002	.00002	.00027	.00027	.00083	.00083	.00169	.00169	20
21	.00002	.00002	.00028	.00028	.00084	.00084	.00171	.00171	21
22	.00002	.00002	.00028	.00028	.00085	.00085	.00173	.00173	22
23	.00002	.00002	.00029	.00029	.00087	.00087	.00174	.00175	23
24	.00002	.00002	.00030	.00030	.00088	.00088	.00176	.00176	24
25	.00003	.00003	.00031	.00031	.00089	.00089	.00177	.00178	25
26	.00003	.00003	.00031	.00031	.00090	.00090	.00179	.00180	26
27	.00003	.00003	.00032	.00032	.00091	.00091	.00181	.00182	27
28	.00003	.00003	.00033	.00033	.00093	.00093	.00183	.00183	28
29	.00004	.00004	.00034	.00034	.00094	.00094	.00185	.00185	29
30	.00004	.00004	.00034	.00034	.00095	.00095	.00187	.00187	30
31	.00004	.00004	.00035	.00035	.00096	.00096	.00188	.00189	31
32	.00004	.00004	.00036	.00036	.00098	.00098	.00190	.00190	32
33	.00005	.00005	.00037	.00037	.00099	.00099	.00192	.00192	33
34	.00005	.00005	.00037	.00037	.00100	.00100	.00194	.00194	34
35	.00005	.00005	.00038	.00038	.00102	.00102	.00196	.00196	35
36	.00005	.00005	.00039	.00039	.00103	.00103	.00197	.00198	36
37	.00006	.00006	.00040	.00040	.00104	.00104	.00199	.00200	37
38	.00006	.00006	.00041	.00041	.00106	.00106	.00201	.00201	38
39	.00006	.00006	.00041	.00041	.00107	.00107	.00203	.00203	39
40	.00007	.00007	.00042	.00042	.00108	.00108	.00205	.00205	40
41	.00007	.00007	.00043	.00043	.00110	.00110	.00207	.00207	41
42	.00007	.00007	.00044	.00044	.00111	.00111	.00208	.00209	42
43	.00008	.00008	.00045	.00045	.00112	.00113	.00210	.00211	43
44	.00008	.00008	.00046	.00046	.00114	.00114	.00212	.00213	44
45	.00009	.00009	.00047	.00047	.00115	.00115	.00214	.00215	45
46	.00009	.00009	.00048	.00048	.00117	.00117	.00216	.00216	46
47	.00009	.00009	.00048	.00048	.00118	.00118	.00218	.00218	47
48	.00010	.00010	.00049	.00049	.00119	.00120	.00220	.00220	48
49	.00010	.00010	.00050	.00050	.00121	.00121	.00222	.00222	49
50	.00011	.00011	.00051	.00051	.00122	.00122	.00224	.00224	50
51	.00011	.00011	.00052	.00052	.00124	.00124	.00226	.00226	51
52	.00011	.00011	.00053	.00053	.00125	.00125	.00228	.00228	52
53	.00012	.00012	.00054	.00054	.00127	.00127	.00230	.00230	53
54	.00012	.00012	.00055	.00055	.00128	.00128	.00232	.00232	54
55	.00013	.00013	.00056	.00056	.00130	.00130	.00234	.00234	55
56	.00013	.00013	.00057	.00057	.00131	.00131	.00236	.00236	56
57	.00014	.00014	.00058	.00058	.00133	.00133	.00238	.00238	57
58	.00014	.00014	.00059	.00059	.00134	.00134	.00240	.00240	58
59	.00015	.00015	.00060	.00060	.00136	.00136	.00242	.00242	59
60	.00015	.00015	.00061	.00061	.00137	.00137	.00244	.00244	60

NATURAL VERSED SINES AND EXTERNAL SEC. 277

	4°			5°			6°			7°			
'	Ver.	Ex. sec.	Ver.	Ex. sec.	Ver.	Ex. sec.	Ver.	Ex. sec.	Ver.	Ex. sec.	Ver.	Ex. sec.	'
0	.00244	.00244	.00381	.00382	.00548	.00551	.00745	.00751					0
1	.00246	.00246	.00383	.00385	.00551	.00554	.00749	.00755					1
2	.00248	.00248	.00386	.00387	.00554	.00557	.00752	.00758					2
3	.00250	.00250	.00388	.00390	.00557	.00560	.00756	.00762					3
4	.00252	.00252	.00391	.00392	.00560	.00563	.00760	.00765					4
5	.00254	.00254	.00393	.00395	.00563	.00566	.00763	.00769					5
6	.00256	.00257	.00396	.00397	.00566	.00569	.00767	.00773					6
7	.00258	.00259	.00398	.00400	.00569	.00573	.00770	.00776					7
8	.00260	.00261	.00401	.00403	.00572	.00576	.00774	.00780					8
9	.00262	.00263	.00404	.00405	.00576	.00579	.00778	.00784					9
10	.00264	.00265	.00406	.00408	.00579	.00582	.00781	.00787					10
11	.00266	.00267	.00409	.00411	.00582	.00585	.00785	.00791					11
12	.00269	.00269	.00412	.00413	.00585	.00588	.00789	.00795					12
13	.00271	.00271	.00414	.00416	.00588	.00592	.00792	.00799					13
14	.00273	.00274	.00417	.00419	.00591	.00595	.00796	.00802					14
15	.00275	.00276	.00420	.00421	.00594	.00598	.00800	.00806					15
16	.00277	.00278	.00422	.00424	.00598	.00601	.00803	.00810					16
17	.00279	.00280	.00425	.00427	.00601	.00604	.00807	.00813					17
18	.00281	.00282	.00428	.00429	.00604	.00608	.00811	.00817					18
19	.00284	.00284	.00430	.00432	.00607	.00611	.00814	.00821					19
20	.00286	.00287	.00433	.00435	.00610	.00614	.00818	.00825					20
21	.00288	.00289	.00436	.00438	.00614	.00617	.00822	.00828					21
22	.00290	.00291	.00438	.00440	.00617	.00621	.00825	.00832					22
23	.00293	.00293	.00441	.00443	.00620	.00624	.00829	.00836					23
24	.00295	.00296	.00444	.00446	.00623	.00627	.00833	.00840					24
25	.00297	.00298	.00447	.00449	.00626	.00630	.00837	.00844					25
26	.00299	.00300	.00449	.00451	.00630	.00634	.00840	.00848					26
27	.00301	.00302	.00452	.00454	.00633	.00637	.00844	.00851					27
28	.00304	.00305	.00455	.00457	.00636	.00640	.00848	.00855					28
29	.00306	.00307	.00458	.00460	.00640	.00644	.00852	.00859					29
30	.00308	.00309	.00460	.00463	.00643	.00647	.00856	.00863					30
31	.00311	.00312	.00463	.00465	.00646	.00650	.00859	.00867					31
32	.00313	.00314	.00466	.00468	.00649	.00654	.00863	.00871					32
33	.00315	.00316	.00469	.00471	.00653	.00657	.00867	.00875					33
34	.00317	.00318	.00472	.00474	.00656	.00660	.00871	.00878					34
35	.00320	.00321	.00474	.00477	.00659	.00664	.00875	.00882					35
36	.00322	.00323	.00477	.00480	.00663	.00667	.00878	.00886					36
37	.00324	.00326	.00480	.00482	.00666	.00671	.00882	.00890					37
38	.00327	.00328	.00483	.00485	.00669	.00674	.00886	.00894					38
39	.00329	.00330	.00486	.00488	.00673	.00677	.00890	.00898					39
40	.00332	.00333	.00489	.00491	.00676	.00681	.00894	.00902					40
41	.00334	.00335	.00492	.00494	.00680	.00684	.00898	.00906					41
42	.00336	.00337	.00494	.00497	.00683	.00688	.00902	.00910					42
43	.00339	.00340	.00497	.00500	.00686	.00691	.00906	.00914					43
44	.00341	.00342	.00500	.00503	.00690	.00695	.00909	.00918					44
45	.00343	.00345	.00503	.00506	.00693	.00698	.00913	.00922					45
46	.00346	.00347	.00506	.00509	.00697	.00701	.00917	.00926					46
47	.00348	.00350	.00509	.00512	.00700	.00705	.00921	.00930					47
48	.00351	.00352	.00512	.00515	.00703	.00708	.00925	.00934					48
49	.00353	.00354	.00515	.00518	.00707	.00712	.00929	.00938					49
50	.00356	.00357	.00518	.00521	.00710	.00715	.00933	.00942					50
51	.00358	.00359	.00521	.00524	.00714	.00719	.00937	.00946					51
52	.00361	.00362	.00524	.00527	.00717	.00722	.00941	.00950					52
53	.00363	.00364	.00527	.00530	.00721	.00726	.00945	.00954					53
54	.00365	.00367	.00530	.00533	.00724	.00730	.00949	.00958					54
55	.00368	.00369	.00533	.00536	.00728	.00733	.00953	.00962					55
56	.00370	.00372	.00536	.00539	.00731	.00737	.00957	.00966					56
57	.00373	.00374	.00539	.00542	.00735	.00740	.00961	.00970					57
58	.00375	.00377	.00542	.00545	.00738	.00744	.00965	.00975					58
59	.00378	.00379	.00545	.00548	.00742	.00747	.00969	.00979					59
60	.00381	.00382	.00548	.00551	.00745	.00751	.00973	.00983					60



## 278 NATURAL VERSED SINES AND EXTERNAL SEC.

8°

9°

10°

11°

	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	
0	.00973	.00983	.01231	.01247	.01519	.01543	.01837	.01872	0
1	.00977	.00987	.01236	.01251	.01524	.01548	.01843	.01877	1
2	.00981	.00991	.01240	.01256	.01529	.01553	.01848	.01883	2
3	.00985	.00995	.01245	.01261	.01534	.01558	.01854	.01889	3
4	.00989	.00999	.01249	.01265	.01540	.01564	.01860	.01895	4
5	.00994	.01004	.01254	.01270	.01545	.01569	.01865	.01901	5
6	.00998	.01008	.01259	.01275	.01550	.01574	.01871	.01906	6
7	.01002	.01012	.01263	.01279	.01555	.01579	.01876	.01912	7
8	.01006	.01016	.01268	.01284	.01560	.01585	.01882	.01918	8
9	.01010	.01020	.01272	.01289	.01565	.01590	.01888	.01924	9
10	.01014	.01024	.01277	.01294	.01570	.01595	.01893	.01930	10
11	.01018	.01029	.01282	.01298	.01575	.01601	.01899	.01936	11
12	.01022	.01033	.01286	.01303	.01580	.01606	.01904	.01941	12
13	.01027	.01037	.01291	.01308	.01586	.01611	.01910	.01947	13
14	.01031	.01041	.01296	.01313	.01591	.01616	.01916	.01953	14
15	.01035	.01046	.01300	.01318	.01596	.01622	.01921	.01959	15
16	.01039	.01050	.01305	.01322	.01601	.01627	.01927	.01965	16
17	.01043	.01054	.01310	.01327	.01606	.01633	.01933	.01971	17
18	.01047	.01059	.01314	.01332	.01612	.01638	.01939	.01977	18
19	.01052	.01063	.01319	.01337	.01617	.01643	.01944	.01983	19
20	.01056	.01067	.01324	.01342	.01622	.01649	.01950	.01989	20
21	.01060	.01071	.01329	.01346	.01627	.01654	.01956	.01995	21
22	.01064	.01076	.01333	.01351	.01632	.01659	.01961	.02001	22
23	.01069	.01080	.01338	.01356	.01638	.01665	.01967	.02007	23
24	.01073	.01084	.01343	.01361	.01643	.01670	.01973	.02013	24
25	.01077	.01089	.01348	.01366	.01648	.01676	.01979	.02019	25
26	.01081	.01093	.01352	.01371	.01653	.01681	.01984	.02025	26
27	.01086	.01097	.01357	.01376	.01659	.01687	.01990	.02031	27
28	.01090	.01102	.01362	.01381	.01664	.01692	.01996	.02037	28
29	.01094	.01106	.01367	.01386	.01669	.01698	.02002	.02043	29
30	.01098	.01111	.01371	.01391	.01675	.01703	.02008	.02049	30
31	.01103	.01115	.01376	.01395	.01680	.01709	.02013	.02055	31
32	.01107	.01119	.01381	.01400	.01685	.01714	.02019	.02061	32
33	.01111	.01124	.01386	.01405	.01690	.01720	.02025	.02067	33
34	.01116	.01128	.01391	.01410	.01696	.01725	.02031	.02073	34
35	.01120	.01133	.01396	.01415	.01701	.01731	.02037	.02079	35
36	.01124	.01137	.01400	.01420	.01706	.01736	.02042	.02085	36
37	.01129	.01142	.01405	.01425	.01712	.01742	.02048	.02091	37
38	.01133	.01146	.01410	.01430	.01717	.01747	.02054	.02097	38
39	.01137	.01151	.01415	.01435	.01723	.01753	.02060	.02103	39
40	.01142	.01155	.01420	.01440	.01728	.01758	.02066	.02110	40
41	.01146	.01160	.01425	.01445	.01733	.01764	.02072	.02116	41
42	.01151	.01164	.01430	.01450	.01739	.01769	.02078	.02122	42
43	.01155	.01169	.01435	.01455	.01744	.01775	.02084	.02128	43
44	.01159	.01173	.01439	.01461	.01750	.01781	.02090	.02134	44
45	.01164	.01178	.01444	.01466	.01755	.01786	.02095	.02140	45
46	.01168	.01182	.01449	.01471	.01760	.01792	.02101	.02146	46
47	.01173	.01187	.01454	.01476	.01766	.01798	.02107	.02153	47
48	.01177	.01191	.01459	.01481	.01771	.01803	.02113	.02159	48
49	.01182	.01196	.01464	.01486	.01777	.01809	.02119	.02165	49
50	.01185	.01200	.01469	.01491	.01782	.01815	.02125	.02171	50
51	.01191	.01205	.01474	.01496	.01788	.01820	.02131	.02178	51
52	.01195	.01209	.01479	.01501	.01793	.01826	.02137	.02184	52
53	.01200	.01214	.01484	.01506	.01799	.01832	.02143	.02190	53
54	.01204	.01219	.01489	.01512	.01804	.01837	.02149	.02196	54
55	.01209	.01223	.01494	.01517	.01810	.01843	.02155	.02203	55
56	.01213	.01228	.01499	.01522	.01815	.01849	.02161	.02209	56
57	.01218	.01233	.01504	.01527	.01821	.01854	.02167	.02215	57
58	.01222	.01237	.01509	.01532	.01826	.01860	.02173	.02221	58
59	.01227	.01242	.01514	.01537	.01832	.01866	.02179	.02228	59
60	.01231	.01247	.01519	.01543	.01837	.01872	.02185	.02234	60

NATURAL VERSED SINES AND EXTERNAL SEC. 279

	12°		13°		14°		15°		
'	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	'
0	.02185	.02234	.02563	.02630	.02970	.03061	.03407	.03528	0
1	.02191	.02240	.02570	.02637	.02977	.03069	.03415	.03536	1
2	.02197	.02247	.02576	.02644	.02985	.03076	.03422	.03544	2
3	.02203	.02253	.02583	.02651	.02992	.03084	.03430	.03552	3
4	.02210	.02259	.02589	.02658	.02999	.03091	.03438	.03560	4
5	.02216	.02266	.02596	.02665	.03006	.03099	.03445	.03568	5
6	.02222	.02272	.02602	.02672	.03013	.03106	.03453	.03576	6
7	.02228	.02279	.02609	.02679	.03020	.03114	.03460	.03584	7
8	.02234	.02285	.02616	.02686	.03027	.03121	.03468	.03592	8
9	.02240	.02291	.02622	.02693	.03034	.03129	.03476	.03601	9
10	.02246	.02298	.02629	.02700	.03041	.03137	.03483	.03609	10
11	.02252	.02304	.02635	.02707	.03048	.03144	.03491	.03617	11
12	.02258	.02311	.02642	.02714	.03055	.03152	.03498	.03625	12
13	.02265	.02317	.02649	.02721	.03063	.03159	.03506	.03633	13
14	.02271	.02323	.02655	.02728	.03070	.03167	.03514	.03642	14
15	.02277	.02330	.02662	.02735	.03077	.03175	.03521	.03650	15
16	.02283	.02336	.02669	.02742	.03084	.03182	.03529	.03658	16
17	.02289	.02343	.02675	.02749	.03091	.03190	.03537	.03666	17
18	.02295	.02349	.02682	.02756	.03098	.03198	.03544	.03674	18
19	.02302	.02356	.02689	.02763	.03106	.03205	.03552	.03683	19
20	.02308	.02362	.02696	.02770	.03113	.03213	.03560	.03691	20
21	.02314	.02369	.02702	.02777	.03120	.03221	.03567	.03699	21
22	.02320	.02375	.02709	.02784	.03127	.03228	.03575	.03708	22
23	.02327	.02382	.02716	.02791	.03134	.03236	.03583	.03716	23
24	.02333	.02388	.02722	.02799	.03142	.03244	.03590	.03724	24
25	.02339	.02395	.02729	.02806	.03149	.03251	.03598	.03732	25
26	.02345	.02402	.02736	.02813	.03156	.03259	.03606	.03741	26
27	.02352	.02408	.02743	.02820	.03163	.03267	.03614	.03749	27
28	.02358	.02415	.02749	.02827	.03171	.03275	.03621	.03758	28
29	.02364	.02421	.02756	.02834	.03178	.03282	.03629	.03766	29
30	.02370	.02428	.02763	.02842	.03185	.03290	.03637	.03774	30
31	.02377	.02435	.02770	.02849	.03193	.03298	.03645	.03783	31
32	.02383	.02441	.02777	.02856	.03200	.03306	.03653	.03791	32
33	.02389	.02448	.02783	.02863	.03207	.03313	.03660	.03799	33
34	.02396	.02454	.02790	.02870	.03214	.03321	.03668	.03808	34
35	.02402	.02461	.02797	.02878	.03222	.03329	.03676	.03816	35
36	.02408	.02468	.02804	.02885	.03229	.03337	.03684	.03825	36
37	.02415	.02474	.02811	.02892	.03236	.03345	.03692	.03833	37
38	.02421	.02481	.02818	.02899	.03244	.03353	.03699	.03842	38
39	.02427	.02488	.02824	.02907	.03251	.03360	.03707	.03850	39
40	.02434	.02494	.02831	.02914	.03258	.03368	.03715	.03858	40
41	.02440	.02501	.02838	.02921	.03266	.03376	.03723	.03867	41
42	.02447	.02508	.02845	.02928	.03273	.03384	.03731	.03875	42
43	.02453	.02515	.02852	.02936	.03281	.03392	.03739	.03884	43
44	.02459	.02521	.02859	.02943	.03288	.03400	.03747	.03892	44
45	.02466	.02528	.02866	.02950	.03295	.03408	.03754	.03901	45
46	.02472	.02535	.02873	.02958	.03303	.03416	.03762	.03909	46
47	.02479	.02542	.02880	.02965	.03310	.03424	.03770	.03918	47
48	.02485	.02548	.02887	.02972	.03318	.03432	.03778	.03927	48
49	.02492	.02555	.02894	.02980	.03325	.03439	.03786	.03935	49
50	.02498	.02562	.02900	.02987	.03333	.03447	.03794	.03944	50
51	.02504	.02569	.02907	.02994	.03340	.03455	.03802	.03952	51
52	.02511	.02576	.02914	.03002	.03347	.03463	.03810	.03961	52
53	.02517	.02582	.02921	.03009	.03355	.03471	.03818	.03969	53
54	.02524	.02589	.02928	.03017	.03362	.03479	.03826	.03978	54
55	.02530	.02596	.02935	.03024	.03370	.03487	.03834	.03987	55
56	.02537	.02603	.02942	.03032	.03377	.03495	.03842	.03995	56
57	.02543	.02610	.02949	.03039	.03385	.03503	.03850	.04004	57
58	.02550	.02617	.02956	.03046	.03392	.03512	.03858	.04013	58
59	.02556	.02624	.02963	.03054	.03400	.03520	.03866	.04021	59
60	.02563	.02630	.02970	.03061	.03407	.03528	.03874	.04030	60

## 280 NATURAL VERSED SINES AND EXTERNAL SEC.

16°

17°

18°

19°

	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	
0	.03874	.04030	.04370	.04569	.04894	.05146	.05448	.05762	0
1	.03882	.04039	.04378	.04578	.04903	.05156	.05458	.05773	1
2	.03890	.04047	.04387	.04588	.04912	.05166	.05467	.05783	2
3	.03898	.04056	.04395	.04597	.04921	.05176	.05477	.05794	3
4	.03906	.04065	.04404	.04606	.04930	.05186	.05486	.05805	4
5	.03914	.04073	.04412	.04616	.04939	.05196	.05496	.05815	5
6	.03922	.04082	.04421	.04625	.04948	.05206	.05505	.05826	6
7	.03930	.04091	.04429	.04635	.04957	.05216	.05515	.05838	7
8	.03938	.04100	.04438	.04644	.04967	.05226	.05524	.05847	8
9	.03946	.04108	.04446	.04653	.04976	.05236	.05534	.05858	9
10	.03954	.04117	.04455	.04663	.04985	.05246	.05543	.05869	10
11	.03963	.04126	.04464	.04672	.04994	.05256	.05553	.05879	11
12	.03971	.04135	.04472	.04682	.05003	.05266	.05562	.05890	12
13	.03979	.04144	.04481	.04691	.05012	.05276	.05572	.05901	13
14	.03987	.04152	.04489	.04700	.05021	.05286	.05582	.05911	14
15	.03995	.04161	.04498	.04710	.05030	.05297	.05591	.05922	15
16	.04003	.04170	.04507	.04719	.05039	.05307	.05601	.05933	16
17	.04011	.04179	.04515	.04729	.05048	.05317	.05610	.05944	17
18	.04019	.04188	.04524	.04738	.05057	.05327	.05620	.05955	18
19	.04028	.04197	.04533	.04748	.05067	.05337	.05630	.05965	19
20	.04036	.04206	.04541	.04757	.05076	.05347	.05639	.05976	20
21	.04044	.04214	.04550	.04767	.05085	.05357	.05649	.05987	21
22	.04052	.04223	.04559	.04776	.05094	.05367	.05658	.05998	22
23	.04060	.04232	.04567	.04786	.05103	.05378	.05668	.06009	23
24	.04069	.04241	.04576	.04795	.05112	.05388	.05678	.06020	24
25	.04077	.04250	.04585	.04805	.05122	.05398	.05687	.06030	25
26	.04085	.04259	.04593	.04815	.05131	.05408	.05697	.06041	26
27	.04093	.04268	.04602	.04824	.05140	.05418	.05707	.06052	27
28	.04102	.04277	.04611	.04834	.05149	.05429	.05716	.06063	28
29	.04110	.04286	.04620	.04843	.05158	.05439	.05726	.06074	29
30	.04118	.04295	.04628	.04853	.05168	.05449	.05736	.06085	30
31	.04126	.04304	.04637	.04863	.05177	.05460	.05746	.06096	31
32	.04135	.04313	.04646	.04872	.05186	.05470	.05755	.06107	32
33	.04143	.04322	.04655	.04882	.05195	.05480	.05765	.06118	33
34	.04151	.04331	.04663	.04891	.05205	.05490	.05775	.06129	34
35	.04159	.04340	.04672	.04901	.05214	.05501	.05785	.06140	35
36	.04168	.04349	.04681	.04911	.05223	.05511	.05794	.06151	36
37	.04176	.04358	.04690	.04920	.05233	.05521	.05804	.06162	37
38	.04184	.04367	.04699	.04930	.05242	.05532	.05814	.06173	38
39	.04193	.04376	.04707	.04940	.05251	.05542	.05824	.06184	39
40	.04201	.04385	.04716	.04950	.05260	.05552	.05833	.06195	40
41	.04209	.04394	.04725	.04959	.05270	.05563	.05843	.06206	41
42	.04218	.04403	.04734	.04969	.05279	.05573	.05853	.06217	42
43	.04226	.04413	.04743	.04979	.05288	.05584	.05863	.06228	43
44	.04234	.04422	.04752	.04989	.05298	.05594	.05873	.06239	44
45	.04243	.04431	.04760	.04998	.05307	.05604	.05882	.06250	45
46	.04251	.04440	.04769	.05008	.05316	.05615	.05892	.06261	46
47	.04260	.04449	.04778	.05018	.05326	.05625	.05902	.06272	47
48	.04268	.04458	.04787	.05028	.05335	.05636	.05912	.06283	48
49	.04276	.04468	.04796	.05038	.05344	.05646	.05922	.06295	49
50	.04285	.04477	.04805	.05047	.05354	.05657	.05932	.06306	50
51	.04293	.04486	.04814	.05057	.05363	.05667	.05942	.06317	51
52	.04302	.04495	.04823	.05067	.05373	.05678	.05951	.06328	52
53	.04310	.04504	.04832	.05077	.05382	.05688	.05961	.06339	53
54	.04319	.04514	.04841	.05087	.05391	.05699	.05971	.06350	54
55	.04327	.04523	.04850	.05097	.05401	.05709	.05981	.06362	55
56	.04336	.04532	.04858	.05107	.05410	.05720	.05991	.06373	56
57	.04344	.04541	.04867	.05116	.05420	.05730	.06001	.06384	57
58	.04353	.04551	.04876	.05126	.05429	.05741	.06011	.06395	58
59	.04361	.04560	.04885	.05136	.05439	.05751	.06021	.06407	59
60	.04370	.04569	.04894	.05146	.05448	.05762	.06031	.06418	60

NATURAL VERSED SINES AND EXTERNAL SEC. 281

20°		21°		22°		23°		
Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	
.06031	.06418	.06642	.07115	.07282	.07853	.07950	.08636	0
.06041	.06429	.06652	.07126	.07293	.07866	.07961	.08649	1
.06051	.06440	.06663	.07138	.07303	.07879	.07972	.08663	2
.06061	.06452	.06673	.07150	.07314	.07892	.07984	.08676	3
.06071	.06463	.06684	.07162	.07325	.07904	.07995	.08690	4
.06081	.06474	.06694	.07174	.07336	.07917	.08006	.08703	5
.06091	.06486	.06705	.07186	.07347	.07930	.08018	.08717	6
.06101	.06497	.06715	.07199	.07358	.07943	.08029	.08730	7
.06111	.06508	.06726	.07211	.07369	.07955	.08041	.08744	8
.06121	.06520	.06736	.07223	.07380	.07968	.08052	.08757	9
.06131	.06531	.06747	.07235	.07391	.07981	.08064	.08771	10
.06141	.06542	.06757	.07247	.07402	.07994	.08075	.08784	11
.06151	.06554	.06768	.07259	.07413	.08006	.08086	.08798	12
.06161	.06565	.06778	.07271	.07424	.08019	.08098	.08811	13
.06171	.06577	.06789	.07283	.07435	.08032	.08109	.08825	14
.06181	.06588	.06799	.07295	.07446	.08045	.08121	.08839	15
.06191	.06600	.06810	.07307	.07457	.08058	.08132	.08852	16
.06201	.06611	.06820	.07320	.07468	.08071	.08144	.08866	17
.06211	.06622	.06831	.07332	.07479	.08084	.08155	.08880	18
.06221	.06634	.06841	.07344	.07490	.08097	.08167	.08893	19
.06231	.06645	.06852	.07356	.07501	.08109	.08178	.08907	20
.06241	.06657	.06863	.07368	.07512	.08122	.08190	.08921	21
.06252	.06668	.06873	.07380	.07523	.08135	.08201	.08934	22
.06262	.06680	.06884	.07393	.07534	.08148	.08213	.08948	23
.06272	.06691	.06894	.07405	.07545	.08161	.08225	.08962	24
.06282	.06703	.06905	.07417	.07556	.08174	.08236	.08975	25
.06292	.06715	.06916	.07429	.07568	.08087	.08248	.08989	26
.06302	.06726	.06926	.07442	.07579	.08200	.08259	.09003	27
.06312	.06738	.06937	.07454	.07590	.08213	.08271	.09017	28
.06323	.06749	.06948	.07466	.07601	.08226	.08282	.09030	29
.06333	.06761	.06958	.07479	.07612	.08239	.08294	.09044	30
.06343	.06773	.06969	.07491	.07623	.08252	.08306	.09058	31
.06353	.06784	.06980	.07503	.07634	.08265	.08317	.09072	32
.06363	.06796	.06990	.07516	.07645	.08278	.08329	.09086	33
.06374	.06807	.07001	.07528	.07657	.08291	.08340	.09099	34
.06384	.06819	.07012	.07540	.07668	.08305	.08352	.09113	35
.06394	.06831	.07022	.07553	.07679	.08318	.08364	.09127	36
.06404	.06843	.07033	.07565	.07690	.08331	.08375	.09141	37
.06415	.06854	.07044	.07578	.07701	.08344	.08387	.09155	38
.06425	.06866	.07055	.07590	.07713	.08357	.08399	.09169	39
.06435	.06878	.07065	.07602	.07724	.08370	.08410	.09183	40
.06445	.06889	.07076	.07615	.07735	.08383	.08422	.09197	41
.06456	.06901	.07087	.07627	.07746	.08397	.08434	.09211	42
.06466	.06913	.07098	.07640	.07757	.08410	.08445	.09224	43
.06476	.06925	.07108	.07652	.07769	.08423	.08457	.09238	44
.06486	.06936	.07119	.07665	.07780	.08436	.08469	.09252	45
.06497	.06948	.07130	.07677	.07791	.08449	.08481	.09266	46
.06507	.06960	.07141	.07690	.07802	.08463	.08492	.09280	47
.06517	.06972	.07151	.07702	.07814	.08476	.08504	.09294	48
.06528	.06984	.07162	.07715	.07825	.08489	.08516	.09308	49
.06538	.06995	.07173	.07727	.07836	.08503	.08528	.09323	50
.06548	.07007	.07184	.07740	.07848	.08516	.08539	.09337	51
.06559	.07019	.07195	.07752	.07859	.08529	.08551	.09351	52
.06569	.07031	.07206	.07765	.07870	.08542	.08563	.09365	53
.06580	.07043	.07216	.07778	.07881	.08556	.08575	.09379	54
.06590	.07055	.07227	.07790	.07893	.08569	.08586	.09393	55
.06600	.07067	.07238	.07803	.07904	.08582	.08598	.09407	56
.06611	.07079	.07249	.07816	.07915	.08596	.08610	.09421	57
.06621	.07091	.07260	.07828	.07927	.08609	.08622	.09435	58
.06632	.07103	.07271	.07841	.07938	.08623	.08634	.09449	59
.06642	.07115	.07282	.07853	.07950	.08636	.08645	.09464	60

282 NATURAL VERSED SINES AND EXTERNAL SEC.

	24°		25°		26°		27°		
'	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	'
0	.08645	.09464	.09369	.10338	.10121	.11260	.10899	.12233	0
1	.08657	.09478	.09382	.10353	.10133	.11276	.10913	.12244	1
2	.08669	.09492	.09394	.10368	.10146	.11292	.10926	.12266	2
3	.08681	.09506	.09406	.10383	.10159	.11308	.10939	.12283	3
4	.08693	.09520	.09418	.10398	.10172	.11323	.10952	.12299	4
5	.08705	.09535	.09431	.10413	.10184	.11339	.10965	.12316	5
6	.08717	.09549	.09443	.10428	.10197	.11355	.10979	.12333	6
7	.08728	.09563	.09455	.10443	.10210	.11371	.10992	.12349	7
8	.08740	.09577	.09468	.10458	.10223	.11387	.11005	.12366	8
9	.08752	.09592	.09480	.10473	.10236	.11403	.11019	.12383	9
10	.08764	.09606	.09493	.10488	.10248	.11419	.11032	.12400	10
11	.08776	.09620	.09505	.10503	.10261	.11435	.11045	.12416	11
12	.08788	.09635	.09517	.10518	.10274	.11451	.11058	.12433	12
13	.08800	.09649	.09530	.10533	.10287	.11467	.11072	.12450	13
14	.08812	.09663	.09542	.10549	.10300	.11483	.11085	.12467	14
15	.08824	.09678	.09554	.10564	.10313	.11499	.11098	.12484	15
16	.08836	.09692	.09567	.10579	.10326	.11515	.11112	.12501	16
17	.08848	.09707	.09579	.10594	.10338	.11531	.11125	.12518	17
18	.08860	.09721	.09592	.10609	.10351	.11547	.11138	.12534	18
19	.08872	.09735	.09604	.10625	.10364	.11563	.11152	.12551	19
20	.08884	.09750	.09617	.10640	.10377	.11579	.11165	.12568	20
21	.08896	.09764	.09629	.10655	.10390	.11595	.11178	.12585	21
22	.08908	.09779	.09642	.10670	.10403	.11611	.11192	.12602	22
23	.08920	.09793	.09654	.10686	.10416	.11627	.11205	.12619	23
24	.08932	.09808	.09666	.10701	.10429	.11643	.11218	.12636	24
25	.08944	.09822	.09679	.10716	.10442	.11659	.11232	.12653	25
26	.08956	.09837	.09691	.10731	.10455	.11675	.11245	.12670	26
27	.08968	.09851	.09704	.10747	.10468	.11691	.11259	.12687	27
28	.08980	.09866	.09716	.10762	.10481	.11708	.11272	.12704	28
29	.08992	.09880	.09729	.10777	.10494	.11724	.11285	.12721	29
30	.09004	.09895	.09741	.10793	.10507	.11740	.11299	.12738	30
31	.09016	.09909	.09754	.10808	.10520	.11756	.11312	.12755	31
32	.09028	.09924	.09767	.10824	.10533	.11772	.11326	.12772	32
33	.09040	.09939	.09779	.10839	.10546	.11789	.11339	.12789	33
34	.09052	.09953	.09792	.10854	.10559	.11805	.11353	.12807	34
35	.09064	.09968	.09804	.10870	.10572	.11821	.11366	.12824	35
36	.09076	.09982	.09817	.10885	.10585	.11838	.11380	.12841	36
37	.09089	.09997	.09829	.10901	.10598	.11854	.11393	.12858	37
38	.09101	.10012	.09842	.10916	.10611	.11870	.11407	.12875	38
39	.09113	.10026	.09854	.10932	.10624	.11886	.11420	.12892	39
40	.09125	.10041	.09867	.10947	.10637	.11903	.11434	.12910	40
41	.09137	.10055	.09880	.10963	.10650	.11919	.11447	.12927	41
42	.09149	.10071	.09892	.10978	.10663	.11936	.11461	.12944	42
43	.09161	.10085	.09905	.10994	.10676	.11952	.11474	.12961	43
44	.09174	.10100	.09918	.11009	.10689	.11968	.11488	.12979	44
45	.09186	.10115	.09930	.11025	.10702	.11985	.11501	.12996	45
46	.09198	.10130	.09943	.11041	.10715	.12001	.11515	.13013	46
47	.09210	.10144	.09955	.11056	.10728	.12018	.11528	.13031	47
48	.09222	.10159	.09968	.11072	.10741	.12034	.11542	.13048	48
49	.09234	.10174	.09981	.11087	.10755	.12051	.11555	.13065	49
50	.09247	.10189	.09993	.11103	.10768	.12067	.11569	.13083	50
51	.09259	.10204	.10006	.11119	.10781	.12084	.11583	.13100	51
52	.09271	.10218	.10019	.11134	.10794	.12100	.11596	.13117	52
53	.09283	.10233	.10032	.11150	.10807	.12117	.11610	.13135	53
54	.09296	.10248	.10044	.11166	.10820	.12133	.11623	.13152	54
55	.09308	.10263	.10057	.11181	.10833	.12150	.11637	.13170	55
56	.09320	.10278	.10070	.11197	.10847	.12166	.11651	.13187	56
57	.09332	.10293	.10082	.11213	.10860	.12183	.11664	.13205	57
58	.09345	.10308	.10095	.11229	.10873	.12199	.11678	.13222	58
59	.09357	.10323	.10108	.11244	.10886	.12216	.11692	.13240	59
60	.09369	.10338	.10121	.11260	.10899	.12233	.11705	.13257	60

NATURAL 'VERSED SINES AND EXTERNAL SEC. 283

28°

29°

30°

31°

	VERS.	EX. SEC.	VERS.	EX. SEC.	VERS.	EX. SEC.	VERS.	EX. SEC.	
0	.11705	.13257	.12538	.14335	.13397	.15470	.14283	.16663	0
1	.11719	.13275	.12552	.14354	.13412	.15489	.14298	.16684	1
2	.11733	.13292	.12566	.14372	.13427	.15509	.14313	.16704	2
3	.11746	.13310	.12580	.14391	.13441	.15528	.14328	.16725	3
4	.11760	.13327	.12595	.14409	.13456	.15548	.14343	.16745	4
5	.11774	.13345	.12609	.14428	.13470	.15567	.14358	.16766	5
6	.11787	.13362	.12623	.14446	.13485	.15587	.14373	.16786	6
7	.11801	.13380	.12637	.14465	.13499	.15606	.14388	.16806	7
8	.11815	.13398	.12651	.14483	.13514	.15626	.14403	.16827	8
9	.11828	.13415	.12665	.14502	.13529	.15645	.14418	.16848	9
10	.11842	.13433	.12679	.14521	.13543	.15665	.14433	.16868	10
11	.11856	.13451	.12694	.14539	.13558	.15684	.14449	.16889	11
12	.11870	.13468	.12708	.14558	.13573	.15704	.14464	.16909	12
13	.11883	.13486	.12722	.14576	.13587	.15724	.14479	.16930	13
14	.11897	.13504	.12736	.14595	.13602	.15743	.14494	.16950	14
15	.11911	.13521	.12750	.14614	.13616	.15763	.14509	.16971	15
16	.11925	.13539	.12765	.14632	.13631	.15782	.14524	.16992	16
17	.11938	.13557	.12779	.14651	.13646	.15802	.14539	.17012	17
18	.11952	.13575	.12793	.14670	.13660	.15822	.14554	.17033	18
19	.11966	.13593	.12807	.14689	.13675	.15841	.14569	.17054	19
20	.11980	.13610	.12822	.14707	.13690	.15861	.14584	.17075	20
21	.11994	.13628	.12836	.14726	.13705	.15881	.14599	.17095	21
22	.12007	.13646	.12850	.14745	.13719	.15901	.14615	.17116	22
23	.12021	.13664	.12864	.14764	.13734	.15920	.14630	.17137	23
24	.12035	.13682	.12879	.14782	.13749	.15940	.14645	.17158	24
25	.12049	.13700	.12893	.14801	.13763	.15960	.14660	.17178	25
26	.12063	.13718	.12907	.14820	.13778	.15980	.14675	.17199	26
27	.12077	.13735	.12921	.14839	.13793	.16000	.14690	.17220	27
28	.12091	.13753	.12936	.14858	.13808	.16019	.14706	.17241	28
29	.12104	.13771	.12950	.14877	.13822	.16039	.14721	.17262	29
30	.12118	.13789	.12964	.14896	.13837	.16059	.14736	.17283	30
31	.12132	.13807	.12979	.14914	.13852	.16079	.14751	.17304	31
32	.12146	.13825	.12993	.14933	.13867	.16099	.14766	.17325	32
33	.12160	.13843	.13007	.14952	.13881	.16119	.14782	.17346	33
34	.12174	.13861	.13022	.14971	.13896	.16139	.14797	.17367	34
35	.12188	.13879	.13036	.14990	.13911	.16159	.14812	.17388	35
36	.12202	.13897	.13051	.15009	.13926	.16179	.14827	.17409	36
37	.12216	.13916	.13065	.15028	.13941	.16199	.14843	.17430	37
38	.12230	.13934	.13079	.15047	.13955	.16219	.14858	.17451	38
39	.12244	.13952	.13094	.15066	.13970	.16239	.14873	.17472	39
40	.12257	.13970	.13108	.15085	.13985	.16259	.14888	.17493	40
41	.12271	.13988	.13122	.15103	.14000	.16279	.14904	.17514	41
42	.12285	.14006	.13137	.15124	.14015	.16299	.14919	.17535	42
43	.12299	.14024	.13151	.15143	.14030	.16319	.14934	.17556	43
44	.12313	.14042	.13166	.15162	.14044	.16339	.14949	.17577	44
45	.12327	.14061	.13180	.15181	.14059	.16359	.14965	.17598	45
46	.12341	.14079	.13195	.15200	.14074	.16380	.14980	.17620	46
47	.12355	.14097	.13209	.15219	.14089	.16400	.14995	.17641	47
48	.12369	.14115	.13223	.15239	.14104	.16420	.15011	.17662	48
49	.12383	.14134	.13238	.15258	.14119	.16440	.15026	.17683	49
50	.12397	.14152	.13252	.15277	.14134	.16460	.15041	.17704	50
51	.12411	.14170	.13267	.15296	.14149	.16481	.15057	.17725	51
52	.12425	.14188	.13281	.15315	.14164	.16501	.15072	.17747	52
53	.12439	.14207	.13296	.15335	.14179	.16521	.15087	.17768	53
54	.12454	.14225	.13310	.15354	.14194	.16541	.15103	.17790	54
55	.12468	.14243	.13325	.15373	.14208	.16562	.15118	.17811	55
56	.12482	.14262	.13339	.15393	.14223	.16582	.15134	.17832	56
57	.12496	.14280	.13354	.15412	.14238	.16602	.15149	.17854	57
58	.12510	.14299	.13368	.15431	.14253	.16623	.15164	.17875	58
59	.12524	.14317	.13383	.15451	.14268	.16643	.15180	.17896	59
60	.12538	.14335	.13397	.15470	.14283	.16663	.15195	.17918	60

## 286 NATURAL VERSED SINES AND EXTERNAL SEC.

	40°		41°		42°		43°		
'	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	'
0	.23396	.30541	.24529	.32501	.25686	.34563	.26865	.36733	0
1	.23414	.30573	.24548	.32535	.25705	.34599	.26884	.36770	1
2	.23432	.30605	.24567	.32568	.25724	.34634	.26904	.36807	2
3	.23452	.30636	.24586	.32602	.25744	.34669	.26924	.36844	3
4	.23470	.30668	.24605	.32636	.25763	.34704	.26944	.36881	4
5	.23489	.30700	.24625	.32669	.25783	.34740	.26964	.36919	5
6	.23508	.30732	.24644	.32703	.25802	.34775	.26984	.36956	6
7	.23527	.30764	.24663	.32737	.25822	.34811	.27004	.36993	7
8	.23545	.30796	.24682	.32770	.25841	.34846	.27024	.37030	8
9	.23564	.30829	.24701	.32804	.25861	.34882	.27043	.37068	9
10	.23583	.30861	.24720	.32838	.25880	.34917	.27063	.37105	10
11	.23602	.30893	.24739	.32872	.25900	.34953	.27083	.37143	11
12	.23620	.30925	.24759	.32905	.25920	.34988	.27103	.37180	12
13	.23639	.30957	.24778	.32939	.25939	.35024	.27123	.37218	13
14	.23658	.30989	.24797	.32973	.25959	.35060	.27143	.37255	14
15	.23677	.31022	.24816	.33007	.25978	.35095	.27163	.37293	15
16	.23696	.31054	.24835	.33041	.25998	.35131	.27183	.37330	16
17	.23714	.31086	.24854	.33075	.26017	.35167	.27203	.37368	17
18	.23733	.31119	.24874	.33109	.26037	.35203	.27223	.37406	18
19	.23752	.31151	.24893	.33143	.26056	.35238	.27243	.37443	19
20	.23771	.31183	.24912	.33177	.26076	.35274	.27263	.37481	20
21	.23790	.31216	.24931	.33211	.26096	.35310	.27283	.37519	21
22	.23808	.31248	.24950	.33245	.26115	.35346	.27303	.37556	22
23	.23827	.31281	.24970	.33279	.26135	.35382	.27323	.37594	23
24	.23846	.31313	.24989	.33314	.26154	.35418	.27343	.37632	24
25	.23865	.31346	.25008	.33348	.26174	.35454	.27363	.37670	25
26	.23884	.31378	.25027	.33382	.26194	.35490	.27383	.37708	26
27	.23903	.31411	.25047	.33416	.26213	.35526	.27403	.37746	27
28	.23922	.31443	.25066	.33451	.26233	.35562	.27423	.37784	28
29	.23941	.31476	.25085	.33485	.26253	.35598	.27443	.37822	29
30	.23959	.31509	.25104	.33519	.26272	.35634	.27463	.37860	30
31	.23978	.31541	.25124	.33554	.26292	.35670	.27483	.37898	31
32	.23997	.31574	.25143	.33588	.26312	.35707	.27503	.37936	32
33	.24016	.31607	.25162	.33622	.26331	.35743	.27523	.37974	33
34	.24035	.31640	.25182	.33657	.26351	.35779	.27543	.38012	34
35	.24054	.31672	.25201	.33691	.26371	.35815	.27563	.38051	35
36	.24073	.31705	.25220	.33726	.26390	.35852	.27583	.38089	36
37	.24092	.31738	.25240	.33760	.26410	.35888	.27603	.38127	37
38	.24111	.31771	.25259	.33795	.26430	.35924	.27623	.38165	38
39	.24130	.31804	.25278	.33830	.26449	.35961	.27643	.38204	39
40	.24149	.31837	.25297	.33864	.26469	.35997	.27663	.38242	40
41	.24168	.31870	.25317	.33899	.26489	.36034	.27683	.38280	41
42	.24187	.31903	.25336	.33934	.26509	.36070	.27703	.38319	42
43	.24206	.31936	.25356	.33968	.26528	.36107	.27723	.38357	43
44	.24225	.31969	.25375	.34003	.26548	.36143	.27743	.38396	44
45	.24244	.32002	.25394	.34038	.26568	.36180	.27764	.38434	45
46	.24263	.32035	.25414	.34073	.26588	.36217	.27784	.38473	46
47	.24281	.32068	.25433	.34108	.26607	.36253	.27804	.38512	47
48	.24300	.32101	.25452	.34142	.26627	.36290	.27824	.38550	48
49	.24320	.32134	.25472	.34177	.26647	.36327	.27844	.38589	49
50	.24339	.32168	.25491	.34212	.26667	.36363	.27864	.38628	50
51	.24358	.32201	.25511	.34247	.26686	.36400	.27884	.38666	51
52	.24377	.32234	.25530	.34282	.26706	.36437	.27904	.38705	52
53	.24396	.32267	.25549	.34317	.26726	.36474	.27924	.38744	53
54	.24415	.32301	.25569	.34352	.26746	.36511	.27945	.38783	54
55	.24434	.32334	.25588	.34387	.26766	.36548	.27965	.38822	55
56	.24453	.32368	.25608	.34423	.26785	.36585	.27985	.38860	56
57	.24472	.32401	.25627	.34458	.26805	.36622	.28005	.38899	57
58	.24491	.32434	.25647	.34493	.26825	.36659	.28026	.38938	58
59	.24510	.32468	.25666	.34528	.26845	.36696	.28046	.38977	59
60	.24529	.32501	.25686	.34563	.26865	.36733	.28066	.39016	60

NATURAL VERSED SINES AND EXTERNAL SEC. 285

	36°		37°		38°		39°		
'	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	'
0	.19098	-.23607	.20136	-.25214	.21199	-.26902	.22285	-.28676	0
1	.19115	-.23633	.20154	-.25241	.21217	-.26931	.22304	-.28706	1
2	.19133	-.23659	.20171	-.25269	.21235	-.26960	.22322	-.28737	2
3	.19150	-.23685	.20189	-.25296	.21253	-.26988	.22340	-.28767	3
4	.19167	-.23711	.20207	-.25324	.21271	-.27017	.22359	-.28797	4
5	.19184	-.23738	.20224	-.25351	.21289	-.27046	.22377	-.28828	5
6	.19201	-.23764	.20242	-.25379	.21307	-.27075	.22395	-.28858	6
7	.19218	-.23790	.20259	-.25406	.21324	-.27104	.22414	-.28889	7
8	.19235	-.23816	.20277	-.25434	.21342	-.27133	.22432	-.28919	8
9	.19252	-.23843	.20294	-.25462	.21360	-.27162	.22450	-.28950	9
10	.19270	-.23869	.20312	-.25489	.21378	-.27191	.22469	-.28980	10
11	.19287	-.23895	.20329	-.25517	.21396	-.27221	.22487	-.29011	11
12	.19304	-.23922	.20347	-.25545	.21414	-.27250	.22506	-.29042	12
13	.19321	-.23948	.20365	-.25572	.21432	-.27279	.22524	-.29072	13
14	.19338	-.23975	.20382	-.25600	.21450	-.27308	.22542	-.29103	14
15	.19356	-.24001	.20400	-.25628	.21468	-.27337	.22561	-.29133	15
16	.19373	-.24028	.20417	-.25656	.21486	-.27366	.22579	-.29164	16
17	.19390	-.24054	.20435	-.25683	.21504	-.27396	.22598	-.29195	17
18	.19407	-.24081	.20453	-.25711	.21522	-.27425	.22616	-.29226	18
19	.19424	-.24107	.20470	-.25739	.21540	-.27454	.22634	-.29256	19
20	.19442	-.24134	.20488	-.25767	.21558	-.27483	.22653	-.29287	20
21	.19459	-.24160	.20506	-.25795	.21576	-.27513	.22671	-.29318	21
22	.19476	-.24187	.20523	-.25823	.21595	-.27542	.22690	-.29349	22
23	.19493	-.24213	.20541	-.25851	.21613	-.27572	.22708	-.29380	23
24	.19511	-.24240	.20559	-.25879	.21631	-.27601	.22727	-.29411	24
25	.19528	-.24267	.20576	-.25907	.21649	-.27630	.22745	-.29442	25
26	.19545	-.24293	.20594	-.25935	.21667	-.27660	.22764	-.29473	26
27	.19562	-.24320	.20612	-.25963	.21685	-.27689	.22782	-.29504	27
28	.19580	-.24347	.20629	-.25991	.21703	-.27719	.22801	-.29535	28
29	.19597	-.24373	.20647	-.26019	.21721	-.27748	.22819	-.29566	29
30	.19614	-.24400	.20665	-.26047	.21739	-.27778	.22838	-.29597	30
31	.19632	-.24427	.20682	-.26075	.21757	-.27807	.22856	-.29628	31
32	.19649	-.24454	.20700	-.26104	.21775	-.27837	.22875	-.29659	32
33	.19666	-.24481	.20718	-.26132	.21794	-.27867	.22893	-.29690	33
34	.19684	-.24508	.20736	-.26160	.21812	-.27896	.22912	-.29721	34
35	.19701	-.24534	.20753	-.26188	.21830	-.27926	.22930	-.29752	35
36	.19718	-.24561	.20771	-.26216	.21848	-.27956	.22949	-.29784	36
37	.19736	-.24588	.20789	-.26245	.21866	-.27985	.22967	-.29815	37
38	.19753	-.24615	.20807	-.26273	.21884	-.28015	.22986	-.29846	38
39	.19770	-.24642	.20824	-.26301	.21902	-.28045	.23004	-.29877	39
40	.19788	-.24669	.20842	-.26330	.21921	-.28075	.23023	-.29909	40
41	.19805	-.24696	.20860	-.26358	.21939	-.28105	.23041	-.29940	41
42	.19822	-.24723	.20878	-.26387	.21957	-.28134	.23060	-.29971	42
43	.19840	-.24750	.20895	-.26415	.21975	-.28164	.23079	-.30003	43
44	.19857	-.24777	.20913	-.26443	.21993	-.28194	.23097	-.30034	44
45	.19875	-.24804	.20931	-.26472	.22012	-.28224	.23116	-.30066	45
46	.19892	-.24832	.20949	-.26500	.22030	-.28254	.23134	-.30097	46
47	.19909	-.24859	.20967	-.26529	.22048	-.28284	.23153	-.30129	47
48	.19927	-.24886	.20985	-.26557	.22066	-.28314	.23172	-.30160	48
49	.19944	-.24913	.21002	-.26586	.22084	-.28344	.23190	-.30192	49
50	.19962	-.24940	.21020	-.26615	.22103	-.28374	.23209	-.30223	50
51	.19979	-.24967	.21038	-.26643	.22121	-.28404	.23228	-.30255	51
52	.19997	-.24995	.21056	-.26672	.22139	-.28434	.23246	-.30287	52
53	.20014	-.25022	.21074	-.26701	.22157	-.28464	.23265	-.30318	53
54	.20032	-.25049	.21092	-.26729	.22176	-.28495	.23283	-.30350	54
55	.20049	-.25077	.21109	-.26758	.22194	-.28525	.23302	-.30382	55
56	.20066	-.25104	.21127	-.26787	.22212	-.28555	.23321	-.30413	56
57	.20084	-.25131	.21145	-.26815	.22231	-.28585	.23339	-.30445	57
58	.20101	-.25159	.21163	-.26844	.22249	-.28615	.23358	-.30477	58
59	.20119	-.25186	.21181	-.26873	.22267	-.28646	.23377	-.30509	59
60	.20136	-.25214	.21199	-.26902	.22285	-.28676	.23396	-.30541	60



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	40°		41°		42°		43°		
'	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	'
0	.23396	.30541	.24529	.32501	.25686	.34563	.26865	.36733	0
1	.23414	.30573	.24548	.32535	.25705	.34599	.26884	.36770	1
2	.23438	.30605	.24567	.32568	.25724	.34634	.26904	.36807	2
3	.23452	.30638	.24586	.32602	.25744	.34669	.26924	.36844	3
4	.23470	.30668	.24605	.32636	.25763	.34704	.26944	.36881	4
5	.23489	.30700	.24625	.32669	.25783	.34740	.26964	.36919	5
6	.23508	.30732	.24644	.32703	.25802	.34775	.26984	.36956	6
7	.23527	.30764	.24663	.32737	.25822	.34811	.27004	.36993	7
8	.23545	.30796	.24682	.32770	.25841	.34846	.27024	.37030	8
9	.23564	.30829	.24701	.32804	.25861	.34882	.27043	.37068	9
10	.23583	.30861	.24720	.32838	.25880	.34917	.27063	.37105	10
11	.23602	.30893	.24739	.32872	.25900	.34953	.27083	.37143	11
12	.23620	.30925	.24759	.32905	.25920	.34988	.27103	.37180	12
13	.23639	.30957	.24778	.32939	.25939	.35024	.27123	.37218	13
14	.23658	.30989	.24797	.32973	.25959	.35060	.27143	.37256	14
15	.23677	.31022	.24816	.33007	.25978	.35095	.27163	.37293	15
16	.23696	.31054	.24835	.33041	.25998	.35131	.27183	.37330	16
17	.23714	.31086	.24854	.33075	.26017	.35167	.27203	.37368	17
18	.23733	.31119	.24874	.33109	.26037	.35203	.27223	.37406	18
19	.23752	.31151	.24893	.33143	.26056	.35238	.27243	.37443	19
20	.23771	.31183	.24912	.33177	.26076	.35274	.27263	.37481	20
21	.23790	.31216	.24931	.33211	.26096	.35310	.27283	.37519	21
22	.23808	.31248	.24950	.33245	.26115	.35346	.27303	.37556	22
23	.23827	.31281	.24970	.33279	.26135	.35382	.27323	.37594	23
24	.23846	.31313	.24989	.33314	.26154	.35418	.27343	.37632	24
25	.23865	.31346	.25008	.33348	.26174	.35454	.27363	.37670	25
26	.23884	.31378	.25027	.33382	.26194	.35490	.27383	.37708	26
27	.23903	.31411	.25047	.33416	.26213	.35526	.27403	.37746	27
28	.23922	.31443	.25066	.33451	.26233	.35562	.27423	.37784	28
29	.23941	.31476	.25085	.33485	.26253	.35598	.27443	.37822	29
30	.23959	.31509	.25104	.33519	.26272	.35634	.27463	.37860	30
31	.23978	.31541	.25124	.33554	.26292	.35670	.27483	.37898	31
32	.23997	.31574	.25143	.33588	.26312	.35707	.27503	.37936	32
33	.24016	.31607	.25162	.33622	.26331	.35743	.27523	.37974	33
34	.24035	.31640	.25182	.33657	.26351	.35779	.27543	.38012	34
35	.24054	.31672	.25201	.33691	.26371	.35815	.27563	.38051	35
36	.24073	.31705	.25220	.33726	.26390	.35852	.27583	.38089	36
37	.24092	.31738	.25240	.33760	.26410	.35888	.27603	.38127	37
38	.24111	.31771	.25259	.33795	.26430	.35924	.27623	.38165	38
39	.24130	.31804	.25278	.33830	.26449	.35961	.27643	.38204	39
40	.24149	.31837	.25297	.33864	.26469	.35997	.27663	.38242	40
41	.24168	.31870	.25317	.33899	.26489	.36034	.27683	.38280	41
42	.24187	.31903	.25336	.33934	.26509	.36070	.27703	.38319	42
43	.24206	.31936	.25356	.33968	.26528	.36107	.27723	.38357	43
44	.24225	.31969	.25375	.34003	.26548	.36143	.27743	.38396	44
45	.24244	.32002	.25394	.34038	.26568	.36180	.27764	.38434	45
46	.24262	.32035	.25414	.34073	.26588	.36217	.27784	.38473	46
47	.24281	.32068	.25433	.34108	.26607	.36253	.27804	.38512	47
48	.24300	.32101	.25452	.34142	.26627	.36290	.27824	.38550	48
49	.24320	.32134	.25472	.34177	.26647	.36327	.27844	.38589	49
50	.24339	.32168	.25491	.34212	.26667	.36363	.27864	.38628	50
51	.24358	.32201	.25511	.34247	.26686	.36400	.27884	.38666	51
52	.24377	.32234	.25530	.34282	.26706	.36437	.27905	.38705	52
53	.24396	.32267	.25549	.34317	.26726	.36474	.27925	.38744	53
54	.24415	.32301	.25569	.34352	.26746	.36511	.27945	.38783	54
55	.24434	.32334	.25588	.34387	.26766	.36548	.27965	.38822	55
56	.24453	.32368	.25608	.34423	.26785	.36585	.27985	.38860	56
57	.24472	.32401	.25627	.34458	.26805	.36622	.28005	.38899	57
58	.24491	.32434	.25647	.34493	.26825	.36659	.28026	.38938	58
59	.24510	.32468	.25666	.34528	.26845	.36696	.28046	.38977	59
60	.24529	.32501	.25686	.34563	.26865	.36733	.28066	.39016	60

NATURAL VERSED SINES AND EXTERNAL SEC. 287

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'	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	'
0	.28066	.39016	.29289	.41421	.30534	.43956	.31800	.46628	0
1	.28086	.39055	.29310	.41463	.30555	.43999	.31821	.46674	1
2	.28106	.39095	.29330	.41504	.30576	.44042	.31843	.46719	2
3	.28127	.39134	.29351	.41545	.30597	.44086	.31864	.46765	3
4	.28147	.39173	.29372	.41586	.30618	.44129	.31885	.46811	4
5	.28167	.39212	.29392	.41627	.30639	.44173	.31907	.46857	5
6	.28187	.39251	.29413	.41669	.30660	.44217	.31928	.46903	6
7	.28208	.39291	.29433	.41710	.30681	.44260	.31949	.46949	7
8	.28228	.39330	.29454	.41752	.30702	.44304	.31971	.46995	8
9	.28248	.39369	.29475	.41793	.30723	.44347	.31992	.47041	9
10	.28268	.39409	.29495	.41835	.30744	.44391	.32013	.47087	10
11	.28289	.39448	.29516	.41876	.30765	.44435	.32035	.47134	11
12	.28309	.39487	.29537	.41918	.30786	.44479	.32056	.47180	12
13	.28329	.39527	.29557	.41959	.30807	.44523	.32077	.47226	13
14	.28350	.39566	.29578	.42001	.30828	.44567	.32099	.47272	14
15	.28370	.39606	.29599	.42042	.30849	.44610	.32120	.47319	15
16	.28390	.39646	.29619	.42084	.30870	.44654	.32141	.47365	16
17	.28410	.39685	.29640	.42126	.30891	.44698	.32162	.47411	17
18	.28431	.39725	.29661	.42168	.30912	.44742	.32184	.47458	18
19	.28451	.39764	.29681	.42210	.30933	.44787	.32205	.47504	19
20	.28471	.39804	.29702	.42251	.30954	.44831	.32227	.47551	20
21	.28492	.39844	.29723	.42293	.30975	.44875	.32248	.47598	21
22	.28512	.39884	.29743	.42335	.30996	.44919	.32270	.47644	22
23	.28532	.39924	.29764	.42377	.31017	.44963	.32291	.47691	23
24	.28553	.39963	.29785	.42419	.31038	.45007	.32312	.47738	24
25	.28573	.40003	.29805	.42461	.31059	.45052	.32334	.47784	25
26	.28593	.40043	.29826	.42503	.31080	.45096	.32355	.47831	26
27	.28614	.40083	.29847	.42545	.31101	.45141	.32377	.47878	27
28	.28634	.40123	.29868	.42587	.31122	.45185	.32398	.47925	28
29	.28655	.40163	.29888	.42630	.31143	.45229	.32420	.47972	29
30	.28675	.40203	.29909	.42672	.31165	.45274	.32441	.48019	30
31	.28695	.40243	.29930	.42714	.31186	.45319	.32462	.48066	31
32	.28716	.40283	.29951	.42756	.31207	.45363	.32484	.48113	32
33	.28736	.40324	.29971	.42799	.31228	.45408	.32505	.48160	33
34	.28757	.40364	.29992	.42841	.31249	.45452	.32527	.48207	34
35	.28777	.40404	.30013	.42883	.31270	.45497	.32548	.48254	35
36	.28797	.40444	.30034	.42926	.31291	.45542	.32570	.48301	36
37	.28818	.40485	.30054	.42968	.31312	.45587	.32591	.48349	37
38	.28838	.40525	.30075	.43011	.31333	.45631	.32613	.48396	38
39	.28859	.40565	.30096	.43053	.31355	.45676	.32634	.48443	39
40	.28879	.40606	.30117	.43096	.31376	.45721	.32656	.48491	40
41	.28900	.40646	.30138	.43139	.31397	.45766	.32677	.48538	41
42	.28920	.40687	.30158	.43181	.31418	.45811	.32699	.48586	42
43	.28941	.40727	.30179	.43224	.31439	.45856	.32720	.48633	43
44	.28961	.40768	.30200	.43267	.31461	.45901	.32742	.48681	44
45	.28981	.40808	.30221	.43310	.31482	.45946	.32763	.48728	45
46	.29002	.40849	.30242	.43352	.31503	.45992	.32785	.48776	46
47	.29022	.40890	.30263	.43395	.31524	.46037	.32806	.48824	47
48	.29043	.40930	.30283	.43438	.31545	.46082	.32828	.48871	48
49	.29063	.40971	.30304	.43481	.31567	.46127	.32849	.48919	49
50	.29084	.41012	.30325	.43524	.31588	.46173	.32871	.48967	50
51	.29104	.41053	.30346	.43567	.31609	.46218	.32893	.49015	51
52	.29125	.41093	.30367	.43610	.31630	.46263	.32914	.49063	52
53	.29145	.41134	.30388	.43653	.31651	.46309	.32936	.49111	53
54	.29166	.41175	.30409	.43696	.31673	.46354	.32957	.49159	54
55	.29187	.41216	.30430	.43739	.31694	.46400	.32979	.49207	55
56	.29207	.41257	.30451	.43783	.31715	.46445	.33001	.49255	56
57	.29228	.41298	.30471	.43826	.31736	.46491	.33022	.49303	57
58	.29248	.41339	.30492	.43869	.31758	.46537	.33044	.49351	58
59	.29269	.41380	.30513	.43912	.31779	.46582	.33065	.49399	59
60	.29289	.41421	.30534	.43956	.31800	.46628	.33087	.49448	60

288 NATURAL VERSED SINES AND EXTERNAL SEC.

	48°		49°		50°		51°		
'	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	'
0	.33087	-.49448	.34394	-.52425	.35721	-.55572	.37068	-.58902	0
1	.33109	-.49496	.34416	-.52476	.35744	-.55626	.37091	-.58959	1
2	.33130	-.49544	.34438	-.52527	.35766	-.55680	.37113	-.59016	2
3	.33152	-.49593	.34460	-.52579	.35788	-.55734	.37136	-.59073	3
4	.33173	-.49641	.34482	-.52630	.35810	-.55789	.37158	-.59130	4
5	.33195	-.49690	.34504	-.52681	.35833	-.55843	.37181	-.59188	5
6	.33217	-.49738	.34526	-.52732	.35855	-.55897	.37204	-.59245	6
7	.33238	-.49787	.34548	-.52784	.35877	-.55951	.37226	-.59302	7
8	.33260	-.49835	.34570	-.52835	.35900	-.56005	.37249	-.59360	8
9	.33282	-.49884	.34592	-.52886	.35922	-.56060	.37272	-.59418	9
10	.33303	-.49933	.34614	-.52938	.35944	-.56114	.37294	-.59475	10
11	.33325	-.49981	.34636	-.52989	.35967	-.56169	.37317	-.59533	11
12	.33347	-.50030	.34658	-.53041	.35989	-.56223	.37340	-.59590	12
13	.33368	-.50079	.34680	-.53092	.36011	-.56278	.37362	-.59648	13
14	.33390	-.50128	.34702	-.53144	.36034	-.56332	.37385	-.59706	14
15	.33412	-.50177	.34724	-.53196	.36056	-.56387	.37408	-.59764	15
16	.33434	-.50226	.34746	-.53247	.36078	-.56442	.37430	-.59822	16
17	.33455	-.50275	.34768	-.53299	.36101	-.56497	.37453	-.59880	17
18	.33477	-.50324	.34790	-.53351	.36123	-.56551	.37476	-.59938	18
19	.33499	-.50373	.34812	-.53403	.36146	-.56606	.37498	-.59996	19
20	.33520	-.50422	.34834	-.53455	.36168	-.56661	.37521	-.60054	20
21	.33542	-.50471	.34856	-.53507	.36190	-.56716	.37544	-.60112	21
22	.33564	-.50520	.34878	-.53559	.36213	-.56771	.37567	-.60171	22
23	.33586	-.50569	.34900	-.53611	.36235	-.56826	.37589	-.60229	23
24	.33607	-.50618	.34922	-.53663	.36258	-.56881	.37612	-.60287	24
25	.33629	-.50669	.34945	-.53715	.36280	-.56937	.37635	-.60346	25
26	.33651	-.50718	.34967	-.53768	.36302	-.56992	.37658	-.60404	26
27	.33673	-.50767	.34989	-.53820	.36325	-.57047	.37680	-.60463	27
28	.33694	-.50817	.35011	-.53872	.36347	-.57103	.37703	-.60521	28
29	.33716	-.50866	.35033	-.53924	.36370	-.57158	.37726	-.60580	29
30	.33738	-.50916	.35055	-.53977	.36392	-.57213	.37749	-.60639	30
31	.33760	-.50966	.35077	-.54029	.36415	-.57269	.37771	-.60698	31
32	.33782	-.51015	.35099	-.54082	.36437	-.57324	.37794	-.60756	32
33	.33803	-.51065	.35122	-.54134	.36460	-.57380	.37817	-.60815	33
34	.33825	-.51115	.35144	-.54187	.36482	-.57436	.37840	-.60874	34
35	.33847	-.51165	.35166	-.54240	.36504	-.57491	.37862	-.60933	35
36	.33869	-.51215	.35188	-.54292	.36527	-.57547	.37885	-.60992	36
37	.33891	-.51265	.35210	-.54345	.36549	-.57603	.37908	-.61051	37
38	.33912	-.51314	.35232	-.54398	.36572	-.57659	.37931	-.61111	38
39	.33934	-.51364	.35254	-.54451	.36594	-.57715	.37954	-.61170	39
40	.33956	-.51415	.35277	-.54504	.36617	-.57771	.37976	-.61229	40
41	.33978	-.51465	.35299	-.54557	.36639	-.57827	.37999	-.61288	41
42	.34000	-.51515	.35321	-.54610	.36662	-.57883	.38022	-.61348	42
43	.34022	-.51565	.35343	-.54663	.36684	-.57939	.38045	-.61407	43
44	.34044	-.51615	.35365	-.54716	.36707	-.57995	.38068	-.61467	44
45	.34065	-.51665	.35388	-.54769	.36729	-.58051	.38091	-.61526	45
46	.34087	-.51716	.35410	-.54822	.36752	-.58108	.38113	-.61586	46
47	.34109	-.51766	.35432	-.54876	.36775	-.58164	.38136	-.61646	47
48	.34131	-.51817	.35454	-.54929	.36797	-.58221	.38159	-.61705	48
49	.34153	-.51867	.35476	-.54982	.36820	-.58277	.38182	-.61765	49
50	.34175	-.51918	.35499	-.55036	.36842	-.58333	.38205	-.61825	50
51	.34197	-.51968	.35521	-.55089	.36865	-.58390	.38228	-.61885	51
52	.34219	-.52019	.35543	-.55143	.36887	-.58447	.38251	-.61945	52
53	.34241	-.52069	.35565	-.55196	.36910	-.58503	.38274	-.62005	53
54	.34262	-.52120	.35588	-.55250	.36932	-.58560	.38296	-.62065	54
55	.34284	-.52171	.35610	-.55303	.36955	-.58617	.38319	-.62125	55
56	.34306	-.52222	.35632	-.55357	.36978	-.58674	.38342	-.62185	56
57	.34328	-.52273	.35654	-.55411	.37000	-.58731	.38365	-.62245	57
58	.34350	-.52323	.35677	-.55465	.37023	-.58788	.38388	-.62306	58
59	.34372	-.52374	.35699	-.55518	.37045	-.58845	.38411	-.62366	59
60	.34394	-.52425	.35721	-.55572	.37068	-.58902	.38434	-.62427	60

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VERS.	EX. SEC.	VERS.	EX. SEC.	VERS.	EX. SEC.	VERS.	EX. SEC.	'
.38434	-.62427	-.39819	-.66164	-.41221	-.70130	-.42642	-.74345	0
.38457	-.62487	-.39842	-.66228	-.41245	-.70198	-.42666	-.74417	1
.38480	-.62548	-.39865	-.66292	-.41269	-.70267	-.42690	-.74490	2
.38503	-.62609	-.39888	-.66357	-.41292	-.70335	-.42714	-.74562	3
.38526	-.62669	-.39911	-.66421	-.41316	-.70403	-.42738	-.74635	4
.38549	-.62730	-.39935	-.66486	-.41339	-.70472	-.42762	-.74708	5
.38571	-.62791	-.39958	-.66550	-.41363	-.70540	-.42785	-.74781	6
.38594	-.62852	-.39981	-.66615	-.41386	-.70609	-.42809	-.74854	7
.38617	-.62913	-.40005	-.66679	-.41410	-.70677	-.42833	-.74927	8
.38640	-.62974	-.40028	-.66744	-.41433	-.70746	-.42857	-.75000	9
.38663	-.63035	-.40051	-.66809	-.41457	-.70815	-.42881	-.75073	10
.38686	-.63096	-.40074	-.66873	-.41481	-.70884	-.42905	-.75146	11
.38709	-.63157	-.40098	-.66938	-.41504	-.70953	-.42929	-.75219	12
.38732	-.63218	-.40121	-.67003	-.41528	-.71022	-.42953	-.75293	13
.38755	-.63279	-.40144	-.67068	-.41551	-.71091	-.42976	-.75366	14
.38778	-.63341	-.40168	-.67133	-.41575	-.71160	-.43000	-.75440	15
.38801	-.63402	-.40191	-.67199	-.41599	-.71229	-.43024	-.75513	16
.38824	-.63464	-.40214	-.67264	-.41622	-.71298	-.43048	-.75587	17
.38847	-.63525	-.40237	-.67329	-.41646	-.71368	-.43072	-.75661	18
.38870	-.63587	-.40261	-.67394	-.41670	-.71437	-.43096	-.75734	19
.38893	-.63648	-.40284	-.67460	-.41693	-.71506	-.43120	-.75808	20
.38916	-.63710	-.40307	-.67525	-.41717	-.71576	-.43144	-.75882	21
.38939	-.63772	-.40331	-.67591	-.41740	-.71646	-.43168	-.75956	22
.38962	-.63834	-.40354	-.67656	-.41764	-.71715	-.43192	-.76031	23
.38985	-.63895	-.40378	-.67722	-.41788	-.71785	-.43216	-.76105	24
.39009	-.63957	-.40401	-.67788	-.41811	-.71855	-.43240	-.76179	25
.39032	-.64019	-.40424	-.67853	-.41835	-.71925	-.43264	-.76253	26
.39055	-.64081	-.40448	-.67919	-.41859	-.71995	-.43287	-.76328	27
.39078	-.64144	-.40471	-.67985	-.41882	-.72065	-.43311	-.76402	28
.39101	-.64206	-.40494	-.68051	-.41906	-.72135	-.43335	-.76477	29
.39124	-.64268	-.40518	-.68117	-.41930	-.72205	-.43359	-.76552	30
.39147	-.64330	-.40541	-.68183	-.41953	-.72275	-.43383	-.76626	31
.39170	-.64393	-.40565	-.68250	-.41977	-.72346	-.43407	-.76701	32
.39193	-.64455	-.40588	-.68316	-.42001	-.72416	-.43431	-.76776	33
.39216	-.64518	-.40611	-.68382	-.42024	-.72487	-.43455	-.76851	34
.39239	-.64580	-.40635	-.68449	-.42048	-.72557	-.43479	-.76926	35
.39262	-.64643	-.40658	-.68515	-.42072	-.72628	-.43503	-.77001	36
.39286	-.64705	-.40682	-.68582	-.42096	-.72698	-.43527	-.77077	37
.39309	-.64768	-.40705	-.68648	-.42119	-.72769	-.43551	-.77152	38
.39332	-.64831	-.40728	-.68715	-.42143	-.72840	-.43575	-.77227	39
.39355	-.64894	-.40752	-.68782	-.42167	-.72911	-.43599	-.77303	40
.39378	-.64957	-.40775	-.68848	-.42191	-.72982	-.43623	-.77378	41
.39401	-.65020	-.40799	-.68915	-.42214	-.73053	-.43647	-.77454	42
.39424	-.65083	-.40822	-.68982	-.42238	-.73124	-.43671	-.77530	43
.39447	-.65146	-.40846	-.69049	-.42262	-.73195	-.43695	-.77606	44
.39471	-.65209	-.40869	-.69116	-.42285	-.73267	-.43720	-.77681	45
.39494	-.65272	-.40893	-.69183	-.42309	-.73338	-.43744	-.77757	46
.39517	-.65336	-.40916	-.69250	-.42333	-.73409	-.43768	-.77833	47
.39540	-.65399	-.40939	-.69318	-.42357	-.73481	-.43792	-.77910	48
.39563	-.65462	-.40963	-.69385	-.42381	-.73552	-.43816	-.77986	49
.39586	-.65526	-.40986	-.69452	-.42404	-.73624	-.43840	-.78062	50
.39610	-.65589	-.41010	-.69520	-.42428	-.73696	-.43864	-.78138	51
.39633	-.65653	-.41033	-.69587	-.42452	-.73768	-.43888	-.78215	52
.39656	-.65717	-.41057	-.69655	-.42476	-.73840	-.43912	-.78291	53
.39679	-.65780	-.41080	-.69723	-.42499	-.73911	-.43936	-.78368	54
.39702	-.65844	-.41104	-.69790	-.42523	-.73983	-.43960	-.78445	55
.39726	-.65908	-.41127	-.69858	-.42547	-.74056	-.43984	-.78521	56
.39749	-.65972	-.41151	-.69926	-.42571	-.74128	-.44008	-.78598	57
.39772	-.66036	-.41174	-.69994	-.42595	-.74200	-.44032	-.78675	58
.39795	-.66100	-.41198	-.70062	-.42619	-.74272	-.44057	-.78752	59
.39819	-.66164	-.41221	-.70130	-.42642	-.74345	-.44081	-.78829	60

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	56°		57°		58°		59°		
'	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	'
0	.44081	.78829	.45538	.83608	.47008	.88708	.48496	.94160	0
1	.44105	.78906	.45560	.83690	.47033	.88796	.48521	.94254	1
2	.44129	.78984	.45585	.83773	.47057	.88884	.48546	.94349	2
3	.44153	.79061	.45609	.83855	.47082	.88972	.48571	.94443	3
4	.44177	.79138	.45634	.83938	.47107	.89060	.48596	.94537	4
5	.44201	.79216	.45658	.84020	.47131	.89148	.48621	.94632	5
6	.44225	.79293	.45683	.84103	.47156	.89237	.48646	.94726	6
7	.44250	.79371	.45707	.84186	.47181	.89325	.48671	.94821	7
8	.44274	.79449	.45731	.84269	.47206	.89414	.48696	.94916	8
9	.44298	.79527	.45756	.84352	.47230	.89503	.48721	.95011	9
10	.44322	.79604	.45780	.84435	.47255	.89591	.48746	.95106	10
11	.44346	.79682	.45805	.84518	.47280	.89680	.48771	.95201	11
12	.44370	.79761	.45829	.84601	.47304	.89769	.48796	.95296	12
13	.44395	.79839	.45854	.84685	.47329	.89858	.48821	.95392	13
14	.44419	.79917	.45878	.84768	.47354	.89948	.48846	.95487	14
15	.44443	.79995	.45903	.84852	.47379	.90037	.48871	.95583	15
16	.44467	.80074	.45927	.84935	.47403	.90126	.48896	.95678	16
17	.44491	.80152	.45951	.85019	.47428	.90216	.48921	.95774	17
18	.44516	.80231	.45976	.85103	.47453	.90305	.48946	.95870	18
19	.44540	.80309	.46000	.85187	.47478	.90395	.48971	.95966	19
20	.44564	.80388	.46025	.85271	.47502	.90485	.48996	.96062	20
21	.44588	.80467	.46049	.85355	.47527	.90575	.49021	.96158	21
22	.44612	.80546	.46074	.85439	.47552	.90665	.49046	.96255	22
23	.44637	.80625	.46098	.85523	.47577	.90755	.49071	.96351	23
24	.44661	.80704	.46123	.85608	.47601	.90845	.49096	.96448	24
25	.44685	.80783	.46147	.85692	.47626	.90935	.49121	.96544	25
26	.44709	.80862	.46172	.85777	.47651	.91026	.49146	.96641	26
27	.44734	.80942	.46196	.85861	.47676	.91116	.49171	.96738	27
28	.44758	.81021	.46221	.85946	.47701	.91207	.49196	.96835	28
29	.44782	.81101	.46246	.86031	.47725	.91297	.49221	.96932	29
30	.44806	.81180	.46270	.86116	.47750	.91388	.49246	.97029	30
31	.44831	.81260	.46295	.86201	.47775	.91479	.49271	.97127	31
32	.44855	.81340	.46319	.86286	.47800	.91570	.49296	.97224	32
33	.44879	.81419	.46344	.86371	.47825	.91661	.49321	.97322	33
34	.44903	.81499	.46368	.86457	.47849	.91752	.49346	.97420	34
35	.44928	.81579	.46393	.86542	.47874	.91844	.49372	.97517	35
36	.44952	.81659	.46417	.86627	.47899	.91935	.49397	.97615	36
37	.44976	.81740	.46442	.86713	.47924	.92027	.49422	.97713	37
38	.45001	.81820	.46466	.86799	.47949	.92118	.49447	.97811	38
39	.45025	.81900	.46491	.86885	.47974	.92210	.49472	.97910	39
40	.45049	.81981	.46516	.86970	.47998	.92302	.49497	.98008	40
41	.45073	.82061	.46540	.87056	.48023	.92394	.49522	.98107	41
42	.45098	.82142	.46565	.87142	.48048	.92486	.49547	.98205	42
43	.45122	.82222	.46589	.87229	.48073	.92578	.49572	.98304	43
44	.45146	.82303	.46614	.87315	.48098	.92670	.49597	.98403	44
45	.45171	.82384	.46639	.87401	.48123	.92762	.49623	.98502	45
46	.45195	.82465	.46663	.87488	.48148	.92855	.49648	.98601	46
47	.45219	.82546	.46688	.87574	.48172	.92947	.49673	.98700	47
48	.45244	.82627	.46712	.87661	.48197	.93040	.49698	.98799	48
49	.45268	.82709	.46737	.87748	.48222	.93133	.49723	.98899	49
50	.45292	.82790	.46762	.87834	.48247	.93226	.49748	.98998	50
51	.45317	.82871	.46786	.87921	.48272	.93319	.49773	.99098	51
52	.45341	.82953	.46811	.88008	.48297	.93412	.49799	.99198	52
53	.45365	.83034	.46836	.88095	.48322	.93505	.49824	.99298	53
54	.45390	.83116	.46860	.88183	.48347	.93598	.49849	.99398	54
55	.45414	.83198	.46885	.88270	.48372	.93692	.49874	.99498	55
56	.45439	.83280	.46909	.88357	.48396	.93785	.49899	.99598	56
57	.45463	.83362	.46934	.88445	.48421	.93879	.49924	.99698	57
58	.45487	.83444	.46959	.88532	.48446	.93973	.49950	.99799	58
59	.45512	.83526	.46983	.88620	.48471	.94066	.49975	.99899	59
60	.45536	.83608	.47008	.88708	.48496	.94160	.50000	1.00000	60

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°	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	°
0	.50000	1.00000	.51519	1.06267	.53053	1.13005	.54601	1.20269	0
1	.50025	1.00101	.51544	1.06375	.53079	1.13122	.54627	1.20395	1
2	.50050	1.00202	.51570	1.06483	.53104	1.13239	.54653	1.20521	2
3	.50076	1.00303	.51595	1.06592	.53130	1.13356	.54679	1.20647	3
4	.50101	1.00404	.51621	1.06701	.53156	1.13473	.54705	1.20773	4
5	.50126	1.00505	.51646	1.06809	.53181	1.13590	.54731	1.20900	5
6	.50151	1.00607	.51672	1.06918	.53207	1.13707	.54757	1.21026	6
7	.50176	1.00708	.51697	1.07027	.53233	1.13825	.54782	1.21153	7
8	.50202	1.00810	.51723	1.07137	.53258	1.13942	.54808	1.21280	8
9	.50227	1.00912	.51748	1.07246	.53284	1.14060	.54834	1.21407	9
10	.50252	1.01014	.51774	1.07356	.53310	1.14178	.54860	1.21535	10
11	.50277	1.01116	.51799	1.07465	.53336	1.14296	.54886	1.21662	11
12	.50303	1.01218	.51825	1.07575	.53361	1.14414	.54912	1.21790	12
13	.50328	1.01320	.51850	1.07685	.53387	1.14533	.54938	1.21918	13
14	.50353	1.01422	.51876	1.07795	.53413	1.14651	.54964	1.22045	14
15	.50378	1.01525	.51901	1.07905	.53439	1.14770	.54990	1.22174	15
16	.50404	1.01628	.51927	1.08015	.53464	1.14889	.55016	1.22302	16
17	.50429	1.01730	.51952	1.08126	.53490	1.15008	.55042	1.22430	17
18	.50454	1.01833	.51978	1.08236	.53516	1.15127	.55068	1.22559	18
19	.50479	1.01936	.52003	1.08347	.53542	1.15246	.55094	1.22688	19
20	.50505	1.02039	.52029	1.08458	.53567	1.15366	.55120	1.22817	20
21	.50530	1.02143	.52054	1.08569	.53593	1.15485	.55146	1.22946	21
22	.50555	1.02246	.52080	1.08680	.53619	1.15605	.55172	1.23075	22
23	.50581	1.02349	.52105	1.08791	.53645	1.15725	.55198	1.23204	23
24	.50606	1.02453	.52131	1.08903	.53670	1.15845	.55224	1.23333	24
25	.50631	1.02557	.52156	1.09014	.53696	1.15965	.55250	1.23462	25
26	.50656	1.02661	.52182	1.09126	.53722	1.16085	.55276	1.23591	26
27	.50682	1.02765	.52207	1.09238	.53748	1.16206	.55302	1.23720	27
28	.50707	1.02869	.52233	1.09350	.53774	1.16326	.55328	1.23849	28
29	.50732	1.02973	.52259	1.09462	.53799	1.16447	.55354	1.23978	29
30	.50758	1.03077	.52284	1.09574	.53825	1.16568	.55380	1.24118	30
31	.50783	1.03182	.52310	1.09686	.53851	1.16689	.55406	1.24247	31
32	.50808	1.03286	.52335	1.09799	.53877	1.16810	.55432	1.24378	32
33	.50834	1.03391	.52361	1.09911	.53903	1.16932	.55458	1.24509	33
34	.50859	1.03496	.52386	1.10024	.53928	1.17053	.55484	1.24640	34
35	.50884	1.03601	.52412	1.10137	.53954	1.17175	.55510	1.24772	35
36	.50910	1.03706	.52438	1.10250	.53980	1.17297	.55536	1.24903	36
37	.50935	1.03811	.52463	1.10363	.54006	1.17419	.55562	1.25035	37
38	.50960	1.03916	.52489	1.10477	.54032	1.17541	.55588	1.25167	38
39	.50986	1.04022	.52514	1.10590	.54058	1.17663	.55615	1.25300	39
40	.51011	1.04128	.52540	1.10704	.54083	1.17786	.55641	1.25432	40
41	.51036	1.04233	.52566	1.10817	.54109	1.17909	.55667	1.25565	41
42	.51062	1.04339	.52591	1.10931	.54135	1.18031	.55693	1.25697	42
43	.51087	1.04445	.52617	1.11045	.54161	1.18154	.55719	1.25830	43
44	.51113	1.04551	.52642	1.11159	.54187	1.18277	.55745	1.25963	44
45	.51138	1.04658	.52668	1.11274	.54213	1.18401	.55771	1.26097	45
46	.51163	1.04764	.52694	1.11388	.54238	1.18524	.55797	1.26230	46
47	.51189	1.04870	.52719	1.11503	.54264	1.18648	.55823	1.26364	47
48	.51214	1.04977	.52745	1.11617	.54290	1.18772	.55849	1.26498	48
49	.51239	1.05084	.52771	1.11732	.54316	1.18895	.55876	1.26632	49
50	.51265	1.05191	.52796	1.11847	.54342	1.19019	.55902	1.26766	50
51	.51290	1.05298	.52822	1.11963	.54368	1.19144	.55928	1.26900	51
52	.51316	1.05405	.52848	1.12078	.54394	1.19268	.55954	1.27035	52
53	.51341	1.05512	.52873	1.12193	.54420	1.19393	.55980	1.27169	53
54	.51366	1.05619	.52899	1.12309	.54446	1.19517	.56006	1.27304	54
55	.51392	1.05727	.52924	1.12425	.54471	1.19642	.56032	1.27439	55
56	.51417	1.05835	.52950	1.12540	.54497	1.19767	.56058	1.27574	56
57	.51443	1.05942	.52976	1.12657	.54523	1.19892	.56084	1.27710	57
58	.51468	1.06050	.53001	1.12773	.54549	1.20018	.56111	1.27845	58
59	.51494	1.06158	.53027	1.12889	.54575	1.20143	.56137	1.27981	59
60	.51519	1.06267	.53053	1.13005	.54601	1.20269	.56163	1.28117	60

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67°

'	Ver.	Ex. sec.	Ver.	Ex. sec.	Ver.	Ex. sec.	Ver.	Ex. sec.	'
0	.56163	1.28117	.57738	1.36620	.59326	1.45859	.60927	1.55930	0
1	.56189	1.28253	.57765	1.36768	.59353	1.46020	.60954	1.56106	1
2	.56215	1.28390	.57791	1.36916	.59379	1.46181	.60980	1.56282	2
3	.56241	1.28526	.57817	1.37064	.59406	1.46342	.61007	1.56458	3
4	.56267	1.28663	.57844	1.37212	.59433	1.46504	.61034	1.56634	4
5	.56294	1.28800	.57870	1.37361	.59459	1.46665	.61061	1.56811	5
6	.56320	1.28937	.57896	1.37509	.59486	1.46827	.61088	1.56988	6
7	.56346	1.29074	.57923	1.37658	.59512	1.46989	.61114	1.57165	7
8	.56372	1.29211	.57949	1.37808	.59539	1.47152	.61141	1.57342	8
9	.56398	1.29349	.57976	1.37957	.59566	1.47314	.61168	1.57520	9
10	.56425	1.29487	.58002	1.38107	.59592	1.47477	.61195	1.57698	10
11	.56451	1.29625	.58028	1.38256	.59619	1.47640	.61222	1.57876	11
12	.56477	1.29763	.58055	1.38406	.59645	1.47804	.61248	1.58054	12
13	.56503	1.29901	.58081	1.38556	.59672	1.47967	.61275	1.58233	13
14	.56529	1.30040	.58108	1.38707	.59699	1.48131	.61302	1.58412	14
15	.56555	1.30179	.58134	1.38857	.59725	1.48295	.61329	1.58591	15
16	.56582	1.30318	.58160	1.39008	.59752	1.48459	.61356	1.58771	16
17	.56608	1.30457	.58187	1.39159	.59779	1.48624	.61383	1.58950	17
18	.56634	1.30596	.58213	1.39311	.59805	1.48789	.61409	1.59130	18
19	.56660	1.30735	.58240	1.39462	.59832	1.48954	.61436	1.59311	19
20	.56687	1.30875	.58266	1.39614	.59859	1.49119	.61463	1.59491	20
21	.56713	1.31015	.58293	1.39766	.59885	1.49284	.61490	1.59672	21
22	.56739	1.31155	.58319	1.39918	.59912	1.49449	.61517	1.59853	22
23	.56765	1.31295	.58345	1.40070	.59938	1.49614	.61544	1.60035	23
24	.56791	1.31436	.58372	1.40222	.59965	1.49778	.61570	1.60217	24
25	.56818	1.31576	.58398	1.40375	.59992	1.49943	.61597	1.60399	25
26	.56844	1.31717	.58425	1.40528	.60018	1.50108	.61624	1.60581	26
27	.56870	1.31858	.58451	1.40681	.60045	1.50273	.61651	1.60763	27
28	.56896	1.31999	.58478	1.40835	.60072	1.50438	.61678	1.60946	28
29	.56923	1.32140	.58504	1.40988	.60098	1.50603	.61705	1.61129	29
30	.56949	1.32282	.58531	1.41142	.60125	1.50768	.61732	1.61313	30
31	.56975	1.32424	.58557	1.41296	.60152	1.50933	.61759	1.61496	31
32	.57001	1.32566	.58584	1.41450	.60178	1.51100	.61786	1.61680	32
33	.57028	1.32708	.58610	1.41605	.60205	1.51265	.61813	1.61864	33
34	.57054	1.32850	.58637	1.41760	.60232	1.51431	.61839	1.62049	34
35	.57080	1.32993	.58663	1.41914	.60259	1.51596	.61866	1.62234	35
36	.57106	1.33135	.58690	1.42070	.60285	1.51762	.61893	1.62419	36
37	.57133	1.33278	.58716	1.42225	.60312	1.51928	.61920	1.62604	37
38	.57159	1.33422	.58743	1.42380	.60339	1.52094	.61947	1.62790	38
39	.57185	1.33565	.58769	1.42536	.60365	1.52260	.61974	1.62976	39
40	.57212	1.33708	.58796	1.42692	.60392	1.52426	.62001	1.63162	40
41	.57238	1.33852	.58822	1.42848	.60419	1.52592	.62027	1.63348	41
42	.57264	1.33996	.58849	1.43005	.60445	1.52758	.62054	1.63535	42
43	.57291	1.34140	.58875	1.43162	.60472	1.52924	.62081	1.63722	43
44	.57317	1.34284	.58902	1.43318	.60499	1.53090	.62108	1.63909	44
45	.57343	1.34429	.58928	1.43475	.60526	1.53256	.62135	1.64097	45
46	.57369	1.34573	.58955	1.43633	.60552	1.53422	.62162	1.64285	46
47	.57396	1.34718	.58981	1.43790	.60579	1.53588	.62189	1.64473	47
48	.57422	1.34863	.59008	1.43948	.60606	1.53754	.62216	1.64662	48
49	.57448	1.35009	.59034	1.44106	.60633	1.54017	.62243	1.64851	49
50	.57475	1.35154	.59061	1.44264	.60659	1.54190	.62270	1.65040	50
51	.57501	1.35300	.59087	1.44423	.60686	1.54363	.62297	1.65229	51
52	.57527	1.35446	.59114	1.44582	.60713	1.54536	.62324	1.65419	52
53	.57554	1.35592	.59140	1.44741	.60740	1.54709	.62351	1.65609	53
54	.57580	1.35738	.59167	1.44900	.60766	1.54883	.62378	1.65799	54
55	.57606	1.35885	.59194	1.45059	.60793	1.55057	.62405	1.65989	55
56	.57633	1.36031	.59220	1.45219	.60820	1.55231	.62432	1.66180	56
57	.57659	1.36178	.59247	1.45378	.60847	1.55405	.62458	1.66371	57
58	.57685	1.36325	.59273	1.45539	.60873	1.55580	.62485	1.66563	58
59	.57712	1.36473	.59300	1.45699	.60900	1.55755	.62512	1.66755	59
60	.57738	1.36620	.59326	1.45859	.60927	1.55930	.62539	1.66947	60

NATURAL VERSED SINES AND EXTERNAL SEC. 293

66°		69°		70°		71°			
'	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	'
0	.62539	1.66947	.64163	1.79043	.65798	1.92380	.67443	2.07155	0
1	.62566	1.67139	.64190	1.79254	.65825	1.92614	.67471	2.07415	1
2	.62593	1.67332	.64218	1.79466	.65853	1.92849	.67498	2.07675	2
3	.62620	1.67525	.64245	1.79679	.65880	1.93083	.67526	2.07936	3
4	.62647	1.67718	.64272	1.79891	.65907	1.93318	.67553	2.08197	4
5	.62674	1.67911	.64299	1.80104	.65935	1.93554	.67581	2.08459	5
6	.62701	1.68105	.64326	1.80318	.65962	1.93790	.67608	2.08721	6
7	.62728	1.68299	.64353	1.80531	.65989	1.94026	.67636	2.08983	7
8	.62755	1.68494	.64381	1.80746	.66017	1.94263	.67663	2.09246	8
9	.62782	1.68689	.64408	1.80960	.66044	1.94500	.67691	2.09510	9
10	.62809	1.68884	.64435	1.81175	.66071	1.94737	.67718	2.09774	10
11	.62836	1.69079	.64462	1.81390	.66099	1.94975	.67746	2.10038	11
12	.62863	1.69275	.64489	1.81605	.66126	1.95213	.67773	2.10303	12
13	.62890	1.69471	.64517	1.81821	.66154	1.95452	.67801	2.10568	13
14	.62917	1.69667	.64544	1.82037	.66181	1.95691	.67829	2.10834	14
15	.62944	1.69864	.64571	1.82254	.66208	1.95931	.67856	2.11101	15
16	.62971	1.70061	.64598	1.82471	.66236	1.96171	.67884	2.11367	16
17	.62998	1.70258	.64625	1.82688	.66263	1.96411	.67911	2.11635	17
18	.63025	1.70455	.64653	1.82906	.66290	1.96652	.67939	2.11903	18
19	.63052	1.70653	.64680	1.83124	.66318	1.96893	.67966	2.12171	19
20	.63079	1.70851	.64707	1.83342	.66345	1.97135	.67994	2.12440	20
21	.63106	1.71050	.64734	1.83561	.66373	1.97377	.68021	2.12709	21
22	.63133	1.71249	.64761	1.83780	.66400	1.97619	.68049	2.12979	22
23	.63161	1.71448	.64789	1.83999	.66427	1.97862	.68077	2.13249	23
24	.63188	1.71647	.64816	1.84219	.66455	1.98106	.68104	2.13520	24
25	.63215	1.71847	.64843	1.84439	.66482	1.98349	.68132	2.13791	25
26	.63242	1.72047	.64870	1.84659	.66510	1.98594	.68159	2.14063	26
27	.63269	1.72247	.64898	1.84880	.66537	1.98838	.68187	2.14335	27
28	.63296	1.72448	.64925	1.85102	.66564	1.99083	.68214	2.14608	28
29	.63323	1.72649	.64952	1.85323	.66592	1.99329	.68242	2.14881	29
30	.63350	1.72850	.64979	1.85545	.66619	1.99574	.68270	2.15155	30
31	.63377	1.73052	.65007	1.85767	.66647	1.99821	.68297	2.15429	31
32	.63404	1.73254	.65034	1.85990	.66674	2.00067	.68325	2.15704	32
33	.63431	1.73456	.65061	1.86213	.66702	2.00315	.68352	2.15979	33
34	.63458	1.73659	.65088	1.86437	.66729	2.00562	.68380	2.16255	34
35	.63485	1.73862	.65116	1.86661	.66756	2.00810	.68408	2.16531	35
36	.63512	1.74065	.65143	1.86885	.66784	2.01059	.68435	2.16808	36
37	.63539	1.74269	.65170	1.87109	.66811	2.01308	.68463	2.17085	37
38	.63566	1.74473	.65197	1.87334	.66839	2.01557	.68490	2.17363	38
39	.63594	1.74677	.65225	1.87560	.66866	2.01807	.68518	2.17641	39
40	.63621	1.74881	.65252	1.87785	.66894	2.02057	.68546	2.17920	40
41	.63648	1.75086	.65279	1.88011	.66921	2.02308	.68573	2.18199	41
42	.63675	1.75292	.65306	1.88238	.66949	2.02559	.68601	2.18479	42
43	.63702	1.75497	.65334	1.88465	.66976	2.02810	.68628	2.18759	43
44	.63729	1.75703	.65361	1.88692	.67003	2.03062	.68656	2.19040	44
45	.63756	1.75909	.65388	1.88920	.67031	2.03315	.68684	2.19322	45
46	.63783	1.76116	.65416	1.89148	.67058	2.03568	.68711	2.19604	46
47	.63810	1.76323	.65443	1.89376	.67086	2.03821	.68739	2.19886	47
48	.63838	1.76530	.65470	1.89605	.67113	2.04075	.68767	2.20169	48
49	.63865	1.76737	.65497	1.89834	.67141	2.04329	.68794	2.20453	49
50	.63892	1.76945	.65525	1.90063	.67168	2.04584	.68822	2.20737	50
51	.63919	1.77154	.65552	1.90293	.67196	2.04839	.68849	2.21021	51
52	.63946	1.77362	.65579	1.90524	.67223	2.05094	.68877	2.21306	52
53	.63973	1.77571	.65607	1.90754	.67251	2.05350	.68905	2.21592	53
54	.64000	1.77780	.65634	1.90986	.67278	2.05607	.68932	2.21878	54
55	.64027	1.77990	.65661	1.91217	.67306	2.05864	.68960	2.22165	55
56	.64055	1.78200	.65689	1.91449	.67333	2.06121	.68988	2.22452	56
57	.64082	1.78410	.65716	1.91681	.67361	2.06379	.69015	2.22740	57
58	.64109	1.78621	.65743	1.91914	.67388	2.06637	.69043	2.23028	58
59	.64136	1.78832	.65771	1.92147	.67416	2.06896	.69071	2.23317	59
60	.64163	1.79043	.65798	1.92380	.67443	2.07155	.69098	2.23607	60



## 294 NATURAL VERSED SINES AND EXTERNAL SEC.

	72°		73°		74°		75°		
'	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	'
0	.69098	2.23607	.70763	2.42030	.72436	2.62796	.74118	2.86370	0
1	.69126	2.23897	.70791	2.42356	.72464	2.63184	.74146	2.86790	1
2	.69154	2.24187	.70818	2.42683	.72492	2.63573	.74174	2.87211	2
3	.69181	2.24478	.70846	2.43010	.72520	2.63963	.74202	2.87633	3
4	.69209	2.24770	.70874	2.43337	.72548	2.64354	.74231	2.88056	4
5	.69237	2.25062	.70902	2.43666	.72576	2.64745	.74259	2.88479	5
6	.69264	2.25355	.70930	2.43995	.72604	2.65138	.74287	2.88904	6
7	.69292	2.25648	.70958	2.44324	.72632	2.65531	.74315	2.89330	7
8	.69320	2.25942	.70985	2.44655	.72660	2.65925	.74343	2.89756	8
9	.69347	2.26237	.71013	2.44986	.72688	2.66319	.74371	2.90184	9
10	.69375	2.26531	.71041	2.45317	.72716	2.66715	.74399	2.90613	10
11	.69403	2.26827	.71069	2.45650	.72744	2.67112	.74427	2.91042	11
12	.69430	2.27123	.71097	2.45983	.72772	2.67509	.74455	2.91473	12
13	.69458	2.27420	.71125	2.46316	.72800	2.67907	.74484	2.91904	13
14	.69486	2.27717	.71153	2.46651	.72828	2.68305	.74512	2.92337	14
15	.69514	2.28015	.71180	2.46986	.72856	2.68705	.74540	2.92770	15
16	.69541	2.28313	.71208	2.47321	.72884	2.69105	.74568	2.93204	16
17	.69569	2.28612	.71236	2.47658	.72912	2.69506	.74596	2.93640	17
18	.69597	2.28912	.71264	2.47995	.72940	2.69907	.74624	2.94076	18
19	.69624	2.29212	.71292	2.48333	.72968	2.69931	.74652	2.94514	19
20	.69652	2.29512	.71320	2.48671	.72996	2.70315	.74680	2.94952	20
21	.69680	2.29814	.71348	2.49010	.73024	2.70700	.74709	2.95392	21
22	.69708	2.30115	.71375	2.49350	.73052	2.71085	.74737	2.95832	22
23	.69735	2.30418	.71403	2.49691	.73080	2.71471	.74765	2.96274	23
24	.69763	2.30721	.71431	2.50032	.73108	2.71858	.74793	2.96716	24
25	.69791	2.31024	.71459	2.50374	.73136	2.72246	.74821	2.97160	25
26	.69818	2.31328	.71487	2.50716	.73164	2.72635	.74849	2.97604	26
27	.69846	2.31633	.71515	2.51060	.73192	2.73024	.74878	2.98050	27
28	.69874	2.31939	.71543	2.51404	.73220	2.73414	.74906	2.98497	28
29	.69902	2.32244	.71571	2.51748	.73248	2.73806	.74934	2.98944	29
30	.69929	2.32551	.71598	2.52094	.73276	2.74198	.74962	2.99393	30
31	.69957	2.32858	.71626	2.52440	.73304	2.74591	.74990	2.99843	31
32	.69985	2.33166	.71654	2.52787	.73332	2.74984	.75018	3.00293	32
33	.70013	2.33474	.71682	2.53134	.73360	2.75377	.75047	3.00745	33
34	.70040	2.33783	.71710	2.53482	.73388	2.75775	.75075	3.01198	34
35	.70068	2.34092	.71738	2.53831	.73416	2.76171	.75103	3.01652	35
36	.70096	2.34403	.71766	2.54181	.73444	2.76568	.75131	3.02107	36
37	.70124	2.34713	.71794	2.54531	.73472	2.76966	.75159	3.02563	37
38	.70151	2.35025	.71822	2.54883	.73500	2.77365	.75187	3.03020	38
39	.70179	2.35336	.71850	2.55235	.73528	2.77765	.75216	3.03479	39
40	.70207	2.35649	.71877	2.55587	.73557	2.78166	.75244	3.03938	40
41	.70235	2.35962	.71905	2.55940	.73585	2.78568	.75272	3.04398	41
42	.70263	2.36276	.71933	2.56294	.73613	2.78970	.75300	3.04860	42
43	.70290	2.36590	.71961	2.56649	.73641	2.79374	.75328	3.05322	43
44	.70318	2.36905	.71989	2.57005	.73669	2.79778	.75356	3.05786	44
45	.70346	2.37221	.72017	2.57361	.73697	2.80183	.75385	3.06251	45
46	.70374	2.37537	.72045	2.57718	.73725	2.80589	.75413	3.06717	46
47	.70401	2.37854	.72073	2.58076	.73753	2.80996	.75441	3.07184	47
48	.70429	2.38171	.72101	2.58434	.73781	2.81404	.75469	3.07652	48
49	.70457	2.38489	.72129	2.58794	.73809	2.81813	.75497	3.08121	49
50	.70485	2.38808	.72157	2.59154	.73837	2.82223	.75526	3.08591	50
51	.70513	2.39128	.72185	2.59514	.73865	2.82633	.75554	3.09063	51
52	.70540	2.39448	.72213	2.59876	.73893	2.83045	.75582	3.09535	52
53	.70568	2.39768	.72241	2.60238	.73921	2.83457	.75610	3.10009	53
54	.70596	2.40089	.72269	2.60601	.73950	2.83871	.75639	3.10484	54
55	.70624	2.40411	.72296	2.60965	.73978	2.84285	.75667	3.10960	55
56	.70652	2.40734	.72324	2.61330	.74006	2.84700	.75695	3.11437	56
57	.70679	2.41057	.72352	2.61695	.74034	2.85116	.75723	3.11915	57
58	.70707	2.41381	.72380	2.62061	.74062	2.85533	.75751	3.12394	58
59	.70735	2.41705	.72408	2.62428	.74090	2.85951	.75780	3.12875	59
60	.70763	2.42030	.72436	2.62796	.74118	2.86370	.75808	3.13357	60

NATURAL VERSED SINES AND EXTERNAL SEC. 295

	76°		77°		78°		79°		
'	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	'
0	.75808	3.18357	.77505	3.44541	.79209	3.80973	.80919	4.24084	0
1	.75836	3.18389	.77533	3.45102	.79237	3.81633	.80948	4.24870	1
2	.75864	3.18423	.77562	3.45664	.79266	3.82294	.80976	4.25658	2
3	.75892	3.18460	.77590	3.46228	.79294	3.82956	.81005	4.26448	3
4	.75921	3.18495	.77618	3.46793	.79323	3.83621	.81033	4.27241	4
5	.75949	3.18572	.77647	3.47360	.79351	3.84288	.81062	4.28036	5
6	.75977	3.18621	.77675	3.47928	.79380	3.84956	.81090	4.28833	6
7	.76005	3.18761	.77703	3.48498	.79408	3.85627	.81119	4.29634	7
8	.76034	3.18722	.77732	3.49069	.79437	3.86299	.81148	4.30438	8
9	.76062	3.18744	.77760	3.49642	.79465	3.86973	.81176	4.31241	9
10	.76090	3.18238	.77788	3.50216	.79493	3.87649	.81205	4.32049	10
11	.76118	3.18733	.77817	3.50791	.79522	3.88327	.81233	4.32859	11
12	.76147	3.19228	.77845	3.51368	.79550	3.89007	.81262	4.33671	12
13	.76175	3.19725	.77874	3.51947	.79579	3.89689	.81290	4.34486	13
14	.76203	3.20224	.77902	3.52527	.79607	3.90373	.81319	4.35304	14
15	.76231	3.20723	.77930	3.53109	.79636	3.91058	.81348	4.36124	15
16	.76260	3.21224	.77959	3.53692	.79664	3.91746	.81376	4.36947	16
17	.76288	3.21728	.77987	3.54277	.79693	3.92436	.81405	4.37772	17
18	.76316	3.22229	.78015	3.54863	.79721	3.93128	.81433	4.38600	18
19	.76344	3.22734	.78044	3.55451	.79750	3.93821	.81462	4.39430	19
20	.76373	3.23239	.78072	3.56041	.79778	3.94517	.81491	4.40263	20
21	.76401	3.23746	.78101	3.56632	.79807	3.95215	.81519	4.41099	21
22	.76429	3.24255	.78129	3.57224	.79835	3.95914	.81548	4.41937	22
23	.76458	3.24764	.78157	3.57819	.79864	3.96616	.81576	4.42778	23
24	.76486	3.25275	.78186	3.58414	.79892	3.97320	.81605	4.43622	24
25	.76514	3.25787	.78214	3.59012	.79921	3.98026	.81633	4.44468	25
26	.76542	3.26300	.78242	3.59611	.79949	3.98733	.81662	4.45317	26
27	.76571	3.26814	.78271	3.60211	.79978	3.99443	.81691	4.46169	27
28	.76599	3.27330	.78299	3.60813	.80006	4.00155	.81719	4.47023	28
29	.76627	3.27847	.78328	3.61417	.80035	4.00869	.81748	4.47881	29
30	.76655	3.28366	.78356	3.62023	.80063	4.01585	.81776	4.48740	30
31	.76684	3.28885	.78384	3.62630	.80092	4.02303	.81805	4.49603	31
32	.76712	3.29406	.78413	3.63238	.80120	4.03024	.81834	4.50468	32
33	.76740	3.29929	.78441	3.63849	.80149	4.03746	.81862	4.51337	33
34	.76769	3.30452	.78470	3.64461	.80177	4.04471	.81891	4.52208	34
35	.76797	3.30977	.78498	3.65074	.80206	4.05197	.81919	4.53081	35
36	.76825	3.31503	.78526	3.65690	.80234	4.05926	.81948	4.53958	36
37	.76854	3.32031	.78555	3.66307	.80263	4.06657	.81977	4.54837	37
38	.76882	3.32560	.78583	3.66925	.80291	4.07390	.82005	4.55720	38
39	.76910	3.33090	.78612	3.67545	.80320	4.08126	.82034	4.56605	39
40	.76938	3.33622	.78640	3.68167	.80348	4.08863	.82063	4.57493	40
41	.76967	3.34154	.78669	3.68791	.80377	4.09602	.82091	4.58383	41
42	.76995	3.34689	.78697	3.69417	.80405	4.10344	.82120	4.59277	42
43	.77023	3.35224	.78725	3.70044	.80434	4.11088	.82148	4.60174	43
44	.77052	3.35761	.78754	3.70673	.80462	4.11835	.82177	4.61073	44
45	.77080	3.36299	.78782	3.71303	.80491	4.12583	.82206	4.61976	45
46	.77108	3.36839	.78811	3.71935	.80520	4.13334	.82234	4.62881	46
47	.77137	3.37380	.78839	3.72569	.80548	4.14087	.82263	4.63790	47
48	.77165	3.37923	.78868	3.73205	.80577	4.14842	.82292	4.64701	48
49	.77193	3.38466	.78896	3.73843	.80605	4.15599	.82320	4.65616	49
50	.77222	3.39012	.78924	3.74482	.80634	4.16358	.82349	4.66533	50
51	.77250	3.39558	.78953	3.75123	.80662	4.17121	.82377	4.67454	51
52	.77278	3.40106	.78981	3.75766	.80691	4.17886	.82406	4.68377	52
53	.77307	3.40656	.79010	3.76411	.80719	4.18652	.82435	4.69304	53
54	.77335	3.41206	.79038	3.77057	.80748	4.19421	.82463	4.70234	54
55	.77363	3.41759	.79067	3.77705	.80776	4.20193	.82492	4.71166	55
56	.77392	3.42312	.79095	3.78355	.80805	4.20966	.82521	4.72102	56
57	.77420	3.42867	.79123	3.79007	.80833	4.21742	.82549	4.73041	57
58	.77448	3.43424	.79152	3.79661	.80862	4.22521	.82578	4.73983	58
59	.77477	3.43982	.79180	3.80316	.80891	4.23301	.82607	4.74929	59
60	.77505	3.44541	.79209	3.80973	.80919	4.24084	.82635	4.75877	60

## 296 NATURAL VERSED SINES AND EXTERNAL SEC.

	80°		81°		82°		83°		
'	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	'
0	.82635	4.75877	.84357	5.39245	.86083	6.18530	.87813	7.20551	0
1	.82664	4.76829	.84385	5.40422	.86112	6.20020	.87842	7.22500	1
2	.82692	4.77784	.84414	5.41602	.86140	6.21517	.87871	7.24457	2
3	.82721	4.78742	.84443	5.42787	.86169	6.23019	.87900	7.26425	3
4	.82750	4.79703	.84471	5.43977	.86198	6.24529	.87929	7.28402	4
5	.82778	4.80667	.84500	5.45171	.86227	6.26044	.87957	7.30388	5
6	.82807	4.81635	.84529	5.46369	.86256	6.27566	.87986	7.32384	6
7	.82836	4.82606	.84558	5.47572	.86284	6.29095	.88015	7.34390	7
8	.82864	4.83581	.84586	5.48779	.86313	6.30630	.88044	7.36405	8
9	.82893	4.84558	.84615	5.49991	.86342	6.32171	.88073	7.38431	9
10	.82922	4.85539	.84644	5.51208	.86371	6.33719	.88102	7.40466	10
11	.82950	4.86524	.84673	5.52429	.86400	6.35274	.88131	7.42511	11
12	.82979	4.87511	.84701	5.53655	.86428	6.36835	.88160	7.44566	12
13	.83008	4.88502	.84730	5.54886	.86457	6.38403	.88189	7.46632	13
14	.83036	4.89497	.84759	5.56121	.86486	6.39978	.88217	7.48707	14
15	.83065	4.90495	.84788	5.57361	.86515	6.41560	.88246	7.50793	15
16	.83094	4.91498	.84816	5.58606	.86544	6.43148	.88275	7.52889	16
17	.83122	4.92501	.84845	5.59855	.86573	6.44743	.88304	7.54996	17
18	.83151	4.93509	.84874	5.61110	.86601	6.46346	.88333	7.57113	18
19	.83180	4.94521	.84903	5.62369	.86630	6.47955	.88362	7.59241	19
20	.83208	4.95536	.84931	5.63633	.86659	6.49571	.88391	7.61379	20
21	.83237	4.96555	.84960	5.64902	.86688	6.51194	.88420	7.63528	21
22	.83266	4.97577	.84989	5.66176	.86717	6.52825	.88448	7.65688	22
23	.83294	4.98603	.85018	5.67454	.86746	6.54462	.88477	7.67859	23
24	.83323	4.99633	.85046	5.68738	.86774	6.56107	.88506	7.70041	24
25	.83352	5.00666	.85075	5.70027	.86803	6.57759	.88535	7.72234	25
26	.83380	5.01703	.85104	5.71321	.86832	6.59418	.88564	7.74438	26
27	.83409	5.02743	.85133	5.72620	.86861	6.61085	.88593	7.76653	27
28	.83438	5.03787	.85162	5.73924	.86890	6.62759	.88622	7.78880	28
29	.83467	5.04834	.85190	5.75233	.86919	6.64441	.88651	7.81118	29
30	.83495	5.05886	.85219	5.76547	.86947	6.66130	.88680	7.83367	30
31	.83524	5.06941	.85248	5.77866	.86976	6.67826	.88709	7.85628	31
32	.83553	5.08000	.85277	5.79191	.87005	6.69530	.88737	7.87901	32
33	.83581	5.09062	.85305	5.80521	.87034	6.71242	.88766	7.90186	33
34	.83610	5.10129	.85334	5.81856	.87063	6.72962	.88795	7.92482	34
35	.83639	5.11199	.85363	5.83196	.87092	6.74689	.88824	7.94791	35
36	.83667	5.12273	.85392	5.84542	.87120	6.76424	.88853	7.97111	36
37	.83696	5.13350	.85420	5.85893	.87149	6.78167	.88882	7.99444	37
38	.83725	5.14432	.85449	5.87250	.87178	6.79918	.88911	8.01788	38
39	.83754	5.15517	.85478	5.88612	.87207	6.81677	.88940	8.04146	39
40	.83782	5.16607	.85507	5.89979	.87236	6.83443	.88969	8.06515	40
41	.83811	5.17700	.85536	5.91352	.87265	6.85218	.88998	8.08897	41
42	.83840	5.18797	.85564	5.92731	.87294	6.87001	.89027	8.11292	42
43	.83868	5.19898	.85593	5.94115	.87322	6.88792	.89055	8.13699	43
44	.83897	5.21004	.85622	5.95505	.87351	6.90592	.89084	8.16120	44
45	.83926	5.22113	.85651	5.96900	.87380	6.92400	.89113	8.18553	45
46	.83954	5.23226	.85680	5.98301	.87409	6.94216	.89142	8.20999	46
47	.83983	5.24343	.85708	5.99708	.87438	6.96040	.89171	8.23459	47
48	.84012	5.25464	.85737	6.01120	.87467	6.97873	.89200	8.25931	48
49	.84041	5.26590	.85766	6.02538	.87496	6.99714	.89229	8.28419	49
50	.84069	5.27719	.85795	6.03962	.87524	7.01565	.89258	8.30917	50
51	.84098	5.28853	.85823	6.05392	.87553	7.03423	.89287	8.33430	51
52	.84127	5.29991	.85852	6.06828	.87582	7.05291	.89316	8.35957	52
53	.84155	5.31133	.85881	6.08269	.87611	7.07167	.89345	8.38497	53
54	.84184	5.32279	.85910	6.09717	.87640	7.09052	.89374	8.41052	54
55	.84213	5.33429	.85939	6.11171	.87669	7.10946	.89403	8.43620	55
56	.84242	5.34584	.85967	6.12630	.87698	7.12849	.89431	8.46203	56
57	.84270	5.35743	.85996	6.14096	.87726	7.14760	.89460	8.48800	57
58	.84299	5.36906	.86025	6.15568	.87755	7.16681	.89489	8.51411	58
59	.84328	5.38073	.86054	6.17046	.87784	7.18612	.89518	8.54037	59
60	.84357	5.39245	.86083	6.18530	.87813	7.20551	.89547	8.56677	60

NATURAL VERSED SINES AND EXTERNAL SEC. 297

84°

85°

86°

Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	'
.89547	8.56677	.91284	10.47371	.93024	13.33559	0
.89576	8.59332	.91313	10.51199	.93053	13.39547	1
.89605	8.62002	.91342	10.55052	.93082	13.45586	2
.89634	8.64687	.91371	10.58932	.93111	13.51676	3
.89663	8.67387	.91400	10.62837	.93140	13.57817	4
.89692	8.70103	.91429	10.66769	.93169	13.64011	5
.89721	8.72833	.91458	10.70728	.93198	13.70258	6
.89750	8.75579	.91487	10.74714	.93227	13.76558	7
.89779	8.78341	.91516	10.78727	.93257	13.82913	8
.89808	8.81119	.91545	10.82768	.93286	13.89323	9
.89836	8.83912	.91574	10.86837	.93315	13.95788	10
.89865	8.86722	.91603	10.90934	.93344	14.02310	11
.89894	8.89547	.91632	10.95060	.93373	14.08890	12
.89923	8.92389	.91661	10.99214	.93402	14.15527	13
.89952	8.95248	.91690	11.03397	.93431	14.22223	14
.89981	8.98123	.91719	1.07610	.93460	14.28979	15
.90010	9.01015	.91748	11.11852	.93489	14.35795	16
.90039	9.03923	.91777	11.16125	.93518	14.42672	17
.90068	9.06849	.91806	11.20427	.93547	14.49611	18
.90097	9.09792	.91835	11.24761	.93576	14.56614	19
.90126	9.12752	.91864	11.29125	.93605	14.63679	20
.90155	9.15730	.91893	11.33521	.93634	14.70810	21
.90184	9.18725	.91922	11.37948	.93663	14.78005	22
.90213	9.21739	.91951	11.42408	.93692	14.85268	23
.90242	9.24770	.91980	11.46900	.93721	14.92597	24
.90271	9.27819	.92009	11.51424	.93750	14.99995	25
.90300	9.30887	.92038	11.55982	.93779	15.07462	26
.90329	9.33973	.92067	11.60572	.93808	15.14999	27
.90358	9.37077	.92096	11.65197	.93837	15.22607	28
.90386	9.40201	.92125	11.69856	.93866	15.30287	29
.90415	9.43343	.92154	11.74550	.93895	15.38041	30
.90444	9.46505	.92183	11.79278	.93924	15.45869	31
.90473	9.49685	.92212	11.84042	.93953	15.53772	32
.90502	9.52886	.92241	11.88841	.93982	15.61751	33
.90531	9.56106	.92270	11.93677	.94011	15.69808	34
.90560	9.59346	.92299	11.98549	.94040	15.77944	35
.90589	9.62605	.92328	12.03458	.94069	15.86159	36
.90618	9.65885	.92357	12.08404	.94098	15.94456	37
.90647	9.69186	.92386	12.13388	.94127	16.02835	38
.90676	9.72507	.92415	12.18411	.94156	16.11297	39
.90705	9.75849	.92444	12.23472	.94186	16.19843	40
.90734	9.79212	.92473	12.28572	.94215	16.28476	41
.90763	9.82596	.92502	12.33712	.94244	16.37196	42
.90792	9.86001	.92531	12.38891	.94273	16.46005	43
.90821	9.89428	.92560	12.44112	.94302	16.54903	44
.90850	9.92877	.92589	12.49373	.94331	16.63893	45
.90879	9.96348	.92618	12.54676	.94360	16.72975	46
.90908	9.99841	.92647	12.60021	.94389	16.82152	47
.90937	10.03356	.92676	12.65408	.94418	16.91424	48
.90966	10.06894	.92705	12.70838	.94447	17.00794	49
.90995	10.10455	.92734	12.76312	.94476	17.10262	50
.91024	10.14039	.92763	12.81829	.94505	17.19830	51
.91053	10.17646	.92792	12.87391	.94534	17.29501	52
.91082	10.21277	.92821	12.92999	.94563	17.39274	53
.91111	10.24932	.92850	12.98651	.94592	17.49153	54
.91140	10.28610	.92879	13.04350	.94621	17.59139	55
.91169	10.32313	.92908	13.10096	.94650	17.69233	56
.91198	10.36040	.92937	13.15889	.94679	17.79438	57
.91226	10.39792	.92966	13.21730	.94708	17.89755	58
.91255	10.43569	.92995	13.27620	.94737	18.00185	59
.91284	10.47371	.93024	13.33559	.94766	18.10732	60

298 NATURAL VERSED SINES AND EXTERNAL SEC.

	87°		88°		89°		
	Vers.	Ex. sec.	Vers.	Ex. sec.	Vers.	Ex. sec.	
0	.94766	18.10732	.96510	27.65371	.98255	53.29869	0
1	.94795	18.21397	.96539	27.89440	.98284	57.26976	1
2	.94825	18.32182	.96568	28.13917	.98313	58.27431	2
3	.94854	18.43088	.96597	28.38812	.98342	59.31411	3
4	.94883	18.54119	.96626	28.64137	.98371	60.39105	4
5	.94912	18.65275	.96655	28.89903	.98400	61.50715	5
6	.94941	18.76560	.96684	29.16120	.98429	62.66480	6
7	.94970	18.87976	.96714	29.42802	.98458	63.86572	7
8	.94999	18.99524	.96743	29.69960	.98487	65.11304	8
9	.95028	19.11208	.96772	29.97607	.98517	66.40927	9
10	.95057	19.23028	.96801	30.25758	.98546	67.75736	10
11	.95086	19.34989	.96830	30.54425	.98575	69.16047	11
12	.95115	19.47093	.96859	30.83623	.98604	70.62207	12
13	.95144	19.59341	.96888	31.13366	.98633	72.14583	13
14	.95173	19.71737	.96917	31.43671	.98662	73.73586	14
15	.95202	19.84283	.96946	31.74554	.98691	75.39655	15
16	.95231	19.96982	.96975	32.06030	.98720	77.13274	16
17	.95260	20.09838	.97004	32.38118	.98749	78.94968	17
18	.95289	20.22852	.97033	32.70835	.98778	80.85315	18
19	.95318	20.36027	.97062	33.04199	.98807	82.84947	19
20	.95347	20.49368	.97092	33.38232	.98836	84.94561	20
21	.95377	20.62878	.97121	33.72952	.98866	87.14924	21
22	.95406	20.76555	.97150	34.08380	.98895	89.46886	22
23	.95435	20.90409	.97179	34.44539	.98924	91.91387	23
24	.95464	21.04440	.97208	34.81462	.98953	94.49471	24
25	.95493	21.18653	.97237	35.19141	.98982	97.22303	25
26	.95522	21.33050	.97266	35.57633	.99011	100.1119	26
27	.95551	21.47635	.97295	35.96953	.99040	103.1757	27
28	.95580	21.62413	.97324	36.37127	.99069	106.4311	28
29	.95609	21.77386	.97353	36.78185	.99098	109.8966	29
30	.95638	21.92559	.97382	37.20155	.99127	113.5930	30
31	.95667	22.07935	.97411	37.63068	.99156	117.5444	31
32	.95696	22.23520	.97440	38.06957	.99185	121.7780	32
33	.95725	22.39316	.97470	38.51865	.99214	126.3253	33
34	.95754	22.55328	.97499	38.97797	.99244	131.2223	34
35	.95783	22.71563	.97528	39.44820	.99273	136.5111	35
36	.95812	22.88022	.97557	39.92983	.99302	142.2406	36
37	.95842	23.04712	.97586	40.42266	.99331	148.4684	37
38	.95871	23.21637	.97615	40.92772	.99360	155.2623	38
39	.95900	23.38802	.97644	41.44525	.99389	162.7033	39
40	.95929	23.56212	.97673	41.97571	.99418	170.8883	40
41	.95958	23.73873	.97702	42.51961	.99447	179.9350	41
42	.95987	23.91790	.97731	43.07748	.99476	189.9868	42
43	.96016	24.09989	.97760	43.64980	.99505	201.2212	43
44	.96045	24.28414	.97789	44.23720	.99535	213.8600	44
45	.96074	24.47134	.97819	44.84026	.99564	228.1839	45
46	.96103	24.66132	.97848	45.45963	.99593	244.5540	46
47	.96132	24.85417	.97877	46.09596	.99622	263.4427	47
48	.96161	25.04994	.97906	46.74997	.99651	285.4795	48
49	.96190	25.24869	.97935	47.42241	.99680	311.5230	49
50	.96219	25.45051	.97964	48.11406	.99709	342.7752	50
51	.96248	25.65548	.97993	48.82576	.99738	380.9723	51
52	.96277	25.86360	.98022	49.55840	.99767	428.7187	52
53	.96307	26.07503	.98051	50.31290	.99796	490.1070	53
54	.96336	26.28981	.98080	51.09027	.99825	571.9581	54
55	.96365	26.50804	.98109	51.89156	.99855	688.5496	55
56	.96394	26.72978	.98138	52.71790	.99884	858.4369	56
57	.96423	26.95513	.98168	53.57046	.99913	1144.916	57
58	.96452	27.18417	.98197	54.45053	.99942	1717.874	58
59	.96481	27.41700	.98226	55.35946	.99971	3436.747	59
60	.96510	27.65371	.98255	56.29869	1.00000	Infinita	60

RADII — METRIC

$$R = 10 \operatorname{csc} \frac{M}{2}$$

Deg.	Radius.	Log. rad.	Deg.	Radius.	Log. rad.	Deg.	Radius.	Log. rad.
0° 00'	∞	∞	1° 00'	1145.930	3.05916	2° 00'	572.987	2.75814
01	68754.931	4.83730	01	1127.145	3.05198	01	568.252	2.75454
02	34377.468	4.53627	02	1108.966	3.04492	02	563.595	2.75097
03	22918.310	4.36018	03	1091.364	3.03797	03	559.013	2.74742
04	17188.735	4.23524	04	1074.311	3.03113	04	554.505	2.74391
05	13750.987	4.13833	05	1057.785	3.02440	05	550.070	2.74042
06	11459.157	4.05912	06	1041.757	3.01777	06	545.705	2.73696
07	9822.134	3.99221	07	1026.209	3.01124	07	541.408	2.73352
08	8594.369	3.93421	08	1011.118	3.00480	08	537.179	2.73012
09	7639.438	3.88306	09	996.465	2.99846	09	533.015	2.72674
10	6875.496	3.83730	10	982.230	2.99221	10	528.916	2.72339
11	6250.451	3.79591	11	968.396	2.98605	11	524.879	2.72006
12	5729.582	3.75812	12	954.947	2.97998	12	520.903	2.71676
13	5288.845	3.72336	13	941.866	2.97399	13	516.985	2.71348
14	4911.070	3.69118	14	929.139	2.96808	14	513.129	2.71023
15	4583.666	3.66121	15	916.751	2.96225	15	509.328	2.70700
16	4297.187	3.63318	16	904.689	2.95650	16	505.584	2.70379
17	4044.412	3.60686	17	892.940	2.95082	17	501.894	2.70061
18	3819.723	3.58203	18	881.492	2.94522	18	498.258	2.69745
19	3618.685	3.55855	19	870.335	2.93969	19	494.674	2.69432
20	3437.752	3.53627	20	859.456	2.93422	20	491.141	2.69121
21	3274.050	3.51509	21	848.846	2.92883	21	487.658	2.68812
22	3125.230	3.49488	22	838.495	2.92350	22	484.224	2.68505
23	2989.351	3.47558	23	828.393	2.91824	23	480.838	2.68200
24	2864.795	3.45709	24	818.532	2.91304	24	477.500	2.67897
25	2750.203	3.43936	25	808.902	2.90790	25	474.207	2.67597
26	2644.427	3.42233	26	799.497	2.90282	26	470.960	2.67298
27	2546.485	3.40594	27	790.308	2.89780	27	467.756	2.67002
28	2455.540	3.39015	28	781.327	2.89283	28	464.596	2.66708
29	2370.867	3.37491	29	772.549	2.88793	29	461.479	2.66415
30	2291.838	3.36018	30	763.966	2.88307	30	458.403	2.66125
31	2217.909	3.34594	31	755.571	2.87828	31	455.367	2.65836
32	2148.600	3.33216	32	747.359	2.87353	32	452.372	2.65550
33	2083.491	3.31879	33	739.323	2.86883	33	449.416	2.65265
34	2022.212	3.30583	34	731.458	2.86419	34	446.498	2.64982
35	1964.435	3.29324	35	723.759	2.85959	35	443.618	2.64701
36	1909.898	3.28100	36	716.221	2.85505	36	440.775	2.64422
37	1858.251	3.26910	37	708.837	2.85055	37	437.968	2.64144
38	1809.350	3.25752	38	701.605	2.84609	38	435.196	2.63868
39	1762.957	3.24624	39	694.518	2.84168	39	432.460	2.63595
40	1718.893	3.23525	40	687.574	2.83732	40	429.757	2.63322
41	1676.959	3.22452	41	680.766	2.83300	41	427.088	2.63052
42	1637.032	3.21406	42	674.093	2.82872	42	424.452	2.62783
43	1598.962	3.20384	43	667.549	2.82448	43	421.849	2.62516
44	1562.623	3.19385	44	661.130	2.82029	44	419.277	2.62250
45	1527.899	3.18409	45	654.834	2.81613	45	416.737	2.61986
46	1494.684	3.17455	46	648.657	2.81202	46	414.227	2.61724
47	1462.883	3.16521	47	642.595	2.80794	47	411.747	2.61463
48	1432.406	3.15607	48	636.646	2.80390	48	409.296	2.61204
49	1403.174	3.14711	49	630.806	2.79990	49	406.875	2.60946
50	1375.111	3.13834	50	625.072	2.79593	50	404.482	2.60690
51	1348.148	3.12974	51	619.441	2.79200	51	402.117	2.60435
52	1322.223	3.12130	52	613.910	2.78810	52	399.780	2.60182
53	1297.276	3.11303	53	608.478	2.78424	53	397.469	2.59930
54	1273.253	3.10491	54	603.141	2.78042	54	395.186	2.59680
55	1250.103	3.09695	55	597.897	2.77663	55	392.928	2.59431
56	1227.780	3.08912	56	592.743	2.77287	56	390.696	2.59184
57	1206.241	3.08143	57	587.677	2.76914	57	388.489	2.58938
58	1185.444	3.07388	58	582.698	2.76544	58	386.307	2.58693
59	1165.352	3.06646	59	577.802	2.76178	59	384.149	2.58450

## RADII — METRIC — (Continued)

Deg.	Radius.	Log. rad.	Deg.	Radius.	Log. rad.	Deg.	Radius.	Log. rad.
3° 00'	382.016	2.58208	4° 00'	286.537	2.45718	5° 00'	229.256	2.36032
01	379.906	2.57968	01	285.348	2.45537	01	228.495	2.35888
02	377.818	2.57728	02	284.170	2.45358	02	227.739	2.35744
03	375.754	2.57490	03	283.001	2.45179	03	226.987	2.35600
04	373.713	2.57254	04	281.842	2.45001	04	226.241	2.35457
05	371.693	2.57018	05	280.692	2.44823	05	225.500	2.35315
06	369.695	2.56784	06	279.551	2.44646	06	224.764	2.35173
07	367.719	2.56552	07	278.420	3.44470	07	224.032	2.35031
08	365.763	2.56320	08	277.298	2.44295	08	223.305	2.34890
09	363.828	2.56090	09	276.185	2.44120	09	222.583	2.34749
10	361.914	2.55861	10	275.080	2.43946	10	221.865	2.34609
11	360.020	2.55633	11	273.985	2.43773	11	221.152	2.34469
12	358.145	2.55406	12	272.898	2.43600	12	220.444	2.34330
13	356.290	2.55180	13	271.820	2.43428	13	219.740	2.34191
14	354.454	2.54956	14	270.750	2.43257	14	219.041	2.34053
15	352.637	2.54733	15	269.689	2.43086	15	218.346	2.33915
16	350.838	2.54511	16	268.636	2.42916	16	217.656	2.33777
17	349.058	2.54290	17	267.591	2.42747	17	216.969	2.33640
18	347.295	2.54070	18	266.555	2.42579	18	216.288	2.33503
19	345.550	2.53851	19	265.526	2.42411	19	215.610	2.33367
20	343.823	2.53633	20	264.505	2.42243	20	214.937	2.33231
21	342.113	2.53417	21	263.492	2.42077	21	214.268	2.33096
22	340.420	2.53202	22	262.487	2.41911	22	213.603	2.32961
23	338.743	2.52987	23	261.489	2.41745	23	212.942	2.32826
24	337.084	2.52774	24	260.499	2.41581	24	212.285	2.32692
25	335.440	2.52561	25	259.517	2.41417	25	211.632	2.32558
26	333.812	2.52350	26	258.542	2.41253	26	210.984	2.32425
27	332.200	2.52140	27	257.574	2.41090	27	210.339	2.32292
28	330.603	2.51931	28	256.613	2.40928	28	209.698	2.32159
29	329.022	2.51722	29	255.660	2.40766	29	209.061	2.32027
30	327.455	2.51515	30	254.713	2.40605	30	208.428	2.31896
31	325.904	2.51309	31	253.774	2.40445	31	207.799	2.31764
32	324.367	2.51104	32	252.841	2.40285	32	207.174	2.31633
33	322.845	2.50899	33	251.916	2.40126	33	206.552	2.31503
34	321.337	2.50696	34	250.997	2.39967	34	205.934	2.31373
35	319.842	2.50494	35	250.085	2.39809	35	205.320	2.31243
36	318.362	2.50292	36	249.179	2.39651	36	204.709	2.31114
37	316.896	2.50092	37	248.280	2.39494	37	204.102	2.30985
38	315.442	2.49892	38	247.387	2.39338	38	203.499	2.30856
39	314.003	2.49693	39	246.501	2.39182	39	202.899	2.30728
40	312.576	2.49496	40	245.621	2.39027	40	202.303	2.30600
41	311.162	2.49299	41	244.748	2.38872	41	201.710	2.30473
42	309.761	2.49103	42	243.880	2.38718	42	201.121	2.30346
43	308.372	2.48907	43	243.019	2.38564	43	200.535	2.30219
44	306.996	2.48713	44	242.164	2.38411	44	199.952	2.30093
45	305.632	2.48520	45	241.314	2.38258	45	199.373	2.29967
46	304.280	2.48327	46	240.471	2.38106	46	198.798	2.29841
47	302.940	2.48136	47	239.634	2.37955	47	198.225	2.29716
48	301.612	2.47945	48	238.802	2.37804	48	197.656	2.29591
49	300.295	2.47755	49	237.976	2.37653	49	197.090	2.29466
50	298.990	2.47566	50	237.156	2.37503	50	196.528	2.29342
51	297.696	2.47377	51	236.342	2.37354	51	195.968	2.29219
52	296.414	2.47190	52	235.533	2.37205	52	195.412	2.29095
53	295.142	2.47003	53	234.730	2.37057	53	194.859	2.28972
54	293.881	2.46817	54	233.932	2.36909	54	194.309	2.28849
55	292.631	2.46632	55	233.139	2.36761	55	193.762	2.28727
56	291.392	2.46448	56	232.352	2.36615	56	193.218	2.28605
57	290.163	2.46264	57	231.570	2.36468	57	192.677	2.28483
58	288.944	2.46081	58	230.794	2.36322	58	192.140	2.28362
59	287.735	2.45899	59	230.022	2.36177	59	191.606	2.28241

## RADII — METRIC — (Continued)

Deg.	Radius.	Log. rad.	Deg.	Radius.	Log. rad.	Deg.	Radius.	Log. rad.
6° 00'	191.073	2.28120	7° 00'	163.804	2.21432	8° 00'	143.356	2.15642
01	190.544	2.28000	01	163.415	2.21329	01	143.058	2.15551
02	190.018	2.27879	02	163.029	2.21226	02	142.762	2.15461
03	189.496	2.27760	03	162.644	2.21124	03	142.467	2.15371
04	188.976	2.27641	04	162.261	2.21021	04	142.173	2.15282
05	188.458	2.27521	05	161.880	2.20919	05	141.880	2.15192
06	187.944	2.27403	06	161.500	2.20817	06	141.589	2.15103
07	187.432	2.27284	07	161.122	2.20715	07	141.299	2.15014
08	186.923	2.27166	08	160.746	2.20614	08	141.010	2.14925
09	186.417	2.27049	09	160.372	2.20513	09	140.722	2.14836
10	185.914	2.26931	10	160.000	2.20412	10	140.435	2.14748
11	185.413	2.26814	11	159.629	2.20311	11	140.150	2.14659
12	184.915	2.26697	12	159.260	2.20211	12	139.865	2.14571
13	184.420	2.26581	13	158.892	2.20110	13	139.582	2.14483
14	183.927	2.26465	14	158.527	2.20010	14	139.300	2.14395
15	183.437	2.26349	15	158.163	2.19910	15	139.019	2.14307
16	182.950	2.26233	16	157.800	2.19811	16	138.739	2.14220
17	182.465	2.26118	17	157.440	2.19712	17	138.460	2.14132
18	181.983	2.26003	18	157.081	2.19612	18	138.183	2.14045
19	181.503	2.25888	19	156.724	2.19514	19	137.906	2.13958
20	181.026	2.25774	20	156.368	2.19415	20	137.631	2.13872
21	180.552	2.25660	21	156.014	2.19316	21	137.357	2.13785
22	180.079	2.25546	22	155.661	2.19218	22	137.084	2.13699
23	179.610	2.25433	23	155.310	2.19120	23	136.812	2.13612
24	179.142	2.25320	24	154.961	2.19022	24	136.541	2.13526
25	178.678	2.25207	25	154.613	2.18925	25	136.271	2.13440
26	178.215	2.25094	26	154.267	2.18827	26	136.002	2.13355
27	177.755	2.24982	27	153.923	2.18730	27	135.734	2.13269
28	177.298	2.24870	28	153.580	2.18633	28	135.468	2.13184
29	176.842	2.24759	29	153.238	2.18537	29	135.202	2.13098
30	176.389	2.24647	30	152.898	2.18440	30	134.937	2.13013
31	175.939	2.24536	31	152.559	2.18344	31	134.674	2.12928
32	175.490	2.24425	32	152.222	2.18248	32	134.411	2.12843
33	175.044	2.24315	33	151.887	2.18152	33	134.150	2.12759
34	174.600	2.24204	34	151.553	2.18056	34	133.889	2.12674
35	174.159	2.24095	35	151.220	2.17961	35	133.630	2.12590
36	173.720	2.23985	36	150.889	2.17866	36	133.371	2.12506
37	173.283	2.23876	37	150.559	2.17771	37	133.114	2.12422
38	172.848	2.23766	38	150.231	2.17676	38	132.857	2.12338
39	172.415	2.23658	39	149.904	2.17581	39	132.602	2.12255
40	171.984	2.23549	40	149.579	2.17487	40	132.347	2.12171
41	171.556	2.23441	41	149.255	2.17393	41	132.094	2.12088
42	171.130	2.23333	42	148.932	2.17299	42	131.841	2.12005
43	170.705	2.23225	43	148.611	2.17205	43	131.589	2.11922
44	170.284	2.23117	44	148.291	2.17111	44	131.339	2.11839
45	169.863	2.23010	45	147.973	2.17018	45	131.089	2.11757
46	169.446	2.22903	46	147.656	2.16925	46	130.840	2.11674
47	169.030	2.22796	47	147.340	2.16832	47	130.593	2.11592
48	168.616	2.22690	48	147.026	2.16739	48	130.346	2.11510
49	168.204	2.22584	49	146.713	2.16647	49	130.100	2.11428
50	167.794	2.22478	50	146.401	2.16554	50	129.855	2.11346
51	167.387	2.22372	51	146.091	2.16462	51	129.611	2.11264
52	166.981	2.22267	52	145.782	2.16370	52	129.368	2.11183
53	166.577	2.22162	53	145.474	2.16278	53	129.125	2.11101
54	166.175	2.22057	54	145.168	2.16187	54	128.884	2.11020
55	165.775	2.21952	55	144.862	2.16095	55	128.644	2.10939
56	165.377	2.21848	56	144.559	2.16005	56	128.404	2.10858
57	164.981	2.21743	57	144.256	2.15913	57	128.166	2.10777
58	164.587	2.21640	58	143.955	2.15823	58	127.928	2.10697
59	164.195	2.21536	59	143.655	2.15732	59	127.691	2.10616



## RADII — METRIC — (Continued)

Deg.	Radius.	Log. rad.	Deg.	Radius.	Log. rad.	Deg.	Radius.	Log. rad.
9° 00'	127.455	2.10536	10° 00'	114.737	2.05970	11° 00'	104.334	2.01843
01	127.220	2.10456	01	114.547	2.05898	01	104.177	2.01777
02	126.986	2.10376	02	114.357	2.05826	02	104.020	2.01712
03	126.752	2.10295	03	114.168	2.05754	03	103.864	2.01646
04	126.520	2.10216	04	113.979	2.05682	04	103.708	2.01581
05	126.288	2.10136	05	113.791	2.05611	05	103.552	2.01516
06	126.057	2.10057	06	113.604	2.05539	06	103.397	2.01451
07	125.827	2.09977	07	113.417	2.05468	07	103.243	2.01386
08	125.598	2.09898	08	113.231	2.05397	08	103.089	2.01321
09	125.370	2.09819	09	113.046	2.05326	09	102.935	2.01256
10	125.142	2.09740	10	112.861	2.05254	10	102.782	2.01192
11	124.916	2.09662	11	112.677	2.05184	11	102.629	2.01127
12	124.690	2.09583	12	112.493	2.05113	12	102.477	2.01063
13	124.465	2.09505	13	112.310	2.05042	13	102.325	2.00998
14	124.241	2.09426	14	112.128	2.04971	14	102.174	2.00934
15	124.017	2.09348	15	111.946	2.04901	15	102.023	2.00870
16	123.795	2.09270	16	111.765	2.04831	16	101.873	2.00806
17	123.573	2.09192	17	111.584	2.04760	17	101.723	2.00742
18	123.352	2.09115	18	111.404	2.04690	18	101.573	2.00678
19	123.132	2.09037	19	111.224	2.04620	19	101.424	2.00614
20	122.912	2.08959	20	111.046	2.04550	20	101.275	2.00550
21	122.694	2.08882	21	110.867	2.04480	21	101.127	2.00487
22	122.476	2.08805	22	110.689	2.04410	22	100.979	2.00423
23	122.259	2.08728	23	110.512	2.04341	23	100.832	2.00360
24	122.043	2.08651	24	110.336	2.04272	24	100.685	2.00296
25	121.827	2.08574	25	110.160	2.04202	25	100.538	2.00233
26	121.612	2.08498	26	109.984	2.04133	26	100.392	2.00170
27	121.398	2.08421	27	109.809	2.04064	27	100.247	2.00107
28	121.185	2.08345	28	109.635	2.03995	28	100.102	2.00044
29	120.973	2.08269	29	109.461	2.03926	29	99.957	1.99981
30	120.761	2.08193	30	109.288	2.03857	30	99.812	1.99918
31	120.550	2.08117	31	109.115	2.03788	31	99.668	1.99856
32	120.340	2.08041	32	108.943	2.03720	32	99.525	1.99793
33	120.130	2.07965	33	108.771	2.03651	33	99.382	1.99731
34	119.921	2.07890	34	108.600	2.03583	34	99.239	1.99668
35	119.713	2.07814	35	108.430	2.03515	35	99.097	1.99606
36	119.506	2.07739	36	108.260	2.03447	36	98.955	1.99544
37	119.299	2.07664	37	108.090	2.03379	37	98.813	1.99481
38	119.093	2.07589	38	107.921	2.03311	38	98.672	1.99419
39	118.888	2.07514	39	107.753	2.03243	39	98.532	1.99358
40	118.684	2.07439	40	107.585	2.03175	40	98.391	1.99296
41	118.480	2.07364	41	107.418	2.03108	41	98.251	1.99234
42	118.277	2.07290	42	107.251	2.03040	42	98.112	1.99173
43	118.074	2.07215	43	107.084	2.02972	43	97.973	1.99111
44	117.873	2.07141	44	106.919	2.02905	44	97.834	1.99049
45	117.672	2.07067	45	106.753	2.02838	45	97.696	1.98988
46	117.471	2.06993	46	106.588	2.02771	46	97.558	1.98926
47	117.272	2.06919	47	106.424	2.02704	47	97.420	1.98865
48	117.073	2.06846	48	106.261	2.02637	48	97.283	1.98804
49	116.875	2.06772	49	106.097	2.02570	49	97.147	1.98743
50	116.677	2.06699	50	105.935	2.02504	50	97.010	1.98682
51	116.480	2.06625	51	105.772	2.02437	51	96.874	1.98621
52	116.284	2.06552	52	105.611	2.02371	52	96.739	1.98560
53	116.088	2.06479	53	105.449	2.02304	53	96.604	1.98500
54	115.893	2.06406	54	105.289	2.02238	54	96.469	1.98439
55	115.699	2.06333	55	105.128	2.02172	55	96.334	1.98378
56	115.505	2.06260	56	104.968	2.02106	56	96.200	1.98318
57	115.312	2.06187	57	104.809	2.02040	57	96.067	1.98257
58	115.120	2.06115	58	104.650	2.01974	58	95.933	1.98197
59	114.928	2.06043	59	104.492	2.01908	59	95.800	1.98137

## RADII — METRIC — (Continued)

Deg.	Radius.	Log. rad.	Deg.	Radius.	Log. rad.	Deg.	Radius.	Log. rad.
13° 00'	95.668	1.98077	13° 00'	88.337	1.94614	14° 00'	82.055	1.91410
01	95.536	1.98017	01	88.224	1.94559	01	81.958	1.91359
02	95.404	1.97957	02	88.112	1.94504	02	81.861	1.91308
03	95.272	1.97897	03	88.000	1.94448	03	81.765	1.91257
04	95.141	1.97837	04	87.888	1.94393	04	81.668	1.91205
05	95.010	1.97777	05	87.776	1.94338	05	81.572	1.91154
06	94.880	1.97717	06	87.665	1.94283	06	81.476	1.91103
07	94.750	1.97658	07	87.554	1.94228	07	81.380	1.91052
08	94.620	1.97598	08	87.444	1.94173	08	81.285	1.91001
09	94.491	1.97539	09	87.333	1.94118	09	81.190	1.90950
10	94.362	1.97480	10	87.223	1.94063	10	81.095	1.90899
11	94.233	1.97420	11	87.114	1.94009	11	81.000	1.90848
12	94.105	1.97361	12	87.004	1.93954	12	80.905	1.90798
13	93.977	1.97302	13	86.895	1.93899	13	80.811	1.90747
14	93.850	1.97243	14	86.786	1.93845	14	80.717	1.90696
15	93.723	1.97185	15	86.677	1.93790	15	80.623	1.90646
16	93.596	1.97126	16	86.569	1.93736	16	80.529	1.90595
17	93.469	1.97067	17	86.461	1.93682	17	80.436	1.90545
18	93.343	1.97008	18	86.353	1.93628	18	80.342	1.90494
19	93.217	1.96950	19	86.245	1.93573	19	80.249	1.90444
20	93.092	1.96891	20	86.138	1.93519	20	80.156	1.90394
21	92.967	1.96833	21	86.031	1.93465	21	80.064	1.90344
22	92.842	1.96774	22	85.924	1.93411	22	79.971	1.90293
23	92.717	1.96716	23	85.818	1.93358	23	79.879	1.90243
24	92.593	1.96658	24	85.711	1.93304	24	79.787	1.90193
25	92.469	1.96600	25	85.605	1.93250	25	79.696	1.90144
26	92.346	1.96542	26	85.500	1.93197	26	79.604	1.90093
27	92.223	1.96484	27	85.394	1.93143	27	79.513	1.90044
28	92.100	1.96426	28	85.289	1.93089	28	79.422	1.89994
29	91.977	1.96368	29	85.184	1.93036	29	79.331	1.89944
30	91.855	1.96310	30	85.079	1.92982	30	79.240	1.89894
31	91.733	1.96253	31	84.975	1.92929	31	79.149	1.89845
32	91.612	1.96195	32	84.871	1.92876	32	79.059	1.89795
33	91.491	1.96138	33	84.767	1.92823	33	78.969	1.89746
34	91.370	1.96080	34	84.663	1.92769	34	78.879	1.89696
35	91.249	1.96023	35	84.560	1.92716	35	78.790	1.89647
36	91.129	1.95966	36	84.457	1.92664	36	78.700	1.89597
37	91.009	1.95908	37	84.354	1.92611	37	78.611	1.89548
38	90.890	1.95852	38	84.251	1.92558	38	78.522	1.89499
39	90.770	1.95794	39	84.149	1.92505	39	78.433	1.89450
40	90.652	1.95738	40	84.047	1.92452	40	78.344	1.89401
41	90.533	1.95681	41	83.945	1.92399	41	78.256	1.89352
42	90.415	1.95624	42	83.843	1.92347	42	78.168	1.89303
43	90.297	1.95567	43	83.742	1.92294	43	78.080	1.89254
44	90.179	1.95511	44	83.640	1.92241	44	77.992	1.89205
45	90.061	1.95454	45	83.540	1.92189	45	77.904	1.89156
46	89.944	1.95397	46	83.439	1.92137	46	77.817	1.89107
47	89.828	1.95341	47	83.339	1.92085	47	77.729	1.89058
48	89.711	1.95285	48	83.238	1.92032	48	77.642	1.89010
49	89.595	1.95228	49	83.138	1.91980	49	77.556	1.88962
50	89.479	1.95172	50	83.039	1.91928	50	77.469	1.88913
51	89.363	1.95116	51	82.939	1.91876	51	77.382	1.88864
52	89.248	1.95060	52	82.840	1.91824	52	77.296	1.88816
53	89.133	1.95004	53	82.741	1.91772	53	77.210	1.88767
54	89.019	1.94948	54	82.642	1.91720	54	77.124	1.88719
55	88.904	1.94892	55	82.544	1.91669	55	77.039	1.88671
56	88.790	1.94836	56	82.446	1.91617	56	76.953	1.88623
57	88.676	1.94781	57	82.348	1.91565	57	76.868	1.88575
58	88.563	1.94725	58	82.250	1.91514	58	76.783	1.88527
59	88.450	1.94670	59	82.152	1.91462	59	76.698	1.88478

## RADI — METRIC — (Continued)

Deg.	Radius.	Log. rad.	Deg.	Radius.	Log. rad.	Deg.	Radius.	Log. rad.
15° 00'	76.613	1.88430	19° 00'	60.589	1.78239	23° 00'	50.159	1.70035
05	76.192	1.88191	05	60.326	1.78050	15	49.626	1.69571
10	75.776	1.87953	10	60.067	1.77864	30	49.106	1.69113
15	75.364	1.87716	15	59.809	1.77677	45	48.596	1.68660
20	74.957	1.87481	20	59.554	1.77491	24° 00'	48.097	1.68212
25	74.554	1.87247	25	59.300	1.77305	15	47.609	1.67769
30	74.156	1.87015	30	59.050	1.77122	30	47.130	1.67330
35	73.762	1.86783	35	58.801	1.76938	45	46.662	1.66896
40	73.372	1.86553	40	58.554	1.76756	25° 00'	46.202	1.66466
45	72.986	1.86324	45	58.309	1.76574	15	45.752	1.66041
50	72.604	1.86096	50	58.067	1.76393	30	45.311	1.65620
55	72.227	1.85870	55	57.826	1.76212	45	44.878	1.65203
16° 00'	71.853	1.85644	20° 00'	57.588	1.76033	26° 00'	44.454	1.64791
05	71.483	1.85420	05	57.351	1.75854	15	44.038	1.64383
10	71.117	1.85197	10	57.117	1.75677	30	43.630	1.63979
15	70.755	1.84976	15	56.884	1.75499	45	43.230	1.63579
20	70.396	1.84755	20	56.653	1.75322	27° 00'	42.837	1.63182
25	70.041	1.84535	25	56.425	1.75147	15	42.451	1.62789
30	69.690	1.84317	30	56.198	1.74972	30	42.072	1.62399
35	69.342	1.84100	35	55.973	1.74798	45	41.701	1.62015
40	68.998	1.83884	40	55.749	1.74624	28° 00'	41.336	1.61633
45	68.657	1.83668	45	55.528	1.74451	15	40.977	1.61254
50	68.320	1.83455	50	55.308	1.74279	30	40.625	1.60879
55	67.986	1.83242	55	55.090	1.74107	45	40.279	1.60508
17° 00'	67.655	1.83030	21° 00'	54.874	1.73937	29° 00'	39.939	1.60140
05	67.327	1.82819	05	54.660	1.73767	15	39.605	1.59775
10	67.003	1.82609	10	54.447	1.73597	30	39.277	1.59414
15	66.682	1.82401	15	54.236	1.73429	45	38.954	1.59055
20	66.363	1.82193	20	54.026	1.73260	30° 00'	38.637	1.58700
25	66.058	1.81986	25	53.819	1.73094			
30	65.756	1.81780	30	53.612	1.72926			
35	65.457	1.81576	35	53.408	1.72761			
40	65.161	1.81372	40	53.205	1.72595			
45	64.868	1.81170	45	53.003	1.72430			
50	64.577	1.80967	50	52.804	1.72267			
55	64.219	1.80766	55	52.605	1.72103			
18° 00'	63.924	1.80566	22° 00'	52.408	1.71940			
05	63.632	1.80368	05	52.213	1.71778			
10	63.343	1.80170	10	52.019	1.71616			
15	63.056	1.79973	15	51.827	1.71456			
20	62.772	1.79777	20	51.636	1.71295			
25	62.490	1.79581	25	51.446	1.71135			
30	62.211	1.79387	30	51.258	1.70976			
35	61.935	1.79194	35	51.072	1.70818			
40	61.661	1.79001	40	50.886	1.70660			
45	61.389	1.78809	45	50.702	1.70503			
50	61.120	1.78618	50	50.520	1.70346			
55	60.853	1.78428	55	50.338	1.70190			

NOTATION

- $\Delta$  = Curvature increment of taper per 10 meters of taper.
- $M$  = Degree of main circular curve.
- $l$  = Length of taper from the B.C. of the taper.
- $f$  = Deflection from tangent at the B.C. of the taper.
- $f', f_1, f_2, \text{ etc.}$  = Deflection from tangent at some point on the taper.
- $b$  = Deflection from tangent at the end of the taper, C.C. of main curve, to the B.C. of the taper.
- $o$  = Central angle of the taper at each end of the curve.
- $d$  = Circular curve offset from tangent to provide room for the taper.
- $t$  = Distance along the tangent, from opposite the offset position of the B.C. of the simple curve to the B.C. of the taper.
- $D = R + d$ , where  $R$  is the radius of the main circular curve.
- $x$  and  $y$  are co-ordinates of points on the taper, referred to the tangent at the B.C. of the taper as meridian, and to a radial line at the B.C. of the taper as base.
- $lc$  = Long chord of the taper, from the B.C. of the taper to points on the taper.
- $s$  = Distance along the taper, from the B.C. of the taper to the transit, when an intermediate set-up is necessary.
- $T$  = Semi-tangent of the entire tapered curve, from P.I. to B.C. or E.C.
- $E$  = External, the distance from the P.I. to a point on the curve radially opposite.

EQUATIONS

- |  | Eqn. No.                                       |
|--|--|
| $t = t + D \tan \frac{1}{2} I.$                            | (7) Both ends the same taper.                  |
| $t = t + D \tan \frac{1}{2} I - d \csc I.$                 | (8) Tapered end — other end not tapered.       |
| $n = R \tan \frac{1}{2} I + d \csc I.$                     | (9) Untapered end — other end tapered.         |
| $t_1 = t_1 + D_1 \tan \frac{1}{2} I - (d_1 - d_2) \csc I.$ | (10) Both ends tapered, with different tapers. |
| $t_2 = t_2 + D_2 \tan \frac{1}{2} I - (d_2 - d_1) \csc I.$ | (11) Both ends tapered, with different tapers. |
| $t = D \sec \frac{1}{2} I - R.$                            | (12) Both ends the same taper.                 |

EMPIRICAL EQUATIONS DERIVED FROM THE  
METRIC TABLES

$$l = \frac{10}{\Delta} (M - \Delta). \quad (45r)$$

$$f = \frac{(l + 5)(l + 10)}{\frac{20}{\Delta}}. \quad (107r)$$

$$f' = \frac{(l + 2s + 15)(l - s) + 50}{\frac{20}{\Delta}}. \quad (94r)$$

$$o = \frac{3l(l + 10)}{\frac{20}{\Delta}}. \quad (108r)$$

The equations under paragraph 18 as derived from the metric taper tables become:

$$l = \frac{10}{\Delta} (M - \Delta). \quad (45r)$$

$$l_2 = \frac{10}{\Delta} (M_2 - \Delta). \quad (46r)$$

$$l_1 = \frac{10 M_1}{\Delta}. \quad (47r)$$

$$l_c = \frac{10}{\Delta} (M_2 - M_1 - \Delta). \quad (48r)$$

$$o_c = \frac{15 (M_2 + M_1) (M_2 - M_1 - \Delta)}{\Delta}. \quad (50r)$$

$$a = \frac{15 M_1 (M_2 - M_1 - \Delta)}{\Delta}. \quad (51a_1)$$

$$f_c = \frac{(3l_1 + l_c + 15)l_c + 50}{\frac{20}{\Delta}}. \quad (56r)$$

$$f_c = \frac{5}{2} \left[ \frac{(4M_1 + 2M_2 + \Delta)(M_2 - M_1 - \Delta)}{\Delta} + \Delta \right]. \quad (57r)$$

TAPER  $\frac{1}{2}$  METRIC. CURVATURE INCREASING 0° 15' EVERY 10 M.  $\Delta = \frac{1}{2}$

Transit at	Deflections to																
	B.C. 0° 15'	C.C. 0° 30'	C.C. 0° 45'	C.C. 1° 00'	C.C. 1° 15'	C.C. 1° 30'	C.C. 1° 45'	C.C. 2° 00'	C.C. 2° 15'	C.C. 2° 30'	C.C. 2° 45'	C.C. 3° 00'	C.C. 3° 15'	C.C. 3° 30'	C.C. 3° 45'	C.C. 4° 00'	
l	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	180
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0 03 $\frac{1}{2}$	0 03 $\frac{1}{2}$	0 07 $\frac{1}{2}$	0 17 $\frac{1}{2}$	0 28 $\frac{1}{2}$	0 41 $\frac{1}{2}$	0 57	1 15	1 35 $\frac{1}{2}$	1 58 $\frac{1}{2}$	2 24 $\frac{1}{2}$	2 52 $\frac{1}{2}$	3 23	3 56 $\frac{1}{2}$	4 32	5 10	
20	0 13	0 07 $\frac{1}{2}$	0 11 $\frac{1}{2}$	0 17	0 28 $\frac{1}{2}$	0 43	1 00	1 19 $\frac{1}{2}$	1 41 $\frac{1}{2}$	2 05 $\frac{1}{2}$	2 32 $\frac{1}{2}$	3 02	3 33 $\frac{1}{2}$	4 08	4 45	5 24 $\frac{1}{2}$	
30	0 27 $\frac{1}{2}$	0 20 $\frac{1}{2}$	0 11 $\frac{1}{2}$	0 15	0 24 $\frac{1}{2}$	0 32	0 58	1 18 $\frac{1}{2}$	1 42	2 07 $\frac{1}{2}$	2 35 $\frac{1}{2}$	3 06 $\frac{1}{2}$	3 39 $\frac{1}{2}$	4 15	4 53	5 33 $\frac{1}{2}$	
40	0 47	0 38 $\frac{1}{2}$	0 28	0 15	0 15	0 18 $\frac{1}{2}$	0 39 $\frac{1}{2}$	1 02 $\frac{1}{2}$	1 28	2 04 $\frac{1}{2}$	2 33 $\frac{1}{2}$	3 09 $\frac{1}{2}$	3 40	4 17	4 56 $\frac{1}{2}$	5 38	
50	1 11 $\frac{1}{2}$	1 02	0 50	0 35 $\frac{1}{2}$	0 18 $\frac{1}{2}$	0 22 $\frac{1}{2}$	0 22 $\frac{1}{2}$	0 47	1 13 $\frac{1}{2}$	1 43	2 15	2 49 $\frac{1}{2}$	3 26 $\frac{1}{2}$	4 05 $\frac{1}{2}$	4 47 $\frac{1}{2}$	5 32	
60	1 40 $\frac{1}{2}$	1 30	1 17	1 01 $\frac{1}{2}$	0 43	0 50 $\frac{1}{2}$	0 26 $\frac{1}{2}$	0 26 $\frac{1}{2}$	1 13 $\frac{1}{2}$	1 25	1 58	2 33 $\frac{1}{2}$	3 12	3 52 $\frac{1}{2}$	4 35 $\frac{1}{2}$	5 21 $\frac{1}{2}$	
70	2 15	2 03	1 48 $\frac{1}{2}$	1 32	1 12 $\frac{1}{2}$	0 50 $\frac{1}{2}$	0 26 $\frac{1}{2}$	0 30	0 30	1 02	1 36 $\frac{1}{2}$	2 13	2 52 $\frac{1}{2}$	3 34 $\frac{1}{2}$	4 18 $\frac{1}{2}$	5 05 $\frac{1}{2}$	
80	2 54 $\frac{1}{2}$	2 41 $\frac{1}{2}$	2 25 $\frac{1}{2}$	2 07 $\frac{1}{2}$	1 47	1 23 $\frac{1}{2}$	0 58	0 30	0 33 $\frac{1}{2}$	1 02	1 36 $\frac{1}{2}$	2 13	2 28	3 11 $\frac{1}{2}$	3 57	4 45	
90	3 38 $\frac{1}{2}$	3 24 $\frac{1}{2}$	3 07 $\frac{1}{2}$	2 48	2 26 $\frac{1}{2}$	2 02	1 35	1 05 $\frac{1}{2}$	0 33 $\frac{1}{2}$	1 02	1 36 $\frac{1}{2}$	2 13	2 28	3 11 $\frac{1}{2}$	3 57	4 45	
100	4 28	4 12 $\frac{1}{2}$	3 54 $\frac{1}{2}$	3 33 $\frac{1}{2}$	3 10 $\frac{1}{2}$	2 45	2 17	1 46 $\frac{1}{2}$	1 13	1 25	1 58	2 33 $\frac{1}{2}$	3 12	3 52 $\frac{1}{2}$	4 35 $\frac{1}{2}$	5 21 $\frac{1}{2}$	
110	5 22 $\frac{1}{2}$	5 05 $\frac{1}{2}$	4 46 $\frac{1}{2}$	4 24 $\frac{1}{2}$	4 00	3 33	3 03 $\frac{1}{2}$	2 32	1 57 $\frac{1}{2}$	1 25	1 58	2 33 $\frac{1}{2}$	3 12	3 52 $\frac{1}{2}$	4 35 $\frac{1}{2}$	5 21 $\frac{1}{2}$	
120	6 22	6 03 $\frac{1}{2}$	5 43	5 20	4 54 $\frac{1}{2}$	4 26 $\frac{1}{2}$	3 55 $\frac{1}{2}$	3 22 $\frac{1}{2}$	2 47	2 08 $\frac{1}{2}$	0 41 $\frac{1}{2}$	0 45	0 45	0 48 $\frac{1}{2}$	1 30 $\frac{1}{2}$	2 32 $\frac{1}{2}$	
130	7 26 $\frac{1}{2}$	7 07	6 45	6 20 $\frac{1}{2}$	5 53 $\frac{1}{2}$	5 24 $\frac{1}{2}$	4 52 $\frac{1}{2}$	4 18	3 41 $\frac{1}{2}$	3 02	0 41 $\frac{1}{2}$	0 45	0 45	0 48 $\frac{1}{2}$	1 30 $\frac{1}{2}$	2 32 $\frac{1}{2}$	
140	8 35 $\frac{1}{2}$	8 15	7 52	7 26 $\frac{1}{2}$	6 58 $\frac{1}{2}$	6 27 $\frac{1}{2}$	5 54 $\frac{1}{2}$	5 18 $\frac{1}{2}$	4 40 $\frac{1}{2}$	4 00	3 17	2 31 $\frac{1}{2}$	1 43	0 52 $\frac{1}{2}$	0 52 $\frac{1}{2}$	1 47	
150	9 50	9 28	9 03 $\frac{1}{2}$	8 37	8 07 $\frac{1}{2}$	7 35 $\frac{1}{2}$	7 01 $\frac{1}{2}$	6 24 $\frac{1}{2}$	5 45	5 03	4 18 $\frac{1}{2}$	3 32	2 42 $\frac{1}{2}$	1 50 $\frac{1}{2}$	0 56 $\frac{1}{2}$	...	

## THE RAILROAD TAPER

TAPER  $\frac{1}{2}$  METRIC. CURVATURE INCREASING  $0^{\circ} 15'$  EVERY 10 M. — (Continued)  $\Delta = \frac{1}{2}$

M	l	o	D	log D	d	t	z	v	lc
0 30	10	$0^{\circ} 07\frac{1}{2}$	2291.843	3.36018	0.005	5.000	0.011	10.000	10.000
0 45	20	$0^{\circ} 22\frac{1}{2}$	1527.921	3.18410	0.022	10.000	0.055	20.000	20.000
1 00	30	$0^{\circ} 45$	1145.984	3.05918	0.054	15.000	0.153	29.999	30.000
1 15	40	$1^{\circ} 15$	916.860	2.96230	0.109	19.999	0.327	39.998	39.999
1 30	50	$1^{\circ} 52\frac{1}{2}$	764.156	2.88318	0.190	24.998	0.600	49.994	49.998
1 45	60	$2^{\circ} 37\frac{1}{2}$	655.139	2.81633	0.305	29.996	0.993	59.986	59.995
2 00	70	$3^{\circ} 30$	573.445	2.75849	0.458	34.992	1.527	69.972	69.989
2 15	80	$4^{\circ} 30$	509.982	2.70755	0.654	39.986	2.224	79.948	79.979
2 30	90	$5^{\circ} 37\frac{1}{2}$	459.303	2.66210	0.900	44.977	3.107	89.909	89.962
2 45	100	$6^{\circ} 52\frac{1}{2}$	417.937	2.62111	1.200	49.964	4.196	99.849	99.937
3 00	110	$8^{\circ} 15$	383.576	2.58385	1.560	54.945	5.512	109.762	109.900
3 15	120	$9^{\circ} 45$	354.622	2.54977	1.985	59.920	7.077	119.639	119.848
3 30	130	$11^{\circ} 22\frac{1}{2}$	329.935	2.51843	2.480	64.885	8.911	129.470	129.775
3 45	140	$13^{\circ} 07\frac{1}{2}$	308.683	2.48951	3.051	69.840	11.035	139.242	139.678
4 00	150	$15^{\circ} 00$	290.240	2.46276	3.703	74.781	13.467	148.942	149.550

TAPER  $\frac{1}{2}$  METRIC — INTERMEDIATE VALUES  $\Delta = \frac{1}{2}$ 

<i>M</i>	<i>l</i>	<i>f</i>	<i>b</i>	<i>o</i>	<i>D</i>	$\log D$	<i>d</i>	<i>t</i>	<i>z</i>	<i>y</i>	<i>lc</i>
0 45	20.000	0 09 $\frac{1}{2}$	0 13	0 22 $\frac{1}{2}$	1527.921	3.18410	0.022	10.000	0.055	20.000	20.000
50	23.333	0 11 $\frac{1}{2}$	0 17 $\frac{1}{2}$	0 29 $\frac{1}{2}$	1375.141	3.13835	0.030	11.667	0.080	23.333	23.333
55	26.667	0 14 $\frac{1}{2}$	0 22 $\frac{1}{2}$	0 36 $\frac{1}{2}$	1250.144	3.09606	0.041	13.333	0.113	26.666	26.667
1 00	30.000	0 17 $\frac{1}{2}$	0 27 $\frac{1}{2}$	0 45	1145.984	3.05918	0.054	15.000	0.153	29.999	30.000
05	33.333	0 20 $\frac{1}{2}$	0 33 $\frac{1}{2}$	0 54 $\frac{1}{2}$	1057.855	3.02443	0.070	16.667	0.201	33.333	33.333
10	36.667	0 24 $\frac{1}{2}$	0 40	1 04 $\frac{1}{2}$	982.318	2.99225	0.088	18.332	0.259	36.665	36.666
15	40.000	0 28	0 47	1 15	916.860	2.96230	0.109	19.999	0.327	39.998	39.999
20	43.333	0 32 $\frac{1}{2}$	0 54 $\frac{1}{2}$	1 26 $\frac{1}{2}$	859.589	2.93429	0.133	21.666	0.407	43.331	43.332
25	46.667	0 36 $\frac{1}{2}$	1 02 $\frac{1}{2}$	1 39 $\frac{1}{2}$	809.062	2.90798	0.160	23.331	0.497	46.662	46.665
30	50.000	0 41 $\frac{1}{2}$	1 11 $\frac{1}{2}$	1 52 $\frac{1}{2}$	764.156	2.88318	0.190	24.998	0.600	49.994	49.998
35	53.333	0 46 $\frac{1}{2}$	1 20 $\frac{1}{2}$	2 06 $\frac{1}{2}$	723.984	2.85973	0.225	26.664	0.716	53.325	53.331
40	56.667	0 51 $\frac{1}{2}$	1 30 $\frac{1}{2}$	2 21 $\frac{1}{2}$	687.837	2.83749	0.263	28.330	0.847	56.656	56.663
45	60.000	0 57	1 40 $\frac{1}{2}$	2 37 $\frac{1}{2}$	655.139	2.81633	0.305	29.996	0.993	59.986	59.995
50	63.333	1 02 $\frac{1}{2}$	1 51 $\frac{1}{2}$	2 54 $\frac{1}{2}$	625.423	2.79617	0.351	31.662	1.154	63.316	63.326
55	66.667	1 08 $\frac{1}{2}$	2 03	3 11 $\frac{1}{2}$	598.299	2.77692	0.402	33.327	1.332	66.644	66.658
2 00	70.000	1 15	2 15	3 30	573.445	2.75849	0.458	34.992	1.527	69.972	69.989
05	73.333	1 21 $\frac{1}{2}$	2 27 $\frac{1}{2}$	3 49 $\frac{1}{2}$	550.588	2.74083	0.518	36.657	1.740	73.299	73.319
10	76.667	1 28 $\frac{1}{2}$	2 40 $\frac{1}{2}$	4 09 $\frac{1}{2}$	529.409	2.72387	0.583	38.321	1.972	76.623	76.650
15	80.000	1 35 $\frac{1}{2}$	2 54 $\frac{1}{2}$	4 30	509.982	2.70755	0.654	39.986	2.224	79.948	79.979
20	83.333	1 43	3 08 $\frac{1}{2}$	4 51 $\frac{1}{2}$	491.872	2.69185	0.731	41.651	2.497	83.270	83.307
25	86.667	1 50 $\frac{1}{2}$	3 23 $\frac{1}{2}$	5 14 $\frac{1}{2}$	475.020	2.67671	0.813	43.314	2.791	86.590	86.635
30	90.000	1 58 $\frac{1}{2}$	3 38 $\frac{1}{2}$	5 37 $\frac{1}{2}$	459.303	2.66210	0.900	44.977	3.107	89.909	89.962
35	93.333	2 07	3 54 $\frac{1}{2}$	6 01 $\frac{1}{2}$	444.612	2.64798	0.994	46.639	3.446	93.224	93.288
40	96.667	2 15 $\frac{1}{2}$	4 11 $\frac{1}{2}$	6 26 $\frac{1}{2}$	430.851	2.63433	1.094	48.302	3.808	96.538	96.614
45	100.000	2 24 $\frac{1}{2}$	4 28	6 52 $\frac{1}{2}$	417.937	2.62111	1.200	49.964	4.196	99.849	99.937
50	103.333	2 33 $\frac{1}{2}$	4 45 $\frac{1}{2}$	7 19 $\frac{1}{2}$	405.795	2.60831	1.313	51.626	4.608	103.157	103.259
55	106.667	2 42 $\frac{1}{2}$	5 04	7 46 $\frac{1}{2}$	394.361	2.59589	1.433	53.285	5.047	106.461	106.581
3 00	110.000	2 52 $\frac{1}{2}$	5 22 $\frac{1}{2}$	8 15	383.576	2.58385	1.560	54.945	5.512	109.762	109.900
05	113.333	3 02 $\frac{1}{2}$	5 41 $\frac{1}{2}$	8 44 $\frac{1}{2}$	373.387	2.57216	1.694	56.605	6.005	113.059	113.217
10	116.667	3 12 $\frac{1}{2}$	6 01 $\frac{1}{2}$	9 14 $\frac{1}{2}$	363.750	2.56080	1.836	58.262	6.526	116.351	116.534
15	120.000	3 23	6 22	9 45	354.622	2.54977	1.985	59.920	7.077	119.639	119.848
20	123.333	3 34	6 42 $\frac{1}{2}$	10 16 $\frac{1}{2}$	345.965	2.53903	2.142	61.576	7.658	122.922	123.160
25	126.667	3 45	7 04 $\frac{1}{2}$	10 49 $\frac{1}{2}$	337.747	2.52859	2.307	63.231	8.269	126.199	126.470
30	130.000	3 56 $\frac{1}{2}$	7 26 $\frac{1}{2}$	11 22 $\frac{1}{2}$	329.935	2.51843	2.480	64.885	8.911	129.470	129.775
35	133.333	4 07 $\frac{1}{2}$	7 49	11 56 $\frac{1}{2}$	322.503	2.50853	2.661	66.539	9.586	132.734	133.078
40	136.667	4 19 $\frac{1}{2}$	8 12	12 31 $\frac{1}{2}$	315.427	2.49890	2.851	68.189	10.294	135.992	136.380
45	140.000	4 32	8 35 $\frac{1}{2}$	13 07 $\frac{1}{2}$	308.683	2.48951	3.051	69.840	11.035	139.242	139.678
50	143.000	4 44 $\frac{1}{2}$	9 00	13 44 $\frac{1}{2}$	302.249	2.48036	3.259	71.489	11.810	142.484	142.973
55	146.667	4 57	9 24 $\frac{1}{2}$	14 21 $\frac{1}{2}$	296.107	2.47145	3.476	73.135	12.620	145.718	146.265
4 00	150.000	5 10	9 50	15 00	290.240	2.46276	3.703	74.751	13.467	148.942	149.550



TAPER 1 METRIC. CURVATURE INCREASING 0° 30' EVERY 10 M.  $\Delta = \frac{1}{2}$ 

Transit at	Deflections to																
	B.C. 0° 30'	C.C. 1° 00'	C.C. 1° 30'	C.C. 2° 00'	C.C. 2° 30'	C.C. 3° 00'	C.C. 3° 30'	C.C. 4° 00'	C.C. 4° 30'	C.C. 5° 00'	C.C. 5° 30'	C.C. 6° 00'	C.C. 6° 30'	C.C. 7° 00'	C.C. 7° 30'		
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	140	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0 07 $\frac{1}{2}$	0 18 $\frac{1}{2}$	0 35	0 56 $\frac{1}{2}$	1 22 $\frac{1}{2}$	1 53 $\frac{1}{2}$	2 30	3 11 $\frac{1}{2}$	3 57 $\frac{1}{2}$	4 48 $\frac{1}{2}$	5 45	6 46 $\frac{1}{2}$	7 52 $\frac{1}{2}$	8 16 $\frac{1}{2}$	9 03 $\frac{1}{2}$	9 03 $\frac{1}{2}$	
20	0 26 $\frac{1}{2}$	0 15	0 33 $\frac{1}{2}$	0 57 $\frac{1}{2}$	1 26 $\frac{1}{2}$	2 00	2 38 $\frac{1}{2}$	3 23 $\frac{1}{2}$	4 11 $\frac{1}{2}$	5 05	6 03 $\frac{1}{2}$	7 07 $\frac{1}{2}$	8 16 $\frac{1}{2}$	8 30	9 46 $\frac{1}{2}$	9 46 $\frac{1}{2}$	
30	0 55	0 22 $\frac{1}{2}$	0 48 $\frac{1}{2}$	0 30	1 20	1 56 $\frac{1}{2}$	2 37 $\frac{1}{2}$	3 23 $\frac{1}{2}$	4 15	5 11 $\frac{1}{2}$	6 12 $\frac{1}{2}$	7 18 $\frac{1}{2}$	8 30	8 33 $\frac{1}{2}$	9 52 $\frac{1}{2}$	9 52 $\frac{1}{2}$	
40	1 33 $\frac{1}{2}$	0 56 $\frac{1}{2}$	0 30	0 37 $\frac{1}{2}$	1 03 $\frac{1}{2}$	1 42 $\frac{1}{2}$	2 26 $\frac{1}{2}$	3 15	4 08 $\frac{1}{2}$	4 53 $\frac{1}{2}$	5 07 $\frac{1}{2}$	6 11 $\frac{1}{2}$	7 20	8 27 $\frac{1}{2}$	9 48 $\frac{1}{2}$	9 48 $\frac{1}{2}$	
50	2 22 $\frac{1}{2}$	1 40	0 30	0 37 $\frac{1}{2}$	1 11 $\frac{1}{2}$	0 45	1 33 $\frac{1}{2}$	2 27 $\frac{1}{2}$	3 26 $\frac{1}{2}$	4 30	5 38 $\frac{1}{2}$	6 00	7 11 $\frac{1}{2}$	8 11 $\frac{1}{2}$	9 35	9 35	
60	3 21 $\frac{1}{2}$	2 32 $\frac{1}{2}$	1 40	1 26 $\frac{1}{2}$	2 02 $\frac{1}{2}$	0 45	0 52 $\frac{1}{2}$	1 48 $\frac{1}{2}$	2 50	3 56 $\frac{1}{2}$	5 07 $\frac{1}{2}$	6 23 $\frac{1}{2}$	7 45	8 11 $\frac{1}{2}$	9 11 $\frac{1}{2}$	9 11 $\frac{1}{2}$	
70	4 30	3 37 $\frac{1}{2}$	2 47 $\frac{1}{2}$	2 25	3 03 $\frac{1}{2}$	1 56 $\frac{1}{2}$	1 00	1 00	2 03 $\frac{1}{2}$	3 12 $\frac{1}{2}$	4 26 $\frac{1}{2}$	5 45	7 08 $\frac{1}{2}$	8 37 $\frac{1}{2}$	9 37 $\frac{1}{2}$	9 37 $\frac{1}{2}$	
80	5 48 $\frac{1}{2}$	4 51 $\frac{1}{2}$	4 03 $\frac{1}{2}$	3 33 $\frac{1}{2}$	4 03 $\frac{1}{2}$	3 10	2 11 $\frac{1}{2}$	1 07 $\frac{1}{2}$	2 07 $\frac{1}{2}$	3 18 $\frac{1}{2}$	4 35	5 45	7 08 $\frac{1}{2}$	8 37 $\frac{1}{2}$	9 37 $\frac{1}{2}$	9 37 $\frac{1}{2}$	
90	7 17 $\frac{1}{2}$	6 15	5 30	4 52 $\frac{1}{2}$	5 30	4 33 $\frac{1}{2}$	3 32 $\frac{1}{2}$	2 26 $\frac{1}{2}$	3 15	4 33 $\frac{1}{2}$	5 53 $\frac{1}{2}$	7 18 $\frac{1}{2}$	8 42 $\frac{1}{2}$	9 26 $\frac{1}{2}$	10 00	10 00	
100	8 56 $\frac{1}{2}$	8 25	7 07 $\frac{1}{2}$	6 21 $\frac{1}{2}$	7 06 $\frac{1}{2}$	6 07 $\frac{1}{2}$	5 03 $\frac{1}{2}$	3 55	4 41 $\frac{1}{2}$	5 53 $\frac{1}{2}$	7 18 $\frac{1}{2}$	8 42 $\frac{1}{2}$	9 26 $\frac{1}{2}$	10 00	10 00	10 00	
110	10 45	9 32 $\frac{1}{2}$	8 48 $\frac{1}{2}$	8 00	8 52 $\frac{1}{2}$	7 51 $\frac{1}{2}$	6 45	5 33 $\frac{1}{2}$	4 21 $\frac{1}{2}$	5 15	6 21 $\frac{1}{2}$	7 30	8 42 $\frac{1}{2}$	9 53 $\frac{1}{2}$	10 45	10 45	
120	12 43 $\frac{1}{2}$	12 07 $\frac{1}{2}$	10 40	9 48 $\frac{1}{2}$	10 40	9 45	8 36 $\frac{1}{2}$	7 22 $\frac{1}{2}$	6 03 $\frac{1}{2}$	4 40	3 11 $\frac{1}{2}$	1 37 $\frac{1}{2}$	1 37 $\frac{1}{2}$	1 45	1 45	1 45	
130	14 52 $\frac{1}{2}$	14 13 $\frac{1}{2}$	13 30	12 41 $\frac{1}{2}$	11 47 $\frac{1}{2}$	11 48 $\frac{1}{2}$	10 37 $\frac{1}{2}$	9 21 $\frac{1}{2}$	8 00	6 33 $\frac{1}{2}$	5 02 $\frac{1}{2}$	3 26 $\frac{1}{2}$	1 45	1 45	1 45	1 45	
140	17 11 $\frac{1}{2}$	16 30	15 43 $\frac{1}{2}$	14 52 $\frac{1}{2}$	13 56 $\frac{1}{2}$	12 55	11 48 $\frac{1}{2}$	10 37 $\frac{1}{2}$	9 21 $\frac{1}{2}$	8 00	6 33 $\frac{1}{2}$	5 02 $\frac{1}{2}$	3 26 $\frac{1}{2}$	1 45	1 45	1 45	

TAPER 1 METRIC. CURVATURE INCREASING 0° 30' EVERY 10 M. — (Continued)  $\Delta = \frac{1}{2}$

M	l	o	D	log. D	d	t	z	v	lc
1 00	10	0 15	1145.941	3.05916	0.011	5.000	0.022	10.000	10.000
1 30	20	0 45	764.009	2.88310	0.043	10.000	0.109	20.000	20.000
2 00	30	1 30	573.095	2.75823	0.108	14.999	0.305	29.998	29.999
2 30	40	2 30	458.620	2.66145	0.217	19.997	0.654	39.992	39.997
3 00	50	3 45	382.396	2.58251	0.380	24.992	1.200	49.977	49.992
3 30	60	5 15	328.064	2.51596	0.609	29.984	1.984	59.946	59.978
4 00	70	7 00	287.452	2.45857	0.915	34.969	3.051	69.889	69.956
4 30	80	9 00	256.020	2.40827	1.307	39.946	4.444	79.792	79.918
5 00	90	11 15	231.054	2.36372	1.798	44.911	6.202	89.636	89.850
5 30	100	13 45	210.825	2.32392	2.397	49.858	8.369	99.399	99.751
6 00	110	16 30	194.188	2.28822	3.115	54.785	10.981	109.052	109.604
6 30	120	19 30	180.350	2.25612	3.961	59.683	14.077	118.563	119.395
7 00	130	22 45	168.751	2.22725	4.947	64.546	17.689	127.890	129.108
7 30	140	26 15	158.979	2.20134	6.081	69.365	21.850	136.990	138.718

TAPER 1 METRIC.—INTERMEDIATE VALUES  $\Delta = \frac{1}{2}$ 

M	l	f	b	o	D	log D	d	t	z	y	lc
1 30	20.000	0 18½	0 26½	0 45	764.009	2.88310	0.043	10.000	0.109	20.000	20.000
35	21.667	0 21	0 30½	0 51½	723.810	2.85962	0.051	10.833	0.133	21.666	21.667
40	23.333	0 23½	0 34½	0 58½	687.634	2.83736	0.060	11.666	0.160	23.333	23.333
45	25.000	0 26½	0 39½	1 05½	654.905	2.81618	0.071	12.499	0.191	24.999	25.000
50	26.667	0 29	0 44½	1 13½	625.154	2.79599	0.082	13.333	0.225	26.665	26.666
55	28.333	0 32	0 49½	1 21½	597.991	2.77669	0.094	14.166	0.263	28.332	28.333
2 00	30.000	0 35	0 55	1 30	573.095	2.75823	0.108	14.999	0.305	29.998	29.999
05	31.666	0 38½	1 00½	1 39	550.193	2.74052	0.123	15.832	0.352	31.664	31.665
10	33.333	0 41½	1 06½	1 48½	529.055	2.72350	0.139	16.665	0.403	33.330	33.332
15	35.000	0 45	1 13	1 58	509.484	2.70713	0.156	17.498	0.458	34.996	34.998
20	36.667	0 48½	1 19½	2 08½	491.316	2.69136	0.175	18.331	0.518	36.661	36.665
25	38.333	0 52½	1 26½	2 19	474.402	2.67615	0.195	19.164	0.583	38.327	38.331
30	40.000	0 56½	1 33½	2 30	458.620	2.66145	0.217	19.997	0.654	39.992	39.997
35	41.667	1 00½	1 41½	2 41½	443.858	2.64725	0.240	20.829	0.730	41.657	41.663
40	43.333	1 04½	1 48½	2 53½	430.022	2.63347	0.265	21.662	0.812	43.322	43.328
45	45.000	1 08½	1 56½	3 05½	417.028	2.62017	0.291	22.495	0.900	44.986	44.995
50	46.667	1 13	2 05	3 18½	404.801	2.60724	0.319	23.327	0.993	46.650	46.661
55	48.333	1 17½	2 13½	3 31½	393.277	2.59470	0.349	24.160	1.063	48.314	48.326
3 00	50.000	1 22½	2 22½	3 45	382.396	2.58251	0.380	24.992	1.200	49.977	49.992
05	51.667	1 27½	2 31½	3 59	372.106	2.57067	0.413	25.824	1.313	51.640	51.657
10	53.333	1 32½	2 41	4 13½	362.363	2.55914	0.449	26.657	1.432	53.302	53.321
15	55.000	1 37½	2 50½	4 28	353.123	2.54793	0.486	27.489	1.559	54.964	54.986
20	56.667	1 42½	3 00½	4 43½	344.348	2.53700	0.525	28.320	1.693	56.626	56.650
25	58.333	1 48½	3 10½	4 59	336.006	2.52635	0.566	29.152	1.835	58.286	58.314
30	60.000	1 53½	3 21½	5 15	328.064	2.51596	0.609	29.984	1.984	59.946	59.978
35	61.667	1 59½	3 32	5 31½	320.496	2.50582	0.654	30.815	2.141	61.606	61.643
40	63.333	2 05½	3 43	5 48½	313.278	2.49593	0.702	31.646	2.306	63.264	63.306
45	65.000	2 11½	3 54½	6 05½	306.384	2.48627	0.752	32.477	2.480	64.922	64.969
50	66.667	2 17½	4 06	6 23½	299.794	2.47682	0.804	33.308	2.662	66.579	66.633
55	68.333	2 23½	4 18	6 41½	293.489	2.46759	0.858	34.139	2.852	68.235	68.294
4 00	70.000	2 30	4 30	7 00	287.452	2.45857	0.915	34.969	3.051	69.889	69.956
05	71.667	2 36½	4 42½	7 19	281.666	2.44973	0.974	35.799	3.260	71.543	71.618
10	73.333	2 43½	4 55	7 38½	276.115	2.44109	1.035	36.629	3.477	73.195	73.278
15	75.000	2 50	5 08	7 58	270.788	2.43263	1.099	37.459	3.704	74.847	74.939
20	76.667	2 57	5 21½	8 18½	265.671	2.42434	1.166	38.288	3.941	76.497	76.600
25	78.333	3 04	5 35	8 39	260.752	2.41623	1.235	39.117	4.187	78.145	78.259
30	80.000	3 11½	5 48½	9 00	256.020	2.40827	1.307	39.946	4.444	79.792	79.918
35	81.667	3 18½	6 03	9 21½	251.467	2.40048	1.382	40.774	4.710	81.437	81.576
40	83.333	3 26	6 17½	9 43½	247.080	2.39284	1.459	41.602	4.987	83.081	83.232
45	85.000	3 33½	6 31½	10 05½	242.854	2.38535	1.540	42.430	5.274	84.723	84.888
50	86.667	3 41½	6 46½	10 28½	238.779	2.37800	1.623	43.257	5.572	86.363	86.543
55	88.333	3 49½	7 02	10 51½	234.848	2.37079	1.709	44.084	5.882	88.000	88.196
5 00	90.000	3 57½	7 17½	11 15	231.054	2.36372	1.798	44.911	6.202	89.636	89.850
05	91.667	4 05½	7 33½	11 39	227.390	2.35677	1.890	45.736	6.534	91.270	91.503
10	93.333	4 14	7 49½	12 03½	223.850	2.34996	1.985	46.562	6.877	92.901	93.154
15	95.000	4 22½	8 05½	12 28	220.429	2.34327	2.083	47.387	7.232	94.529	94.805
20	96.667	4 31	8 22½	12 53½	217.122	2.33670	2.185	48.211	7.599	96.155	96.455
25	98.333	4 39½	8 39½	13 19	213.921	2.33025	2.289	49.035	7.977	97.780	98.103
30	100.000	4 48½	8 56½	13 45	210.825	2.32392	2.397	49.858	8.369	99.399	99.751
35	101.667	4 57½	9 13½	14 11½	207.828	2.31770	2.508	50.681	8.772	101.016	101.401
40	103.333	5 07	9 31½	14 38½	204.925	2.31159	2.622	51.503	9.188	102.631	103.041
45	105.000	5 16½	9 49½	15 05½	202.113	2.30559	2.740	52.325	9.617	104.241	104.684
50	106.667	5 25½	10 07½	15 33½	199.389	2.29970	2.861	53.145	10.059	105.849	106.326
55	108.333	5 36½	10 25½	16 01½	196.748	2.29391	2.986	53.965	10.517	107.452	107.969
6 00	110.000	5 45	10 45	16 30	194.188	2.28823	3.115	54.785	10.981	109.052	109.604
15	115.000	6 15	11 43	17 58	186.958	2.27174	3.521	57.238	12.466	113.828	114.508
30	120.000	6 46½	12 43½	19 30	180.350	2.25612	3.961	59.683	14.077	118.563	119.395
45	125.000	7 18½	13 46½	21 05½	174.299	2.24129	4.436	62.119	15.817	123.252	124.263
7 00	130.000	7 52½	14 52½	22 45	168.751	2.22725	4.947	64.546	17.689	127.890	129.108
15	135.000	8 27½	16 00½	24 28	163.658	2.21394	5.495	66.961	19.698	132.471	133.929
30	140.000	9 03½	17 11½	26 15	158.979	2.20134	6.081	69.365	21.850	136.990	138.718



TAPER  $1\frac{1}{2}$  METRIC. CURVATURE INCREASING  $0^{\circ} 45'$  EVERY 10 M. — (Continued)  $\Delta = \frac{1}{4}$

$M$	$l$	$\phi$	$D$	$\log D$	$d$	$t$	$z$	$y$	$lc$
1 30	10	$0^{\circ} 22\frac{1}{2}$	763.982	2.88308	0.016	5.000	0.032	10.000	10.000
2 15	20	$1^{\circ} 07\frac{1}{2}$	509.393	2.70705	0.065	9.999	0.164	19.999	20.000
3 00	30	$2^{\circ} 15$	382.179	2.58227	0.163	14.997	0.458	29.995	29.999
3 45	40	$3^{\circ} 45$	305.958	2.48566	0.326	19.992	0.981	39.982	39.994
4 30	50	$5^{\circ} 37\frac{1}{2}$	255.285	2.40703	0.572	24.982	1.799	49.948	49.980
5 15	60	$7^{\circ} 52\frac{1}{2}$	219.261	2.34096	0.915	29.963	2.974	59.879	59.952
6 00	70	$10^{\circ} 30$	192.446	2.28431	1.373	34.930	4.572	69.750	69.900
6 45	80	$13^{\circ} 30$	171.824	2.23508	1.961	39.877	6.652	79.531	79.811
7 30	90	$16^{\circ} 52\frac{1}{2}$	155.593	2.19199	2.695	44.798	9.276	89.182	89.665
8 15	100	$20^{\circ} 37\frac{1}{2}$	142.609	2.15414	3.590	49.681	12.499	98.651	99.439
9 00	110	$24^{\circ} 45$	132.115	2.12095	4.660	54.517	16.356	107.878	109.110
9 45	120	$29^{\circ} 15$	123.594	2.09200	5.922	59.291	20.921	116.788	118.647
10 30	130	$34^{\circ} 07\frac{1}{2}$	116.676	2.06698	7.388	63.987	26.204	125.298	128.009

TAPER 1½ METRIC. INTERMEDIATE VALUES

M	t	f	b	o	D	log D	d	t	z	y	lc
2 15	20.000	0.28	0.39½	1.07½	509.393	2.70705	0.065	9.999	0.164	19.999	20.000
20	21.111	0.30½	0.43½	1.14	491.214	2.69127	0.073	10.555	0.188	21.111	21.111
25	22.222	0.33	0.47½	1.20½	474.289	2.67604	0.082	11.110	0.213	22.221	22.222
30	23.333	0.35½	0.52	1.27½	458.494	2.66183	0.091	11.665	0.240	23.332	23.333
35	24.444	0.38	0.57	1.34½	443.719	2.64711	0.101	12.221	0.270	24.444	24.444
40	25.556	0.40½	0.61½	1.42½	429.869	2.63334	0.112	12.776	0.303	25.553	25.556
45	26.667	0.43	0.66½	1.50	416.861	2.61990	0.124	13.331	0.338	26.664	26.666
50	27.778	0.45½	0.71½	1.58	404.618	2.60705	0.136	13.887	0.375	27.774	27.777
55	28.889	0.48	0.77	1.66½	393.077	2.59485	0.149	14.452	0.415	28.885	28.888
3 00	30.000	0.52½	0.82½	1.75	382.179	2.58327	0.163	14.997	0.458	29.995	29.999
05	31.111	0.57	0.88½	1.84	371.870	2.57089	0.177	15.552	0.504	31.105	31.109
10	32.222	0.59	0.94	1.94	362.106	2.55984	0.192	16.108	0.552	32.215	32.220
15	33.333	0.62	1.00½	2.04	352.845	2.54978	0.208	16.663	0.604	33.325	33.331
20	34.444	0.65	1.07½	2.14	344.048	2.53962	0.225	17.218	0.659	34.435	34.441
25	35.556	0.68	1.15	2.24	335.683	2.52933	0.243	17.773	0.716	35.545	35.552
30	36.667	0.71	1.23	2.34	327.717	2.51950	0.262	18.328	0.778	36.654	36.662
35	37.778	0.74	1.31½	2.44	320.124	2.50932	0.282	18.883	0.842	37.764	37.772
40	38.889	0.77	1.40	2.54	312.890	2.49938	0.304	19.437	0.910	38.873	38.883
45	40.000	0.80	1.48½	2.64	305.958	2.48966	0.326	19.992	0.981	39.982	39.994
50	41.111	0.83	1.57	2.74	299.339	2.47916	0.349	20.547	1.057	41.090	41.104
55	42.222	0.86	1.66	2.84	293.004	2.46887	0.373	21.102	1.136	42.199	42.214
4 00	43.333	0.89	1.75	2.94	286.935	2.45878	0.398	21.656	1.218	43.307	43.324
05	44.444	0.91	1.84	3.04	281.116	2.44889	0.424	22.211	1.305	44.414	44.433
10	45.556	0.94	1.94	3.14	275.531	2.44017	0.451	22.765	1.395	45.522	45.543
15	46.667	0.97	2.04	3.24	270.168	2.43163	0.479	23.319	1.490	46.629	46.653
20	47.778	1.00	2.14	3.34	265.013	2.42327	0.508	23.874	1.588	47.736	47.762
25	48.889	1.03	2.24	3.44	260.056	2.41507	0.539	24.428	1.692	48.842	48.871
30	50.000	1.06	2.34	3.54	255.285	2.40703	0.572	24.982	1.799	49.948	49.980
35	51.111	1.09	2.44	3.64	250.690	2.39914	0.605	25.536	1.911	51.054	51.089
40	52.222	1.12	2.54	3.74	246.260	2.39139	0.639	26.090	2.027	52.159	52.198
45	53.333	1.15	2.64	3.84	241.988	2.38379	0.674	26.643	2.148	53.264	53.307
50	54.444	1.18	2.74	3.94	237.867	2.37633	0.711	27.197	2.273	54.367	54.415
55	55.556	1.21	2.84	4.04	233.888	2.36901	0.749	27.750	2.403	55.471	55.523

$\Delta = \frac{1}{4}$

TAPER  $1\frac{1}{4}$  METRIC. INTERMEDIATE VALUES — (Continued)

M	l	f	b	o	D	log D	d	t	z	v	lc
5 00	56 667	2 341	4 301	7 05	230 045	2 36181	0 789	28 304	2 539	56 574	56 631
5 05	57 778	2 391	4 411	7 201	226 330	2 35474	0 830	27 879	2 679	57 678	57 735
10 10	58 889	2 45	4 511	7 361	222 737	2 34770	0 872	26 410	2 824	58 778	58 846
15 15	60 000	2 501	5 021	7 521	219 261	2 34068	0 915	25 043	2 974	59 879	59 952
20 20	61 111	2 551	5 121	8 081	215 897	2 33365	0 960	23 515	3 130	60 979	61 059
25 25	62 222	3 02	5 221	8 251	212 639	2 32704	1 007	22 068	3 291	62 079	62 165
30 30	63 333	3 08	5 341	8 421	209 483	2 32115	1 065	20 512	3 457	63 177	63 271
35 35	64 444	3 131	5 461	8 591	206 424	2 31476	1 104	19 000	3 628	64 275	64 377
40 40	65 556	3 181	5 571	9 171	203 458	2 30847	1 155	17 424	3 804	65 372	65 483
45 45	66 667	3 26	6 091	9 351	200 580	2 30229	1 207	16 000	3 986	66 468	66 588
50 50	67 778	3 321	6 201	9 531	197 789	2 29620	1 261	14 700	4 175	67 563	67 692
55 55	68 889	3 381	6 331	10 111	195 078	2 29021	1 316	13 400	4 371	68 657	68 796
60 00	70 000	3 45	6 451	10 301	192 446	2 28431	1 373	12 200	4 572	69 750	69 900
15	73 333	4 041	7 221	11 271	184 991	2 26715	1 554	10 500	5 208	73 022	73 208
30	76 667	4 251	8 021	12 271	178 139	2 25076	1 750	9 200	5 901	76 253	76 512
45	80 000	4 571	8 831	13 301	171 824	2 23508	1 961	8 000	6 652	79 531	79 811
7 00	83 333	5 091	9 251	14 351	165 993	2 22009	2 189	7 000	7 483	82 765	83 104
15	86 667	5 321	10 101	15 421	160 598	2 20573	2 433	6 200	8 337	85 982	86 389
30	90 000	5 561	10 581	16 521	155 593	2 19199	2 695	5 500	9 276	89 182	89 685
45	93 333	6 211	11 441	18 051	150 948	2 17883	2 973	4 800	10 282	92 361	92 932
8 00	96 667	6 481	12 351	19 201	146 659	2 16622	3 273	4 300	11 356	95 518	96 190
15	100 000	7 13	13 241	20 371	142 609	2 15414	3 590	3 900	12 499	98 651	99 439
30	103 333	7 401	14 171	21 571	138 863	2 14269	3 926	3 500	13 713	101 756	102 676
45	106 667	8 091	15 111	23 201	135 372	2 13153	4 283	3 100	14 990	104 833	105 900
9 00	110 000	8 371	16 071	24 451	132 115	2 12095	4 660	2 700	16 356	107 878	109 110
15	113 333	9 071	17 051	26 121	129 076	2 11065	5 069	2 300	17 800	110 888	112 306
30	116 667	9 38	18 041	27 431	126 240	2 10120	5 479	1 900	19 323	113 859	115 486
45	120 000	10 041	19 051	29 151	123 594	2 09200	5 923	1 500	20 921	116 788	118 647
10 00	123 333	10 411	20 061	30 801	121 124	2 08323	6 387	1 100	22 600	119 673	121 789
15	126 667	11 141	21 131	32 371	118 691	2 07489	6 876	700	24 361	122 510	124 910
30	130 000	11 481	22 181	34 071	116 476	2 06698	7 388	500	26 304	123 298	128 009

TAPER 2 METRIC. CURVATURE INCREASING 1° 00' EVERY 10 M. Δ=1

Transit at	Deflections to												
	B.C. 1° 00'	C.C. 2° 00'	C.C. 3° 00'	C.C. 4° 00'	C.C. 5° 00'	C.C. 6° 00'	C.C. 7° 00'	C.C. 8° 00'	C.C. 9° 00'	C.C. 10° 00'	C.C. 11° 00'	C.C. 12° 00'	C.C. 13° 00'
l	0	10	20	30	40	50	60	70	80	90	100	110	120
0	•	•	•	•	•	•	•	•	•	•	•	•	•
10	0 15	0 15	0 37½	1 10	1 52½	2 45	3 47½	5 00	6 22½	7 55	9 37½	11 30	13 32½
20	0 52½	•	0 30	1 07½	1 55	2 52½	4 00	5 17½	6 45	8 22½	10 10	12 07½	14 15
30	1 50	0 30	•	0 45	1 37½	2 40	3 52½	5 15	6 47½	8 30	10 22½	12 25	14 37½
40	3 07½	1 22½	•	•	1 00	2 07½	3 25	4 52½	6 30	8 17½	10 15	12 22½	14 40
50	4 45	2 35	0 45	•	•	1 15	2 37½	4 10	5 52½	7 45	9 47½	12 00	14 22½
60	6 42½	4 07½	3 20	2 22½	•	•	1 30	3 07½	4 55	6 52½	9 00	11 17½	13 45
70	9 00	6 00	5 07½	4 05	3 20	•	•	1 45	3 37½	5 40	7 52½	10 15	12 47½
80	11 37½	8 12½	7 15	6 07½	4 50	3 22½	1 45	•	2 00	4 07½	6 25	8 52½	11 30
90	14 35	10 45	9 42½	8 30	7 07½	5 35	3 52½	2 00	2 15	2 15	2 30	5 07½	7 55
100	17 52½	13 37½	12 30	11 12½	9 45	8 07½	6 20	4 22½	2 15	•	•	2 45	5 37½
110	21 30	16 50	15 37½	14 15	12 42½	11 00	9 07½	7 05	2 15	2 30	•	•	3 00
120	25 27½	20 22½	19 05	17 37½	16 00	14 12½	12 15	10 07½	2 15	2 30	•	•	•
		24 15	22 52½	21 20	19 37½	17 45	15 42½	13 30	11 07½	8 35	5 52½	3 00	•



TAPER 2 METRIC. CURVATURE INCREASING 1°00' EVERY 10 M. — (Continued)  $\Delta = 1$

$M$	$l$	$o$	$D$	$\log D$	$d$	$t$	$z$	$v$	$lc$
2 00	10	0 30	573.009	2.75816	0.022	5.000	0.044	10.000	10.000
3 00	20	1 30	383.103	2.58218	0.087	9.999	0.218	19.999	20.000
4 00	30	3 00	286.755	2.45751	0.218	14.995	0.611	29.991	29.997
5 00	40	5 00	229.692	2.36115	0.436	19.986	1.308	39.967	39.988
6 00	50	7 30	191.836	2.28293	0.763	24.967	2.397	49.907	49.965
7 00	60	10 30	165.024	2.21755	1.220	29.933	3.962	59.784	59.915
8 00	70	14 00	145.185	2.16192	1.829	34.875	6.085	69.556	69.822
9 00	80	18 00	130.065	2.11416	2.610	39.782	8.845	79.168	79.661
10 00	90	22 30	118.320	2.07306	3.583	44.642	12.314	88.550	89.402
11 00	100	27 30	109.102	2.03783	4.768	49.437	16.554	97.613	99.007
12 00	110	33 00	101.852	2.00797	6.184	54.148	21.617	106.253	108.430
13 00	120	39 00	96.187	1.98312	7.850	58.751	27.539	114.343	117.613

TAPER 2 METRIC. INTERMEDIATE VALUES

$\Delta=1$

$M$	$l$	$f$	$b$	$o$	$D$	$\log D$	$d$	$t$	$z$	$y$	$lc$
3 00	20.000	0.371	0.521	1.30	382.103	2.58218	0.087	9.999	0.218	19.999	20.000
05	20.833	0.394	0.564	1.364	371.768	2.57080	0.095	10.415	0.241	20.833	20.833
10	21.667	0.421	1.005	1.439	362.018	2.55873	0.104	10.832	0.266	21.667	21.666
15	22.500	0.444	1.054	1.493	352.760	2.54747	0.113	11.248	0.292	22.497	22.497
20	23.333	0.471	1.094	1.564	343.946	2.53649	0.123	11.664	0.320	23.330	23.332
25	24.167	0.494	1.141	1.644	335.573	2.52579	0.133	12.081	0.350	24.163	24.165
30	25.000	0.524	1.184	1.711	327.599	2.51534	0.144	12.497	0.382	24.996	24.999
35	25.833	0.551	1.231	1.781	319.997	2.50515	0.155	12.914	0.415	25.828	25.832
40	26.667	0.58	1.281	1.861	312.742	2.49519	0.166	13.330	0.450	26.661	26.665
45	27.500	0.61	1.334	1.944	305.810	2.48545	0.178	13.746	0.487	27.494	27.498
50	28.333	0.64	1.39	2.03	299.180	2.47593	0.190	14.162	0.526	28.326	28.331
55	29.167	0.67	1.441	2.11	292.834	2.46662	0.203	14.579	0.568	29.159	29.164
4 00	30.000	1.10	1.50	3.00	286.755	2.45751	0.218	14.995	0.611	29.991	29.997
05	30.833	1.131	1.551	3.081	280.925	2.44859	0.233	15.411	0.656	30.823	30.830
10	31.667	1.164	2.011	3.18	275.328	2.43985	0.248	15.827	0.703	31.655	31.663
15	32.500	1.194	2.071	3.271	269.952	2.43129	0.263	16.243	0.753	32.487	32.495
20	33.333	1.23	2.13	3.361	264.795	2.42289	0.280	16.659	0.805	33.319	33.328
25	34.167	1.264	2.194	3.461	259.814	2.41466	0.297	17.075	0.859	34.150	34.161
30	35.000	1.30	2.261	3.561	255.028	2.40659	0.315	17.491	0.916	34.982	34.994
35	35.833	1.331	2.321	4.061	250.418	2.39867	0.333	17.907	0.975	35.813	35.826
40	36.667	1.371	2.394	4.161	245.973	2.39089	0.352	18.323	1.037	36.644	36.659
45	37.500	1.41	2.461	4.271	241.686	2.38325	0.372	18.739	1.101	37.475	37.492
50	38.333	1.444	2.531	4.38	237.549	2.37575	0.393	19.155	1.167	38.306	38.324
55	39.167	1.481	3.001	4.491	233.553	2.36839	0.414	19.570	1.236	39.137	39.156
5 00	40.000	1.521	3.071	5.00	229.692	2.36115	0.436	19.986	1.308	39.967	39.988
05	40.833	1.561	3.141	5.111	225.958	2.35403	0.458	20.401	1.383	40.797	40.820
10	41.667	2.001	3.221	5.23	222.347	2.34703	0.482	20.817	1.460	41.627	41.652
15	42.500	2.04	3.30	5.34	218.853	2.34015	0.507	21.232	1.540	42.456	42.484
20	43.333	2.08	3.371	5.461	215.469	2.33338	0.532	21.648	1.623	43.285	43.316
25	44.167	2.131	3.461	5.581	212.190	2.32672	0.558	22.063	1.710	44.114	44.147
30	45.000	2.17	3.541	6.111	209.012	2.32017	0.584	22.478	1.799	44.943	44.979

$\Delta = 1$

TAPER 2 METRIC. INTERMEDIATE VALUES — (Continued)

$M$	$l$	$f$	$b$	$o$	$D$	$\log D$	$d$	$t$	$z$	$y$	$lc$
5 35	46.833	2.22	4.012	6.231	205.932	2.31372	0.612	22.893	1.891	45.771	45.810
40	46.967	2.264	4.101	6.363	202.944	2.30738	0.641	23.308	1.966	46.599	46.642
45	47.101	2.311	4.191	6.494	200.043	2.30112	0.670	23.723	2.084	47.427	47.473
50	48.333	2.351	4.271	7.031	197.238	2.29497	0.700	24.138	2.185	48.403	48.453
55	49.167	2.401	4.361	7.161	194.483	2.28880	0.731	24.553	2.290	49.081	49.134
6 00	50.000	2.451	4.451	7.801	191.886	2.28263	0.763	24.967	2.397	49.907	49.965
15	52.500	2.594	5.124	8.124	184.301	2.26553	0.864	26.210	2.740	52.384	52.455
30	55.000	3.151	5.411	8.561	177.363	2.24886	0.974	27.452	3.115	54.856	54.943
45	57.500	3.311	6.111	9.421	170.956	2.23288	1.093	28.693	3.522	57.323	57.430
7 00	60.000	3.471	6.421	10.301	165.024	2.21755	1.220	29.933	3.962	59.794	59.915
15	62.500	4.041	7.151	11.191	159.520	2.20282	1.357	31.171	4.437	62.239	62.397
30	65.000	4.221	7.481	12.111	154.402	2.18865	1.504	32.407	4.948	64.686	64.876
45	67.500	4.411	8.231	13.041	149.634	2.17503	1.661	33.642	5.497	67.125	67.351
8 00	70.000	5.001	9.001	14.001	145.185	2.16192	1.829	34.875	6.085	69.556	69.822
15	72.500	5.191	9.271	14.871	141.026	2.14930	2.007	36.106	6.713	71.976	72.288
30	75.000	5.401	10.161	15.661	137.133	2.13714	2.196	37.333	7.381	74.760	74.965
45	77.500	6.011	10.961	16.571	133.496	2.12544	2.397	38.559	8.092	77.208	77.268
9 00	80.000	6.221	11.371	18.001	130.065	2.11416	2.610	39.782	8.845	79.061	79.061
15	82.500	6.441	12.201	19.041	126.852	2.10335	2.835	41.002	9.643	81.539	82.108
30	85.000	7.071	13.031	20.111	123.883	2.09302	3.072	42.219	10.487	83.898	84.547
45	87.500	7.311	13.481	21.191	120.993	2.08376	3.321	43.432	11.377	86.230	86.978
5 00	90.000	7.551	14.351	22.301	118.320	2.07506	3.583	44.642	12.314	88.540	89.402
10 00	92.500	8.191	15.221	23.421	115.805	2.06673	3.859	45.848	13.299	90.860	91.818
15	95.000	8.451	16.111	24.561	113.486	2.05873	4.148	47.049	14.333	93.198	94.225
30	97.500	9.111	17.021	26.121	111.264	2.04612	4.451	48.245	15.418	95.553	96.621
45	100.000	9.371	17.621	27.801	109.102	2.03783	4.768	49.437	16.564	97.613	99.007
11 00	102.500	10.041	18.451	28.491	107.123	2.02968	5.100	50.623	17.741	99.817	101.351
15	105.000	10.291	19.381	30.111	105.268	2.02226	5.446	51.804	18.980	102.744	103.808
30	107.500	11.011	20.331	31.341	103.503	2.01495	5.807	52.979	20.272	104.139	106.094
45	110.000	11.301	21.301	33.001	101.852	2.00797	6.184	54.148	21.617	105.253	108.340
13 00	112.500	11.591	22.271	34.271	100.300	2.00130	6.577	55.310	23.018	106.333	110.751
15	115.000	12.301	23.261	35.561	98.840	1.99498	6.985	56.466	24.469	110.376	113.056
30	117.500	13.011	24.261	37.271	97.470	1.98887	7.409	57.612	25.977	112.360	115.343
45	120.000	13.821	25.271	39.001	96.187	1.98312	7.850	58.751	27.539	114.343	117.613

TAPER 2½ METRIC. CURVATURE INCREASING 1° 15' EVERY 10 M. Δ=1½

Transit at	Deflection to											
	B.C. 1° 15'	C.C. 2° 30'	C.C. 3° 45'	C.C. 5° 00'	C.C. 6° 15'	C.C. 7° 30'	C.C. 8° 45'	C.C. 10° 00'	C.C. 11° 15'	C.C. 12° 30'	C.C. 13° 45'	C.C. 15° 00'
l	0	10	20	30	40	50	60	70	80	90	100	110
0	0 18½	0 18½	0 47	1 27½	2 20½	3 26½	4 44½	6 15	7 58	9 53½	12 02	14 22½
10	0 18½	0 37½	0 37½	1 24½	2 23½	3 35½	5 00	6 37	8 26½	10 28	12 42½	15 09½
20	1 05½	0 37½	0 56½	1 24½	2 02	3 20	4 50½	6 33½	8 29½	10 37½	12 58	15 31½
30	2 17½	1 43	0 56½	1 15	1 15	2 39½	4 16½	6 05½	8 07½	10 22	12 48½	15 28
40	3 54½	3 13½	2 20½	1 15	1 33½	1 33½	3 17	5 12½	7 20½	9 41½	12 14½	15 00
50	5 56½	5 09½	4 10	2 58	1 33½	1 52½	1 52½	3 54½	6 08½	8 35½	11 15	14 07
60	8 23	7 30	6 24½	5 06½	3 35½	1 52½	2 11½	2 11½	4 32	7 05	9 50½	12 48½
70	11 15	10 15½	9 03½	7 39½	6 02½	4 13	2 11½	2 30	5 09½	8 01½	11 05½	14 07
80	14 32	13 26½	12 08	10 37½	8 54½	6 58½	4 50½	2 30	5 09½	8 01½	11 05½	14 07
90	18 13½	17 02½	15 37½	14 00½	12 11½	10 09½	7 55	5 28	2 48½	5 47	8 57½	12 48½
100	22 20½	21 02½	19 32	17 48½	15 53	13 45	11 24½	8 51½	2 48½	3 07½	6 24½	10 05½
110	26 52½	25 28	23 51½	22 02	20 00	17 45½	15 18½	12 39½	2 30	6 43	3 26½	6 24½

TAPER  $2\frac{1}{2}$  METRIC. CURVATURE INCREASING  $1^\circ 15'$  EVERY 10 M. — (Continued)  $\Delta=1\frac{1}{2}$ 

$M$	$l$	$o$	$D$	$\log D$	$d$	$t$	$z$	$y$	$lc$
2 30	10	0 37 $\frac{1}{2}$	458.430	2.66127	0.027	5.000	0.055	10.000	10.000
3 45	20	1 52 $\frac{1}{2}$	305.741	2.48535	0.109	9.998	0.273	19.998	19.999
5 00	30	3 45	229.528	2.36084	0.272	14.992	0.763	29.986	29.996
6 15	40	6 15	183.981	2.26477	0.544	19.978	1.635	39.948	39.982
7 30	50	9 22 $\frac{1}{2}$	153.850	2.18710	0.952	24.949	2.995	49.855	49.945
8 45	60	13 07 $\frac{1}{2}$	132.611	2.12258	1.522	29.896	4.947	59.663	59.868
10 00	70	17 30	117.018	2.06825	2.281	34.805	7.590	69.307	69.722
11 15	80	22 30	105.276	2.02233	3.253	39.662	11.017	78.704	79.471
12 30	90	28 07 $\frac{1}{2}$	96.317	1.98370	4.462	44.444	15.307	87.744	89.069
13 45	100	34 22 $\frac{1}{2}$	89.474	1.95170	5.934	49.126	20.523	96.293	98.456
15 00	110	41 15	84.304	1.92585	7.691	53.679	26.704	104.193	107.560

TAPER 2½ METRIC. INTERMEDIATE VALUES Δ=1½

M	l	f	b	o	D	log D	d	t	z	y	lc
3.45	20.000	0.47	1.054	1.534	305.741	2.48535	0.109	9.998	0.273	19.998	19.999
5.0	20.667	0.494	1.094	1.584	298.107	2.47583	0.117	10.331	0.296	20.664	20.666
5.5	21.333	0.514	1.134	2.084	282.756	2.46651	0.125	10.664	0.320	21.333	21.333
4.00	22.000	0.54	1.18	2.12	268.671	2.45738	0.134	10.997	0.345	21.997	21.999
0.5	22.667	0.564	1.224	2.184	260.835	2.44845	0.143	11.330	0.372	22.663	22.666
1.0	23.333	0.59	1.264	2.254	275.233	2.43970	0.153	11.663	0.400	23.332	23.332
1.5	24.000	1.01	1.314	2.334	269.852	2.43113	0.163	11.996	0.429	23.995	23.998
2.0	24.667	1.04	1.364	2.414	264.678	2.42272	0.173	12.329	0.460	24.661	24.666
2.5	25.333	1.07	1.414	2.494	259.701	2.41447	0.184	12.662	0.493	25.327	25.332
3.0	26.000	1.09	1.464	2.574	254.908	2.40638	0.195	12.995	0.527	25.993	25.998
3.5	26.667	1.12	1.514	3.054	250.292	2.39845	0.207	13.328	0.563	26.659	26.664
4.0	27.333	1.15	1.564	3.114	245.840	2.39065	0.219	13.661	0.600	27.324	27.331
4.5	28.000	1.18	1.614	3.194	241.546	2.38300	0.232	13.994	0.638	27.997	27.997
5.0	28.667	1.21	2.064	3.274	237.401	2.37548	0.245	14.326	0.678	28.655	28.663
5.5	29.333	1.24	2.114	3.364	233.397	2.36810	0.258	14.659	0.720	29.321	29.330
6.00	30.000	1.27	2.174	3.45	229.528	2.36084	0.272	14.992	0.763	29.986	29.996
0.5	30.667	1.304	2.23	3.534	225.787	2.35370	0.287	15.325	0.808	30.651	30.662
1.0	31.333	1.334	2.29	4.024	222.167	2.34668	0.302	15.657	0.855	31.316	31.328
1.5	32.000	1.374	2.34	4.12	218.663	2.33978	0.317	15.990	0.904	31.995	31.995
2.0	32.667	1.404	2.40	4.214	215.270	2.33298	0.333	16.323	0.954	32.646	32.660
2.5	33.333	1.434	2.47	4.304	211.981	2.32620	0.349	16.655	1.006	33.311	33.326
3.0	34.000	1.474	2.53	4.404	208.794	2.31972	0.366	16.988	1.060	33.975	33.988
3.5	34.667	1.504	2.59	4.504	205.704	2.31324	0.384	17.320	1.116	34.640	34.658
4.0	35.333	1.544	3.06	5.004	202.705	2.30686	0.402	17.653	1.174	35.304	35.324
4.5	36.000	1.58	3.12	5.104	199.794	2.30058	0.421	17.985	1.234	35.968	35.990
5.0	36.667	2.014	3.19	5.204	196.968	2.29440	0.440	18.317	1.296	36.632	36.656
5.5	37.333	2.04	3.26	5.314	194.221	2.28830	0.459	18.649	1.360	37.296	37.322
6.00	38.000	2.09	3.33	5.42	191.553	2.28229	0.480	18.982	1.425	37.959	37.986
1.5	40.000	2.204	3.54	6.15	183.981	2.26477	0.544	19.978	1.635	39.948	39.982
3.0	42.000	2.324	4.16	6.494	177.002	2.24798	0.613	20.974	1.865	41.935	41.977
4.5	44.000	2.454	4.40	7.284	170.551	2.23185	0.688	21.969	2.115	43.920	43.971

TAPER 24 METRIC. INTERMEDIATE VALUES — (Continued)

$M$	$l$	$f$	$b$	$o$	$D$	$\log D$	$d$	$t$	$z$	$v$	$lc$
7 00	48 000	2 581	5 041	8 03	164 573	2 21636	0 769	22 963	2 386	45 902	45 963
7 15	48 000	3 121	5 291	8 42	159 020	2 20145	0 827	23 956	2 679	47 880	47 965
7 30	50 000	3 261	5 541	9 22	153 850	2 18710	0 952	24 949	2 995	49 855	49 945
7 45	52 000	3 41	6 23	10 04	149 025	2 17326	1 052	25 941	3 335	51 826	51 924
8 00	54 000	3 56	6 92	10 48	144 515	2 15991	1 189	26 931	3 699	53 793	53 920
8 15	56 000	4 11	7 21	11 53	140 252	2 14663	1 273	27 921	4 085	55 755	55 905
8 30	58 000	4 27	7 51	12 19	136 311	2 13459	1 394	28 909	4 504	57 712	57 888
8 45	60 000	4 44	8 23	13 07	132 611	2 12258	1 522	29 898	4 947	59 663	59 868
9 00	62 000	5 01	8 55	13 57	129 113	2 11097	1 658	30 881	5 417	61 607	61 845
15	64 000	5 19	9 29	14 48	125 819	2 09975	1 802	31 865	5 916	63 545	63 819
30	66 000	5 37	10 03	15 40	122 714	2 08889	1 953	32 847	6 444	65 474	65 790
45	68 000	5 56	10 38	16 34	119 785	2 07840	2 113	33 827	7 002	67 395	67 758
10 00	70 000	6 15	11 15	17 30	117 018	2 06825	2 281	34 805	7 590	69 307	69 722
15	72 000	6 34	11 52	18 27	114 403	2 05844	2 457	35 781	8 210	71 210	71 682
30	74 000	6 54	12 30	19 25	111 980	2 04905	2 642	36 755	8 862	73 101	73 637
45	76 000	7 15	13 10	20 25	109 589	2 03977	2 836	37 727	9 544	74 981	75 587
11 00	78 000	7 38	13 50	21 27	107 374	2 03090	3 040	38 696	10 263	76 848	77 532
15	80 000	7 58	14 32	22 30	105 276	2 02233	3 253	39 662	11 017	78 704	79 471
30	82 000	8 20	15 14	23 34	103 288	2 01405	3 470	40 625	11 804	80 544	81 404
45	84 000	8 43	15 57	24 40	101 404	2 00606	3 708	41 585	12 626	82 370	83 331
12 00	86 000	9 06	16 42	25 48	99 617	1 99833	3 949	42 541	13 483	84 178	85 251
15	88 000	9 29	17 27	26 57	97 923	1 99098	4 200	43 494	14 377	85 971	87 060
30	90 000	9 53	18 13	28 07	96 317	1 98370	4 462	44 444	15 307	87 744	88 089
45	92 000	10 18	19 01	29 19	94 796	1 97679	4 735	45 389	16 279	89 497	90 965
13 00	94 000	10 43	19 49	30 33	93 355	1 97014	5 018	46 330	17 274	91 231	92 863
15	96 000	11 09	20 39	31 48	91 989	1 96374	5 312	47 267	18 322	92 942	94 731
30	98 000	11 35	21 30	33 04	90 697	1 95760	5 618	48 199	19 408	94 630	96 599
45	100 000	12 02	22 20	34 23	89 474	1 95170	5 934	49 126	20 523	96 283	98 456
14 00	102 000	12 29	23 13	35 52	88 317	1 94604	6 263	50 048	21 681	97 891	100 302
15	104 000	12 58	24 06	37 08	87 224	1 94064	6 601	50 965	22 878	99 542	102 137
30	106 000	13 24	25 03	38 25	86 192	1 93547	6 952	51 876	24 114	101 223	103 769
45	108 000	13 53	26 06	39 49	85 219	1 93054	7 316	52 780	25 389	102 674	105 399
15 00	110 000	14 22	26 52	41 16	84 304	1 92585	7 691	53 679	26 704	104 163	107 560

TAPER 2½ METRIC. CURVATURE INCREASING 1° 30' EVERY 10 M. Δ=1½

Transit at	Deflections to										
	B.C. 1° 30'	C.C. 3° 00'	C.C. 4° 30'	C.C. 6° 00'	C.C. 7° 30'	C.C. 9° 00'	C.C. 10° 30'	C.C. 12° 00'	C.C. 13° 30'	C.C. 15° 00'	C.C. 16° 30'
l	0	10	20	30	40	50	60	70	80	90	100
0	0 22½	0 22½	0 56½	1 45	2 48½	4 07½	5 41½	7 30	9 33½	11 52½	14 26½
10	1 18½	0 45	0 45	1 41½	2 52½	4 18½	6 00	7 56½	10 07½	12 33½	15 15
20	2 45	1 07½	1 07½	1 07½	2 26½	4 00	5 48½	7 52½	10 11½	12 45	15 33½
30	4 41½	2 03½	1 07½	1 30	1 30	3 11½	5 07½	7 18½	9 45	12 26½	15 22½
40	7 07½	3 52½	2 48½	3 33½	1 52½	1 52½	3 56½	6 15	8 48½	11 37½	14 41½
50	10 03½	6 11½	5 00	6 07½	4 18½	2 15	2 15	4 41½	7 22½	10 18½	13 30
60	13 30	9 00	7 41½	9 11½	7 15	2 15	2 37½	5 26½	8 30	11 48½	15 30
70	17 26½	12 18½	10 52½	12 45	10 41½	5 03½	2 37½	8 00	11 11½	14 37½	18 45
80	21 52½	16 07½	14 33½	16 48½	14 37½	8 22½	5 48½	10 37½	13 22½	17 18½	21 30
90	26 48½	20 26½	18 45	21 22½	19 03½	12 11½	9 30	13 00	16 11½	20 00	24 15
100		25 15	23 26½	21 22½	19 03½	16 30	13 41½	10 37½	17 18½	23 45	28 15



TAPER 2½ METRIC. CURVATURE INCREASING 1° 30' EVERY 10 M. — (Continued)  $\Delta = 1\frac{1}{2}$

M	l	o	D	log D	d	t	z	y	lc
3 00	10	0 45	382.049	2.58212	0.033	4.999	0.066	10.000	10.000
4 30	20	2 15	254.844	2.40627	0.131	9.997	0.327	19.997	19.999
6 00	30	4 30	191.400	2.28194	0.327	14.988	0.916	29.979	29.993
7 30	40	7 30	153.552	2.18626	0.654	19.968	1.961	39.925	39.973
9 00	50	11 15	128.597	2.10923	1.142	24.926	3.591	49.791	49.920
10 30	60	15 45	111.112	2.04576	1.824	29.849	5.927	59.514	59.809
12 00	70	21 00	98.399	1.99299	2.731	34.720	9.085	69.004	69.600
13 30	80	27 00	88.970	1.94924	3.891	39.514	13.164	78.139	79.240
15 00	90	33 45	81.947	1.91353	5.334	44.203	18.245	86.767	88.665
16 30	100	41 15	76.777	1.88523	7.087	48.751	24.381	94.701	97.789

TAPER 2½ METRIC. INTERMEDIATE VALUES Δ = 1½

M	l	f	b	o	D	log D	d	t	z	y	lc
4 30											19.999
35	20.000	0.561	1.181	2.15	254.844	2.40827	0.131	9.927	0.327	19.997	20.555
40	20.556	0.554	1.224	2.214	250.224	2.39853	0.139	10.274	0.350	20.552	21.110
45	21.111	1.01	1.264	2.274	245.768	2.38663	0.147	10.562	0.374	21.107	21.665
50	21.667	1.034	1.311	2.344	241.470	2.37296	0.156	10.829	0.399	21.662	22.221
55	22.222	1.054	1.354	2.41	237.321	2.35754	0.165	11.107	0.425	22.217	22.776
6 00	22.778	1.081	1.394	2.48	233.314	2.34074	0.175	11.384	0.452	22.772	23.332
	23.333	1.104	1.441	2.55	229.440	2.32087	0.184	11.661	0.480	23.327	
06	23.889	1.131	1.481	3.024	225.694	2.35352	0.194	11.939	0.510	23.882	24.887
10	24.444	1.16	1.531	3.064	222.069	2.34649	0.204	12.216	0.541	24.436	25.442
15	25.000	1.181	1.581	3.17	218.561	2.33957	0.215	12.493	0.573	24.991	26.008
20	25.556	1.211	2.031	3.244	215.162	2.33276	0.225	12.771	0.606	25.546	26.553
25	26.111	1.241	2.08	3.324	211.869	2.32607	0.237	13.048	0.640	26.100	27.108
30	26.667	1.27	2.13	3.40	208.677	2.31947	0.249	13.325	0.675	26.655	27.663
35	27.222	1.30	2.18	3.48	205.581	2.31298	0.261	13.603	0.712	27.209	28.218
40	27.778	1.321	2.231	3.56	202.576	2.30659	0.273	13.880	0.750	27.763	28.773
45	28.333	1.341	2.281	4.044	199.659	2.30029	0.286	14.157	0.789	28.318	29.328
50	28.889	1.361	2.34	4.124	196.827	2.29408	0.299	14.434	0.830	28.872	29.884
55	29.444	1.42	2.391	4.214	194.075	2.28797	0.313	14.711	0.872	29.426	30.439
6 00	30.000	1.45	2.45	4.30	191.400	2.28194	0.327	14.988	0.916	29.979	30.993
15	31.667	1.544	3.024	4.57	183.809	2.26437	0.372	15.819	1.055	31.640	31.658
30	33.333	2.044	3.204	5.25	176.809	2.24750	0.420	16.650	1.207	33.300	33.322
45	35.000	2.15	3.594	5.544	170.335	2.23130	0.472	17.480	1.374	34.959	34.986
7 00	36.667	2.241	3.594	6.25	164.332	2.21572	0.528	18.310	1.554	36.616	36.649
15	38.333	2.37	4.20	6.57	158.752	2.20072	0.589	19.139	1.751	38.271	38.311
30	40.000	2.481	4.411	7.30	153.552	2.18626	0.654	19.968	1.961	39.925	39.973
45	41.667	3.001	5.031	8.044	148.696	2.17200	0.723	20.796	2.189	41.577	41.624
8 00	43.333	3.131	5.261	8.40	144.153	2.15882	0.797	21.623	2.433	43.226	43.294
15	45.000	3.261	5.501	9.17	139.895	2.14580	0.876	22.450	2.695	44.872	44.952
30	46.667	3.391	6.151	9.55	135.897	2.13321	0.960	23.276	2.975	46.515	46.600
45	48.333	3.531	6.411	10.344	132.137	2.12102	1.048	24.101	3.273	48.155	48.285

TAPER 2½ METRIC. INTERMEDIATE VALUES — (Continued)  $\Delta = 1\frac{1}{4}$ 

M	f	b	a	D	log D	d	t	z	y	tc
9 00	4 07½	7 07½	11 15	128.597	2.10923	1.142	24.926	3.591	49.701	49.020
15	4 22	7 35	11 57	125.259	2.09781	1.247	25.749	3.597	49.701	49.020
30	4 37	8 03	12 40	122.107	2.08674	1.346	26.572	4.285	51.573	51.573
45	4 52½	8 32	13 24½	119.129	2.07602	1.457	27.393	4.663	53.051	53.224
10 00	5 08½	9 01½	14 10	116.310	2.06562	1.573	28.213	5.063	54.675	54.873
15	5 24½	9 32½	14 57	113.642	2.05554	1.696	29.032	5.484	56.294	56.321
30	5 41½	10 03½	15 45	111.112	2.04576	1.824	29.849	5.927	57.907	58.107
45	5 58½	10 36½	16 34½	108.711	2.03627	1.958	30.665	6.393	59.514	59.809
11 00	6 15½	11 09½	17 25	106.433	2.02708	2.099	31.479	6.883	61.115	61.448
15	6 33½	11 43½	18 17	104.270	2.01816	2.247	32.292	7.397	62.709	63.084
30	6 52	12 18	19 10	102.214	2.00961	2.402	33.103	7.934	64.295	64.717
45	7 10½	12 52	20 04½	100.259	2.00112	2.563	33.913	8.497	65.873	66.347
12 00	7 30	13 30	21 00	98.399	1.99299	2.731	34.720	9.085	67.443	67.975
15	7 49½	14 07½	21 57	96.629	1.98511	2.906	35.525	9.698	69.004	69.600
30	7 73	14 45½	22 55	94.943	1.97746	3.088	36.328	10.337	70.555	71.220
45	7 97	15 24½	23 54½	93.338	1.97006	3.277	37.128	11.003	72.095	72.834
13 00	8 30	16 04½	24 55	91.811	1.96289	3.474	37.926	11.696	73.624	74.443
15	9 12	16 45	25 57	90.356	1.95596	3.679	38.721	12.416	75.141	76.047
30	9 33½	17 29½	27 00	88.970	1.94924	3.891	39.514	13.164	76.646	77.646
45	9 55½	18 08½	28 04½	87.651	1.94276	4.111	40.304	13.939	78.139	79.240
14 00	10 18½	18 57½	29 10	86.394	1.93648	4.339	41.091	14.743	79.618	80.828
15	10 41	19 32½	30 17	85.198	1.93043	4.575	41.874	15.575	81.081	82.410
30	10 41	20 29½	31 25	84.059	1.92455	4.819	42.654	16.436	82.528	83.985
45	11 04	21 04	32 34½	82.976	1.91885	5.072	43.430	17.326	83.958	85.553
15 00	11 28½	21 52½	33 45	81.947	1.91333	5.334	44.203	18.245	85.371	86.971
30	11 52½	22 42	34 55	80.938	1.90800	5.602	44.976	19.191	86.724	88.365
45	12 17	23 28	36 10	80.038	1.90387	5.882	45.753	20.171	88.065	89.649
16 00	13 33½	24 06½	37 30	79.249	1.89987	6.166	46.526	21.181	89.349	90.874
30	14 26½	26 48½	41 15	78.577	1.89523	7.087	48.751	22.217	90.549	91.789

TAPER 2½ METRIC. CURVATURE INCREASING 2° 00' EVERY 10 M. Δ=2

Transit at	Deflections to									
	B.C. 2° 00'	C.C. 4° 00'	C.C. 6° 00'	C.C. 8° 00'	C.C. 10° 00'	C.C. 12° 00'	C.C. 14° 00'	C.C. 16° 00'	C.C. 18° 00'	C.C.1) 20° 00'
l	0	10	20	30	40	50	60	70	80	90
0	0 30	0 30	1 15	2 20	3 45	5 30	7 35	10 00	12 45	15 50
10	.....	.....	1 00	2 15	3 50	5 45	8 00	10 35	13 30	16 45
20	0 30	1 00	.....	1 30	3 15	5 20	7 45	10 30	13 35	17 00
30	3 40	2 45	1 30	.....	2 00	4 15	6 50	9 45	13 00	16 35
40	6 15	5 10	3 45	2 00	.....	2 30	5 15	8 20	11 45	15 30
50	9 30	8 15	6 40	4 45	2 30	.....	3 00	6 15	9 50	13 45
60	13 25	12 00	10 15	8 10	5 45	3 00	.....	3 30	7 15	11 20
70	18 00	16 25	14 30	12 15	9 40	6 45	3 30	.....	4 00	8 15
80	23 15	21 30	19 25	17 00	14 15	11 10	7 45	4 00	.....	4 30
90	29 10	27 15	25 00	22 25	19 30	16 15	12 40	8 45	4 30	.....

TAPER  $2\frac{1}{4}$  METRIC. CURVATURE INCREASING  $2^{\circ}00'$  EVERY 10 M.—(Continued)  $\Delta=2$

$M$	$l$	$\phi$	$D$	$\log D$	$\delta$	$t_j$	$z$	$y$	$lc$
4 00	10	1 00	286.581	2.45725	0.044	4.999	0.087	10.000	10.000
6 00	20	3 00	191.248	2.28160	0.175	9.994	0.436	19.994	19.999
8 00	30	6 00	143.791	2.15773	0.435	14.979	1.221	29.964	29.989
10 00	40	10 00	115.607	2.06298	0.870	19.942	2.613	39.866	39.952
12 00	50	15 00	97.187	1.98761	1.519	24.868	4.779	49.628	49.858
14 00	60	21 00	84.475	1.92673	2.420	29.733	7.873	59.139	59.661
16 00	70	28 00	75.471	1.87778	3.618	34.505	12.032	68.238	69.291
18 00	80	36 00	69.073	1.83931	5.149	39.145	17.360	76.719	78.659
20 00	90	45 00	64.637	1.81048	7.049	43.602	23.914	84.323	87.648

TAPER 2½ METRIC. INTERMEDIATE VALUES Δ=2

M	l	f	b	o	D	log D	d	t	z	v	lc
6 00	20.000	1 15	1 45	3 00	191.248	2.28160	0.175	9.994	0.436	19.994	19.999
15	21.250	1 22	1 57½	3 19½	183.637	2.26396	0.200	10.618	0.508	21.242	21.248
30	22.500	1 29½	2 10	3 39½	176.615	2.24703	0.226	11.241	0.585	22.489	22.497
45	23.750	1 37	2 23½	4 00½	170.118	2.23075	0.255	11.864	0.670	23.736	23.746
7 00	25.000	1 45	2 37½	4 22½	164.009	2.21487	0.286	12.487	0.763	24.983	24.995
15	26.250	1 53½	2 52½	4 45½	158.483	2.19998	0.320	13.110	0.864	26.229	26.243
30	27.500	2 02	3 07½	5 09½	153.254	2.18541	0.356	13.733	0.974	27.474	27.491
45	28.750	2 10½	3 23½	5 34½	148.367	2.17134	0.394	14.356	1.093	28.719	28.740
8 00	30.000	2 20	3 40	6 00	143.791	2.15773	0.435	14.979	1.221	29.964	29.989
15	31.250	2 29½	3 57½	6 26½	139.498	2.14457	0.479	15.601	1.358	31.207	31.237
30	32.500	2 39½	4 15	6 54½	135.463	2.13182	0.526	16.222	1.505	32.448	32.484
45	33.750	2 49½	4 33½	7 23	131.665	2.11947	0.576	16.843	1.662	33.668	33.730
9 00	35.000	3 00	4 52½	7 52½	128.083	2.10749	0.628	17.464	1.830	34.927	34.975
15	36.250	3 10½	5 12½	8 23	124.701	2.09587	0.684	18.084	2.009	36.164	36.220
30	37.500	3 22	5 32½	8 54½	121.503	2.08459	0.742	18.704	2.199	37.400	37.465
45	38.750	3 33½	5 53½	9 26½	118.476	2.07363	0.804	19.323	2.400	38.634	38.709
10 00	40.000	3 45	6 15	10 00	115.607	2.06298	0.870	19.942	2.613	39.866	39.952
15	41.250	3 57	6 37½	10 34½	112.885	2.05264	0.939	20.560	2.838	41.096	41.194
30	42.500	4 09½	7 00	11 09½	110.299	2.04257	1.011	21.177	3.076	42.323	42.435
45	43.750	4 22	7 23½	11 45½	107.840	2.03278	1.087	21.794	3.326	43.548	43.675
11 00	45.000	4 35	7 47½	12 22½	105.500	2.02325	1.166	22.410	3.589	44.770	44.914
15	46.250	4 48½	8 12½	13 00½	103.272	2.01398	1.249	23.025	3.866	45.989	46.152
30	47.500	5 02	8 37½	13 39½	101.147	2.00495	1.335	23.640	4.156	47.205	47.389
45	48.750	5 15½	9 03½	14 19½	99.121	1.99617	1.425	24.254	4.460	48.418	48.624

TAPER  $2\frac{1}{2}$  METRIC. INTERMEDIATE VALUES — (Continued)  $\Delta = 2$

$M$	$l$	$f$	$b$	$o$	$D$	$\log D$	$d$	$t$	$z$	$v$	$lc$
12 00	50.000	5 30	9 30	15 00	97.187	1.98761	1.519	24.868	4.779	49.628	49.858
15	51.250	5 44 $\frac{1}{2}$	9 57 $\frac{1}{2}$	15 41 $\frac{1}{2}$	95.340	1.97928	1.617	25.481	5.112	50.834	51.091
30	52.500	5 59 $\frac{1}{2}$	10 25	16 24 $\frac{1}{2}$	93.574	1.97116	1.719	26.093	5.460	52.036	52.322
45	53.750	6 14 $\frac{1}{2}$	10 53 $\frac{1}{2}$	17 08	91.886	1.96225	1.825	26.703	5.823	53.234	53.551
13 00	55.000	6 30	11 22 $\frac{1}{2}$	17 52 $\frac{1}{2}$	90.272	1.95555	1.935	27.312	6.201	54.426	54.778
15	56.250	6 45 $\frac{1}{2}$	11 52 $\frac{1}{2}$	18 38	88.726	1.94905	2.049	27.919	6.595	55.612	56.002
30	57.500	7 02	12 22 $\frac{1}{2}$	19 24 $\frac{1}{2}$	87.247	1.94075	2.168	28.525	7.005	56.794	57.224
45	58.750	7 18 $\frac{1}{2}$	12 53 $\frac{1}{2}$	20 11 $\frac{1}{2}$	85.832	1.93365	2.292	29.130	7.431	57.970	58.444
14 00	60.000	7 35	13 25	21 00	84.475	1.92673	2.420	29.733	7.873	59.139	59.661
15	61.250	7 52	13 57 $\frac{1}{2}$	21 49 $\frac{1}{2}$	83.176	1.92000	2.553	30.335	8.332	60.303	60.875
30	62.500	8 09 $\frac{1}{2}$	14 30	22 39 $\frac{1}{2}$	81.931	1.91345	2.691	30.935	8.808	61.458	62.086
45	63.750	8 27	15 03 $\frac{1}{2}$	23 30 $\frac{1}{2}$	80.738	1.90708	2.834	31.534	9.301	62.608	63.295
15 00	65.000	8 45	15 37 $\frac{1}{2}$	24 22 $\frac{1}{2}$	79.594	1.90088	2.981	32.131	9.812	63.751	64.501
30	67.500	9 22	16 47 $\frac{1}{2}$	26 09 $\frac{1}{2}$	78.446	1.89457	3.290	33.321	10.886	66.010	66.903
16 00	70.000	10 00	18 00	28 00	75.471	1.87778	3.618	34.505	12.032	68.238	69.291
30	72.500	10 39 $\frac{1}{2}$	19 15	29 54 $\frac{1}{2}$	73.659	1.86723	3.969	35.681	13.252	70.427	71.663
45	75.000	11 20	20 32 $\frac{1}{2}$	31 52 $\frac{1}{2}$	71.996	1.85731	4.341	36.847	14.546	72.573	74.016
17 00	77.500	12 02	21 52 $\frac{1}{2}$	33 54 $\frac{1}{2}$	70.470	1.84800	4.734	38.002	15.915	74.672	76.349
30	80.000	12 45	23 15	36 00	69.073	1.83931	5.149	39.145	17.360	76.719	78.659
45	82.500	13 29 $\frac{1}{2}$	24 40	38 09 $\frac{1}{2}$	67.798	1.83122	5.587	40.277	18.882	78.711	80.945
18 00	85.000	14 15	26 07 $\frac{1}{2}$	40 22 $\frac{1}{2}$	66.638	1.82372	6.049	41.397	20.482	80.645	83.206
30	87.500	15 02	27 37 $\frac{1}{2}$	42 39 $\frac{1}{2}$	65.586	1.81681	6.536	42.505	22.159	82.517	85.440
45	90.000	15 50	29 10	45 00	64.637	1.81048	7.049	43.602	23.914	84.323	87.648

TAPER 3 METRIC. CURVATURE INCREASING 2° 30' EVERY 10 M. Δ = 2½

Transit at	Deflections to									
	B.C. 2° 30'	C.C. 5° 00'	C.C. 7° 30'	C.C. 10° 00'	C.C. 12° 30'	C.C. 15° 00'	C.C. 17° 30'	C.C. 20° 00'	C.C. 22° 30'	
l	0	10	20	30	40	50	60	70	80	
0	0 37½	0 37½	0 37½	0 37½	0 37½	0 37½	0 37½	0 37½	0 37½	
10	0 37½	0 37½	1 33½	2 55	4 41½	6 52½	9 28½	12 30	15 56½	
20	2 11½	1 15	1 15	2 48½	4 47½	7 11½	10 00	13 13½	16 52½	
30	4 35	1 15	1 52½	1 52½	4 03½	6 40	9 41½	13 07½	16 58½	
40	7 48½	3 26½	4 41½	2 30	2 30	5 18½	8 32½	12 11½	16 15	
50	11 52½	6 27½	8 20	2 30	3 07½	3 07½	6 33½	10 25	14 41½	
60	16 46½	10 18½	12 48½	5 56½	7 11½	3 45	7 48½	12 17½	16 15	
70	22 30	15 00	18 07½	10 12½	12 05	3 45	4 22½	7 48½	12 17½	
80	29 03½	20 31½	24 16½	15 18½	17 48½	8 26½	4 22½	4 22½	9 03½	
		26 52½		21 15		13 57½	9 41½	5 00	5 00	



TAPER 3 METRIC. CURVATURE INCREASING 2° 30' EVERY 10 M. — (Continued)  $\Delta = 2\frac{1}{2}$

$M$	$l$	$o$	$D$	$\log D$	$d$	$t$	$z$	$y$	$lc$
5 00	10	1 15	229.310	2.36042	0.054	4.998	0.109	9.999	10.000
7 30	20	3 45	153.116	2.18502	0.218	9.991	0.545	19.990	19.998
10 00	30	7 30	115.281	2.06176	0.544	14.967	1.526	29.943	29.981
12 30	40	12 30	92.940	1.96820	1.085	19.909	3.263	39.790	39.924
15 00	50	18 45	78.506	1.89490	1.893	24.794	5.959	49.420	49.779
17 30	60	26 15	68.751	1.83728	3.015	29.585	9.794	58.659	59.471
20 00	70	35 00	62.085	1.79299	4.497	34.233	14.912	67.264	68.897
22 30	80	45 00	57.640	1.76072	6.382	38.680	21.396	74.925	77.920

$\Delta = 2\frac{1}{2}$

TAPER 3 METRIC. INTERMEDIATE VALUES

$M$	$l$	$f$	$b$	$o$	$D$	$\log D$	$d$	$t$	$z$	$v$	$lc$
7 30	20.000	1.33 $\frac{1}{2}$	2.11 $\frac{1}{2}$	3.45	153.116	2.18502	0.218	9.991	0.545	19.990	19.998
45	21.000	1.40 $\frac{1}{2}$	2.23 $\frac{1}{2}$	4.04	148.215	2.17089	0.242	10.489	0.615	20.988	20.997
8 00	22.000	1.48	2.36	4.24	143.624	2.15723	0.268	10.988	0.691	21.986	21.996
15	23.000	1.55 $\frac{1}{2}$	2.49	4.44 $\frac{1}{2}$	139.314	2.14399	0.295	11.486	0.772	22.983	22.995
30	24.000	2.03 $\frac{1}{2}$	3.02 $\frac{1}{2}$	5.06	135.262	2.13117	0.325	11.984	0.860	23.979	23.994
45	25.000	2.11 $\frac{1}{2}$	3.16 $\frac{1}{2}$	5.28	131.446	2.11875	0.357	12.481	0.954	24.975	24.993
9 00	26.000	2.19 $\frac{1}{2}$	3.31 $\frac{1}{2}$	5.51	127.846	2.10669	0.391	12.979	1.054	25.970	25.991
15	27.000	2.28	3.46 $\frac{1}{2}$	6.14 $\frac{1}{2}$	124.443	2.09497	0.426	13.476	1.161	26.964	26.988
30	28.000	2.36 $\frac{1}{2}$	4.02 $\frac{1}{2}$	6.39	121.224	2.08359	0.463	13.973	1.275	27.958	27.986
45	29.000	2.45 $\frac{1}{2}$	4.18 $\frac{1}{2}$	7.04	118.174	2.07252	0.502	14.470	1.397	28.951	28.984
10 00	30.000	2.55	4.35	7.30	115.281	2.06176	0.544	14.967	1.526	29.943	29.981
15	31.000	3.04 $\frac{1}{2}$	4.52	7.56 $\frac{1}{2}$	112.533	2.05128	0.587	15.463	1.662	30.934	30.978
30	32.000	3.14 $\frac{1}{2}$	5.09 $\frac{1}{2}$	8.24	109.921	2.04108	0.633	15.958	1.806	31.924	31.974
45	33.000	3.24 $\frac{1}{2}$	5.27 $\frac{1}{2}$	8.52	107.434	2.03114	0.681	16.454	1.958	32.912	32.970
11 00	34.000	3.34 $\frac{1}{2}$	5.46 $\frac{1}{2}$	9.21	105.065	2.02146	0.731	16.949	2.118	33.899	33.965
15	35.000	3.45	6.05 $\frac{1}{2}$	9.50 $\frac{1}{2}$	102.807	2.01202	0.784	17.443	2.287	34.885	34.960
30	36.000	3.55 $\frac{1}{2}$	6.25 $\frac{1}{2}$	10.21	100.651	2.00282	0.839	17.937	2.465	35.870	35.954
45	37.000	4.06 $\frac{1}{2}$	6.45 $\frac{1}{2}$	10.52	98.593	1.99385	0.897	18.431	2.651	36.853	36.948
12 00	38.000	4.18	7.06	11.24	96.625	1.98509	0.957	18.924	2.845	37.834	37.941
15	39.000	4.29 $\frac{1}{2}$	7.27	11.56 $\frac{1}{2}$	94.743	1.97655	1.020	19.417	3.049	38.813	38.933
30	40.000	4.41 $\frac{1}{2}$	7.48 $\frac{1}{2}$	12.30	92.940	1.96820	1.085	19.909	3.263	39.790	39.924
45	41.000	4.53 $\frac{1}{2}$	8.10 $\frac{1}{2}$	13.04	91.214	1.96006	1.153	20.401	3.486	40.766	40.914

TAPER 3 METRIC. INTERMEDIATE VALUES — (Continued)  $\Delta = 2\frac{1}{2}$

<i>M</i>	<i>l</i>	<i>f</i>	<i>b</i>	<i>o</i>	<i>D</i>	$\log D$	<i>d</i>	<i>t</i>	<i>z</i>	<i>v</i>	<i>lc</i>
13 00	42.000	5 05½	8 33½	13 39	89.561	1.95212	1.224	20.892	3.719	41.739	41.903
15	43.000	5 18	8 56½	14 14½	87.975	1.94436	1.298	21.382	3.962	42.709	42.892
30	44.000	5 30½	9 20½	14 51	86.453	1.93678	1.374	21.872	4.215	43.677	43.880
45	45.000	5 43½	9 44½	15 28	84.993	1.92938	1.453	22.361	4.479	44.642	44.866
14 00	46.000	5 57	10 09	16 06	83.590	1.92215	1.535	22.849	4.753	45.604	45.851
15	47.000	6 10½	10 34	16 44½	82.243	1.91510	1.620	23.336	5.038	46.563	46.835
30	48.000	6 24½	10 59½	17 24	80.948	1.90821	1.708	23.823	5.334	47.519	47.818
45	49.000	6 38½	11 25½	18 04	79.703	1.90147	1.799	24.309	5.640	48.472	48.799
15 00	50.000	6 52½	11 52½	18 45	78.506	1.89490	1.893	24.794	5.959	49.420	49.779
30	52.000	7 21½	12 47½	20 09	76.247	1.88222	2.091	25.761	6.629	51.306	51.733
16 00	54.000	7 52	13 44	21 36	74.154	1.87013	2.301	26.724	7.347	53.175	53.680
30	56.000	8 23½	14 42½	23 06	72.215	1.85863	2.525	27.683	8.113	55.024	55.620
17 00	58.000	8 55½	15 43½	24 39	70.419	1.84769	2.764	28.636	8.928	56.853	57.550
30	60.000	9 28½	16 46½	26 15	68.751	1.83728	3.015	29.585	9.794	58.659	59.471
18 00	62.000	10 03	17 51	27 54	67.205	1.82740	3.281	30.527	10.711	60.439	61.381
30	64.000	10 38½	18 57½	29 36	65.273	1.81473	3.562	31.464	11.681	62.193	63.280
19 00	66.000	11 14½	20 06½	31 21	64.447	1.80920	3.858	32.394	12.704	63.916	65.167
30	68.000	11 51½	21 17½	33 09	63.220	1.80085	4.170	33.317	13.781	65.608	67.039
20 00	70.000	12 30	22 30	35 00	62.085	1.79299	4.497	34.233	14.912	67.264	68.897
30	72.000	13 09½	23 44½	36 54	61.038	1.78660	4.840	35.141	16.098	68.883	70.739
21 00	74.000	13 49½	25 01½	38 51	60.074	1.77969	5.200	36.040	17.340	70.462	72.564
30	76.000	14 30½	26 20½	40 51	59.189	1.77224	5.577	36.930	18.636	71.997	74.369
22 00	78.000	15 13	27 41	42 54	58.379	1.76626	5.971	37.810	19.988	73.485	76.154
30	80.000	15 56½	29 03½	45 00	57.640	1.76072	6.382	38.680	21.396	74.925	77.920

TAPER  $3\frac{1}{2}$  METRIC. CURVATURE INCREASING  $3^\circ 00'$   
EVERY 10 M.  $\Delta=3$

Transit at	Deflections to							
	B.C. $3^\circ 00'$	C.C. $6^\circ 00'$	C.C. $9^\circ 00'$	C.C. $12^\circ 00'$	C.C. $15^\circ 00'$	C.C. $18^\circ 00'$	C.C. $21^\circ 00'$	C.C. $24^\circ 00'$
<i>l</i>	0	10	20	30	40	50	60	70
0	.....	0 45	1 52½	3 30	5 37½	8 15	11 22½	15 00
10	0 45	.....	1 30	3 22½	5 45	8 37½	12 00	15 52½
20	2 37½	1 30	.....	2 15	4 52½	8 00	11 37½	15 45
30	5 30	4 07½	2 15	.....	3 00	6 22½	10 15	14 37½
40	9 22½	7 45	5 37½	3 00	.....	3 45	7 52½	12 30
50	14 15	12 22½	10 00	7 07½	3 45	.....	4 30	9 22½
60	20 07½	18 00	15 22½	12 15	8 37½	4 30	.....	5 15
70	27 00	24 37½	21 45	18 22½	14 30	10 07½	5 15	.....

TAPER  $3\frac{1}{2}$  METRIC. CURVATURE INCREASING  $3^\circ 00'$   
EVERY 10 M.— (Continued)  $\Delta=3$

<i>M</i>	<i>l</i>	<i>o</i>	<i>D</i>	log <i>D</i>	<i>d</i>	<i>t</i>	<i>z</i>	<i>y</i>	<i>lc</i>
6 00	10	1 30	191.138	2.28135	0.065	4.998	0.131	9.999	10.000
9 00	20	4 30	127.716	2.10625	0.261	9.986	0.654	19.986	19.997
12 00	30	9 00	96.320	1.98372	0.652	14.951	1.830	29.916	29.972
15 00	40	15 00	77.912	1.89160	1.299	19.868	3.910	39.697	39.889
18 00	50	22 30	66.186	1.82077	2.262	24.703	7.129	49.166	49.680
21 00	60	31 30	58.471	1.76694	3.597	29.405	11.684	58.076	59.240
24 00	70	42 00	53.451	1.72796	5.354	33.906	17.709	66.090	68.421

$\Delta = 3$ TAPER  $3\frac{1}{4}$  METRIC. INTERMEDIATE VALUES

$M$	$l$	$f$	$b$	$o$	$D$	$\log D$	$d$	$t$	$z$	$y$	$lc$
9 00	20.000	1 52 $\frac{1}{2}$	2 37 $\frac{1}{2}$	4 30	127.716	2.10625	0.261	9.986	0.654	19.986	19.997
15	20.833	1 59 $\frac{1}{2}$	2 49 $\frac{1}{2}$	4 49	124.302	2.09448	0.285	10.401	0.724	20.816	20.829
30	21.667	2 06 $\frac{1}{2}$	3 02	5 08 $\frac{1}{2}$	121.072	2.08304	0.311	10.815	0.798	21.646	21.661
45	22.500	2 14	3 15	5 29	118.010	2.07192	0.338	11.230	0.877	22.476	22.493
10 00	23.333	2 21 $\frac{1}{2}$	3 28 $\frac{1}{2}$	5 50	115.104	2.06109	0.367	11.644	0.961	23.306	23.325
15	24.167	2 29 $\frac{1}{2}$	3 42	6 11 $\frac{1}{2}$	112.343	2.05055	0.397	12.058	1.050	24.135	24.157
30	25.000	2 37 $\frac{1}{2}$	3 56 $\frac{1}{2}$	6 33 $\frac{1}{2}$	109.716	2.04027	0.428	12.472	1.144	24.963	24.988
45	25.833	2 45 $\frac{1}{2}$	4 10 $\frac{1}{2}$	6 56 $\frac{1}{2}$	107.214	2.03025	0.461	12.886	1.244	25.790	25.819
11 00	26.667	2 54 $\frac{1}{2}$	4 25 $\frac{1}{2}$	7 20	104.830	2.02040	0.496	13.300	1.350	26.617	26.651
15	27.500	3 02 $\frac{1}{2}$	4 41 $\frac{1}{2}$	7 44	102.555	2.01096	0.532	13.713	1.461	27.443	27.482
30	28.333	3 11 $\frac{1}{2}$	4 57	8 08 $\frac{1}{2}$	100.382	2.00166	0.570	14.126	1.578	28.268	28.312
45	29.167	3 20 $\frac{1}{2}$	5 13 $\frac{1}{2}$	8 34	98.306	1.99258	0.610	14.539	1.701	29.092	29.143
12 00	30.000	3 30	5 30	9 00	96.320	1.98372	0.652	14.951	1.830	29.916	29.972
15	30.833	3 39 $\frac{1}{2}$	5 47	9 26 $\frac{1}{2}$	94.418	1.97505	0.695	15.363	1.965	30.739	30.801
30	31.667	3 49 $\frac{1}{2}$	6 04 $\frac{1}{2}$	9 53 $\frac{1}{2}$	92.595	1.96659	0.740	15.774	2.107	31.561	31.631
45	32.500	3 59	6 22 $\frac{1}{2}$	10 21 $\frac{1}{2}$	90.848	1.95832	0.787	16.186	2.255	32.381	32.459
13 00	33.333	4 09 $\frac{1}{2}$	6 40 $\frac{1}{2}$	10 50	89.173	1.95023	0.836	16.597	2.410	33.200	33.287
15	34.167	4 19 $\frac{1}{2}$	6 58 $\frac{1}{2}$	11 19	87.564	1.94233	0.887	17.007	2.572	34.018	34.115
30	35.000	4 30	7 18 $\frac{1}{2}$	11 48 $\frac{1}{2}$	86.019	1.93459	0.940	17.417	2.741	34.834	34.942
45	35.833	4 40 $\frac{1}{2}$	7 38 $\frac{1}{2}$	12 19	84.534	1.92703	0.994	17.827	2.917	35.649	35.768

TAPER 3½ METRIC. INTERMEDIATE VALUES — (Continued) Δ=3

M	l	f	b	o	D	log D	d	t	z	v	lc
14 00	36.667	4 51½	7 58½	12 50	83.106	1.91963	1.051	18.236	3.100	36.462	36.594
15	37.500	5 02½	8 18½	13 21½	81.733	1.91240	1.110	19.045	3.291	37.273	37.419
30	38.333	5 14½	8 39½	13 53½	80.411	1.90532	1.171	19.053	3.490	38.083	38.243
45	39.167	5 25½	9 00½	14 26½	79.238	1.89893	1.234	19.461	3.686	38.891	39.067
15 00	40.000	5 37½	9 22½	15 00	77.912	1.89160	1.299	19.868	3.910	39.697	39.889
30	41.667	6 01½	10 07	16 08½	75.592	1.87848	1.436	20.681	4.362	41.303	41.532
16 00	43.333	6 26½	10 53½	17 20	73.435	1.86590	1.582	21.492	4.846	42.899	43.171
30	45.000	6 52½	11 41½	18 33½	71.428	1.85387	1.738	22.299	5.363	44.484	44.806
17 00	46.667	7 19½	12 30½	19 50	69.557	1.84234	1.902	23.104	5.916	46.058	46.437
30	48.333	7 46½	13 22	21 08½	67.813	1.83131	2.077	23.905	6.504	47.619	48.062
18 00	50.000	8 15	14 15	22 30	66.186	1.82077	2.262	24.703	7.129	49.166	49.680
30	51.667	8 44½	15 09½	23 53½	64.668	1.81069	2.457	25.497	7.791	50.698	51.293
19 00	53.333	9 14½	16 05½	25 20	63.252	1.80107	2.663	26.287	8.491	52.213	52.899
30	55.000	9 45	17 03½	26 48½	61.930	1.79190	2.880	27.074	9.229	53.710	54.497
20 00	56.667	10 16½	18 03½	28 20	60.695	1.78315	3.107	27.856	10.007	55.187	56.087
30	58.333	10 49½	19 04½	29 53½	59.544	1.77484	3.346	28.633	10.826	56.644	57.669
21 00	60.000	11 22½	20 07½	31 30	58.471	1.76694	3.597	29.405	11.684	58.076	59.240
30	61.667	11 56½	21 12	33 08½	57.471	1.75945	3.859	30.171	12.583	59.484	60.801
22 00	63.333	12 31½	22 18½	34 50	56.541	1.75236	4.133	30.931	13.524	60.866	62.351
30	65.000	13 07½	23 26½	36 33½	55.677	1.74568	4.419	31.685	14.508	62.220	63.889
23 00	66.667	13 44½	24 35½	38 20	54.877	1.73939	4.718	32.433	15.533	63.543	65.414
24 00	70.000	15 00	27 00	42 00	53.451	1.72796	5.354	33.906	17.709	66.090	68.421

TAPER  $3\frac{1}{2}$  METRIC. CURVATURE INCREASING  
EVERY 10 M.

Transit at	Deflections to					
	B.C. 4° 00'	C.C. 8° 00'	C.C. 12° 00'	C.C. 16° 00'	C.C. 20° 00'	C.C. 24° 00'
<i>l</i>	0	10	20	30	40	50
0	.....	1 00	2 30	4 40	7 30	11 00
10	1 00	.....	2 00	4 30	7 40	11 30
20	3 30	2 00	.....	3 00	6 30	10 40
30	7 20	5 30	3 00	.....	4 00	8 30
40	12 30	10 20	7 30	4 00	.....	5 00
50	19 00	16 30	13 20	9 30	5 00	.....
60	26 50	24 00	20 30	16 20	11 30	6 00

TAPER  $3\frac{1}{2}$  METRIC. CURVATURE INCREASING 4  
EVERY 10 M. — (Continued)

<i>M</i>	<i>l</i>	<i>o</i>	<i>D</i>	log <i>D</i>	<i>d</i>	<i>t</i>	<i>z</i>	<i>y</i>
8 00	10	2 00	143.443	2.15668	0.087	4.996	0.175	9.999
12 00	20	6 00	96.016	1.98234	0.348	9.974	0.872	19.974
16 00	30	12 00	72.719	1.86165	0.866	14.912	2.437	29.851
20 00	40	20 00	59.309	1.77312	1.721	19.767	5.195	39.463
24 00	50	30 00	51.083	1.70828	2.986	24.477	9.432	48.526
28 00	60	42 00	46.067	1.66339	4.731	28.957	15.347	56.616

TAPER 3 $\frac{1}{2}$  METRIC. INTERMEDIATE VALUES  $\Delta=4$

<i>M</i>	<i>l</i>	<i>f</i>	<i>b</i>	<i>o</i>	<i>D</i>	log <i>D</i>	<i>d</i>	<i>t</i>	<i>z</i>	<i>y</i>	<i>lc</i>
12 00	20.000	2 30	3 30	6 00	96.016	1.98234	0.348	9.974	0.872	19.974	19.993
15	20.625	2 37	3 42	6 19	94.095	1.97357	0.372	10.284	0.941	20.596	20.617
30	21.250	2 44	3 53 $\frac{1}{2}$	6 38 $\frac{1}{2}$	92.252	1.96498	0.397	10.594	1.013	21.217	21.241
45	21.875	2 51 $\frac{1}{2}$	4 07	6 58 $\frac{1}{2}$	90.484	1.95657	0.423	10.904	1.089	21.838	21.865
13 00	22.500	2 58 $\frac{1}{2}$	4 20	7 18 $\frac{1}{2}$	88.787	1.94835	0.450	11.214	1.169	22.458	22.488
15	23.125	3 06 $\frac{1}{2}$	4 33 $\frac{1}{2}$	7 39 $\frac{1}{2}$	87.155	1.94029	0.478	11.523	1.252	23.077	23.111
30	23.750	3 14	4 47	8 01	85.587	1.93241	0.506	11.833	1.339	23.696	23.734
45	24.375	3 22	5 00 $\frac{1}{2}$	8 22 $\frac{1}{2}$	84.078	1.92468	0.538	12.142	1.430	24.315	24.357
14 00	25.000	3 30	5 15	8 45	82.625	1.91711	0.570	12.450	1.525	24.933	24.979
15	25.625	3 38 $\frac{1}{2}$	5 29 $\frac{1}{2}$	9 07 $\frac{1}{2}$	81.225	1.90969	0.602	12.759	1.624	25.550	25.602
30	26.250	3 46 $\frac{1}{2}$	5 44 $\frac{1}{2}$	9 31	79.876	1.90242	0.636	13.067	1.727	26.167	26.224
45	26.875	3 55	5 59 $\frac{1}{2}$	9 54 $\frac{1}{2}$	78.575	1.89528	0.671	13.375	1.834	26.783	26.846
15 00	27.500	4 03 $\frac{1}{2}$	6 15	10 18 $\frac{1}{2}$	77.321	1.88830	0.708	13.683	1.945	27.398	27.467
30	28.750	4 21 $\frac{1}{2}$	6 47	11 08 $\frac{1}{2}$	74.940	1.87471	0.784	14.298	2.182	28.626	28.710
16 00	30.000	4 40	7 20	12 00	72.719	1.86165	0.866	14.912	2.437	29.851	29.951
30	31.250	4 59	7 54 $\frac{1}{2}$	12 53 $\frac{1}{2}$	70.643	1.84906	0.953	15.524	2.710	31.072	31.190
17 00	32.500	5 18 $\frac{1}{2}$	8 30	13 48 $\frac{1}{2}$	68.700	1.83696	1.045	16.135	3.002	32.288	32.427
30	33.750	5 39	9 07	14 46	66.879	1.82529	1.143	16.745	3.315	33.499	33.662
18 00	35.000	6 00	9 45	15 45	65.170	1.81405	1.246	17.353	3.648	34.704	34.895
30	36.250	6 21 $\frac{1}{2}$	10 24 $\frac{1}{2}$	16 46	63.567	1.80323	1.356	17.959	4.002	35.904	36.126
19 00	37.500	6 43 $\frac{1}{2}$	11 05	17 48 $\frac{1}{2}$	62.060	1.79281	1.471	18.563	4.377	37.097	37.355
30	38.750	7 06 $\frac{1}{2}$	11 47	18 53 $\frac{1}{2}$	60.643	1.78278	1.593	19.166	4.775	38.284	38.581
20 00	40.000	7 30	12 30	20 00	59.309	1.77312	1.721	19.767	5.195	39.463	39.804
30	41.250	7 54	13 14 $\frac{1}{2}$	21 08 $\frac{1}{2}$	58.053	1.76382	1.855	20.365	5.639	40.633	41.023
21 00	42.500	8 18 $\frac{1}{2}$	14 00	22 18 $\frac{1}{2}$	56.870	1.75488	1.996	20.961	6.106	41.794	42.238
30	43.750	8 44	14 47	23 31	55.755	1.74628	2.143	21.554	6.598	42.945	43.449
22 00	45.000	9 10	15 35	24 45	54.706	1.73804	2.298	22.145	7.114	44.086	44.656
30	46.250	9 36 $\frac{1}{2}$	16 24 $\frac{1}{2}$	26 01	53.717	1.73011	2.459	22.733	7.655	45.215	45.858
23 00	47.500	10 03 $\frac{1}{2}$	17 15	27 18 $\frac{1}{2}$	52.787	1.72253	2.628	23.317	8.222	46.332	47.056
24 00	50.000	11 00	19 00	30 00	51.083	1.70828	2.986	24.477	9.432	48.526	49.434
25 00	52.500	11 58 $\frac{1}{2}$	20 50	32 48 $\frac{1}{2}$	49.577	1.69528	3.375	25.623	10.749	50.660	51.787
26 00	55.000	13 00	22 45	35 45	48.248	1.68348	3.794	26.753	12.173	52.725	54.111
27 00	57.500	14 03 $\frac{1}{2}$	24 45	38 48 $\frac{1}{2}$	47.083	1.67286	4.246	27.865	13.705	54.714	56.403
28 00	60.000	15 10	26 50	42 00	46.067	1.66339	4.731	28.957	15.347	56.616	58.660



TAPER  $3\frac{3}{4}$  METRIC. CURVATURE INCREASING  $5^{\circ}00'$   
EVERY 10 M.  $\Delta=5$

Transit at	Deflections to					
	B.C. $5^{\circ}00'$	C.C. $10^{\circ}00'$	C.C. $15^{\circ}00'$	C.C. $20^{\circ}00'$	C.C. $25^{\circ}00'$	C.C. $30^{\circ}00'$
<i>l</i>	0	10	20	30	40	50
0	0 0	0 0	0 0	0 0	0 0	0 0
10	1 15	1 15	3 07½	5 50	9 22½	13 45
20	4 22½	2 30	2 30	5 37½	9 35	14 22½
30	9 10	6 52½	3 45	3 45	8 07½	13 20
40	15 37½	12 55	9 22½	5 00	5 00	10 37½
50	23 45	20 37½	16 40	11 52½	6 15	6 15
						.....

TAPER  $3\frac{3}{4}$  METRIC. CURVATURE INCREASING  $5^{\circ}00'$   
EVERY 10 M. — (Continued)  $\Delta=5$

<i>M</i>	<i>l</i>	<i>o</i>	<i>D</i>	log <i>D</i>	<i>d</i>	<i>t</i>	<i>z</i>	<i>y</i>	<i>lc</i>
0 0	0 0	0 0							
10 00	10	2 30	114.847	2.06012	0.110	4.993	0.218	9.998	10.000
15 00	20	7 30	77.048	1.88676	0.435	9.960	1.090	19.960	19.990
20 00	30	15 00	58.667	1.76839	1.079	14.863	3.041	29.767	29.922
25 00	40	25 00	48.338	1.68429	2.136	19.638	6.465	39.164	39.694
30 00	50	37 30	42.331	1.62666	3.694	24.192	11.675	47.713	49.120

TAPER  $3\frac{1}{2}$  METRIC. INTERMEDIATE VALUES  $\Delta=5$

$M$	$l$	$f$	$b$	$o$	$D$	$\log D$	$d$	$t$	$z$	$v$	$lc$
15 00	20.000	3.07 $\frac{1}{2}$	4.22 $\frac{1}{2}$	7 30	77.048	1.88676	0.435	9.960	1.090	19.960	19.990
30	21.000	3.21 $\frac{1}{2}$	4.46 $\frac{1}{2}$	8 08 $\frac{1}{2}$	74.640	1.87297	0.484	10.454	1.229	20.951	20.987
16 00	22.000	3.36	5 12	8 48	72.388	1.85967	0.535	10.947	1.380	21.940	21.983
30	23.000	3.51	5.38 $\frac{1}{2}$	9 29 $\frac{1}{2}$	70.280	1.84683	0.590	11.440	1.543	22.927	22.979
17 00	24.000	4.06 $\frac{1}{2}$	6.05 $\frac{1}{2}$	10 12	68.304	1.83445	0.649	11.932	1.718	23.912	23.974
30	25.000	4.22 $\frac{1}{2}$	6.33 $\frac{1}{2}$	10 56 $\frac{1}{2}$	66.448	1.82248	0.712	12.423	1.905	24.895	24.968
18 00	26.000	4.39	7.03	11 42	64.701	1.81091	0.777	12.913	2.105	25.876	25.961
30	27.000	4.56	7.33 $\frac{1}{2}$	12 29 $\frac{1}{2}$	63.057	1.79973	0.846	13.402	2.318	26.854	26.953
19 00	28.000	5.13 $\frac{1}{2}$	8.04 $\frac{1}{2}$	13 18	61.509	1.78894	0.920	13.890	2.545	27.829	27.944
30	29.000	5.31 $\frac{1}{2}$	8.36 $\frac{1}{2}$	14 08 $\frac{1}{2}$	60.047	1.77849	0.997	14.377	2.786	28.800	28.934
20 00	30.000	5.50	9 10	15 00	58.667	1.76839	1.079	14.863	3.041	29.767	29.922
30	31.000	6.09	9.44 $\frac{1}{2}$	15 53 $\frac{1}{2}$	57.362	1.75862	1.164	15.347	3.311	30.731	30.909
21 00	32.000	6.28 $\frac{1}{2}$	10.19 $\frac{1}{2}$	16 48	56.128	1.74918	1.254	15.830	3.597	31.691	31.894
30	33.000	6.48 $\frac{1}{2}$	10.55 $\frac{1}{2}$	17 44 $\frac{1}{2}$	54.960	1.74005	1.348	16.312	3.898	32.645	32.877
22 00	34.000	7.09	11.33	18 42	53.855	1.73123	1.447	16.793	4.214	33.596	33.858
30	35.000	7.30	12.11 $\frac{1}{2}$	19 41 $\frac{1}{2}$	52.808	1.72270	1.550	17.271	4.547	34.540	34.838
23 00	36.000	7.51 $\frac{1}{2}$	12.50 $\frac{1}{2}$	20 42	51.817	1.71447	1.658	17.748	4.896	35.478	35.814
24 00	38.000	8.36	14.12	22 48	49.984	1.69883	1.887	18.697	5.645	37.336	37.762
25 00	40.000	9.22 $\frac{1}{2}$	15.37 $\frac{1}{2}$	25 00	48.338	1.68429	2.136	19.638	6.465	39.164	39.694
26 00	42.000	10 11	17 07	27 18	46.559	1.66800	2.405	20.570	7.357	40.958	41.614
27 00	44.000	11 01 $\frac{1}{2}$	18.40 $\frac{1}{2}$	29 42	45.531	1.65831	2.694	21.492	8.323	42.714	43.520
28 00	46.000	11 54	20.18	32 12	44.341	1.64681	3.005	22.404	9.363	44.428	45.405
29 00	48.000	12 48 $\frac{1}{2}$	21.59 $\frac{1}{2}$	34 48	43.273	1.63622	3.338	23.305	10.480	46.096	47.273
30 00	50.000	13 45	23.45	37 30	42.331	1.62666	3.694	24.192	11.675	47.713	49.120











COMPARATIVE VALUES. METRIC — (Continued)

M	Δ	1		14		2		24		3		4		5	
		1	14	2	14	2	14	2	14	3	34	34	34	34	34
12° 00'	l	110.000	86.000	70.000	50.000	38.000	30.000	20.000	38.000	30.000	20.000	38.000	30.000	20.000	38.000
	d	6.184	3.949	2.731	1.519	0.957	0.652	0.348	0.957	0.652	0.348	0.957	0.652	0.348	0.957
	o	33° 00'	25° 48'	21° 00'	15° 00'	11° 24'	9° 00'	6° 00'	11° 24'	9° 00'	6° 00'	11° 24'	9° 00'	6° 00'	11° 24'
13° 00'	l	120.000	94.000	76.667	55.000	42.000	33.333	22.500	42.000	33.333	22.500	42.000	33.333	22.500	42.000
	d	7.850	5.018	3.474	1.935	1.224	0.836	0.450	1.224	0.836	0.450	1.224	0.836	0.450	1.224
	o	39° 00'	30° 33'	24° 55'	17° 52½'	13° 39'	10° 50'	7° 18½'	13° 39'	10° 50'	7° 18½'	13° 39'	10° 50'	7° 18½'	13° 39'
14° 00'	l	102.000	102.000	83.333	60.000	46.000	36.667	25.000	46.000	36.667	25.000	46.000	36.667	25.000	46.000
	d	6.202	6.202	4.339	2.420	1.535	1.051	0.570	1.535	1.051	0.570	1.535	1.051	0.570	1.535
	o	35° 42'	35° 42'	29° 10'	21° 00'	16° 06'	12° 50'	8° 45'	16° 06'	12° 50'	8° 45'	16° 06'	12° 50'	8° 45'	16° 06'
15° 00'	l	110.000	110.000	90.000	65.000	50.000	40.000	27.500	50.000	40.000	27.500	50.000	40.000	27.500	50.000
	d	7.691	7.691	5.334	2.981	1.893	1.299	0.708	1.893	1.299	0.708	1.893	1.299	0.708	1.893
	o	41° 15'	41° 15'	33° 45'	24° 22½'	18° 45'	15° 00'	10° 18½'	18° 45'	15° 00'	10° 18½'	18° 45'	15° 00'	10° 18½'	18° 45'
16° 00'	l	96.667	96.667	70.000	50.000	38.000	30.000	20.000	38.000	30.000	20.000	38.000	30.000	20.000	38.000
	d	6.466	6.466	4.466	2.466	1.582	1.051	0.570	1.582	1.051	0.570	1.582	1.051	0.570	1.582
	o	38° 40'	38° 40'	30° 40'	21° 36'	17° 20'	12° 00'	8° 48'	17° 20'	12° 00'	8° 48'	17° 20'	12° 00'	8° 48'	17° 20'
18° 00'	l	80.000	80.000	62.000	45.000	35.000	26.000	17.500	35.000	26.000	17.500	35.000	26.000	17.500	35.000
	d	5.149	5.149	3.281	2.262	1.466	0.977	0.514	2.262	1.466	0.977	2.262	1.466	0.977	2.262
	o	36° 00'	36° 00'	27° 54'	22° 30'	17° 54'	13° 45'	9° 45'	22° 30'	17° 54'	13° 45'	22° 30'	17° 54'	13° 45'	22° 30'





## CONVERSION OF ENGLISH INCHES INTO CENTIMETERS.

Ins.	0	1	2	3	4	5	6	7	8	9
	Cm.	Cm.	Cm.	Cm.	Cm.	Cm.	Cm.	Cm.	Cm.	Cm.
0	0.000	2.540	5.080	7.620	10.16	12.70	15.24	17.78	20.32	22.86
10	25.40	27.94	30.48	33.02	35.56	38.10	40.64	43.18	45.72	48.26
20	50.80	53.34	55.88	58.42	60.96	63.50	66.04	68.58	71.12	73.66
30	76.20	78.74	81.28	83.82	86.36	88.90	91.44	93.98	96.52	99.06
40	101.60	104.14	106.68	109.22	111.76	114.30	116.84	119.38	121.92	124.46
50	127.00	129.54	132.08	134.62	137.16	139.70	142.24	144.78	147.32	149.86
60	152.40	154.94	157.48	160.02	162.56	165.10	167.64	170.18	172.72	175.26
70	177.80	180.34	182.88	185.42	187.96	190.50	193.04	195.58	198.12	200.66
80	203.20	205.74	208.28	210.82	213.36	215.90	218.44	220.98	223.52	226.06
90	228.60	231.14	233.68	236.22	238.76	241.30	243.84	246.38	248.92	251.46
100	254.00	256.54	259.08	261.62	264.16	266.70	269.24	271.78	274.32	276.86

## CONVERSION OF CENTIMETERS INTO ENGLISH INCHES.

Cm.	0	1	2	3	4	5	6	7	8	9
	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.
0	0.000	0.394	0.787	1.181	1.575	1.969	2.362	2.756	3.150	3.543
10	3.937	4.331	4.724	5.118	5.512	5.906	6.299	6.693	7.087	7.480
20	7.874	8.268	8.662	9.055	9.449	9.843	10.236	10.630	11.024	11.418
30	11.811	12.205	12.599	12.992	13.386	13.780	14.173	14.567	14.961	15.355
40	15.748	16.142	16.536	16.929	17.323	17.717	18.111	18.504	18.898	19.292
50	19.685	20.079	20.473	20.867	21.260	21.654	22.048	22.441	22.835	23.229
60	23.622	24.016	24.410	24.804	25.197	25.591	25.985	26.378	26.772	27.166
70	27.560	27.953	28.347	28.741	29.134	29.528	29.922	30.316	30.709	31.103
80	31.497	31.890	32.284	32.678	33.071	33.465	33.859	34.253	34.646	35.040
90	35.434	35.827	36.221	36.615	37.009	37.402	37.796	38.190	38.583	38.977
100	39.370	39.764	40.158	40.552	40.945	41.339	41.733	42.126	42.520	42.914

## CONVERSION OF ENGLISH FEET INTO METERS.

Feet.	0	1	2	3	4	5	6	7	8	9
	Met.	Met.	Met.	Met.	Met.	Met.	Met.	Met.	Met.	Met.
0	0.000	0.3048	0.6096	0.9144	1.2192	1.5239	1.8287	2.1335	2.4383	2.7431
10	3.0479	3.3527	3.6575	3.9623	4.2671	4.5719	4.8767	5.1815	5.4863	5.7911
20	6.0959	6.4006	6.7055	7.0102	7.3150	7.6198	7.9246	8.2294	8.5342	8.8390
30	9.1438	9.4486	9.7534	10.058	10.363	10.668	10.972	11.277	11.582	11.887
40	12.192	12.496	12.801	13.106	13.411	13.716	14.020	14.325	14.630	14.935
50	15.239	15.544	15.849	16.154	16.459	16.763	17.068	17.373	17.678	17.983
60	18.287	18.592	18.897	19.202	19.507	19.811	20.116	20.421	20.726	21.031
70	21.335	21.640	21.945	22.250	22.555	22.859	23.164	23.469	23.774	24.079
80	24.383	24.688	24.993	25.298	25.602	25.907	26.212	26.517	26.822	27.126
90	27.431	27.736	28.041	28.346	28.651	28.955	29.260	29.565	29.870	30.174
100	30.479	30.784	31.089	31.394	31.698	32.003	32.308	32.613	32.918	33.222

## CONVERSION OF METERS INTO ENGLISH FEET.

Met.	0	1	2	3	4	5	6	7	8	9
	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.
0	0.000	3.2809	6.5618	9.8427	13.123	16.404	19.685	22.966	26.247	29.528
10	32.809	36.090	39.371	42.651	45.932	49.213	52.494	55.775	59.056	62.337
20	65.618	68.899	72.179	75.461	78.741	82.022	85.303	88.584	91.865	95.146
30	98.427	101.71	104.99	108.27	111.55	114.83	118.11	121.39	124.67	127.95
40	131.234	134.52	137.80	141.08	144.36	147.64	150.92	154.20	157.48	160.76
50	164.04	167.33	170.61	173.89	177.17	180.45	183.73	187.01	190.29	193.57
60	196.85	200.13	203.42	206.70	209.98	213.26	216.54	219.82	223.10	226.38
70	229.66	232.94	236.22	239.51	242.79	246.07	249.35	252.63	255.91	259.19
80	262.47	265.75	269.03	272.31	275.59	278.88	282.16	285.44	288.72	292.00
90	295.28	298.56	301.84	305.12	308.40	311.69	314.97	318.25	321.53	324.81
100	328.09	331.37	334.65	337.93	341.21	344.49	347.77	351.05	354.34	357.62

TRIGONOMETRIC AND MISCELLANEOUS  
FORMULAS.

SOLUTION OF RIGHT TRIANGLES.

Required.	Given.	Formulas.
$A, C, c$	$a, b$	$\sin A = \cos C = \frac{a}{b}; c = \sqrt{(b+a)(b-a)}.$
$A, C, b$	$a, c$	$\tan A = \cot B = \frac{a}{c}; b = \sqrt{a^2 + c^2}.$
$C, b, c$	$A, a$	$C = 90^\circ - A; c = a \cot A; b = a \operatorname{cosec} A.$
$C, a, c$	$A, b$	$C = 90^\circ - A; a = b \sin A; c = b \cos A.$
$C, a, b$	$A, c$	$C = 90^\circ - A; a = c \tan A; b = c \sec A.$

SOLUTION OF OBLIQUE TRIANGLES.

Required.	Given.	Formulas.
$b$	$A, B, a$	$b = \frac{a \sin B}{\sin A}$
$B$	$A, a, b$	$\sin B = \frac{b \sin A}{a}$
$\frac{1}{2}(A+B)$	$a, b, C$	$\frac{1}{2}(A+B) = \frac{1}{2}(180 - C)$
$\frac{1}{2}(A-B)$		$\tan \frac{1}{2}(A-B) = \frac{a-b}{a+b} \tan \frac{1}{2}(A+B)$
$A$		$A = \frac{1}{2}(A+B) + \frac{1}{2}(A-B)$
$B$		$B = \frac{1}{2}(A+B) - \frac{1}{2}(A-B)$
$A$	$a, b, c$	If $s = \frac{1}{2}(a+b+c)$ , $\sin \frac{1}{2}A = \sqrt{\frac{(s-b)(s-c)}{bc}}$
		$\cos \frac{1}{2}A = \sqrt{\frac{s(s-a)}{bc}}$
		$\tan \frac{1}{2}A = \sqrt{\frac{(s-b)(s-c)}{s(s-a)}}$
		$\sin A = \frac{2\sqrt{s(s-a)(s-b)(s-c)}}{bc}$
Area		Area = $\sqrt{s(s-a)(s-b)(s-c)}$
Area	$A, b, c$	Area = $\frac{1}{2}bc \sin A$
Area	$A, B, c$	Area = $\frac{c^2 \sin A \sin B}{2 \sin(A+B)}$

TRIGONOMETRIC AND MISCELLANEOUS  
FORMULAS.

GENERAL FORMULAS.

$$\sin A = \sqrt{1 - \cos^2 A} = \tan A \cos A.$$

$$\sin A = 2 \sin \frac{1}{2} A \cos \frac{1}{2} A.$$

$$\sin A = \frac{1}{\operatorname{cosec} A} = \sqrt{\frac{1}{2}(1 - \cos 2A)}.$$

$$\cos A = \frac{1}{\sec A} = \sqrt{1 - \sin^2 A} = \cot A \sin A.$$

$$\cos A = 1 - 2 \sin^2 \frac{1}{2} A = 1 - \operatorname{vers} A.$$

$$\cos A = \sqrt{\frac{1}{2} + \frac{1}{2} \cos 2A} = \cos^2 \frac{1}{2} A - \sin^2 \frac{1}{2} A.$$

$$\tan A = \frac{\sin A}{\cos A} = \sqrt{\sec^2 A - 1}.$$

$$\tan A = \frac{\sqrt{1 - \cos^2 A}}{\cos A} = \frac{\sin 2A}{1 + \cos 2A}.$$

$$\tan A = \frac{1}{\cot A} = \frac{1 - \cos 2A}{\sin 2A}.$$

$$\cot A = \frac{1}{\tan A} = \frac{\cos A}{\sin A} = \sqrt{\operatorname{cosec}^2 A - 1}.$$

$$\cot A = \frac{\sin 2A}{1 - \cos 2A} = \frac{1 + \cos 2A}{\sin 2A}.$$

$$\sec A = \frac{1}{\cos A} = \text{the reciprocal of any expression for } \cos A.$$

$$\operatorname{cosec} A = \frac{1}{\sin A} = \text{the reciprocal of any expression for } \sin A.$$

$$\operatorname{vers} A = 1 - \cos A = 2 \sin^2 \frac{1}{2} A.$$

$$\operatorname{exsec} A = \sec A - 1 = \frac{\operatorname{vers} A}{\cos A}.$$

$$\sin \frac{1}{2} A = \sqrt{\frac{1 - \cos A}{2}} = \sqrt{\frac{\operatorname{vers} A}{2}}.$$

