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# THE THEORY AND PRACTICE OF TWO-DIMENSIONAL SUPERSONIC PRESSURE CALCULATIONS

BY

N. EDMONSON, F. D. MURNAGHAN, R. M. SNOW



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# INTRODUCTION

The experience of the Analysis Group engaged in theoretical supersonic aerodynamic analysis in the Applied Physics Laboratory of The Johns Hopkins University has shown that the computations of pressure distributions on airfoils of infinite span in a two-dimensional flow and of the effects of shock fronts can be greatly speeded up by the use of appropriate tables. Brief tables for the calculation of pressure distributions have been given by Lighthill<sup>1</sup> but so far as was known to the Analysis Group, when its work was started, tables to facilitate the computation of oblique shock front effects did not exist. The Analysis Group has calculated extensive tables for facilitating oblique shock front computations.

At the same time the need for a concise and accurate discussion of the principles of supersonic aerodynamics became apparent. With the aid of its consultant, Dr. F. D. Murnaghan, Professor of Mathematics in The Johns Hopkins University, the Analysis Group prepared such a discussion for two-dimensional supersonic flows, giving careful attention to the precise definition of terms. An important feature of this study is the demonstration that an arbitrary curve intersecting once and only once each of the straight-line patching or characteristic curves in an expansive supersonic flow can be treated as if it were a characteristic curve. This fact leads at once to the formulas for calculating pressure distributions over airfoils immersed in two-dimensional supersonic flows, and hence to lift, drag, and moment computations. This explicit demonstration is not given in any of the literature that so far has come to the attention of the Analysis Group. Also it is explicitly demonstrated that the Ackeret linear theory and the Busemann second order theory are approximations to the more general theory.

The present Bumblebee report includes both of the studies just described—the computation tables and the discussion of the principles of two-dimensional supersonic flow. Thus it is essentially a manual, for the two-dimensional case, on the theory and practice of computation in supersonic, aerodynamic flow, as far as the present state of the subject is concerned.

<sup>1</sup> F. M. Panel No. 654, Ac. 2420; A. R. C. No. 7384.

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## PART I. GENERAL THEORY

## 1. The theory of patching curves (characteristics) in two-dimensional supersonic flow.

We shall confine our discussion to the case of steady two-dimensional flow of a perfect fluid. The basic equations of motion are, in the absence of mass forces,

$$-\frac{1}{\rho}\frac{\partial p}{\partial x}=\frac{\mathrm{d}u}{\mathrm{d}t}\,,\qquad -\frac{1}{\rho}\frac{\partial p}{\partial y}=\frac{\mathrm{d}v}{\mathrm{d}t}\,.$$

We postulate a relation

$$\mathbf{p} = \mathbf{p}(\rho, \eta)$$

where  $\eta$  is the entropy and assume that  $\eta$  does not vary with x and y; then

$$\frac{\partial p}{\partial x} = \frac{\partial p}{\partial \rho} \frac{\partial \rho}{\partial x} = c^2 \frac{\partial \rho}{\partial x}, \qquad \frac{\partial p}{\partial y} = \frac{\partial p}{\partial \rho} \frac{\partial \rho}{\partial y} = c^2 \frac{\partial \rho}{\partial y}$$

where

$$c^2 = \frac{\partial p}{\partial \rho}$$

so that c is the "local sound-velocity". Since the flow is steady

$$\frac{\mathrm{d}\mathbf{u}}{\mathrm{d}\mathbf{t}} = \mathbf{u}\frac{\partial\mathbf{u}}{\partial\mathbf{x}} + \mathbf{v}\frac{\partial\mathbf{u}}{\partial\mathbf{y}}, \qquad \frac{\mathrm{d}\mathbf{v}}{\mathrm{d}\mathbf{t}} = \mathbf{u}\frac{\partial\mathbf{v}}{\partial\mathbf{x}} + \mathbf{v}\frac{\partial\mathbf{v}}{\partial\mathbf{y}}$$

and so the equations of motion may be written in the form

$$-\frac{c^2}{\rho}\frac{\partial\rho}{\partial x} = u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y}, \qquad -\frac{c^2}{\rho}\frac{\partial\rho}{\partial y} = u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y}.$$

The equation of continuity (for steady flow) is

$$\frac{\partial}{\partial x}(\rho u) + \frac{\partial}{\partial y}(\rho v) = 0$$

Upon multiplying this by  $-\frac{c^2}{\rho}$  and substituting the values jus' given for  $-\frac{c^2}{\rho}\frac{\partial\rho}{\partial x}$ ,  $-\frac{c^2}{\rho}\frac{\partial\rho}{\partial y}$  we obtain

$$u\left(u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y}\right) + v\left(u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y}\right) - c^{2}\left(\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y}\right) = 0$$
  
i.e.

$$(c^{2} - u^{2})\frac{\partial u}{\partial x} - uv\left(\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x}\right) + (c^{2} - v^{2})\frac{\partial v}{\partial y} = 0.$$
(1)

We now consider an arbitrarily given curve C:

$$x = x(\alpha); \quad y = y(\alpha)$$

( $\alpha$  being any convenient parameter or independent variable) and suppose that the values of u, v and of the vorticity  $\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}$  are prescribed along this curve. In other words, u, v, and  $\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}$  are given functions of  $\alpha$ ; does it, then, follow that the values of the four space derivatives  $\frac{\partial u}{\partial x}$ ,  $\frac{\partial u}{\partial y}$ ,  $\frac{\partial v}{\partial x}$ ,  $\frac{\partial v}{\partial y}$  of the two velocity components (u, v) are unambiguously determined along C? If not we can regard the curve C as a *patching curve* along which two different flows are patched together, there being *no* discontinuity in the velocity components (u, v) nor in the vorticity  $\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}$  across the patching curve. For this reason any such patching curve C must be clearly distinguished from a *shock-curve* across which the normal component of velocity is discontinuous.

Since u and v are given functions of  $\alpha$  along C we have

$$\frac{\partial u}{\partial x}\frac{dx}{d\alpha} + \frac{\partial u}{\partial y}\frac{dy}{d\alpha} = \frac{du}{d\alpha}$$
$$\frac{\partial v}{\partial x}\frac{dx}{d\alpha} + \frac{\partial v}{\partial y}\frac{dy}{d\alpha} = \frac{dv}{d\alpha}.$$

These two equations together with the equation

$$\frac{\partial \mathbf{v}}{\partial \mathbf{x}} - \frac{\partial \mathbf{u}}{\partial \mathbf{y}} = \omega(\alpha),$$

where  $\omega(\alpha)$  is a given function of  $\alpha$ , and the equation (1) constitute a system of four linear equations for the four space derivatives of the velocity components (u, v). These equations determine, without ambiguity, the four space derivatives of u and v unless the determinant of the coefficients happens to be zero. Thus in order that C may be a curve which patches together two flows for which, at the various points of C, at least one of the four derivatives  $\frac{\partial u}{\partial x}$ ,  $\frac{\partial u}{\partial y}, \frac{\partial v}{\partial x}, \frac{\partial v}{\partial y}$  has different values for the two flows (the values of u, v and  $\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}$  being, however, the same

for both flows along C), it is necessary that

$$(c^{2} - v^{2})\left(\frac{dx}{d\alpha}\right)^{2} + 2uv\frac{dx}{d\alpha}\frac{dy}{d\alpha} + (c^{2} - u^{2})\left(\frac{dy}{d\alpha}\right)^{2} = 0. (2)$$

This quadratic equation for the ratio  $\frac{dx}{d\alpha} : \frac{dy}{d\alpha}$  has real roots if, and only if,

$$u^2 + v^2 \ge c^2$$

(the roots being equal when the equality holds). Thus a point of the flow cannot be a point of a patching curve unless the flow is supersonic (or, at least, sonic) at that point; in other words a *necessary* condition for a point of the flow to be a point of a patching curve is

 $\mathbf{q} \geq \mathbf{c}$ 

(where  $q = (u^2 + v^2)^1$  is the speed of the flow). The essential difference between supersonic and subsonic flow is:

There are no patching curves in subsonic flow.<sup>2</sup>

It remains now to see what further condition, if any, must be imposed on u, v and  $\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}$  (which are given functions of  $\alpha$  along C) in order that the four linear equations connecting  $\frac{\partial u}{\partial x}, \frac{\partial u}{\partial y}, \frac{\partial v}{\partial x}, \frac{\partial v}{\partial y}$  may have a solution when the determinant of their coefficients is zero. This condition is obtained by equating to zero the determinant obtained by replacing any one of the four columns of the determinant of the coefficients of the four equations by the column of numbers on the right-hand side of the four equations. Replacing the second column, for example, we obtain

$$\begin{vmatrix} \frac{dx}{d\alpha} & \frac{du}{d\alpha} & 0 & 0 \\ 0 & \frac{dv}{d\alpha} & \frac{dx}{d\alpha} & \frac{dy}{d\alpha} \\ 0 & \omega(\alpha) & 1 & 0 \\ c^2 - u^2 & 0 & -uv & c^2 - v^2 \end{vmatrix} = 0$$

or, equivalently,

$$\begin{array}{l} (\mathbf{c}^2 - \mathbf{v}^2) \ \frac{\mathrm{dx}}{\mathrm{d\alpha}} \frac{\mathrm{dv}}{\mathrm{d\alpha}} + (\mathbf{c}^2 - \mathbf{u}^2) \frac{\mathrm{dy}}{\mathrm{d\alpha}} \frac{\mathrm{du}}{\mathrm{d\alpha}} \\ \\ = \left\{ (\mathbf{c}^2 - \mathbf{v}^2) \ \frac{\mathrm{dx}}{\mathrm{d\alpha}} + \ \mathrm{uv} \ \frac{\mathrm{dy}}{\mathrm{d\alpha}} \right\} \frac{\mathrm{dx}}{\mathrm{d\alpha}} \omega(\alpha). \end{array}$$

<sup>2</sup> What are here termed patching curves are usually called *characteristics*; we prefer the name patching curve since there is danger of confusing characteristics with shock curves.

We shall confine ourselves to the case where  $\omega(\alpha) = 0$  so that the vorticity is taken to be zero along the patching curve; in particular, this will certainly be the case when the flow is *irrotational*, i.e. when the vorticity is zero throughout the entire flow. Then the sufficient condition for the existence of solutions of the four linear equations for the four space derivatives of u and v along C (when the determinant of these four equations is zero) is

$$(c^2 - v^2) \frac{dx}{d\alpha} \frac{dv}{d\alpha} + (c^2 - u^2) \frac{dy}{d\alpha} \frac{du}{d\alpha} = 0.$$
(3)

From this point on we shall suppose that the flow is *irrotational*, i.e., that  $\frac{\partial v}{\partial x} = \frac{\partial u}{\partial y}$  and that the relation which expresses p as a function of the density  $\rho$  and the entropy  $\eta$  is of the form

$$\mathbf{p} = \mathbf{k} \boldsymbol{\rho}^{\boldsymbol{\gamma}}$$

where k is a function of the entropy  $\eta$  alone (so that k does not vary with x and y). Since, when the flow is irrotational,

$$\frac{\mathrm{d}\mathbf{u}}{\mathrm{d}\mathbf{t}} = \mathbf{u} \frac{\partial \mathbf{u}}{\partial \mathbf{x}} + \mathbf{v} \frac{\partial \mathbf{u}}{\partial \mathbf{y}} = \mathbf{u} \frac{\partial \mathbf{u}}{\partial \mathbf{x}} + \mathbf{v} \frac{\partial \mathbf{v}}{\partial \mathbf{x}} = \frac{\partial}{\partial \mathbf{x}} \left( \frac{1}{2} \mathbf{q}^2 \right)$$
$$\frac{\mathrm{d}\mathbf{v}}{\mathrm{d}\mathbf{t}} = \mathbf{u} \frac{\partial \mathbf{v}}{\partial \mathbf{x}} + \mathbf{v} \frac{\partial \mathbf{v}}{\partial \mathbf{y}} = \mathbf{u} \frac{\partial \mathbf{u}}{\partial \mathbf{y}} + \mathbf{v} \frac{\partial \mathbf{v}}{\partial \mathbf{y}} = \frac{\partial}{\partial \mathbf{y}} \left( \frac{1}{2} \mathbf{q}^2 \right)$$

the *two* equations of motion are equivalent to (i.e. imply and are implied by) the *single* relation

$$\frac{1}{2}q^2 + \int \frac{c^2}{\rho} d\rho = \text{const.}$$
 (4)

Using the relation  $p = k\rho^{\gamma}$  we have  $c^2 = \frac{\partial p}{\partial \rho} = \gamma k\rho^{\gamma-1}$ =  $\frac{\gamma p}{\rho}$  so that  $\int \frac{c^2}{\rho} d\rho = \frac{\gamma k}{\gamma - 1}\rho^{\gamma-1} = \frac{\gamma}{\gamma - 1}\frac{p}{\rho} = \frac{c^2}{\gamma - 1}$ . We may, then, write the single relation which is equivalent to the two equations of motion in the form

$$c^{2} = \frac{\gamma - 1}{2} \left( q_{M}^{2} - q^{2} \right)$$
 (5)

where  $q_M$  is a constant  $\ge q$  (it is the value of q at those points, if any, of the flow where c = 0).

The differential equation which determines the patching curves may be written in the form

$$(c^{2} - v^{2})(dx)^{2} + 2 uv dxdy + (c^{2} - u^{2})(dy)^{2} = 0$$

 $\mathbf{2}$ 

and, on dividing through by  $ds^2 = (dx)^2 + (dy)^2$ , we obtain

$$\mathbf{c}^{2} = \left(\mathbf{v} \; \frac{\mathrm{d}\mathbf{x}}{\mathrm{d}\mathbf{s}} - \mathbf{u} \frac{\mathrm{d}\mathbf{y}}{\mathrm{d}\mathbf{s}}\right)^{2}.$$

On denoting by  $\theta$  the inclination of the flow we have

$$u = q \cos \theta, v = q \sin \theta$$

so that

$$\frac{c^2}{q^2} = \left(\sin\theta \frac{dx}{ds} - \cos\theta \frac{dy}{ds}\right)^2 = \sin^2\theta$$

where  $\mu$  is the angle between the direction of flow and the direction of the patching curve;  $\mu$  is the Mach angle and

$$\sin \mu = c/q.$$

The number  $M = q/c = \csc \mu$  is known as the Mach number of the flow at the point in question.

Through any point, then, where the flow is supersonic there pass two possible patching curves and the direction of flow bisects the angle between these two curves (the angle between the direction of flow and the patching curves being  $\pm \mu$ ; it is convenient to direct the patching curves so that the direction of flow bisects *internally* the angle between the two curves). At a point where the flow is sonic,  $\mu = \pi/2$  and the two possible patching curves through this point touch at the point (the direction of flow being along their common normal at the point).

The two slopes of the possible patching curves through a point where the flow is supersonic are

$$\frac{-\mathrm{uv}\pm\mathrm{c}\sqrt{q^2-\mathrm{c}^2}}{\mathrm{c}^2-\mathrm{u}^2}$$

Let us consider the curve for which

$$\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{-(\mathrm{u}v + \mathrm{c}\sqrt{q^2 - \mathrm{c}^2})}{\mathrm{c}^2 - \mathrm{u}^2}$$

and calculate the rate,  $\frac{dq}{d\alpha}$ , at which the speed q

varies along this patching curve. Since  $q^2 = u^2 + v^2$ and since  $(c^2 - v^2) dx dv + (c^2 - u^2) dy du = 0$ we have

$$q \, dq = u \, du + v \, dv = \left\{ u - v \frac{c^2 - u^2 \, dy}{c^2 - v^2 \, dx} \right\} du$$
$$= \left\{ u + v \frac{uv + c \sqrt{q^2 - c^2}}{c^2 - v^2} \right\} du$$
$$= \frac{c}{c^2 - v^2} (uc + v \sqrt{q^2 - c^2}) \, du$$

so that

$$q\frac{dq}{d\alpha} = \frac{c}{c^2 - v^2} (uc + v\sqrt{q^2 - c^2}) \frac{du}{d\alpha}$$

Since  $u = q \cos \theta$ ,  $v = q \sin \theta$ , we have

$$u dv - v du = u(\sin \theta dq + q \cos \theta d\theta)$$

$$- v(\cos \theta \, dq - q \sin \theta \, d\theta) = q^2 d\theta$$

and since

$$udv - vdu = -\left\{ u \frac{c^2 - u^2 dy}{c^2 - v^2 dx} + v \right\} du$$
$$= \left\{ \frac{u}{c^2 - v^2} (uv + c \sqrt{q^2 - c^2}) - v \right\} du$$
$$= \frac{v(q^2 - c^2) + uc \sqrt{q^2 - c^2}}{c^2 - v^2} du$$

we obtain

$$q^{2}\frac{d\theta}{d\alpha} = \frac{\sqrt{q^{2}-c^{2}}}{c^{2}-v^{2}} \left\{ uc + v\sqrt{q^{2}-c^{2}} \right\} \frac{du}{d\alpha}$$

On combining this with the formula furnishing  $q \frac{dq}{d\alpha}$  we find

$$\frac{1}{q}\frac{\mathrm{d}q}{\mathrm{d}\theta} = \frac{c}{\sqrt{q^2 - c^2}} = \tan\mu. \tag{6}$$

This is the fundamental relation as far as the application of the theory of patching curves (characteristics) to supersonic calculations is concerned. It is easy to show that if we had selected the other characteristic direction through the given point we should have obtained

$$\frac{1}{q}\frac{\mathrm{d}q}{\mathrm{d}\theta}=-\tan\mu.$$

Summarizing these results, we may say:

Along any patching curve (or characteristic) in supersonic flow

$$\frac{1}{q}\frac{\mathrm{d}q}{\mathrm{d}\theta} = \pm \tan \mu$$

where q is the speed,  $\theta$  is the inclination of flow and  $\mu$  is the Mach angle.

If we denote by t the component of velocity tangent to the patching curve, so that  $t = q \cos \mu$ , we have, since  $c = q \sin \mu$ ,

$$q^2 = c^2 + t^2$$

When this is substituted in the relation

$$e^{2} = \frac{\gamma - 1}{2} (q_{M}^{2} - q^{2})$$
 we get  
 $\frac{\gamma + 1}{2} e^{2} = \frac{\gamma - 1}{2} (q_{M}^{2} - t^{2})$ 

so that

$$c^2 = \frac{\gamma - 1}{\gamma + 1} (q_M^2 - t^2).$$

Now the relation  $t = q \cos \mu$  yields

$$dt = \cos \mu \, dq - q \sin \mu \, d\mu$$

and on substituting for dq its value  $\pm q \tan \mu d\theta$ , we obtain

$$dt = q \sin \mu (\pm d\theta - d\mu) = c(\pm d\theta - d\mu).$$

Hence

$$\pm \theta = \mu + \int \frac{dt}{c} = \mu + \sqrt{\frac{\gamma + 1}{\gamma - 1}} \int \frac{dt}{\sqrt{q_{34}^2 - t^2}}$$
$$= \mu + \sqrt{\frac{\gamma + 1}{\gamma - 1}} \sin^{-1} \frac{t}{q_{34}} + \text{const.}$$

Since

$$\sqrt{q_{M}^{2} - t^{2}} = \sqrt{\frac{\gamma + 1}{\gamma - 1}}c,$$

$$\sin^{-1} \frac{t}{q_{M}} = \cot^{-1}\left(\sqrt{\frac{\gamma + 1}{\gamma - 1}}\frac{c}{t}\right) = \cot^{-1}\left(\sqrt{\frac{\gamma + 1}{\gamma - 1}}\tan\mu\right)$$

$$= \frac{\pi}{2} - \tan^{-1}\left(\sqrt{\frac{\gamma + 1}{\gamma - 1}}\tan\mu\right).$$

Thus the inclination of the flow at any point of a patching curve is connected with the Mach angle by the formula

$$\pm \theta = \mu - \sqrt{\frac{\gamma + 1}{\gamma - 1}} \tan^{-1} \left( \sqrt{\frac{\gamma + 1}{\gamma - 1}} \tan \mu \right) + \text{ constant}$$
$$= \text{ constant} - f(\mu)$$

$$=$$
 constant  $-$ 

where

$$f(\mu) = \sqrt{\frac{\gamma+1}{\gamma-1}} \tan^{-1} \left( \sqrt{\frac{\gamma+1}{\gamma-1}} \tan \mu \right) - \mu. \quad (7)$$

It follows from this relation that if  $\theta$  is known at every point of a patching curve and if  $\mu$  is known at one point of this curve then  $\mu$  may be determined at every point of the curve. All that is needed is a table of values of the function  $f(\mu)$ . For

$$\pm (\theta - \theta_0) = f(\mu_0) - f(\mu)$$

so that

$$f(\mu) = \pm (\theta_0 - \theta) + f(\mu_0). \tag{S}$$

This relation determines  $f(\mu)$  and, hence (by means of the table),  $\mu$ , for any given value of  $\theta$ .

Table 5 furnishes the values of  $f(\mu)$ , calculated for  $\gamma = 1.4$ .

The relation  $c^2 = \frac{\gamma - 1}{2} (q_M^2 - q^2)$  implies the relation  $q^2 - c^2 = \frac{\gamma + 1}{2} (q^2 - q_m^2)$  where  $q_m =$ 

 $\sqrt{\frac{\gamma-1}{\gamma+1}} q_{\rm M}$ . Hence, at any point where the flow is supersonic,

$$q_{\mathfrak{u}} \geq q \geq q_{\mathfrak{m}} = \sqrt{\frac{\gamma-1}{\gamma+1}} q_{\mathfrak{u}}.$$

In a velocity diagram (where the coordinates of any point are the velocity components (u, v)) a point where the flow is supersonic lies in the circular ring

$$\mathfrak{q}_{\mathfrak{U}} \geq \mathfrak{q} \geq \mathfrak{q}_{\mathfrak{m}}$$

(the polar coordinates of any point in the velocity diagram being  $q \angle \vartheta$ ). The relation

$$\frac{1}{q}\frac{\mathrm{d}q}{\mathrm{d}\theta} = \pm \tan \mu$$

shows that the graph, in the velocity diagram, of the points on a patching curve lie on an epicycloid traced by a point on the circumference of a circle of diameter  $q_M - q_m$  which rolls externally on the circle of radius q<sub>m</sub> whose center is at the origin. In fact if a circle of radius b rolls externally on a circle of radius a the coordinates of a point on its circumference are given by

x = (a + b) 
$$\cos \frac{b}{a} \tau - b \cos \left(1 + \frac{b}{a}\right) \tau$$
,  
y = (a + b)  $\sin \frac{b}{a} \tau - b \sin \left(1 + \frac{b}{a}\right) \tau$ 

where  $\tau$  is the angle through which the circle of radius b has rolled. The polar coordinates  $r \angle \theta$  of this point are given by

$$r^2 = x^2 + y^2 = (a^2 + 2ab + 2b^2) - 2b(a + b)\cos \tau$$
,  $\tan \theta = y/x$ .

From the latter relation we deduce 
$$\sec^2 \theta \, d\theta = \frac{x \, dy - y \, dx}{x^2}$$
 so that  $d\theta = \frac{x \, dy - y \, dx}{x^2 + y^2}$ . Hence

 $\mathbf{r}^{\mathbf{t}} \, \mathrm{d}\boldsymbol{\theta} = \mathbf{x} \, \mathrm{d}\mathbf{y} - \mathbf{y} \, \mathrm{d}\mathbf{x}$ 

$$= \frac{(a+b)b}{a} \times \left\{ \left[ (a+b) \cos \frac{b}{a} \tau - b \cos \left(1 + \frac{b}{a}\right) \tau \right] \right. \\ \left. \times \left[ \cos \frac{b}{a} \tau - \cos \left(1 + \frac{b}{a}\right) \tau \right] \right. \\ \left. + \left[ (a+b) \sin \frac{b}{a} \tau - b \sin \left(1 + \frac{b}{a}\right) \tau \right] \right. \\ \left. \times \left[ \sin \frac{b}{a} \tau - \sin \left(1 + \frac{b}{a}\right) \tau \right] \right\} d\tau \\ \left. = \frac{(a+b)b(a+2b)}{a} (1 - \cos \tau) d\tau.$$

In the case of the velocity diagram, q takes the place of r and for points on any member of ene of the two families of patching curves we have

$$\pm \frac{1}{q} \frac{\mathrm{d}q}{\mathrm{d}\theta} = \tan \mu = \frac{c}{\sqrt{q^2 - c^2}} = \sqrt{\frac{\gamma - 1}{\gamma + 1}} \sqrt{\frac{q_{\mathrm{M}}^2 - q^2}{q^2 - q_{\mathrm{m}}^2}}.$$

Then  $q_M$ , the radius of the outer circle, takes the place of a + 2b; and  $q_m$ , the radius of the inner circle, takes the place of a. We calculate, accordingly,  $(a + 2b)^2 - r^2$  and  $r^2 - a^2$ :

$$(a + 2b)^2 - r^2 = 2b(a + b)(1 + \cos \tau)$$
  
 $r^2 - a^2 = 2b(a + b)(1 - \cos \tau)$ 

so that

$$\sqrt{\frac{(a+2b)^2-r^2}{r^2-a^2}} = \cot\frac{\tau}{2}.$$

Since

$$r dr = b(a + b) \sin \tau d\tau$$

we find, on using the value of  $r^2 d\theta$  calculated above, that

$$\frac{1}{r}\frac{dr}{d\theta} = \frac{a}{a+2b}\cot\frac{\tau}{2} = \frac{a}{a+2b}\sqrt{\frac{(a+2b)^2 - r^2}{r^2 - a^2}}$$

Since  $\frac{a}{a+2b} = \frac{q_m}{q_M} = \sqrt{\frac{\gamma-1}{\gamma+1}}$  it follows that the plot, in the velocity diagram, of any member of one of the two families of patching curves (namely, the family for which  $\frac{1}{q} \frac{dq}{d\theta} = + \tan \mu$ ) is an epicycloid traced by a point on the circumference of a circle which rolls between two circles, of radii  $q_m$  and  $q_M$ , both circles having a common center (the origin).

The members of the second family of characteristics also plot as epicycloids traced by a point on the circumference of the same rolling circle; all we have to do is to replace  $\tau$  by  $-\tau$  (or, equivalently, by  $2\pi - \tau$ ). This merely amounts to the geometric fact that through any point in a circular ring there can be drawn two circles each of which touches the circles which determine the ring (the common radius of the constructed circles being the difference of the radii of these two circles).

When a patching curve serves to patch a uniform flow to a second flow (uniform or non-uniform) the plot, in the velocity diagram, of the patching curve is a point and the patching curve itself is a straight line. In fact u and v are constant along the patching curve so that the plot, in the velocity diagram, of the patching curve is a point. Since q is constant along the patching curve so also is c, in view of the relation  $c^2 = \frac{\gamma - 1}{2} (q_u^2 - q^2)$ , and it follows from (2) that  $\frac{dy}{dx}$  is constant along the patching curve; in other words the patching curve is a straight line. This result is of fundamental importance:

A curve which patches, in supersonic flow, a uniform flow onto a second flow (uniform or non-uniform) is a straight line whose plot, in the velocity diagram, is a point.

What can we say about the various members of the other family of patching curves which intersect such a straight line patching curve (whose plot in the velocity diagram is the point  $P_0 = (u_0, v_0)$ )? The plot of any such patching curve (of the second family) in the velocity diagram must pass through  $P_0$  and hence must be the epicycloid (of the second type) which passes through  $P_0$ . In other words:

All patching curves of the second family which intersect a curve which patches a uniform flow to a second flow (uniform or non-uniform) have the same plot in the velocity diagram.

Let us now examine the various members of the first family of patching curves which intersect these members of the second family. The various points where a fixed member of the first family intersects different members of the second family all have the same plot in the velocity diagram (for the *various* members of the second family plot into a *single* curve in the velocity diagram). Hence the velocity vector is constant along the fixed member of the first family of patching curves and this implies that this member of the first family of patching curves is a straight line. In other words:

The patching curve which patches a uniform flow to a second flow (uniform or non-uniform) is not only a straight line but it is one of a family of straight lines cach of which is a patching curve; furthermore the velocity vector is constant along cach member of this family of straight lines.

Along each member of the family of straight line patching curves, both q and  $\theta$  are constant so that the relation  $\frac{1}{q} \frac{dq}{d\theta} = \pm \tan \mu$  is meaningless (the lefthand side of this relation being indeterminate). If the relation  $\frac{1}{q} \frac{dq}{d\theta} = + \tan \mu$  is valid along the members of the second family, q decreases with  $\theta$  and hence c,  $\rho$  and p *increase* as  $\theta$  decreases. If  $\frac{1}{q} \frac{dq}{d\theta} =$  $- \tan \mu$ , q increases as  $\theta$  decreases, c,  $\rho$  and p decrease as  $\theta$  decreases, and the flow is defined as an *expansive* flow. It will be assumed from now on in this paper that the flow is expansive.

Since the velocity vector is constant along each member of the family of straight-line patching curves so also is c, by virtue of the relation

$$c^{2} = \frac{\gamma - 1}{2} (q_{M}^{2} - q^{2}).$$

What is the practical significance of these facts? If we draw an *arbitrary* curve (not merely a member of the second family of patching curves) which intersects once and only once each member of the family of straight-line patching curves, the values of q,  $\theta$  and  $\mu$  at any point of this curve are the same as those at the corresponding point of any member of the second family of patching curves (two points being said to correspond when they lie on the same straight-line patching curve). In other words the plot in the velocity diagram of the *arbitrary* curve is the same as the plot of any one of the members of the second family of patching curves. This implies that the relation

$$\frac{1}{q}\frac{\mathrm{d}q}{\mathrm{d}\theta}=-\tan\,\mu,$$

which is valid for any member of the second family of patching curves, is also valid for any curve which intersects once and only once each member of the family of straight-line patching curves. In particular, it is valid, in two dimensional flow, for the contour of an obstacle immersed in the flow if each component curve of the contour intersects once and only once each member of the family of straight-line patching curves. It is understood that  $\theta$  does not increase as we move from the nose towards the trailing edge of the obstacle.

To avoid two sets of formulas, one set for the upper part of the contour and another for the lower part of the contour, we must keep in mind that, as usual,  $\theta$  is measured positively in the counterclockwise direction. We then treat the lower part of the contour as if it were the upper part of a contour obtained by reflecting the given contour in a line through the nose and parallel to the direction of flow. This amounts to taking  $\theta$  positive in the clockwise direction when we are working on the *lower* contour. We now have a basis for the following theorem on which rest the lift, drag and moment calculations in supersonic flow:

If  $P_1$  and P are two points which are both on the upper part, or both on the lower part, of the contour of the obstacle then

$$\theta_1 - \theta = f(\mu_1) - f(\mu)$$

where  $\theta$ ,  $\mu$  are the inclination and the Mach angle,



respectively, at P, and  $\theta_1$ ,  $\mu_1$  are the inclination and Mach angle, respectively, at  $P_1$ . Since  $\theta$  and  $\theta_1$  are given by the geometry of the obstacle (they are the inclinations of the tangents at P and  $P_1$ , respectively) this relation furnishes  $\mu$  when  $\mu_1$  is given.

Once  $\mu$  has been determined it is easy to calculate the ratio  $p/p_1$  of the pressures at the points P and P<sub>1</sub>. In fact the relation  $p = k\rho^{\gamma}$  yields  $c^2 = \frac{\partial p}{\partial \rho} =$  $\gamma k\rho^{\gamma-1}$  so that  $\frac{c^2}{c_1^2} = \left(\frac{\rho}{\rho_1}\right)^{\gamma-1}$  and  $\frac{p}{p_1} = \left(\frac{\rho}{\rho_1}\right)^{\gamma} =$  $\left(\frac{c^2}{c_1^2}\right)^{\frac{\gamma}{\gamma-1}}$ . The relations  $c = q \sin \mu; \quad c^2 = \frac{\gamma - 1}{2} (q_M^2 - q^2)$ 

yield

$$q^2(\gamma - \cos 2\mu) = (\gamma - 1)q_{\rm M}^2$$

so that

$$c^{2} = \frac{\gamma - 1}{2} \left\{ 1 - \frac{\gamma - 1}{\gamma - \cos 2\mu} \right\} q_{M}^{2}$$
$$= (\gamma - 1)q_{M}^{2} \left( \frac{\sin^{2}\mu}{\gamma - \cos 2\mu} \right).$$
On denoting by  $g(\mu)$  the function  $\left( \frac{\sin^{2}\mu}{\gamma - \cos 2\mu} \right)^{\frac{\gamma}{\gamma - 1}}$  it follows that

follows that

$$\frac{p}{p_1} = \frac{g(\omega)}{g(\omega_1)} \tag{9}$$

Table 5 furnishes values of  $g(\mu)$  (calculated for  $\gamma = 1.4$ ).

The determination of the pressure at any point of an obstacle in supersonic flow is, then, merely a matter of reading tables once  $\mu_1$  is known. It is convenient to take P1 as the nose of the obstacle; once  $\mu_1$  is known at the nose  $f(\mu)$  is calculated from

$$f(\mu) = f(\mu_1) - (\theta_1 - \theta)$$

and then  $\mu$  is determined.  $\frac{p}{p_1}$  is then read from a table. Since the uniform flow usually suffers a shock at the nose of the obstacle,  $\mu_1$  is not, in general, the Mach angle  $\mu_0$  of the undisturbed flow. Rather  $\mu_1$  must be determined by a separate shock calculation, the theory of which is explained in the following section.

# 2. The theory of shock surfaces in supersonic flow.

The conditions which hold at a shock surface may readily be found by considering the time derivative of a volume integral

$$I = \int_{V} f(x, y, z, t) dV$$

The surface S bounding the volume V of integration may vary with t and

$$\frac{\mathrm{dI}}{\mathrm{dt}} = \int_{\mathrm{V}} \frac{\mathrm{df}}{\mathrm{dt}} \,\mathrm{dV} + \int_{\mathrm{s}} \mathrm{fw}_{\mathrm{n}} \,\mathrm{dS}$$

where  $w_n$  is the normal component of velocity of the surface (the normal being drawn away from the volume of integration). This result is valid if f possesses continuous derivatives with respect to x, y, z and t throughout V. If f does not satisfy

these conditions the theorem is not necessarily valid. However if V is divided by a surface  $\Sigma$  into two regions  $V_0$  and  $V_1$  in each of which the conditions held we may apply the theorem to V<sub>0</sub> and V<sub>1</sub> separately and combine the results; the only penalty is



that we have to consider the surface integrals of fwn over the two sides of  $\Sigma$ . We obtain, then,

$$\frac{\mathrm{d}\mathbf{I}}{\mathrm{d}\mathbf{t}} = \int_{\mathbf{V}} \frac{\partial \mathbf{f}}{\partial \mathbf{t}} \,\mathrm{d}\mathbf{V} + \int_{\mathbf{S}} \mathbf{f} \mathbf{w}_{n} \,\mathrm{d}\mathbf{S} + \int_{\boldsymbol{\Sigma}} (\mathbf{f}_{0} - \mathbf{f}_{1}) \mathbf{w}_{n} \,\mathrm{d}\boldsymbol{\Sigma}$$

(the normal on  $\Sigma$  being drawn from V<sub>0</sub> to V<sub>1</sub>). Applying this theorem to a volume where  $S_0$  and  $S_1$  are



composed of particles of the fluid and are such that  $V_0$  and  $V_1$  are infinitesimal we obtain, up to infinitesimals,

$$\frac{\mathrm{d}\mathbf{I}}{\mathrm{d}\mathbf{t}} = \int_{s_0} \mathbf{f} \mathbf{v}_n \,\mathrm{d}\mathbf{S} + \int_{s} \mathbf{f} \mathbf{v}_n \,\mathrm{d}\mathbf{S} + \int_{\Sigma} (\mathbf{f}_0 - \mathbf{f}_1) \mathbf{w}_n \,\mathrm{d}\Sigma$$

where v denotes fluid velocity (as opposed to w which denotes velocity of the surface  $\Sigma$ ); as S<sub>0</sub> and  $S_1 \rightarrow \Sigma$  we obtain

$$\frac{\mathrm{d}\mathbf{I}}{\mathrm{d}\mathbf{t}} \rightarrow \int_{\Sigma} f_0(\mathbf{w} - \mathbf{v}_0)_n \,\mathrm{d}\Sigma - \int_{\Sigma} f_1(\mathbf{w} - \mathbf{v}_1)_n \,\mathrm{d}\Sigma.$$

If we know that  $\frac{dI}{dt} = 0$  (for every V whose boundary consists of given fluid particles), it follows (in view of the arbitrary choice of the part of  $\Sigma$  over which the integration is carried out) that

$$f_0(w - v_0)_n = f_1(w - v_1)_n$$

If, in particular,  $\Sigma$  is stationary we find

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$$(f_{\bullet}v_{\bullet})_{n} = (f_{1}v_{1})_{n}.$$

In other words this means that the product of f by the normal component  $v_n$  of the fluid velocity is continuous across  $\Sigma$ . This is certainly the case (in view of the principle of conservation of mass) when f is the density  $\rho$ . This furnishes the *first shock condition* (for stationary shock fronts), namely

$$(\rho_0 v_0)_n = (\rho_1 v_1)_n$$
, (10)

and it merely expresses the principle of conservation of mass.

We obtain the second and third shock conditions from the mechanical law that force = time rate of change of momentum. If l is the x-direction cosine of the unit outward-drawn normal we have

$$\int_{S} p\ell \, dS = \frac{d}{dt} \int_{V} \rho u \, dV.$$

Setting  $f = \rho u$  and proceeding as before we obtain

$$\int_{\Sigma} (\mathbf{p}_0 - \mathbf{p}_l) \ell \, d\Sigma = \int_{\Sigma} \{ \rho_0 \, \mathbf{u}_0 (\mathbf{w}_n - \mathbf{v}_n)_0 \}$$

 $-\rho_t u_1 (w_n - v_a)_1 d\Sigma$ 

(the outward drawn normal to  $S_0$ , for example, approaches, as  $S \to \Sigma$ , the normal to  $\Sigma$  drawn from  $V_2$  towards  $V_0$ ). Hence at any point of  $\Sigma$ 

$$(p_0 - p_1)\ell = \rho_0 u_0 (w_n - v_n)_0 - \rho_1 u_1 (w_n - v_n)_1.$$

Taking the x-axis tangential to  $\Sigma$  we have  $\ell = 0$  so that

$$\rho_0 u_0 (w_n - v_n)_0 = \rho_1 u_1 (w_n - v_n)_1.$$

On combining this with the first shock condition we obtain

$$(v_t)_0 = (v_t)_1.$$
 (11)

This is the second shock condition; the tangential component of fluid velocity is continuous across the shock (whether or not the shock is stationary). Note that this is a result of the combination of two physical laws: a) conservation of mass, and b) conservation of momentum under zero force.

The third shock condition follows on taking the xaxis normal to  $\Sigma$  so that  $\ell = 1$ . For a stationary shock we obtain

$$p_0 + \rho_0(v_n)_0^2 = p_1 + \rho_1(v_n)_0^2.$$
 (12)

The fourth and final shock-condition follows from the energy principle. The rate at which work is being done on the fluid is  $-\int_{s} pv_{n} dS$  and we equate this to

$$\frac{\mathrm{d}}{\mathrm{d}t}\int_{V}\rho(\frac{1}{2}\mathrm{q}^{2}+\mathrm{U})\mathrm{d}\mathrm{V}$$

where U is the internal energy.

This gives

 $p_0(v_n)_0 + \rho_0(\frac{1}{2}q_0^2 + U_0)(v_n - w_n)_0$ 

$$= p_1(v_n)_1 + \rho_1(\frac{1}{2}q_1^2 + U_1) (v_n - w_n)_1.$$

For stationary shocks this reduces, in view of the first shock condition, to

$$i_e + \frac{1}{2}q_0^2 = i_1 + \frac{1}{2}q_1^2$$

where  $i = U + \frac{p}{\rho}$  is the *heat content*, or enthalpy. If the flow is isentropic in each region  $di = dU + pd\left(\frac{1}{\rho}\right) + \frac{dp}{\rho} = \frac{dp}{\rho}$  and writing  $p = k\rho^{\gamma}$  we have  $di = \gamma k\rho^{\gamma-2} d\rho$  so that  $i = \frac{\gamma}{\gamma - 1} \frac{p}{\rho} = \frac{c^2}{\gamma - 1}$  (the constant of integration being determined by the convention that i vanishes with  $\rho$ ). Now the argument which showed that in irrotational *two-dimensional* flow the two equations of motion are equivalent to the single relation

$$c^2 = \frac{\gamma - 1}{2} (q_M^2 - q^2)$$

may be repeated without change for three-dimensional flow; we find that, when the flow is irrotational, the three equations of motion are equivalent to the single relation

$$c^2 = \frac{\gamma - 1}{2} (q_M^2 - q^2).$$

Hence the shock condition,

$$\frac{c_0^2}{\gamma - 1} + \frac{1}{2}q_0^2 = \frac{c_1^2}{\gamma - 1} + \frac{1}{2}q_1^2$$
(13)

may be formulated as follows:

In irrotational flow the value of the constant  $q_M$  is the same on both sides of a shock surface. In twodimensional irrotational flow, then, the circular ring in the velocity diagram whose bounding circles have

radii'  $q_M$  and  $q_m$  respectively, is unaffected by the presence of shock lines (straight or curved).

In view of the relations  $c^2 = \frac{\gamma p}{\rho}$ ,  $(v_t)_0 = (v_t)_1$ we may write the fourth shock condition in the form

$$\frac{\gamma}{\gamma-1}\left(\frac{p_1}{\rho_1}-\frac{p_0}{\rho_0}\right)=\frac{1}{2}\left\{\left(v_n\right)_0^2-\left(v_n\right)_1^2\right\}.$$

But the first and third shock conditions yield

$$p_1 - p_0 = \rho_0 \left(1 - \frac{\rho_0}{\rho_1}\right) (v_n)_0^2 = \rho_1 \left(\frac{\rho_1}{\rho_0} - 1\right) (v_n)_1^2$$

so that

$$(v_n)_0^2 - (v_n)_1^2 = \frac{p_1 - p_0}{\rho_1 - \rho_0} \left( \frac{\rho_1}{\rho_0} - \frac{\rho_0}{\rho_1} \right) = \frac{(p_1 - p_0)(\rho_1 + \rho_0)}{\rho_0 \rho_1}$$
  
=  $\frac{p_1}{\rho_1} \left( 1 + \frac{\rho_1}{\rho_0} \right) - \frac{p_0}{\rho_0} \left( 1 + \frac{\rho_0}{\rho_1} \right).$ 

Hence

$$\frac{\mathbf{p}_1}{\rho_1}\left(\frac{\gamma+1}{\gamma-1}-\frac{\rho_1}{\rho_2}\right)=\frac{\mathbf{p}_0}{\rho_0}\left(\frac{\gamma+1}{\gamma-1}-\frac{\rho_0}{\rho_1}\right)$$

or, equivalently,

$$\frac{p_1}{p_0} = \frac{(\gamma+1)\rho_1 - (\gamma-1)\rho_0}{(\gamma+1)\rho_0 - (\gamma-1)\rho_1} = \frac{(\gamma+1)x - (\gamma-1)}{(\gamma+1) - (\gamma-1)x}$$
(14)

where  $x = \frac{\rho_1}{\rho_0}$  is the density ratio across the shock surface. This is the *Rankinc-Hugoniot relation*. It may be written in the equivalent form

$$\frac{\rho_{1}}{\rho_{0}} = \frac{(\gamma + 1)p_{1} + (\gamma - 1)p_{0}}{(\gamma - 1)p_{1} + (\gamma + 1)p_{0}} = \frac{(\gamma + 1)y + (\gamma - 1)}{(\gamma - 1)y + (\gamma + 1)}$$
(15)

where  $y = \frac{p_1}{p_0}$  is the pressure ratio across the shock. Taking  $p_0$  as given ( $\neq 0$ ),  $x = \frac{\rho_1}{\rho_0}$  cannot surpass the ratio  $\frac{\gamma + 1}{\gamma - 1} = 6$  (with  $\gamma = 1.4$ ) nor be less than  $\frac{\gamma - 1}{\gamma + 1} = \frac{1}{6}$ .

# 3. Flow against the nose of a wedge.

We denote by  $w < \frac{\pi}{2}$  the angle from the direction of the incident flow to the upper surface of the wedge and assume a plane shock inclined at angle  $\alpha$  as shown. Then  $(v_1)_0 = q_0 \cos \alpha$ ;  $(v_n)_0 = q_0 \sin \alpha$ ;  $(v_1)_1 = q_1 \cos (\alpha - w)$ ;  $(v_n)_1 = q_1 \sin (\alpha - w)$ . The first and second shock conditions yield

$$\rho_{\alpha}q_{\theta}\sin\alpha = \rho_{1}q_{1}\sin(\alpha - w) \qquad (16)$$

$$q_0 \cos \alpha = q_1 \cos(\alpha - w) \qquad (17)$$



Eliminating  $q_1$  and  $q_0$  by division we obtain

$$\tan (\alpha - w) = \tan \alpha \qquad (18)$$

where  $x = \frac{\rho_1}{\rho_0}$  is the condensation (so that x lies in the range  $\frac{1}{6} \le x \le 6$ ).

The relation (18) expresses either of the two variables x and  $\alpha$  as a function of the other (the angle w being supposed given). In order to determine either of the variables x and  $\alpha$  (and, hence, the other) we need a second relation between them. This is forthcoming when the Mach number  $M_0$  of the incident flow is given. In fact since  $(v_n)_0 = q_0 \sin \alpha$ ,  $(v_n)_1 = q_1 \sin (\alpha - w)$  we obtain from (12) and (16)

$$p_1 - p_0 = \rho_0 q_0^2 \sin^2 \alpha \left(1 - \frac{1}{x}\right) = \rho_1 q_1^2 \sin^2 (\alpha - w)(x - 1).$$

Hence

$$\frac{p_1}{p_0} = 1 + \frac{\rho_0 q_0^2}{p_0} \sin^2 \alpha \left(1 - \frac{1}{x}\right) = 1 + \gamma M_0^2 \sin^2 \alpha \left(1 - \frac{1}{x}\right)$$

since  $c^2 = \frac{\partial p}{\partial \rho} = \gamma \frac{p}{\rho}$  (on the assumption that  $p = k\rho^{\gamma}$ ). From the Rankine-Hugoniot relation (14) we derive

$$\frac{p_1}{p_0} - 1 = \frac{2\gamma(x-1)}{(\gamma+1) - (\gamma-1)}$$

and so

$$M_0^2 \sin^2 \alpha = \frac{2x}{(\gamma + 1) - (\gamma - 1)x}.$$
 (19)

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Similarly

$$M_1^2 \sin^2(\alpha - w) = \frac{2}{(\gamma + 1)x - (\gamma - 1)}.$$
 (20)

In order to facilitate the determination of the ratio  $p_1/p_0$  when  $M_0$  and w are given, Tables 1-4 have been prepared. Their use is discussed in detail in Sections 8 and 10.

# 4. Approximate evaluation of the pressure ratio p/p1.

As we have seen in the previous sections, the determination of the pressure ratio  $p/p_0$  involves two separate calculations. In the first place the shock tables furnish the pressure ratio  $p_1/p_0$  and the Mach angle  $\mu_1$  after the shock when w and  $M_0$  are given. Then Table 5 furnishes  $p/p_1$  at any point of the contour. On multiplying  $p/p_1$  by  $p_1/p_0$  we obtain the desired pressure ratio  $p/p_0$ . The shock calculation is the more troublesome of the two and it may be completely avoided (if w is not too large) by means of the following observation. It may be verified<sup>3</sup> by Tables 2 and 3 that, when w is not too large, the relation

$$f(\mu_1) = f(\mu_0) + w$$

holds to a high degree of approximation. Since

$$\mathbf{x} - \theta = \mathbf{f}(\mu_1) - \mathbf{f}(\mu)$$

it follows that, to a high degree of approximation,

$$-\theta = f(\mu_0) - f(\mu).$$

This means that we can ignore completely the shock calculation and evaluate the pressure by means of Table 5 starting from any point P<sub>0</sub> in the uniform flow (the value of  $\theta$  at P<sub>0</sub> being zero). The following samples show how closely this "short-cut" calculation approximates the calculation made by using the shock tables. It was convenient to base this comparison on M<sub>1</sub>, the Mach number behind the shock-wave. The result of the "short-cut" method is marked by an asterisk.

<sup>3</sup> For example, it is found from Table 1-that  $M_0 = 1.777$  for  $\alpha = 39^{\circ}$  and  $w = 5^{\circ}$ , so that  $\mu_0 = 34.25$  and  $f(\mu_0) = 110.40$ . The relation in question yields  $f(\mu_1) = 115.40^{\circ}$ , whence  $\mu_1 = 38.49^{\circ}$ . But from Table 2 it is found that when  $\alpha = 39^{\circ}$  and  $w = 5^{\circ}$ ,  $M_1 = 1.605$ , whence  $\mu_1 = 38.54^{\circ}$ .

					М.	= 2.13	3		
	- 1	•	2.	5*	10*	15*	20*	22* 2	4° 25.0
. н	- 2.0	91	2.05	5 1.94	6 1.759	1.53	1.340	1,233 1.	096 .92
. =	- 2.0	91	2.05	5 1.94	6 1.771	1.601	1.432	1.361 1.	289 1.25
via-									
n *	0.0	70	0.07	% 0.0%	6 0.7%	2.4%	6.9% 1	0.4% 17.	6% 35.0
					M• =	= 1.85			
<b>w</b> .		 1	•	2*	M• =	= 1.85 10*	15*	20•	20.20*
w Mi	2	1	1• \$15	2* 1.780	M• = 5* 1.676	= 1.85 10* 1.498	15° 1.29S	20° .9502	20.20* _9178
w Mı Mi	7 8	 1 1.3	1• \$15 \$15	2* 1.750 1.750	M• = 5* 1.676 1.678	= 1.85 10* 1.498 1.509	15° 1.29S 1.336	20* .9\$02 1.140	20.20* .9178 1.131
w Mı Mî devi:		1 1.3 1.3	1° \$15 \$15	2* 1.750 1.750	M• = 5* 1.676 1.678	= 1.\$5 10* 1.49\$ 1.509	15° 1.29S 1.336	20° .9\$02 2.140	20.20* .9178 1.131

		1	le ≕ 1.4	HU		
w.	=	1*	2°	- 5°	<b>S</b> *	 Į
Mi	×	1.365	1.330	1.215	1.075	l
$M_1^{\bullet}$	-	1.365	1.330	1.217	1.051	
devia	•					ľ
tion	Ħ	0.0%	0.0%	0.1%	0.6%	

The behavior of the ratio  $M_1^*/M_1$  shows that there is a high degree of continuity in the physical variables as w changes from positive through zero to negative, since the simplified method then becomes exact. (When w is negative there is no shock and the flow is expansive from the very beginning.) It should also be noticed that  $M_1^*/M_1$  seems to be almost independent of  $M_0$  for wedge angles not too large.

Two further properties of this solution are worthy of mention:

(1) The simplified method gives zero entropy increase on passing through the shock wave.

(2) The calculations using the shock wave tables cannot in general give a description of conditions in the wake, since there are two independent physical quantities to be matched on the two sides of the wake, and only one adjustable degree of freedom, namely the direction of the final flow. Using the simplified method, the difficulty is of a different sort since now an infinite number of solutions exist. Since p,  $\rho$ , M depend only on  $M_0$  and on the angle between the incident and final flow directions, the two flows derived from the upper and lower surfaces always match, no matter what direction is assumed for the final uniform flow.

#### 5. The linear theory.

It is easy to derive, from the rather complicated formulas of the preceding sections, simpler formulas which serve as approximations which are valid for

sufficiently small values of w and of  $\theta$ . If w is so small that its square is negligible, we have

$$\tan (\alpha - w) = \tan \alpha - w \sec^2 \alpha$$

so that, from formula (18)

$$x = 1 + w \frac{\sec^2 \alpha}{\tan \alpha} = 1 + 2w \csc 2\alpha.$$

Hence as  $w \to 0$ ,  $x \to 1$ , and formula (19) then shows that  $\sin^2 \alpha \to \frac{1}{M_0^2} = \sin^2 \mu_0$ . Thus a first approximation to the shock angle  $\alpha$  is the Mach angle  $\mu_0$ of the undisturbed uniform flow. Hence a second approximation to x is

$$x = 1 + 2w \operatorname{cosec} 2\mu_1$$
. (21)

It follows from formula (14) that a second approximation to the pressure ratio  $p_1/p_0$  across the shock line is

$$\frac{\mathbf{p}_{1}}{\mathbf{p}_{0}} = \frac{1 + (\gamma + 1) \mathrm{w} \operatorname{cosec} 2\mu_{0}}{1 - (\gamma - 1) \mathrm{w} \operatorname{cosec} 2\mu_{0}}$$

Since we are neglecting squares of w this may be written in the equivalent form

$$\frac{p_1}{p_0} = 1 + 2 \gamma \text{ w cosec } 2\mu_0.$$
 (22)

It follows from formula (20) that as  $w \to 0$ ,  $M_1 \to M_0$  so that a first approximation to  $\mu_1$  is  $\mu_0$ . In order to obtain a second approximation to  $\mu_1$ we must first obtain from formula (19) a second approximation to the shock angle  $\alpha$ . To do this we set  $\alpha = \mu_0 + kw$  (where k is a multiplier which we wish to determine) and  $x = 1 + 2w \operatorname{cosec} 2\mu_0$ in (19). Since  $M_0 = \operatorname{cosec} \mu_0$  we obtain

$$1 + 2kw \cot \mu_0 = \frac{1 + 2w \operatorname{cosec} 2\mu_0}{1 - (\gamma - 1)w \operatorname{cosec} 2\mu_0}$$
$$= 1 + (\gamma + 1)w \operatorname{cosec} 2\mu_0$$

so that  $k = \frac{(\gamma + 1) \cdot \operatorname{cosec} 2\mu_0}{2 \operatorname{cov} \mu_0} = \frac{\gamma + 1}{4 \cos^2 \mu_0}$ . Hence a second approximation to the shock angle  $\alpha$  is

$$\alpha = \mu_0 + \frac{\gamma + 1}{4 \cos^2 \mu_0} w.$$
 (23)

On setting  $\mu_1 = \mu_0 + k'w$  in formula (20), after replacing  $M_1$  by  $\frac{1}{\sin \mu_1}$  and making use of (23) and (21) we find that  $k' = \frac{\gamma + 1}{2\cos^2 \mu_0} - 1 = \frac{\gamma - \cos 2\mu_0}{2\cos^2 \mu_0}$ .

Thus a second approximation to  $\mu_1$  is

$$\mu_{1} = \mu_{0} + \frac{\gamma - \cos 2\mu_{0}}{2\cos^{2}\mu_{0}} w.$$
 (24)

Now it follows from formula (7) that

$$f'(\mu) = \frac{2\cos^2\mu}{\gamma - \cos 2\mu}.$$
 (25)

so that to a second approximation

$$f(\mu_1) = f(\mu_6) + w.$$
 (26)

This is the basis for the short-cut calculation of Section 4.

It follows from formula (25) and the relation  $\theta - w = f(\mu) - f(\mu)$  that

$$\theta - w = (\mu - \mu_1) \frac{2\cos^2 \mu_1}{\gamma - \cos 2\mu_1}.$$

Hence

$$\mu - \mu_1 = \frac{\gamma - \cos 2\mu_1}{2\cos^2 \mu_1} (\theta - w) = \frac{\gamma - \cos 2\mu_0}{2\cos^2 \mu_0} (\theta - w) \quad (27)$$

since  $\mu_0$  is a first approximation to  $\mu_1$ . On combining (24) and (27) we obtain

$$\mu = \mu_0 + \frac{\gamma - \cos 2\mu_0}{2 \cos^2 \mu_0} \theta.$$
 (28)

On taking the logarithmic derivative of the function  $g(\mu) = \left(\frac{\sin^2 \mu}{\gamma - \cos 2\mu}\right)^{\frac{\gamma}{\gamma - 1}}$  we obtain

$$\frac{\mathbf{g}'(\mu)}{\mathbf{g}(\mu)} = \frac{2\gamma}{\gamma - 1} \left\{ \cot \mu - \frac{\sin 2\mu}{\gamma - \cos 2\mu} \right\} = 2\gamma \frac{\cot \mu}{\gamma - \cos 2\mu}.$$
 (29)

It follows from formula (9) that

$$\frac{\mathbf{p}}{\mathbf{p}_{1}}=1+2\gamma\frac{\cot\mu_{1}}{\gamma-\cos2\mu_{1}}\left(\mu-\mu_{1}\right)$$

and this reduces, by means of formula (27), to

$$\frac{p}{p_1} = 1 + 2\gamma \operatorname{cosec} 2\mu_1 \cdot (\theta - w)$$

$$= 1 + 2\gamma \operatorname{cosec} 2\mu_0 \cdot (\theta - w)$$
(30)

since we are neglecting  $w(\theta - w)$ . On combining formulas (22) and (30) we obtain

$$\frac{\mathbf{p}}{\mathbf{v}_0} = 1 + 2\gamma\theta \operatorname{cosec} 2\mu_0.$$
(31)

This simple formula for the pressure ratio  $\frac{p}{p_0}$  is

known as the *linear theory*. Since  $c^2 = \frac{\gamma p}{\rho}$  formula (30) may be rewritten in the following equivalent form:

$$\Delta p = p - p_0 = \frac{p_0 \gamma}{\sin \mu_0 \cos \mu_0} \theta = \frac{c_0^2 \rho_0}{\sin \mu_0 \cos \mu_0} \theta$$
$$= \rho_0 q_0^2 \frac{\theta}{M_0^2 \sin \mu_0 \cos \mu_0} = \rho_0 q_0^2 \frac{\theta}{\cot \mu_0} \quad (32)$$
$$= \rho_0 q_0^2 \frac{\theta}{\sqrt{M_0^2 - 1}}.$$

## 6. The quadratic or Busemann theory.

This theory is obtained from the method of this report by carrying out the various approximations as far as the  $w^2$  terms. Since

 $\tan (\alpha - w) = \tan \alpha - \sec^2 \alpha \cdot w + \sec^2 \alpha \tan \alpha \cdot w^2$ we have

$$\frac{\tan (\alpha - w)}{\tan \alpha} = 1 - \frac{\sec^2 \alpha}{\tan \alpha} w + \sec^2 \alpha \cdot w^2$$

so that

$$x = \frac{\tan \alpha}{\tan (\alpha - w)} = 1 + \frac{\sec^2 \alpha}{\tan \alpha} w + \left(\frac{\sec^4 \alpha}{\tan^2 \alpha} - \sec^2 \alpha\right) w^2$$
$$= 1 + \frac{\sec^2 \alpha}{\tan \alpha} w + \csc^2 \alpha \cdot w^2.$$

On substituting for  $\alpha$ , in the coefficient of w, the second approximation

$$\alpha = \mu_0 + \frac{\gamma + 1}{4 \cos^2 \mu_0} \text{ w (see (23)) we obtain, since}$$
$$\tan \alpha = \tan \mu_0 + \frac{\gamma + 1}{4 \cos^4 \mu_0} \text{ w}$$

$$\frac{\sec^2 \alpha}{\tan \alpha} = \tan \alpha + \frac{1}{\tan \alpha} = \frac{\sec^2 \mu_0}{\tan \mu_0} + \frac{\gamma + 1}{4 \cos^4 \mu_0} (1 - \cot^2 \mu_0) w.$$

Hence the third approximation to x is

$$x = 1 + \frac{\sec^{2} \mu_{0}}{\tan \mu_{0}} w$$

$$+ \left\{ \csc^{2} \mu_{0} + \frac{\gamma + 1}{4 \cos^{4} \mu_{0}} (2 - \csc^{2} \mu_{0}) \right\} w^{2}$$
(33)

On substituting this value of x in (14) we obtain  $\frac{\mathbf{p}_1}{\mathbf{p}_0} = 1 + 2\gamma \operatorname{cosec} 2\mu_0 \cdot \mathbf{w}$ (34)

$$+ \gamma \left\{ \csc^2 \mu_0 + \frac{4 + (\gamma - 3) \operatorname{ccsec^2} \mu_0}{4 \cos^4 \mu_0} \right\} w^2.$$
(34)

On differentiating (29) with respect to  $\mu$  we obtain  $\frac{g''(\mu)}{g(\mu)} - \left\{\frac{g'(\mu)}{g(\mu)}\right\}^2$   $= \frac{-2\gamma}{(\gamma - \cos 2\mu)^2} \left\{ (\gamma - \cos 2\mu) \csc^2 \mu + 2 \cot \mu \sin 2\mu \right\}$  so that

$$\frac{g''(\mu)}{g(\mu)} = \frac{2\gamma}{(\gamma - \cos 2\mu)^2} \left\{ (\gamma + 1) \cos 2\mu \operatorname{cosec}^2 \mu - \frac{4}{2} \cos^2 \mu \right\}.$$
  
Hence

$$\frac{p}{p_{1}} = 1 + \frac{2\gamma \cot \mu_{1}}{\gamma - \cos 2\mu_{1}} (\mu - \mu_{1}) + \frac{\gamma}{(\gamma - \cos 2\mu_{1})^{2}} \\ \times \{(\gamma + 1) \cos 2\mu_{1} \csc^{2} \mu_{1} - 4 \cos^{2} \mu_{1}\} \\ \times (\mu - \mu_{1})^{2} \cdots (35)$$

On differentiating (25) we obtain

$$f''(\mu) = \frac{-2(\gamma + 1) \sin 2\mu}{(\gamma - \cos 2\mu)^2}$$

and so the relation  $\theta - w = f(\mu) - f(\mu_1)$  yields

$$\theta - w = \frac{2 \cos^2 \mu_1}{\gamma - \cos 2\mu_1} (\mu - \mu_i) + \frac{(\gamma + 1) \sin 2\mu_1}{(\gamma - \cos 2\mu_1)^2} (\mu - \mu_i)^2.$$

Inverting this relation we obtain

$$\mu - \mu_{1} = \frac{\gamma \cos 2\mu_{1}}{2 \cos^{2} \mu_{1}} (\theta - w) + \frac{(\gamma + 1) \sin 2\mu_{1} (\gamma - \cos 2\mu_{1})}{8 \cos^{6} \mu_{1}} \times (\theta - w)_{2}$$

and on substituting this in (35) we find

$$\frac{p}{p_1} = 1 + 2\gamma \operatorname{cosec} 2\mu_1 (\theta - w) + \frac{\gamma \operatorname{sec}^4 \mu_1}{4} \times [(\gamma + 1) \operatorname{cosec}^2 \mu_1 - 4 \operatorname{cos}^2 \mu_1](\theta - w)^2. \quad (36)$$

We replace in this formula  $\mu_1$  by  $\mu_0$  in the coefficient of  $(\theta - w)^2$  and by  $\mu_0 + \frac{\gamma - \cos 2\mu_0}{2\cos^2 \mu_0} w$  (see formula (24)) in the coefficient of  $\theta - w$ . In this way we obtain

 $\frac{p}{p_1} = 1 + 2\gamma \operatorname{cosec} 2\mu_0 \cdot (\theta - w) - 2\gamma \operatorname{sec}^2 \mu_0 \left\{ \operatorname{cosec} 2\mu_0 \operatorname{cot} 2\mu_0 \times \right.$ 

$$(\gamma - \cos 2\mu_0)$$
  $w(\theta - w) + \frac{\gamma}{4} \sec^3 \mu_0 \{(\gamma + 1) \operatorname{cosec}^2 \mu_0$ 

 $= 1 + 2\gamma \operatorname{cosec} 2\mu_0 \cdot (\theta - w) + \gamma \operatorname{sec}^2 \mu_0 (\gamma \operatorname{cosec}^2 2\mu_0)$ 

$$+ 2\gamma \operatorname{cosec} 2\mu_0 \operatorname{cot} 2\mu_0 - \operatorname{cot}^2 2\mu_0) \mathrm{w}^2$$

$$-2\gamma \sec^2 \mu_0 (\gamma \csc^2 2\mu_0 + \gamma \csc 2\mu_0 \cot 2\mu_0) w\theta$$

+  $\gamma \sec^2 \mu_0 (\gamma \operatorname{cosec}^2 2\mu_0 + \operatorname{cot}^2 2\mu_0) \theta^2$ .

Upon multiplying this by (34) we obtain

$$\frac{p}{p_0} = 1 + 2\gamma \theta \operatorname{cosec} 2\mu_0 + \gamma \operatorname{sec}^2 \mu_0 \operatorname{cosec}^2 2\mu_0 \times (\gamma + \cos^2 2\mu_0)\theta^2.$$
(37)

This approximation to the pressure ratio is known as the quadratic or Busemann Theory.

# PART II. APPLICATION OF THE GENERAL THEORY

#### 7. Limitations on method.

This part of the report describes in detail the calculation of the pressure at any point of an airfoil in a supersonic stream. The lift, drag and moment may then be obtained by numerical integration, when the pressure is known at enough points on the surface of the airfoil. In making the application it should be remembered that the method is subject to the following limitations:

(1) The effect of viscosity in forming a boundary layer is neglected. It is assumed in effect that the flow past the surface is not retarded by frictional forces.

(2) The calculations are strictly two-dimensional. No attempt is made here to correct for the effect of finite span.

(3) The procedure breaks down for wedge angles which are too large. For a given incident Mach number, there is a maximum wedge angle through which the flow may be turned by a plane shock wave issuing from the corner. For greater wedge angles, the shock is presumably curved and detached from the corner. As applied to airfoil calculations this limitation means not only that the leading edge of the airfoil must be fairly acute (which is likely to be true of any airfoil worthy of consideration), but also that the angle of attack must not be too great. No matter how thin the airfoil, this limits the permissible range in angle of attack. This limitation is more restrictive for lower Mach numbers; in fact, it is always possible for the Mach number to be so low (vet greater than unity) that the calculations cannot be carried out for any angle of attack. As an example, for the symmetrical bi-convex GU2 profile with a semi-angle of 11.42° at the leading edge, the computations can only be carried out for angles of attack up to  $13.43^{\circ}$  for  $M_0 = 2.13^{\circ}$ , and up to  $8.45^{\circ}$ for  $M_0 = 1.85^\circ$ ; for  $M_0$  less than 1.489, the calculations cannot be carried out for any angle of attack including zero.

(4) This method is not exact even for the ideal two-dimensional non-viscous case. Unless the obstacle is a wedge formed by two half planes, the shoek wave is necessarily curved and the motion has vorticity. However, the initial slope of the shock wave is given by the present method, and the curvature of the shock wave is small if the curvature of the airfoil is small; hence, the effect of vorticity will operate chiefly near the trailing edge and will probably be small. It seems probable that this effect is small in comparison with the effect of the boundary layer near the trailing edge, which is likewise ignored.

In all of these tables the ratio of the specific heats  $(\gamma)$  is taken as 1.4. The formulas on which the tables are based are restated below for this value of  $\gamma$ .

# 3. Plane shock wave solution for flow in a corner.

The following formulas describe two-dimensional, non-viscous supersonic flow in a corner, throughout the range of Mach numbers and corner angles for which the shock wave is plane. By juxtaposition of two such corner flows with, in general, different wedge angles we have the case of a uniform stream impinging on an infinite wedge, not necessarily placed symmetrically with respect to the stream. On either side of the shock wave the flow is uniform. The angle w through which the flow must turn in order to stay in the corner is called the wedge angle. The Mach number, pressure density and velocity are denoted by M, p,  $\rho$ , q, with subscript 0 or 1 used to refer respectively to the state before or after the shock wave. The angle which the shock wave makes with the incident flow is denoted by  $\alpha$ . The relations between these quantities are as follows:

$$\frac{\rho_{1}}{\rho_{0}} = \frac{\tan \alpha}{\tan (\alpha - w)} \equiv \kappa$$

$$M_{0} = \sqrt{\frac{5x}{6 - x}} / \sin \alpha$$

$$M_{1} = \sqrt{\frac{5}{6x - 1}} / \sin (\alpha - w)$$

$$\frac{\rho_{1}}{\rho_{0}} = \frac{6x - 1}{6 - x}$$

$$\frac{q_{1}}{q_{0}} = \frac{\cos \alpha}{\cos (\alpha - w)}$$
(38)

Tables 1-4 give x,  $M_0$ ,  $M_1$ , and  $\frac{p_1}{p_0}$  respectively as functions of  $\alpha$  and w. The usual problem is to find  $M_1$  and  $\frac{p_1}{p_0}$ , given w and  $M_0$ . Since w and  $M_0$  are known,  $\alpha$  may be found from the table of  $M_0$  as a function of  $\alpha$  and w (Table 2). Then  $M_1$  and  $\frac{p_1}{p_0}$ may be read from Tables 3 and 4. In general a two way interpolation is required in each table. A specific numerical illustration will be given later.

Usually the x-table (Table 1) is not used. It was a necessary step in the preparation of Tables 2-4, and is included here because it gives a quantity of physical interest, namely the ratio of densities behind and in front of the shock wave.

Several properties of this solution may be pointed out.

The density is greater, the Mach number smaller, the pressure greater, the velocity smaller, and the velocity of sound greater behind the shock wave (subscript 1) than in front of the shock wave (subscript 0).

The shock angle  $\alpha$  is approximately equal to the Mach angle  $\mu$  for small wedge angles, as would be expected on general grounds. (In general small wedge angles give weak shocks.)

For a given Mach number, there is a maximum wedge angle w<sub>m</sub>. For wedge angles greater than w<sub>m</sub> the problem has no solution in terms of a plane shock wave; presumably the shock moves forward from the edge and is curved. There is another, slightly smaller, critical wedge angle w<sub>s</sub> for which the Mach number  $M_2$  is just equal to unity; for wedge angles between w, and wm the flow behind the shock wave is subsonic. In this case the procedure of the next two sections is not applicable since the Mach angle is not real; furthermore, it seems likely that the solution is unstable even for the case of an infinite wedge, if the flow behind the shock wave is subsonic. It therefore seems likely that the critical angle<sup>4</sup> for which the shock breaks away from the nose is nearer to  $w_s$  than to  $w_m$ . Practically, the distinction between  $w_m$  and  $w_s$  is quite unimportant. These angles are tabulated in Table 6. They approach equality for both small and large Mach numbers;

<sup>4</sup> It is not certain that such a critical angle exists. Since the plane shock wave solution is not really "exact", the shock may be detached slightly and have some curvature even for small wedge angles. the maximum difference  $w_m - w_s$  is 0.420° (occurring for  $M_0 = 1.52$ ). As  $M_6$  increases,  $w_m$  and  $w_s$  both increase; but it should be noted that for any Mach number, no matter how large,  $w_m$  and  $w_s$  are each less than 45.584°.

Table 6 was constructed from the following formulas given by Crocco<sup>5</sup>.

$$\sin^{2} \alpha_{m} = \frac{1}{\gamma M^{2}} \left[ \frac{\gamma + 1}{4} M_{0}^{2} - 1 + \sqrt{(\gamma + 1) \left( 1 + \frac{\gamma - 1}{2} M_{0}^{2} + \frac{\gamma + 1}{16} M_{0}^{4} \right)} \right]$$
$$\sin^{2} \alpha_{*} = \frac{1}{\gamma M_{0}^{2}} \left[ \frac{\gamma + 1}{4} M_{0}^{2} - \frac{3 - \gamma}{4} + \sqrt{(\gamma + 1) \left( \frac{9 + \gamma}{16} - \frac{3 - \gamma}{8} M_{0}^{2} + \frac{\gamma + 1}{16} M_{0}^{4} \right)} \right]$$

With either subscript,

$$\frac{\tan \beta}{\tan \alpha} = \frac{2}{\gamma+1} \left( \frac{\sin^2 \mu_0}{\sin^2 \alpha} + \frac{\gamma-1}{2} \right)$$

An alternative formula may be derived for the determination of  $w_m$ , by eliminating  $\alpha$  between the first two of equations (38). Writing  $z \equiv \left(\frac{\tan w_m}{5}\right)^2$ ,  $m \equiv M_0^2$ ,

$$az^2 + bz + c = 0$$

where a = 
$$4(6m + 5)^{3}(m + 5)$$
  
b =  $27(m + 5)^{2} - (m - 1)^{2}(6m + 5)^{2} + 18(m + 5)(m - 1)(6m + 5)$   
c =  $-4(m - 1)^{3}$ 

A similar formula may be obtained for  $w_s$ , also of the fourth degree in tan  $w_s$ ; but it cannot be solved explicitly.

There is a wedge angle w<sup>\*</sup>, analogous to w<sub>s</sub> or w<sub>m</sub>, which limits the existence of the "short cut method" described. Since  $f(\mu) = f(\mu_0) + w$ , and since

Mo I	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2
w* 0°	1.3°	3.6*	6.2°	9.0°	11.9°	14.9°	17.8°	20.7°	23.6°	26.4
w <sub>8</sub> 0°	1.4°	3.7°	6.3°	9.0°	11.7°	14.2°	16.6°	18.8°	20.9°	22.7
w <sub>m</sub> 0°	1 <sub>&lt;</sub> 5°	3.9°	6.7°	9.4°	12.1°	14.6°	17.0°	19.2°	21.2°	23.0
2.5 39.1° 29.7° 29.8'	4	3 9.8° 4.0° 4.1°	4 65 38 38	.8° .7° .8°	5 76.9° 41.1° 41.1°	6 85 42 42	.0° .4° .4°	10 102.3° 44.4° 44.4°	∞ 130.5' 45.6' 45.6	•

<sup>5</sup> L. Crocco, Singolarita della corrente gassosa iperacustica nell'intorno di una prora a diedro. L'aerotecnica. Vol. XVII, fasc. 6, 1937.

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 $f(\mu) \leq 90^{\circ} (\sqrt{6} - 1) = 130.45^{\circ}$ , w must be less than  $130.45^{\circ} - f(\mu_0)$  if  $\mu$  is to be real. Therefore  $w^* = 130.45^\circ - f(\mu_0)$ . The preceding table shows that w\* is of the same order of magnitude as w, and w<sub>m</sub> for small Mach numbers, but diverges radically at very high Mach numbers.

Inspection of Table 2 shows that, for fixed w and varying  $\alpha$ , M<sub>0</sub> decreases as  $\alpha$  increases up to a point in the neighborhood of 65°, after which it increases. Thus for each wedge angle, there is a critical value of  $M_0$ , below which the plane shock wave solution does not exist.<sup>6</sup> In Table 2, the smallest value of  $M_0$  for each wedge angle is enclosed in a box. Similarly the value of  $M_0$  for which the flow behind the shock becomes sonic is underlined and in italics. For any wedge angle and for any M<sub>0</sub> above the minimum, two values of  $\alpha$  may be read from Table 2, or at least could be if the table were extended. The smaller of these two values of  $\alpha$  should always be chosen. The solution obtained on using the other value involves subsonic flow behind the shock wave and is probably unstable. In any case, the method of this report is applicable only to supersonic flow.

#### 9. Flow around a corner or convex curve ("expansive flow").

The Mach angle of the initial uniform flow is  $\mu_1 = \sin^{-1} \frac{1}{M_1}$ . The Mach angle  $\mu = \sin^{-1} \frac{1}{M}$ at any point where the flow has turned through an angle  $\eta$  is determined by

$$(\mu_1) - f(\mu) = \eta$$

where  $f(\mu) \equiv \sqrt{6} \tan^{-1} (\sqrt{6} \tan \mu) - \mu$ .

Table 5 gives the numerical value of  $f(\mu)$  in degrees. Since  $f(\mu)$  is a monotonically increasing function of  $\mu$ , it is seen that  $\mu$  steadily decreases, and hence M steadily increases as we move with the flow. Since  $\mu$  is an essentially positive quantity, the maximum angle through which the flow may turn is  $\eta_{\text{max}} = f(\mu_1)$ . Practically, however, this is no restriction since  $f(\mu_1)$  is greater than a right angle for Mach numbers less than 2.5, and greater than 60° for Mach numbers less than 4.3.

After  $\mu$  has been determined at any point, the pressure (p), velocity (q) and density ( $\rho$ ) are determined by the following formulae:

$$\frac{p}{p_{i}} = \frac{g(\mu)}{g(u_{i})} \qquad g(\mu) = \left(\frac{\sin^{2}\mu}{0.2 + \sin^{2}\mu}\right)^{1/2}$$
$$\frac{q}{q_{1}} = \sqrt{\frac{0.2 + \sin^{2}\mu_{1}}{0.2 + \sin^{2}\mu}}$$
$$\frac{\rho}{\rho_{1}} = \left(\frac{p}{p_{1}}\right)^{s/7} \equiv \frac{h(\mu)}{h(\mu)} \quad \text{where} \quad h(\mu) = |g(\mu)|^{s/7}$$
$$= \left(\frac{\sin^{2}\mu}{0.2 + \sin^{2}\mu}\right)^{s/2}$$

ρ

It was convenient to use the above definition of  $g(\mu)$ , which differs by a (non-essential) constant from the function  $g(\mu)$  defined in Section 1. It is to be noted that p,  $\rho$ , and  $\sqrt{\frac{dp}{d\rho}}$  (the local velocity of sound) decrease, and q increases, in flow around a corner or convex surface. Of the functions  $f(\mu)$ ,  $g(\mu)$ ,  $h(\mu)$  tabulated in Table 5, only f and g are used in obtaining the pressure. The function  $h(\mu)$  was a necessary step in calculating  $g(\mu)$ , and is given in the table since it may occasionally be of interest to know the density changes in expansive flow.

## 10. Specific numerical illustration.

The calculations for two-dimensional airfoils are based on the two problems just discussed. The first problem, with the aid of Tables 1-4, gives the pressure and Mach number on either surface of the airfoil at the leading edge, just behind the shock wave (the pressure and Mach number in the undisturbed stream being given). The Mach number thus obtained is converted into a Mach angle  $\left(\mu = \sin^{-1} \frac{1}{M}\right)$ and the flow around the curved profile is followed by means of the solution to the second problem. In this way it is possible to calculate a value for the pressure and the Mach angle at any point of the profile. The shock waves proceeding from the trailing edge, and the conditions in the wake, are ignored, on the principle that they do not affect the pressure on the airfoil.

As a numerical example, consider a GU2 profile (formed by two 22.84° circular arcs), and specifically the 30% chord station on the upper surface, with  $+5^{\circ}$  angle of attack and Mach number 1.77. The semi-angle at the leading edge is 11.42°, and this

<sup>&</sup>lt;sup>6</sup> The relation between this critical M<sub>0</sub> and w is precisely the same as the relation between M<sub>0</sub> and w<sub>m</sub> given by Table 6. In constructing Table 6, a very slightly different approach was made, in that the maximum w was found for fixed  $M_0$  (instead of the minimum  $M_0$  for fixed w).

would be the wedge angle to use in connection with a zero angle of attack; but as a result of the 5° angle of attack, the wedge angle to be used for calculations on the upper surface is  $w = 11.42^{\circ} - 5^{\circ} = 6.42^{\circ}$ . The shock angle  $\alpha$  is then to be found from Table 1 by double interpolation. Inspection of Table 2 shows that  $M_0 = 1.77$  and  $w = 6.42^{\circ}$  determines  $\alpha$  to be between 40° and 41°. For  $w = 6.42^{\circ}$ , interpolation gives  $M_0 = .58 \times 1.779 + .42 \times 1.822 = 1.797$  for  $\alpha = 40^{\circ}$  and  $M_0 = .58 \times 1.740 + .42 \times 1.783 = 1.758$  for  $\alpha = 41^{\circ}$ . Another linear interpolation shows that for  $M_0 = 1.77$ ,  $\alpha = 40 + \frac{27}{340} = 40.69^{\circ}$ . Now that  $\alpha$  is known,  $M_1$  and  $p_1/p_0$  are obtained by interpolating in Tables 3 and 4.

$$M_1 = .31 \times (.58 \times 1.573 + .42 \times 1.580) + .69 \times (.58 \times 1.536 + .42 \times 1.541) = 1.550$$

$$p_1/p_0 = .31 \times (.58 \times 1.359 + .42 \times 1.434) + .69 \times (.58 \times 1.354 + .42 \times 1.429) = 1.387$$

This describes the state just behind the shock wave. To follow the subsequent changes, find the Mach angle  $\mu_1$  corresponding to the Mach number M<sub>1</sub>:

$$\sin \mu_1 = M_1 = .6452$$
  
 $\mu_1 = 40.18^\circ$ ,

and determine  $\mu$  at any point by

$$f(\mu_1) - f(\mu) = \eta$$

where  $\eta$  is the angle between the tangent at the point in question and the tangent at the leading edge. For example, the geometry of the wing shows that at the 30% chord station  $\eta = 6.88^{\circ}$ , so that at this point (using Table 5)

$$f(\mu) = f(40.18^{\circ}) - 6.88^{\circ} = 117.08^{\circ} - 6.88^{\circ} = 110.20^{\circ}$$
$$\mu = 34 + \frac{13}{136} = 34.10^{\circ}$$
$$P^{\circ} = \sigma(\mu) = -17843$$

Then  $\frac{p}{p_1} = \frac{g(\mu)}{g(\mu_1)} = \frac{.17843}{.25328} = .7045$ . This is the ratio of the pressure at any point to the pressure just

behind the shock wave. To find the ratio of the pressure to the pressure in the undisturbed stream, this must be multiplied by  $p_1/p_0$ . In the above example, the ratio of the pressure at the 30% chord station to the pressure in the undisturbed stream is

$$p/p_0 = 1.387 \times .7045 = .9771$$

The calculations for the lower surface proceed similarly, but with a wedge angle  $w = 11.42^{\circ} + 5^{\circ} = 16.42^{\circ}$ .

After the pressure has been obtained at a sufficient number of points on both upper and lower surface, the lift, drag, and moment forces are obtained by numerical integration. For the GU2 profile it is sufficient to calculate the pressure at 10% chord intervals, including both leading and trailing edges, and integrate by Simpson's rule. For profiles in the shape of a polygon, the integrations may be effected without approximation. In any case, the integrals to be evaluated are

$$\int p \, dx$$
$$\int p \, \tan \beta \, dx$$
$$\int (x + y \, \tan \beta) p \, dx.$$

on both surfaces. Here x is the distance back along the chord (measured from  $\hat{any}$  fixed point on the chord line; the moment derived is then understood to be the moment about this fixed origin), y the distance of the point on the surface above the chord line,  $\beta$  the angle which the tangent to the surface makes with the chord line. All of these quantities must be taken with correct sign: y is positive on the upper surface and negative on the lower surface;  $\beta$  is positive on the front of the upper surface and the rear of the lower surface, but negative on the rear of the upper surface and the front of the lower surface; x takes on negative values unless the origin is taken at the leading edge. The moment per unit span is

$$\int_{upper} (x + y \tan \beta) p \, dx - \int_{lower} (x + y \tan \beta) p \, dx$$

which is considered as positive if it tends to rotate the wing about the origin in the sense of increasing angle of attack. The lift and drag, measured perpendicular and parallel to the chord line, are

$$\lambda = \int_{1 \text{ ower}} p \, dx - \int_{u \, p \, p \, er} p \, dx$$
$$\delta = \int_{1 \text{ ower}} p \, \tan \beta \, dx - \int_{u \, p \, p \, er} p \, \tan \beta \, dx$$

per unit span. The lift and drag, measured perpendicular and parallel to the undisturbed stream, are per unit span

$$L_{z} = \lambda \cos \phi - \delta \sin \phi$$
$$D = \lambda \sin \phi - \delta \cos \phi$$

where  $\phi$  is the angle of attack.

5

Although this procedure is occasionally referred to as an "exact" method, it is actually an approximation, although presumably a very good one. Two facts must be neglected in the development of this method:

(1) The mathematical solution for the flow around a corner, or around a cylindrical surface which is never concave outward, is based on the assumption that the characteristic lines proceed from the body to infinity without meeting any barrier or locus of discontinuity. In the wedge problem, all of the characteristics on both sides of the shock wave intersect the shock wave. Hence the flow around a corner (or convex surface) cannot be treated independently of a preceding flow in a corner involving shock. Likewise the shape of the shock wave is not independent of the flow following the shock wave. The theory of the plane shock wave is developed on the assumption that the magnitude and direction of flow just behind the shock wave is everywhere the same. This is impossible if expansive flow follows. It appears certain that for an airfoil such as the GU2, a general theory taking account of this interaction would lead to a curved<sup>7</sup> shock wave, perhaps slightly

<sup>7</sup> There are physical reasons for believing that, at distances which are large compared with the maximum diameter of a body disturbing a uniform flow, the shock angle approaches the Mach angle of the undisturbed stream. This leads to a shock which continually decreases in intensity with distance from the disturbance, as compared with the present solution which gives a shock wave which has the same "strength" at every point.

detached from the leading edge, even for small wedge angles; in this case the critical wedge angle discussed earlier would have no exact meaning.

(2) The conditions in the wake have been ignored, presumably on the theory that the wake is bounded by shock waves proceeding from the trailing edge, and hence can have no effect on the pressure at any point on the surface. In general, however, this method does not yield a solution for the flow in the wake, since it is necessary to match three physical quantities such as p,  $\rho$ , M, of which two are inde-

pendent (because of the relation  $\frac{q^2}{2} + \frac{c^2}{\gamma - 1}$ 

constant) and there is only one degree of freedom in applying the method of this report, namely the direction of the final flow. Therefore the assumption, that conditions in the wake do not affect the flow over the airfoil, is without any satisfactory foundation.

Neglecting these two effects might be justified, partly by photographic evidence and partly by the consideration that the pressure distribution is affected mainly near the trailing edge, where the pressure is small, and therefore the total lift, drag and moment are affected only slightly. However, both of these faults in this method should be recognized as mathematical inconsistencies, quite distinct from objections that may be raised on physical grounds (e.g., the neglect of viscosity).

TABLE	
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3.0

																	$\frac{P}{P}$	$\frac{r_1}{r_2} \equiv$	X = -	tan an (a	$\frac{\alpha}{(-w)}$	;X	=
α≁	ſ	1°	2°	3°	40	5°	60	72	8°	.9°	10°	11°	12°	13°	14°	15°	16°	17°	18°	19°	20°		8°
¥	1° 2° 3° 4°		2.001	1.501 3.002	1.334 2.002 4.006	1.251 1.669 2.506 5.012	1.201 1.503 2.006 3.010	1.168 1.403 1.753 2.343	1.145 1.337 1.606 2.010	1.127 1.290 1.507 1.810	1.113 1.255 1.436 1.678	1.102 1.227 1.383 1.583	1.094 1.205 1.342 1.512	1.086 1.188 1.309 1.458	1.080 1.173 1.263 1.414	1.075 1.161 1.261 1.378	1.070 1.150 1.242 1.349	1.066 1.141 1.226 1.324	1.063 1.133 1.213 1.303	1.060 1.126 1.201 1.265	1.057 1.120 1.190 1.269	11.1.1.1.1.	062 132 213 302
	ວິ 6° 7° 8° 9°	14					6.021	3,516 7.034	2.682 4.025 8.052	2.265 3.022 4.536 9.074	2.015 2.522 3.365 5.049 10.102	1.849 2.222 2.780 3.709 5.566	1.731 2.022 2.430 3.040 4.066	1.643 1.880 2.197 2.639 3.302	1.574 1.774 2.031 2.372 2.850	1.520 1.632 1.907 2.182 2.549	1.475 1.626 1.810 2.040 2.335	1.438 1.573 1.734 1.930 2.175	1.407 1.529 1.672 1.843 2.051	1.381 1.491 1.620 1.771 1.953	1.358 1.460 1.577 1.712 1.872	111111	407 529 672 843 051
	10° 11° 12° 13° .14°			×	*							11.136	6.087 12.177	4.405 6.511 13.226	3.568 4.757 7.140	3.063 3.832 5.113 7.673	2.728 3.273 4.101 5.471 8.211	2.490 2.909 3.495 4.372 5.834	2.312 2.646 3.091 3.714 4.647	2.174 2.450 2.804 3.278 3.936	2.064 2.298 2.590 2.964 3.463	<b></b>	312 64( 091 714 647
	<b>15°</b> 16° 17° 18° 19°	r																8.755	6.200 6.304	4.924 6.570 9.860	4.160 5.205 6.945 10.423	10 4 5 7	20X 304
	20° 21° 21° 21° 21° 21° 21° 21° 21° 21° 21											-									-	1.2.10 % 10 11 11 1 2 2 4	
	<b>នំ</b> នំ នំ នំ នំ នំ នំ	۰				~				-	,											San Star - S Vorts - Notes	
	<b>3</b> 0°					·								-								and the second	
		39°	<b>4</b> 0°	41°	42°	43°	44°	<b>45°</b>	46°	47°	48°	49°	50°	51°	52°	53°	54°	55°	56°	57°	59°		56
	1° 2° 3° 4°	1.036 1.075 1.115 1.158	1.038 1.074 17114 1.155	1.036 1.073 1.113 1.154	1.036 1.073 1.112 1.152	1.038 1.073 1.111 1.152	1.038 1.073 1.111 1.151	1.038 1.072 1.111 1.150	1.038 1.072 1.110 1.150	1.036 1.072 1.110 1.150	1.036 1.073 1.111 1.150	1.038 1.073 1.111 1.150	1.036 1.073 1.111 1.151	1.036 1.073 1.112 1.152	1.036 1.074 1.113 1.152	1.037 1.075 1.114 1.154	1.037 1.075 1.115 1.155	1.038 1.076 1.116 1.156	1.038 1.077 1.117 1.158	1.039 1.078 1.119 1.160	1.039 1.079 1.121 1.163	× 1 3 1 • 1	.0 .0 .1 .1
	<b>5</b> <sup>•</sup> ຸ 6ັ 7° 8° 9°	1.201 1.247 1.293 1.348 1.403	1.198 1.244 1.292 1.343 1.396	1.196 1.241 1.289 1.339 1.391	1.196 1.239 1.286 1.335 1.387	1.194 1.237 1.283 1.332 1.383	1.193 1.238 1.282 1.329 1.379	1.192 1.235 1.280 1.327 1.376	1.191 1.234 1.279 1.325 1.374	1.191 1.234 1.278 1.324 1.373	1.191 1.233 1.278 1.324 1.371	1.191 1.234 1.278 1.323 1.371	1.192 1.234 1.278 1.324 1.371	1.193 1.235 1.279 1.324 1.371	1.194 1.236 1.280 1.325 1.373	1.195 1.237 1.282 1.327 1.374	1.196 1.239 1.283 1.329 1.376	1.198 1.241 1.286 1.332 1.379	1.201 1.244 1.289 1.335 1.383	1.203 1.247 1.292 1.339 1.387	1.206 1.250 1.296 1.343 1.391	1	.2 .2 .2 .3
	10° 11° 12° 13° 14°	1.461 1.523 1.589 1.660 1.737	1.453 1.514 1.578 1.647 1.720	1.447 1.506 1.568 1.635 1.706	1.441 1.459 1.560 1.624 1.693	1.438 1.492 1.552 1.615 1.682	1.432 1.487 1.545 1.607 1.673	1.428 1.483 1.540 1.600 1.664	1.425 1.479 1.535 1.595 1.657	1.423 1.478 1.532 1.590- 1.651	1.422 1.474 1.529 1.586 1.647	1.421 1.472 1.527 1.583 1.643	1.420 1.472 1.525 1.582 1.640	1.421 1.472 1.525 1.581 1.639	1.422 1.472 1.525 1.581 1.638	1.423 1.474 1.527 1.582 1.639	1.425 1.476 1.529 1.583 1.640	1.428 1.479 1.532 1.586 1.643	1.432 1.483 1.535 1.590 1.647	1.436 1.487 1.540 1.595 1.651	1.441 1.492 1.545 1.600 1.657	1 1 1 1	.4 .4 .5 .5
	<b>15°</b> 16° 17° 18° 19°	1.819 1.908 2.004 2.110 2.225	1.799 1.885 1.977 2.077 2.186	1.782 1.864 1.952 2.048 2.152	1.767 1.846 1.931 2.022 2.121	1.754 1.830 1.912 2.000 2.094	1.742 1.816 1.895 1.980 2.071	1.732 1.804 1.881 1.963 2.050	1.723 1.794 1.868 1.948 2.032	1.716 1.785 1.857 1.935 2.017	1.710 1.777 1.848 1.924 2.004	1.705 1.771 1.841 1.915 1.992	1.702 1.767 1.835 1.907 1.983	1.700 1.764 1.831 1.902 1.976	1.699 1.762 1.828 1.896 1.971	1.699 1.761 1.827 1.895 1.967	1.700 1.762 1.827 1.894 1.965	1.702 1.764 1.828 1.895 1.966	1.705 1.767 1.831 1.898 1.967	1.710 1.771 1.835 1.902 1.971	1.716 1.777 1.841 1.907 1.976		.7 .7 .8 .8
	20° 21° 22° 33° 24°	2.352 2.492 2.649 2.824 3.022	2.305 2.437 2.582 2.745 2.928	2.265 2.388 2.525 2.675 2.843	2.229 2.346 2.474 2.615 2.771	2.197 2.308 2.429 2.562 2.708	2.169 2.275 2.390 2.516 2.653	2.145 2.246 2.356 2.475 2.605	2.123 2.221 2.328 2.440 2.563	2.105 2.199 2.300 2.409 2.526	2.089 2.180 2.277 2.382 2.494	2.075 2.164 2.258 2.369 2.467	2.064 2.150 2.241 2.339 2.443	2.055 2.139 2.228 2.323 2.424	2.048 2.130 2.217 2.309 2.407	2.043 2.124 2.209 2.299 2.394	2.041 2.119 2.203 2.291 2.384	2.040 2.117 2.199 2.286 2.377	2.041 2.117 2.198 2.283 2.373	2.043 2.119 2.199 2.283 2.371	2.048 2.124 2.203 2.286 2.373	2 2 2 2 2 2	.0 .1 .1 .2 .3
	25° 26° 27° 28° 29°	3.248 3.508 3.810 4.166 4.593	3.132 3.365 3.635 3.948 4.317	3.032 3.244 3.487 3.765 4.060	2.945 3.140 3.360 3.611 3.900	2.870 3.050 3.252 3.480 3.740	2.805 2.972 3.159 3.368 3.604	2.747 2.904 3.078 3.271 3.487	2.698 2.845 3.007 3.187 3.387	2.664 2.794 2.946 3.114 3.300	2.616 2.749 2.893 3.061 3.225	2.584 2.710 2.847 2.997 3.161	2.556 2.677 2.808 2.950 3.105	2.532 2.648 2.774 2.09 3.056	2.512 2.624 2.745 2.875 3.015	2.496 2.604 2.721 2.846 2.981	2.483 2.589 2.701 2.822 2.952	2.474 2.576 2.686 2.803 2.928	2.467 2.568 2.675 2.788 2.910	2.464 2.563 2.667 2.778 2.896	2.464 2.561 2.663 2.772 2.687	2222	.4 .5 .6 .7

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30° 5.113 4.759 4.472 4.236 4.039 3.873 3.732 3.611 3.508 3.418 3.341 3.274 3.217 3.168 3.126 3.091 3.063 3.040 3.022 3.010

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× = ∙	tan (a	<u>(</u> -w)	; α>	> W																
.] 18°	19°	20°	21°	æ°	జి	24°	జి	26°	27°	28°	జి	<b>3</b> 0°	31°	32°	ఔో	34°	35°	36°	37°	39°
1.063	1.660	1.067	1.055	1.053	1.051	1.049	1.047	1.046	1.045	1.644	1.043	1.342	1.641	1.040	1.039	1.039	1.038	1.038	1.037	1.037
1.133	1.126 1.201	1.120 1.190	1.115 1.181	1.110 1.173	1.106	1.102	1.099 1.154	1.036 1.149	1.093 1.144	1.090 1.140	1.088 1.137	1.065 _ 1.133	1.064 1.130	1.022 1.127	1.081 1.125	1.079 1.123	1.078 1.121	1.0 <sup>77</sup> 1.119	1.076	1.075 1.116
1.303	1.265	1.269	1.256	1.243	1.233	1.223	1.215	1.207	1.200	1,194	.1.189	1.184	1.179	1.175	1.172	1.108	1.105	1.163	1.100	1.158
1.529	1.301	1.338	1.33	1.409	1.388	1.370	1.354	1.271	1.327	1.255	1.245	1.236	1.232	1.225	1.221	1.209	1.213	1.258	1.25	1.250
1.672	1.620 1.771	1.577 1.712	1.540 1.663	1.508	1.480 1.584	1.456 1.553	1.435 1.525	1.416 1.501	1.400 1.480	1.385 1.461	1.372 1.444	1.390 1.429	1.350 1.416	1.340 1.403	1.331 1.393	1.324 1.383	1.317 1.374	1.311 1.388	1.355 1.359	1.300
<b>2.</b> 051	1.953	1.872	1.806	1.750	1.702	1.882	1.628	1.595	1.568	1.544	1.523	1.504	1.487	1.472	1.459	1.448	1.438	1.426	1.417	1.409
2.312 2.646	2.174 2.450	2.084 2.298	1.975 2.177	1.901 2.079	1.839 1.997	1.786 1.928	1.740 1.870	1.701 1.620	1.687 1.777	1.636 1.739	1.610 1.706	1.588	1.5%5	1.547	1.530	1-515	1.502	1.490 1.568	1.479	1.469 1.553
8.091	2.804	2.590	2.424	2.291	2.184	2.096	2.020	1.956	1.902	1.854	1.813	1:277	1.745	1.717	1.892	1.669	1.650	1.632	1.616	1.62
4.647	3.936	2.904 3.463	3.126	2.875	2.680	2.525	2.399	2.295	2.207	2.133	2.069	2.013	1.965	1.923	1.855	1.55	1.735	1.728	1.000	1.675
6.200	4.924	4.160	3.652	3.291	3.020	2.811	2.645	2.509	2.397	2.303	2.223	2.155	2.095	2.040	1.929	-1,969	1.924	1.893	1.935	1.841
1	9.860	6.945	4.300 5.490	4.618	4.039	3.100	2.944 3.318	3.079	2.890	2.501	2.608	2.516	2.242	2.332	2.265	2.206	2.034 2.155	2.110	2.00	2.035
1. 14		10,423	7.325	5.778	4.852	4.236	3.799	3.470	3.217	3.015	2.852	2.716	2.003	2.500	2.424	2.352	2.290	2.236	2.188	2.147
				1.109	8.000	6 347	5 720	3.912	<b>3-020</b>	3.307	7 500	2.8(0	2.021	2.707	2.005	0.005	6. m2	2.515	219	2.247
10. Y 10.					00000	3.49E	6.669	5.575	4.848	4.330	3.944	3.645	3.408	2.910 3.215	3.055	2.922	2.808	2.55	2.628	2.555
							8.698	6.975 9.306	5.824 7.287	5.059 6.077	4.514 5.274	4.105	3.794	3.544	3.341 3.683	3.173 3.470	3.033	2.914	2.812 3.022	2.725
<u><u> </u></u>										7.604	6.336	5.493	4.894	4.446	4.100	3-825	3.002	3.418	3.26;	3.134
10											7.927	6.599	5.717	5.089	4.621	4.259	3.971	3.738	3.545	3.35
and the second												0.200	6.593	7.142	5.289 6.179	5.493	4.932	4.587	3.577 4.274	4.019
											-				7.423	6.418	5.703 6.662	5.170 5.917	4.758 5.362	4.431 4.933
				·								•					<u> </u>	6.913	8.137	5.559
							····· ·····	,												
56°	57°	58°	59°	60°	61°	62°	63°	64°	<b>65</b> °	66°	.67°	68°	69°	70°	71°	72°	73°	74°	75°	76°
1.038	1.039	1.039	. 1.040	1,041	1.042	1.043	1.044	1.045	1.046	1.047	1.049	1.051	1.053	1.055	1.057	1,060	1.063	1.088	1.070	1.075
1.077	1.078	1.079	1.081	1.082	1.064	1.086	1.088	1.090	1.093	1.095	1.099	1.102	1.106	1.110	1.115	1.120	1.128	1.133	1.141	1.150
1.117	1.119	1.121	1.125	1.125	1.127	1.130	1.155	1.137 1.184	1.140	1.144	1.149	1.154	1.160	1.166	1.233	1.181 1.243	1.190	1.201 1.209	1.213	1.226
1.201	1.203	1.206	1.209	1.213	1.217	1.221	1.228	1.232	1.238	1.245	1.253	1.261	1.271	1.281	1.293	1.306	1.322	1.339	1.358	1.381
1.244	1.247	1.250	1.254	1.258 1.305	1.263	1.269 1.317	1.275	1.281	1.289	1.297 1.350	1.308	1.316 1.372	1.327	1.340 1.400	1.354 1.416	1.370 1.435	1.388	1.409 1.480	1.433	1.460
1.335	1.339	1.343	1.348	1.353	1.359	1.366	1.374	1.363	1.393	1.403	1.416	1.429	1.444	1.461	1.480	1.501	1.625	1.553	1.584	1.620
1.432	1.436	1.441	1.000	1.453	1:405	1.469	1.479	1.490	1.502	1.515	1.530	1.547	1.585	1.598	1.810	1.000	1.667	1 201	1.002	1.702
1.483	1.487	1.492	1:499	1.508	1.514	1.523	1.533	1.545	1.558	1.573	1.589	1.607	1.628	1.651	1.677	1.706	1.739	1.777	1.820	1.870
1.535	1.540	1.600	1.552	1.560	1.568	1.578	1.589 1.647	1.602	1.616	1.632	1.860	1.669	1.692	1.717 1.784	1.745 1.815	1.777 1.849	1.813	1.864	1.902	1.956
1.647	1.661	1.657	1.664	1.673	1.682	1.693	1.706	1.720	1.737	1.755	1.775	1.798	1.84	1.853	1,886	1.923	1.985	2.013	2.069	2.133
1.705	1.710	1.716	1.723	1.732	1.742	· 1,754	1.767	1.782 1.846	1.799	1.819	1.841	1.865	1.893	1.924	1.959 2.034	1.999 2.078	2.044	2.095	2.155	2.223
1.831	1.835	1.841	1.848	1.867	1.968	1.881	1.895	1.912	1.931	1.952	1.977	2.004	2.035	2.070	2.110	2.155	2.206	2.265	2.332	2.410
1.898	1.902	1.976	1.915	1.924 1.992	1.935 2.004	1.948 2.017	1.963	1.980 2.050	2.000	2.022	2.048	2.077	2.110	2.147 2.225	2.188 2.269	2.238 2.319	2.290 2.376	2-352 2-442	2.424 2.517	2.508 2.605
2.041	2.043	2.048	2.055	2.064	2.075	2.089	2.105	2.123	2.145	2,169	2.197	2.229	2.285	2.305	2.352	2.405	2.465	2.534	2.613	2.705
2.117	2.119	2.124	2.130	2.139	2.150	2.164	2.180	2.199	2.221	2.248	2.275	2.308	2.346	2.388	2,437	2.492	2.555	2.625	2.711	2.808
2.283	2.283	2.286	2.291	2.299	2.309	2.323	2.339	2.359	2.382	2.409	2,440	2.475	2.510	2.582	2.615	2.675	2.745	2.824	2.916	3.022
2.373	2.371	2.373	2.377	2.384	2.394	2.407	2.424	2.443	2.467	2.494	2.528	2.563	2.605	2.653	2.708	2.771	2.843	2.926	3.022	3.134
2.568	2.563	2.561	2.563	2.568	2.576	2.589	2.604	2.624	2.648	2.677	2.710	2.749	2.794	2.845	2.904	2.972	3.050	3.140	3.244	3.385
2.675	2.667	2.663	2.663	2.667	2.675	2.686	2.701	2.721	2.745	2.774	2.808	2.847	2.893	2.946 3.061	3.007 3.114	3.078 3.187	3.159 3.271	3.252	3.360	3.487
2.910	2.896	2.887	2.883	2.883	2.887	2.896	2.910	2.928	2.962	2.981	3.015	3.058	3.105	3.161	3.225	3.300	3.387	3.487	3.604	3.740
3.040	3.022	3.010	3.002	3.000	3.002	3.010	3.022	3.040	3.063	3.091	3.128	3.168	3.217	3.274	3.341	3.418	3.508	3.611	3.732	3.873



TABLE 2

1

	15X	12	
M. =		1.5	COSEC

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141	

- 1		· · · · ·															.0-	Χ'		,	1
α→		16°	16*	17°	18°	19°	20°	21°	<b>62°</b>	23°	24°	<b>25°</b>	28 <sup>6</sup>	<b>27</b> *	28°	29°	30°	31°	3E°	33 <sup>6</sup>	28
*	1*	4.086	3.779	3.555	7 860	7 102	7 008	2 602	9 75 4	2 4177	9 671	9 498	2 744	0 000	3.104						÷
+	2 <b>°</b>	4.222	3.950	3.706	3.491	3.301	3,132	2.981	2.544	2.721	2.008	2.506	2.410	2.36	2.244	2.171	2.102	1.959	1.932	1.925	18
	3°	4.407	4.145	3.676	3.643	3.435	8-282	3.089	2.945	2.811	2.691	2.582	2.482	2.391	2.27	2.220	2.158	2.091	2.029	1.972	2.0
	•	4.717	4.369	4.070	3.811	3.586	3.386	3.211	3.051	2.910	2.782	2.505	2.580	2.465	2.874	2.295	2.217	2.147	2.082	2.025	2.87
	້ວັ	5.032	4.532	4.294	4.006	3.756	3.536	3.344	3.173	3.019	2.891	2.757	2.644	2.541	2-40	2.380	2.280	2.207	2,138	2.07	2.4
	<u>5</u> °	5.414	4.946	4.559	4.23E	3.949	3.708	3.496	3.307	3.189	2.990	2.866	2.736	2.625	2. <b>885</b>	2.433	2.349	2.271	2.198	2.136	2.8
	8 <sup>•</sup>	8.631	5.332	4.876	4.428	4.177	3.904	3.666	3.459	3.275	3.112	2.966	2.635	2.717	2.609	2.511	2.421	2.339	2.263	2.196	2.00
	9.	7.425	6.475	5.767	4.616	4.440	4.131	3.804	3.63) 3.850	8.427 3.601	3,249	3.009	2.946	2.030	2.702	2.897	2.500	2.413	2.331	2.256	2.70
	10.	: G 007	a 101							00001	0.00			2.200	2.000	2.000	2.001	2.446	2.400	2.021	<b>5.8</b> 0
	11°	11.485	8.902	7.419	6.427	5.177	<b>4.751</b> 5.151	4.371	4.346	3.805	3.579	3,500	3.209	3.195	2.916	2.793	2.681	2.579	2.487	2.402	2.91
	12*	20.743	11.921	9,054	7.459	6.435	5.098	5.137	4.091	4.329	4.027	3.769	3.547	5.356	3.185	3.035	2.901	2.780	2.072	2.57	8.10
	13		26.089	12.533	9.223	7.532	5.460	5.703	5.134	4.684	4.321	4.017	3.761	3.540	3.348	3,180	3.030	2.898	2.779	2.07	<b>(8.</b> 5)
				45.340	13.410	9.486	7.688	8.507	5.725	5.142	4.000	4.319	4.015	3.757	3.537	3.366	3.178	3.080	2.898	2.780	8.5
	<b>35°</b>					14.00E	9.830	7.782	6.579	5.781	5.161	4.698	4.324	4.017	3.759	3.538	3.348	3.180	3.035	2.902	5.7
	16 <sup>-</sup> 17 <sup>0</sup>				i		16.729	10.295	7.970	6.672	5.815	5.193	4.717	4.338	4.027	3.767	3.546	3.363	3.187	3.05	4.0
	18*	-	1					20.4/2	50.482	11.755	8.519	6.949	5.974	5,295	4.787	4.390	4.047	3.801	3.574	3.390	4.3
	19 <sup>°</sup>		1		}						12.994	8.915	7.132	1.085	5.308	4.839	4.428	4.098	3.826	3.596	5.3
	20°			·								14.923	·	7.377	6.222	5.487	4.901	4.475	4.138	3.857	
·	21°				Į								18.474	10.104	7.509	6.388	5.564	4.978	4.534	4.182	7.6
	22													28.805	11.044	8.080	6.590	5.094	5.069	4.602	1.0
	23° 24°															12.431	8.512	6.835	5.846	5.175	Ĩ
	~			<u>`</u>	<b> </b>		· · · ·				·						14.720	9.133	7.137	0.031	<u>1</u>
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	273	-												İ					43.870	11.190	- 14 - 14
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		48°	- <b>40</b> *	<b>_50°</b>	51°	52°	ూి	54°	86°	56°	\$7°	<b>56°</b> .	59°	60°	61°	62°	63° :	64 <sup>9</sup>	65°	68°'	81
	1°	48 <sup>°</sup> 1,375	40° 1.854	50°	51° 1.314	52° 2.296	53° 1.280	54°	<b>55°</b> 1.249	56° 1.234	57° 1.220	<b>58°</b> . 1.207	59°	<b>60°</b> 1. 183	61° 1.172	62°	63° : 1.152	64°	65°	66°	61 1.1
	1° 2°	48° 1.375 1.404	40° 1.854 1.365	50° 1.884 1.562	51° 1.314 1.343	52° 2.296 1.325	53° 1.280 1.306	54° 1.283 1.291	<b>55°</b> 1.249 1.276	56° 1.234 1.262	57° 1.220 1.248	58° 1.207 1.235	59° 1.195 1.223	60° 1.183 1.211	61° 1.172 1.201	62° 1.162 1.191	63° 1.152 1.161	64° 1.142 1.172	65° 1.134 1.164	68° 1.12€ 1.15€	61
	1° 2° 3°	48° 1,375 1,404 1,434	40° 1.354 1.385 1.412	50° 1.884 1.302 1.391 1.482	51° 1.314 1.343 1.372	52° 1.296 1.325 1.364	53° 1.280 1.306 1.337	54° 1.263 1.291 1.330 1.340	<b>255°</b> 1.249 1.276 1.305 1.334	56° 1.234 1.262 1.290 1.719	57° 1.220 1.248 1.277 1.205	58° 1.207 1.235 1.264 1.293	59° 1.195 1.223 1.252	60° 1.183 1.211 1.240 1.240	61° 1.172 1.201 1.220	62° 1.162 1.191 1.£20	63° 1.152 1.161 1.211	64° 1.142 1.172 1.803	65° 1.134 1.164 1.195 1.227	66° 1.12£ 1.16¢ 1.10¢	61 1.1 1.8 1.2
	1° 2° 3° 4°	48° 1.375 1.404 1.484 1.485	40° 1.354 1.385 1.412 1.443	50° 1.884 1.382 1.391 1.422	51° 1.314 1.343 1.372 1.403	52° 2.296 1.325 -1.364 1.383	53° 1.280 1.306 1.337 1.366	54° 1.263 1.291 1.320 1.349	<b>35°</b> 1.249 1.276 1.306 1.334	56° 1.234 1.262 1.290 1.319	57° 1.220 1.248 1.277 1.305	58° 1.207 1.235 1.264 1.293	59° 1.195 1.223 1.252 1.281	60° 1.183 1.211 1.240 1.269	61° 1.172 1.201 1.250 1.250	62° 1.162 1.191 1.£20 1.250	63° 1.152 1.161 1.241	64° 1.142 1.172 1.803 1.254	65° 1.134 1.164 1.196 1.227	68°' 1.12€ 1.16€ 1.10€ 1.220	61
	1° 2° 8° 4° 8°	48° 1.375 1.404 1.434 1.405 1.497	40° 1.354 1.365 1.412 1.443 1.474	50° 1.884 1.562 1.391 1.422 1.453 1.485	51° 1.314 1.343 1.372 1.403 1.433 1.435	52° 1.326 1.335 1.364 1.383 1.414	53° 1.280 1.306 1.337 1.366 1.396 1.427	54° 1.263 1.291 1.320 1.349 1.379	<b>55°</b> 1.249 1.276 1.305 1.334 1.363 1.363	56° 1.234 1.262 1.290 1.319 1.349 1.379	57° 1.220 1.248 1.277 1.305 1.335 1.335	58° 1.207 1.235 1.264 1.293 1.322 1.353	59° 1.195 1.223 1.252 1.281 1.310 1.341	60° 1.183 1.211 1.240 1.269 1.300 1.330	61° 1.172 1.201 1.220 1.220 1.290	62° 1.162 1.191 1.£20 1.250	63° 1.152 1.161 1.241 1.241 1.272 1.304	64° 1.142 1.172 1.803 1.254 1.265	65° 1.134 1.164 1.195 1.227 1.258 1.291	68° 1.12€ 1.12€ 1.16€ 1.220 <u>1.258</u>	61 1.1 1.8 1.8 51.2 1.2
	1° 2° 4° <b>5°</b> 6° 7°	45° 1.375 1.404 1.454 1.465 1.407 1.580 1.565	40° 1.354 1.385 1.412 1.443 1.443 1.474 1.508 1.541	50° 1.884 1.362 1.391 1.422 1.423 1.465 1.485 1.519	51° 1.314 1.343 1.372 1.403 1.403 1.433 1.405 1.498	52° 1.326 1.325 1.364 1.383 1.414 1.445 1.478	53° 1.280 1.308 1.337 1.366 1.396 1.427 1.459	54° 1.263 1.291 1.329 1.349 1.349 1.379 1.410 1.441	55° 1.249 1.276 1.306 1.334 1.363 1.394 1.428	55° 1.234 1.262 1.290 1.319 1.319 1.349 1.379 1.411	57° 1.220 1.248 1.277 1.305 1.335 1.366 1.367	58° 1.207 1.235 1.264 1.293 1.322 1.353 1.384	59° 1.195 1.223 1.252 1.281 1.310 1.341 1.372	60° 1.183 1.211 1.200 1.209 1.300 1.330 1.361	61° 1.172 1.201 1.250 1.250 1.290 1.320 1.320 1.352	62° 1.162 1.191 1.230 1.250 1.250 1.312 1.343	63° 1.152 1.161 1.241 1.241 1.272 1.304 1.335	64° 1.142 1.172 1.803 1.254 1.265 1.296 1.328	<b>65°</b> 1.134 1.164 1.196 1.227 1.258 <u>1.291</u> 1.323	66°, 1. 12 <sup>2</sup> 1. 15 <sup>2</sup> 1. 12 <sup>5</sup> 1. 22 <sup>5</sup> 1. 22 <sup>5</sup> 1. 22 <sup>5</sup> 1. 22 <sup>5</sup> 1. 22 <sup>5</sup>	61 1.1 1.2 1.2 1.2 1.2 1.3
	1° 2° 3° 4° 5° 6° 7° 8°	48° 1,375 1;404 1,454 1,465 1,497 1,630 1;505 1,601	40° 1.854 1.365 1.412 1.443 1.474 1.608 1.541 1.578	50° 1.384 1.382 1.391 1.422 1.465 1.465 1.619 1.563	51° 1.314 1.343 1.372 1.403 1.435 1.406 1.498 1.551 <sup>2</sup>	52° 1.325 1.354 1.383 1.414 1.445 1.478 1.511	53° 1.280 1.308 1.337 1.366 1.427 1.459 1.492	54° 1.283 1.291 1.329 1.349 1.379 1.410 1.441 1.474	<b>35°</b> 1.249 1.276 1.306 1.334 1.363 1.394 1.426 1.456	56° 1.234 1.262 1.290 1.319 1.379 1.411 1.443	57° 1.220 1.248 1.277 1.305 1.335 1.335 1.368 1.367 1.429	58° 1.207 1.235 1.264 1.293 1.322 1.353 1.354 1.416	59° 1.195 1.223 1.252 1.281 1.310 1.341 1.372 1.404	60° 1.183 1.211 1.200 1.300 1.330 1.361 1.393	61° 1.172 1.201 1.220 1.220 1.220 1.320 1.320 1.352 1.385	62° 1.162 1.191 1.£20 1.250 1.250 1.312 1.343 1.375	63° 1.152 1.161 1.211 1.272 1.304 1.335 <u>1.368</u>	64° 1.142 1.172 1.803 1.255 1.206 <u>1.328</u> 1.362	65° 1.134 1.164 1.196 1.227 1.258 <u>1.291</u> 1.323 1.357	66° 1.12£ 1.12£ 1.16¢ 1.252 1.252 1.255 1.255 1.315 1.315	61 1.1 1.8 1.8 1.2 1.2 1.3 1.3 1.3
	1° 2° <b>8°</b> 4° <b>5°</b> 7° 8° 9°	48° 1.375 1.404 1.434 1.465 1.497 1.535 1.601 1.638	40° 1.354 1.365 1.412 1.443 1.474 1.508 1.541 1.575 1.612	50° 1.384 1.582 1.391 1.422 1.463 1.485 1.619 1.553 1.589	51° 1.314 1.343 1.372 1.403 1.433 1.465 1.498 1.531 1.566	52° 1.296 1.325 1.354 1.383 1.414 1.445 1.478 1.511 1.546	53° 1.280 1.308 1.337 1.308 1.336 1.427 1.459 1.492 1.526	54° 1.283 1.291 1.320 1.349 1.379 1.410 1.441 1.474 1.508	<b>55°</b> 1.249 1.276 1.305 1.334 1.363 1.394 1.428 1.456 1.491	56° 1.234 1.262 1.200 1.319 1.379 1.411 1.443 1.476	57° 1.220 1.248 1.277 1.305 1.335 1.336 1.366 1.397 1.429 <b>1.429</b>	58° 1.207 1.235 1.264 1.293 1.322 1.353 1.384 1.416 1.449	59° 1.195 1.223 1.252 1.281 1.310 1.341 1.372 1.404 1.436	60° 1.183 1.211 1.240 1.209 1.300 1.361 1.393 1.425	61° 1.172 1.201 1.200 1.200 1.200 1.200 1.200 1.252 1.385 1.415	62° 1.162 1.191 1.820 1.250 1.250 1.250 1.312 1.343 1.375 1.408	63° 1.152 1.151 1.211 1.241 1.272 1.304 1.335 <u>1.368</u> <u>1.401</u>	64° 1.142 1.172 1.803 1.254 1.265 1.296 <u>1.328</u> 1.362 1.365	<b>65°</b> 1.134 1.164 1.227 1.258 <u>1.291</u> 1.323 1.357 1.390	68°. 1. 12Ê 1. 16Ê 1. 16Ê 1. 252 1. 252 1. 252 1. 315 1. 355 1. 355	61 1.1 1.8 1.2 1.2 1.3 1.3 1.3 1.3
	1° 2° 3° 4° 5° 5° 7° 8° 9° 10°	48° 1.375 1.404 1.434 1.465 1.497 1.630 1.605 1.601 1.638 1.677	40° 1.354 1.365 1.412 1.443 1.443 1.474 1.508 1.541 1.576 1.612 1.612	50° 1.384 1.302 1.391 1.422 1.465 1.485 1.519 1.553 1.589	51° 1.314 1.343 1.372 1.403 1.433 1.405 1.406 1.581 1.506 1.608	52° 1.326 1.325 1.364 1.383 1.414 1.445 1.478 1.511 1.546 1.561	53° 1.280 1.308 1.337 1.388 1.437 1.459 1.462 1.526 1.561	54° 1.283 1.291 1.320 1.349 1.379 1.410 1.441 1.474 1.508 1.543	<b>35°</b> 1.249 1.276 1.506 1.334 1.363 1.364 1.426 1.426 1.491 1.525	56° 1.234 1.262 1.290 1.319 1.319 1.379 1.411 1.443 1.476 1.510	57° 1.220 1.248 1.277 1.306 1.336 1.336 1.336 1.367 1.429 <b>2.462</b> 1.496	58° 1.207 1.235 1.264 1.293 1.322 1.353 1.384 1.416 1.449	50° 1.195 1.223 1.252 1.281 1.310 1.341 1.372 1.404 1.436 1.471	60° 1.183 1.211 1.240 1.269 1.300 1.330 1.351 1.363 1.428 1.429	61° 1.172 1.201 1.200 1.220 1.220 1.320 1.320 1.322 1.325 1.416 1.450	62° 1.162 1.191 1.220 1.250 1.250 1.250 1.220 1.312 1.343 1.375 1.408 <u>1.408</u> <u>1.408</u>	63° 1,152 1,161 1,241 1,44	64 <sup>°</sup> 1.142 1.172 1.803 1.255 1.265 1.266 <u>1.328</u> 1.328 1.3295 1.430	65° 1.134 1.164 1.196 1.227 1.258 <u>1.291</u> 1.323 1.357 1.390 1.426	66°' 1.12£ 1.12£ 1.12£ 1.252 1.252 1.255 1.315 1.315 1.357 1.357 1.485	61 1.1 1.8 1.2 1.2 1.2 1.2 1.3 1.3 1.3 1.4
	1° 2° 3° 4° 5° 7° 8° 9° 10° 11°	48° 1.375 1.404 1.454 1.465 1.497 1.880 1.601 1.658 1.677 1.717	40° 1.254 1.365 1.412 1.443 1.474 1.508 1.578 1.612 5.661 1.689	50° 1.384 1.362 1.391 1.422 1.465 1.485 1.619 1.553 1.569 1.625 1.664	51° 1.314 1.343 1.372 1.403 1.433 1.465 1.498 1.531 1.566 1.603 1.603 1.613	52° 1.326 1.325 1.364 1.383 1.414 1.445 1.511 1.546 1.581 1.618 1.618	53° 1.280 1.306 1.337 1.366 1.437 1.459 1.427 1.459 1.492 1.526 1.561 1.598	54° 1.283 1.291 1.389 1.349 1.379 1.410 1.441 1.474 1.508 1.543 1.573	<b>355°</b> 1.249 1.276 1.305 1.334 1.363 1.394 1.428 1.458 1.458 1.451 1.528	56° 1.234 1.262 1.290 1.319 1.319 1.379 1.411 1.443 1.476 1.510 1.545	57° 1.220 1.248 1.277 1.305 1.335 1.366 1.367 1.429 1.429 1.496 1.630	58° 1.207 1.235 1.264 1.293 1.322 1.353 1.384 1.416 1.449 1.482 1.517	50° 1.195 1.223 1.252 1.281 1.310 1.341 1.372 1.404 1.436 1.471 1.505	60° 1.183 1.211 1.240 1.269 1.300 1.330 1.361 1.363 1.428 1.480 1.485	61° 1.172 1.201 1.220 1.220 1.220 1.220 1.220 1.220 1.220 1.220 1.252 1.383 1.416 1.450 1.465	62° 1.162 1.191 1.280 1.280 1.280 1.280 1.312 1.343 1.375 1.408 <u>1.442</u> <u>1.442</u>	63° 1.152 1.161 1.211 1.241 1.272 1.304 1.335 <u>1.368</u> <u>1.401</u> 1.435 1.470	64°           1.142           1.172           1.803           1.254           1.265           1.206           1.328           1.328           1.329           1.329           1.362           1.365           1.465	65° 1.134 1.164 1.196 1.227 1.258 <u>1.291</u> 1.323 1.357 1.390 1.466 1.461	66°' 1.12£ 1.15£ 1.10£ 1.222 1.225 1.225 1.255 1.315 1.355 1.355 1.355 1.355 1.355 1.355 1.455 1.455	61 1.1 1.2 1.2 1.2 1.3 1.3 1.3 1.4 1.4
	1° 2° 5° 6° 7° 8° 9° 10° 11° 12°	48° 1.375 1.404 1.454 1.465 1.497 1.530 1.605 1.601 1.638 1.677 1.717 1.717	40° 1.365 1.412 1.443 1.474 1.508 1.541 1.576 1.612 1.661 1.669 1.731 1.774	50° 1.384 1.362 1.391 1.422 1.463 1.485 1.619 1.553 1.569 1.625 1.604 1.704 1.704	51° 1.314 1.343 1.372 1.403 1.433 1.405 1.408 1.531 1.566 1.605 1.605 1.605 1.605 1.605 1.605	52° 1.226 1.325 1.354 1.383 1.414 1.445 1.478 1.511 1.546 1.681 1.618 1.658 1.658	53° 1.280 1.308 1.337 1.306 1.427 1.459 1.492 1.526 1.561 1.598 1.636 1.636 1.675	54° 1.283 1.291 1.320 1.349 1.379 1.410 1.441 1.474 1.508 1.579 1.616 1.655	<b>55°</b> 1.249 1.276 1.305 1.334 1.363 1.394 1.425 1.456 1.456 1.491 1.525 1.601 1.608 1.608 1.609	56° 1.234 1.262 1.290 1.319 1.349 1.379 1.411 1.443 1.476 1.510 1.545 1.501 1.645	57° 1.220 1.248 1.277 1.305 1.335 1.366 1.367 1.429 1.429 1.498 1.630 1.630 1.657 1.604	58° 1.207 1.235 1.264 1.293 1.353 1.384 1.416 1.449 1.482 1.517 1.563 1.590	59° 1.195 1.223 1.252 1.281 1.310 1.341 1.372 1.404 1.436 1.471 1.605 1.641 1.578	60° 1.183 1.211 1.240 1.269 1.300 1.361 1.363 1.426 1.426 1.400 1.496	61° 1.172 1.201 1.220 1.220 1.220 1.220 1.220 1.252 1.383 1.415 1.450 1.450 1.455 1.521 1.557	62° 1.162 1.191 1.230 1.250 1.250 1.250 1.250 1.250 <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.250</u> <u>1.2550</u> <u>1.2550</u> <u>1.2550</u> <u>1.2550</u> <u>1.2550</u> <u>1.2550</u> <u>1.2550</u> <u>1.2550</u> <u>1.2550</u> <u>1.2550</u> <u>1.2550</u> <u>1.2550</u> <u>1.2550</u> <u>1.2550</u> <u>1.2550</u> <u>1.408</u> <u>1.408</u> <u>1.5550</u> <u>1.550</u> <u>1.550</u>	63° 1.152 1.151 1.211 1.211 1.272 1.304 1.335 <u>1.368</u> <u>1.401</u> 1.435 1.470 1.603 1.544	64° 1.142 1.172 1.803 1.255 1.296 <u>1.328</u> 1.362 1.365 1.450 1.450 1.539	65° 1.134 1.164 1.196 1.227 1.258 <u>1.291</u> 1.323 1.357 1.390 1.466 1.461 1.496 1.555	66°' 1.122 1.125 1.125 1.225 1.225 1.225 1.225 1.255 1.355 1.355 1.455 1.455 1.455	1.8 1.8 1.8 1.3 1.3 1.4 1.4 1.4 1.5
	1° 2° 4° 5° 6° 7° 8° 9° 10° 11° 12° 13° 14°	48° 1.375 1.404 1.454 1.465 1.605 1.605 1.601 1.638 1.677 1.717 1.780 1.804 1.661	40° 1.354 1.365 1.412 1.443 1.443 1.443 1.474 1.508 1.541 1.576 1.612 1.659 1.731 1.774 1.819	50° 1.384 1.362 1.391 1.482 1.463 1.485 1.519 1.553 1.569 1.625 1.664 1.704 1.747 1.790	51° 1.314 1.345 1.372 1.403 1.405 1.406 1.531 1.505 1.603 1.603 1.631 1.680 1.721 1.764	52° 1.226 1.325 1.364 1.383 1.414 1.445 1.445 1.511 1.546 1.581 1.618 1.658 1.659 1.739	53° 1.280 1.308 1.337 1.386 1.427 1.459 1.492 1.526 1.598 1.626 1.675 1.716	54° 1.283 1.291 1.320 1.349 1.379 1.410 1.441 1.474 1.508 1.568 1.579 1.616 1.665 1.696	<b>35°</b> 1.249 1.276 1.505 1.334 1.363 1.394 1.426 1.456 1.491 1.525 1.561 1.598 1.699 1.675	56° 1.234 1.262 1.290 1.319 1.319 1.379 1.411 1.443 1.476 1.510 1.545 1.581 1.620 1.659	57° 1.220 1.248 1.277 1.305 1.335 1.336 1.336 1.366 1.397 1.429 2.462 1.495 1.530 2.567 1.604 1.643	58° 1.207 1.235 1.264 1.293 1.353 1.353 1.354 1.416 1.449 1.482 1.517 1.553 1.590 1.629	59° 1.195 1.223 1.252 1.281 1.310 1.341 1.372 1.404 1.436 1.471 1.505 1.541 1.578 1.616	<b>60°</b> 1.183 1.211 1.240 1.269 1.300 1.330 1.361 1.363 1.425 1.425 1.425 1.425 1.530 1.567 1.605	61° 1.172 1.201 1.200 1.220 1.252 1.416 1.415 1.415 1.415 1.521 1.521 1.522 1.416 1.521 1.521 1.521 1.525 1.525 1.525 1.525 1.525 1.525 1.525 1.557 1.55	62° 1.162 1.191 1.£20 1.250 1.250 1.250 1.312 1.345 1.375 1.408 <u>1.408</u> <u>1.408</u> <u>1.408</u> <u>1.407</u> <u>1.513</u> 1.550 1.588	63° 1.152 1.151 1.211 1.221 1.221 1.204 1.304 1.304 1.304 1.305 1.401 1.435 1.470 1.505 1.544 1.582	64 <sup>°</sup> 1.142 1.172 1.803 1.254 1.265 1.206 <u>1.329</u> 1.362 1.365 1.450 1.450 1.539 1.577	65° 1.134 1.164 1.196 1.227 1.258 <u>1.291</u> 1.323 1.357 1.360 1.466 1.461 1.498 1.535 1.575	66°' 1.12£ 1.16£ 1.105 1.220 1.225 1.205 1.357 1.450 1.450 1.450 1.450 1.575	1.2 1.3 3 1.3 1.4 1.4 1.5 1.4 1.4 1.5 1.4 1.5 1.4 1.5 1.5 1.5
	1° 2° 4° 5° 6° 7° 8° 9° 10° 11° 12° 13° 14°	48° 1.375 1.404 1.434 1.465 1.497 1.580 1.505 1.601 1.638 1.677 1.717 1.700 1.804 1.651	40° 1.354 1.365 1.412 1.443 1.443 1.474 1.508 1.576 1.612 1.609 1.731 1.774 1.819 1.877	50° 1.384 1.362 1.391 1.422 1.465 1.485 1.519 1.553 1.553 1.553 1.563 1.625 1.664 1.704 1.747 1.790 1.827	51° 1.314 1.343 1.403 1.403 1.403 1.406 1.605 1.605 1.605 1.605 1.605 1.600 1.721 1.764	52° 1.296 1.325 1.364 1.383 1.414 1.445 1.511 1.546 1.661 1.618 1.656 1.697 1.739 1.783	53° 1.280 1.308 1.337 1.388 1.437 1.459 1.462 1.528 1.598 1.636 1.675 1.716	54° 1.283 1.291 1.380 1.349 1.379 1.410 1.441 1.474 1.508 1.643 1.579 1.616 1.655 1.696 1.778	<b>35°</b> 1.249 1.276 1.306 1.334 1.363 1.363 1.426 1.426 1.456 1.456 1.651 1.528 1.661 1.598 1.676 1.718	56° 1.234 1.262 1.290 1.319 1.319 1.349 1.379 1.411 1.443 1.478 1.510 1.545 1.561 1.620 1.659 1.699	57° 1.220 1.248 1.277 1.305 1.335 1.336 1.336 1.368 1.397 1.429 1.429 1.429 1.429 1.498 1.630 1.657 1.604 1.643 1.643 1.643	58° 1.207 1.235 1.264 1.293 1.353 1.384 1.416 1.462 1.517 1.553 1.590 1.629 1.2649	50° 1.195 1.223 1.252 1.281 1.310 1.341 1.372 1.404 1.436 1.471 1.605 1.641 1.678 1.616 1.659	60° 1.183 1.211 1.240 1.269 1.300 1.330 1.361 1.363 1.426 1.460 1.486 1.530 1.567 1.605 1.645	61° 1.172 1.201 1.200 1.200 1.220 1.252 1.252 1.415 1.450 1.450 1.450 1.450 1.450 1.450 1.450 1.450 1.450 1.450 1.450 1.450 1.450 1.450 1.450 1.450 1.450 1.455 1.455 1.455 1.5577 1.5577 1.5577 1.5577 1.5577 1.5577 1.5577 1.5577 1.5	62° 1.162 1.191 1.280 1.280 1.280 1.280 1.312 1.343 1.375 1.408 <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.513</u> 1.550 1.568	63° 1.152 1.161 1.211 1.241 1.241 1.272 1.304 1.335 <u>1.335</u> <u>1.435</u> 1.470 1.605 1.544 1.582 1.691	64 <sup>°</sup> 1.142 1.172 1.803 1.254 1.265 1.206 <u>1.329</u> 1.322 1.325 1.450 1.450 1.602 1.539 1.677 1.617	65° 1.134 1.164 1.196 1.227 1.258 <u>1.291</u> 1.323 1.357 1.390 1.466 1.461 1.498 1.535 1.575 1.615	66°' 1.12£ 1.12£ 1.126 1.126 1.126 1.126 1.225 1.255 1.255 1.255 1.255 1.255 1.315 1.355 1.456 1.456 1.496 1.456 1.496 1.456 1.496 1.456 1.496 1.456 1.456 1.357 1.456 1.456 1.456 1.456 1.456 1.355 1.2	61 1.1.2.2.1.2.2.1.2.2.1.2.2.1.2.2.2.2.2.
	1° 2° 4° 5° 6° 7° 8° 9° 10° 11° 12° 13° 14° 15° 16°	48° 1.375 1.404 1.454 1.465 1.497 1.880 1.601 1.658 1.677 1.717 1.780 1.804 1.651 1.900 1.952	40° 1.254 1.365 1.412 1.443 1.474 1.508 1.541 1.576 1.612 5.661 1.689 1.731 1.774 1.819 1.807 1.917	50° 1.384 1.362 1.391 1.422 1.465 1.485 1.519 1.553 1.569 1.625 1.664 1.704 1.747 1.790 1.837, 1.896	51° 1.314 1.343 1.372 1.403 1.433 1.465 1.498 1.531 1.566 1.603 1.603 1.603 1.603 1.603 1.721 1.764 1.809 1.809 1.807	52° 1.296 1.325 1.364 1.383 1.414 1.445 1.511 1.546 1.551 1.618 1.656 1.657 1.739 1.783 1.830	53° 1.280 1.306 1.337 1.366 1.427 1.459 1.492 1.526 1.598 1.626 1.675 1.716 1.700 1.605	54° 1.283 1.291 1.329 1.349 1.379 1.410 1.441 1.474 1.508 1.579 1.616 1.665 1.696 1.738 1.782	<b>355°</b> 1.249 1.276 1.305 1.334 1.363 1.363 1.426 1.426 1.456 1.456 1.459 1.508 1.609 1.678 1.718 1.762	56° 1.234 1.262 1.290 1.319 1.319 1.379 1.411 1.443 1.476 1.510 1.545 1.581 1.620 1.659 1.609 1.743	57° 1.220 1.248 1.277 1.305 1.335 1.366 1.367 1.429 1.429 1.429 1.429 1.429 1.429 1.496 1.630 1.643 1.663 1.725	58° 1.207 1.235 1.264 1.293 1.353 1.353 1.354 1.416 1.449 1.482 1.517 1.553 1.590 1.629 1.710	50° 1.195 1.223 1.252 1.291 1.310 1.341 1.372 1.404 1.436 1.471 1.505 1.541 1.578 1.616 1.658 1.699	60° 1.183 1.211 1.240 1.269 1.300 1.330 1.361 1.363 1.426 1.460 1.485 1.605 1.645 1.688	61° 1.172 1.201 1.220 1.220 1.220 1.220 1.220 1.220 1.220 1.220 1.220 1.220 1.220 1.250 1.250 1.250 1.425 1.450 1.455 1.557 <u>1.596</u> <u>1.596</u>	62° 1.162 1.191 1.250 1.250 1.250 1.250 1.280 1.312 1.343 1.375 1.408 <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.550</u> 1.560 1.568 1.628 1.628 1.628	63° 1.152 1.151 1.211 1.241 1.272 1.304 1.335 <u>1.368</u> <u>1.470</u> 1.435 1.470 1.508 1.544 1.582 1.621 1.662	64°           1.142           1.172           1.803           1.254           1.265           1.206           1.328           1.328           1.329           1.329           1.329           1.329           1.329           1.329           1.329           1.329           1.329           1.455           1.602           1.539           1.617           1.617           1.658	65° 1.134 1.164 1.196 1.227 1.258 <u>1.2291</u> 1.323 1.357 1.390 1.426 1.461 1.498 1.575 1.615 1.615	66°' 1.12£ 1.12£ 1.125 1.252 1.252 1.255 1.315 1.355 1.355 1.355 1.455 1.455 1.455 1.455 1.455 1.455 1.574 1.617	61 1.1.1 1.2 51.0 51.3 51.3 51.3 51.4 1.4 1.5 1.5 1.5 1.6 1.6 1.6 1.6 1.6 1.6 1.6 1.6 1.6 1.6
	1° 2° 4° 5° 6° 7° 8° 9° 10° 11° 12° 15° 14° 15° 16° 17°	48° 1.375 1.404 1.454 1.465 1.497 1.530 1.601 1.638 1.677 1.717 1.780 1.804 1.651 1.900 1.952 2.007	40° 1.365 1.412 1.443 1.474 1.508 1.541 1.576 1.612 1.659 1.731 1.774 1.619 1.807 1.917 1.971	50° 1.384 1.362 1.391 1.422 1.463 1.485 1.519 1.563 1.563 1.569 1.625 1.664 1.704 1.747 1.790 1.827, 1.806 1.907	51° 1.314 1.343 1.372 1.403 1.433 1.405 1.405 1.408 1.581 1.508 1.603 1.603 1.603 1.603 1.603 1.605 1.609 1.809 1.809 1.807 1.907	52° 1.296 1.325 1.354 1.383 1.414 1.445 1.511 1.546 1.618 1.659 1.697 1.739 1.733 1.830 1.878	53° 1.280 1.308 1.337 1.365 1.427 1.459 1.427 1.459 1.492 1.526 1.598 1.626 1.626 1.716 1.700 1.805 1.853	54° 1.263 1.291 1.329 1.349 1.379 1.410 1.441 1.474 1.508 1.579 1.616 1.665 1.696 1.738 1.782 1.829	<b>355°</b> 1.249 1.276 1.305 1.334 1.363 1.394 1.428 1.428 1.428 1.456 1.459 1.561 1.508 1.609 1.676 1.718 1.762 1.807	56° 1.234 1.262 1.290 1.319 1.319 1.379 1.411 1.443 1.476 1.510 1.561 1.660 1.669 1.699 1.743 1.787	57° 1.220 1.248 1.277 1.305 1.335 1.335 1.366 1.397 1.429 1.429 1.429 1.429 1.496 1.530 2.567 1.604 1.643 1.725 1.770	58° 1.207 1.235 1.264 1.293 1.353 1.353 1.354 1.416 1.449 1.482 1.517 1.563 1.590 1.629 1.710 1.754	50° 1.195 1.223 1.252 1.291 1.310 1.341 1.372 1.404 1.436 1.471 1.505 1.541 1.578 1.616 1.658 1.658 1.696 1.740	60° 1.183 1.211 1.240 1.209 1.300 1.330 1.361 1.393 1.426 1.426 1.426 1.426 1.426 1.426 1.605 1.605 1.645 1.636 1.729	61° 1.172 1.201 1.220 1.220 1.220 1.220 1.220 1.220 1.220 1.220 1.220 1.220 1.220 1.250 1.557 <u>1.556</u> <u>1.557</u> <u>1.556</u> <u>1.676</u> <u>1.676</u> <u>1.577</u> <u>1.556</u>	62° 1.162 1.191 1.220 1.250 1.250 1.250 1.250 1.250 1.312 1.343 1.375 1.408 <u>1.407</u> <u>1.513</u> 1.560 1.568 1.628 1.628 1.628 1.628	63° 1.152 1.161 1.211 1.241 1.272 1.304 1.335 <u>1.368</u> <u>1.470</u> 1.435 1.470 1.508 1.582 1.621 1.682 1.705	64°           1.142           1.172           1.803           1.254           1.265           1.296           1.329           1.329           1.329           1.329           1.329           1.329           1.329           1.329           1.329           1.329           1.329           1.465           1.502           1.617           1.617           1.617           1.617           1.617	65° 1.134 1.164 1.196 1.227 1.258 <u>1.2291</u> 1.323 1.357 1.390 1.466 1.461 1.498 1.635 1.615 1.615 1.656 1.700	66°' 1.122 1.122 1.126 1.120 1.220 1.220 1.220 1.225 1.205 1.257 1.355 1.355 1.456 1.456 1.457 1.614 1.657 1.614	
	1° 2° 3° 4° 5° 5° 7° 8° 9° 10° 11° 12° 13° 14° 15° 16° 17° 18°	48° 1.375 1.404 1.454 1.465 1.605 1.605 1.605 1.601 1.638 1.677 1.717 1.717 1.760 1.804 1.651 1.900 1.952 2.007 2.067	40° 1.354 1.365 1.412 1.443 1.443 1.443 1.474 1.508 1.541 1.575 1.612 1.639 1.731 1.774 1.819 1.867 1.917 1.971 2.029	50° 1.384 1.362 1.391 1.452 1.453 1.455 1.465 1.569 1.553 1.664 1.704 1.747 1.790 1.837, 1.886 1.992	51° 1.314 1.345 1.372 1.403 1.433 1.406 1.406 1.531 1.566 1.603 1.603 1.631 1.680 1.721 1.764 1.809 1.807 1.907 1.907	52° 1.226 1.325 1.364 1.383 1.414 1.445 1.445 1.445 1.511 1.546 1.681 1.618 1.656 1.697 1.783 1.830 1.878 1.930 1.930	53° 1.280 1.306 1.337 1.306 1.427 1.452 1.492 1.526 1.598 1.636 1.675 1.716 1.700 1.805 1.853 1.902 1.902	54° 1.283 1.291 1.320 1.349 1.379 1.410 1.441 1.474 1.508 1.579 1.616 1.665 1.696 1.738 1.782 1.829 1.829 1.877 1.622 1.829	<b>35°</b> 1.249 1.276 1.505 1.334 1.363 1.304 1.426 1.426 1.456 1.491 1.525 1.561 1.509 1.676 1.718 1.762 1.807 1.807 1.807 1.805	56° 1.234 1.262 1.200 1.319 1.319 1.379 1.411 1.443 1.476 1.510 1.545 1.561 1.620 1.659 1.699 1.743 1.787 1.835	57° 1.220 1.248 1.277 1.305 1.335 1.336 1.336 1.336 1.366 1.397 1.429 2.462 1.630 2.567 1.604 1.643 1.663 1.725 1.770 1.818 1.077	58° 1.207 1.235 1.264 1.293 1.353 1.384 1.416 1.469 1.482 1.517 1.563 1.590 1.629 1.710 1.754 1.900	59° 1.195 1.223 1.252 1.281 1.310 1.341 1.372 1.404 1.436 1.471 1.505 1.541 1.578 1.616 1.658 1.658 1.699 1.740 1.768	60° 1.183 1.211 1.240 1.269 1.300 1.330 1.361 1.393 1.426 1.480 1.486 1.485 1.665 1.665 1.665 1.665 1.729 1.774	61° 1.172 1.201 1.200 1.220 1.252 1.415 1.415 1.521 <u>1.557</u> <u>1.557</u> <u>1.596</u> <u>1.635</u> <u>1.635</u> <u>1.635</u> <u>1.676</u> <u>1.779</u> <u>1.597</u> <u>1.598</u>	62° 1.162 1.191 1.£20 1.250 1.505 1.560 1.568 1.668 1.771 1.755	63° 1.152 1.151 1.211 1.221 1.221 1.221 1.221 1.204 1.272 1.304 1.272 1.304 1.272 1.304 1.272 1.304 1.272 1.304 1.272 1.304 1.255 1.272 1.304 1.255 1.261 1.265 1.400 1.405 1.405 1.405 1.405 1.568 1.568 1.662 1.705 1.760 1.760 1.760 1.760 1.765 1.760 1.765 1.765 1.765 1.765 1.765 1.765 1.775 1.765 1.77	64°           1.142           1.172           1.803           1.254           1.265           1.265           1.329           1.329           1.329           1.329           1.329           1.329           1.450           1.450           1.539           1.617           1.618           1.701           1.746	65° 1.134 1.164 1.196 1.227 1.258 <u>1.291</u> 1.323 1.357 1.360 1.426 1.461 1.498 1.615 1.615 1.655 1.655	66°' 1.12£ 1.16£ 1.16£ 1.220 1.225 1.205 1.405 1.405 1.505 1.507 1.607 1.607 1.700 1.700 1.745 1.700	
	1° 2° 4° 5° 6° 7° 8° 9° 10° 11° 12° 13° 14° 15° 16° 17° 18°, 19°	48° 1.375 1.404 1.434 1.465 1.497 1.580 1.505 1.601 1.638 1.677 1.717 1.700 1.804 1.651 1.900 1.952 2.007 2.131	40° 1.354 1.365 1.412 1.443 1.443 1.474 1.508 1.576 1.612 1.609 1.731 1.774 1.619 1.819 1.867 1.917 1.917 1.917 1.902 2.069	50° 1.384 1.362 1.391 1.422 1.465 1.485 1.519 1.553 1.553 1.563 1.563 1.563 1.563 1.625 1.664 1.704 1.747 1.780 1.887 1.992 2.061	51° 1.314 1.343 1.403 1.403 1.403 1.405 1.406 1.551 1.566 1.605 1.605 1.605 1.605 1.606 1.721 1.764 1.809 1.807 1.907 1.900 2.013	52° 1.296 1.325 1.364 1.383 1.414 1.445 1.478 1.511 1.546 1.618 1.656 1.697 1.739 1.783 1.830 1.878 1.930 1.985	53° 1.280 1.308 1.337 1.308 1.437 1.459 1.462 1.561 1.598 1.636 1.675 1.716 1.760 1.805 1.905 1.905	54° 1.283 1.291 1.320 1.349 1.379 1.410 1.441 1.474 1.508 1.643 1.579 1.616 1.655 1.696 1.738 1.782 1.829 1.677 1.930	<b>35°</b> 1.249 1.276 1.306 1.334 1.363 1.364 1.428 1.608 1.718 1.702 1.807 1.806	56° 1.234 1.262 1.290 1.319 1.319 1.379 1.411 1.443 1.478 1.510 1.561 1.561 1.669 1.669 1.743 1.787 1.635 1.664	57° 1.220 1.248 1.277 1.305 1.335 1.335 1.3268 1.327 1.429 1.429 1.429 1.429 1.429 1.429 1.430 1.630 1.657 1.604 1.643 1.770 1.816 1.865	58° 1.207 1.235 1.264 1.293 1.353 1.353 1.384 1.416 1.449 1.482 1.517 1.553 1.590 1.629 1.700 1.754 1.800 1.648	50° 1.195 1.223 1.252 1.281 1.310 1.341 1.372 1.404 1.436 1.471 1.605 1.641 1.678 1.618 1.658 1.658 1.658 1.658 1.658 1.740 1.740 1.768 1.633	60° 1.183 1.211 1.240 1.269 1.300 1.301 1.363 1.426 1.460 1.495 1.630 1.567 1.605 1.645 1.666 1.729 1.774 1.820	61° 1.172 1.201 1.200 1.220 1.252 1.416 1.557 <u>1.557</u> <u>1.557</u> <u>1.635</u> <u>1.635</u> <u>1.635</u> <u>1.635</u> <u>1.676</u> <u>1.719</u> <u>1.611</u>	62° 1.162 1.191 1.220 1.250 1.250 1.250 1.280 1.280 1.280 1.280 1.280 1.280 1.280 1.290 1.312 1.345 1.375 1.408 1.500 1.700 1.500 1.500 1.700 1.500 1.500 1.700 1.500 1.700 1.500 1.700 1.500 1.700 1.500 1.700 1.500 1.700 1.500 1.700 1.500 1.700 1.500 1.700 1.500 1.700 1.500 1.700 1.500 1.700 1.500 1.500 1.600 1.8000 1.8000 1.8000 1.8000 1.8000 1.8000 1.8000 1.8000 1.8	63° 1.152 1.161 1.211 1.241 1.435 1.470 1.608 1.544 1.662 1.705 1.750 1.750 1.750 1.750	64°           1.142           1.172           1.803           1.254           1.265           1.208           1.329           1.329           1.329           1.329           1.329           1.329           1.450           1.602           1.539           1.617           1.618           1.701           1.746           1.792	65° 1.134 1.164 1.196 1.227 1.258 <u>1.291</u> 1.323 1.357 1.390 1.426 1.461 1.498 1.535 1.615 1.615 1.655 1.700 1.745	66°' 1.12£ 1.12£ 1.126 1.126 1.126 1.220 1.2252 1.2352 1.2352 1.2352 1.315 1.355 1.355 1.456 1.355 1.355 1.456 1.457 1.456 1.457 1.574 1.770 1.776	61 1.1.1 1.2 1.2 1.2 1.2 1.2 1.2 1.2 1.2
	1° 2° 4° 5° 6° 7° 8° 9° 10° 11° 12° 13° 14° 15° 16° 17° 18°. 19°	48° 1.375 1.404 1.454 1.465 1.497 1.880 1.601 1.658 1.677 1.717 1.780 1.904 1.965 1.900 1.952 2.007 2.131 2.199	40° 1.254 1.365 1.412 1.443 1.474 1.508 1.541 1.576 1.612 5.661 1.689 1.731 1.774 1.819 1.877 1.917 1.917 1.971 2.029 2.059 2.154	50° 1.384 1.362 1.391 1.422 1.465 1.485 1.519 1.553 1.563 1.565 1.664 1.704 1.747 1.790 1.837 1.896 1.907 1.902 2.061 2.114	51° 1.314 1.343 1.372 1.403 1.433 1.465 1.498 1.531 1.566 1.603 1.603 1.603 1.603 1.603 1.603 1.603 1.605 1.605 1.907 1.907 1.900 2.013 2.077	52° 1.296 1.325 1.354 1.383 1.414 1.445 1.511 1.546 1.551 1.618 1.656 1.697 1.739 1.783 1.830 1.878 1.930 1.905 2.043	53° 1.280 1.308 1.337 1.366 1.427 1.459 1.459 1.459 1.458 1.598 1.588 1.598 1.636 1.675 1.716 1.700 1.805 1.653 1.902 1.965 2.012	54° 1.283 1.291 1.329 1.349 1.379 1.410 1.441 1.474 1.508 1.543 1.579 1.616 1.665 1.696 1.738 1.782 1.829 1.877 1.930 1.985 2.011	<b>355°</b> 1.249 1.276 1.305 1.334 1.363 1.363 1.363 1.426 1.426 1.456 1.456 1.459 1.509 1.609 1.609 1.718 1.762 1.807 1.855 1.906 1.969	56° 1.234 1.262 1.290 1.319 1.319 1.379 1.411 1.443 1.476 1.510 1.545 1.561 1.669 1.669 1.609 1.743 1.787 1.635 1.684 1.937	57° 1.220 1.248 1.277 1.305 1.335 1.366 1.367 1.429 1.429 1.429 1.429 1.429 1.429 1.496 1.630 1.643 1.663 1.725 1.770 1.816 1.865 1.916	58° 1.207 1.235 1.264 1.293 1.353 1.353 1.384 1.416 1.482 1.517 1.553 1.590 1.629 1.710 1.754 1.800 1.888 1.898	50° 1.195 1.223 1.252 1.281 1.310 1.341 1.372 1.404 1.436 1.471 1.505 1.541 1.578 1.616 1.658 1.699 1.740 1.768 1.693 1.693 1.693	60° 1.183 1.211 1.240 1.269 1.300 1.330 1.361 1.363 1.426 1.460 1.485 1.460 1.485 1.605 1.645 1.685 1.685 1.729 1.774 1.820 1.870	61° 1.172 1.200 1.405 <u>1.501</u> <u>1.507</u> <u>1.6076</u> <u>1.6076</u> <u>1.709</u> <u>1.6076</u> <u>1.6076</u> <u>1.6076</u> <u>1.6076</u> <u>1.801</u> <u>1.6076</u> <u>1.809</u>	62° 1.162 1.191 1.250 1.250 1.250 1.250 1.250 1.250 1.312 1.343 1.375 1.408 <u>1.4442</u> <u>1.4442</u> <u>1.4442</u> <u>1.4442</u> <u>1.4442</u> <u>1.4442</u> <u>1.513</u> 1.560 1.588 1.628 1.628 1.628 1.711 1.756 1.851	63° 1.152 1.151 1.241 1.241 1.272 1.304 1.335 <u>1.368</u> 1.435 1.470 1.508 1.544 1.582 1.602 1.705 1.760 1.780 1.784	64°           1.142           1.172           1.803           1.254           1.265           1.206           1.329           1.320           1.329           1.329           1.320           1.320           1.320           1.320           1.320           1.455           1.802           1.539           1.617           1.617           1.658           1.701           1.746           1.792           1.841	65° 1.134 1.164 1.227 1.258 <u>1.2291</u> 1.323 1.357 1.390 1.426 1.461 1.496 1.535 1.615 1.655 1.655 1.655 1.700 1.745 1.791 1.840	66°' 1.12£ 1.12£ 1.125 1.252 1.252 1.255 1.255 1.255 1.315 1.355 1.355 1.355 1.4	$\begin{array}{c} 61 \\ 1.1 \\ 1.2 \\ $
	1° 2° 4° 5° 5° 7° 8° 9° 10° 11° 12° 15° 14° 15° 16° 17° 18° 19° 20° 21°	48° 1.375 1.404 1.454 1.465 1.477 1.530 1.605 1.601 1.638 1.677 1.717 1.760 1.804 1.900 1.952 2.007 2.131 2.199 2.273 	40° 1.365 1.412 1.443 1.474 1.508 1.541 1.576 1.612 1.651 1.639 1.731 1.774 1.819 1.807 1.917 1.977 1.977 2.029 2.059 2.154 2.225 9.709	50° 1.384 1.362 1.391 1.422 1.465 1.619 1.563 1.569 1.665 1.664 1.704 1.747 1.780 1.886 1.992 2.061 2.114 2.254	51° 1.314 1.343 1.372 1.403 1.433 1.405 1.405 1.408 1.581 1.505 1.605 1.605 1.605 1.605 1.605 1.609 1.809 1.809 1.807 1.907 2.013 2.077 2.142 2.211	52° 1.296 1.325 1.354 1.383 1.414 1.445 1.478 1.511 1.546 1.659 1.659 1.659 1.659 1.659 1.659 1.659 1.659 1.659 1.659 1.659 1.739 1.739 1.783 1.830 1.830 1.878 1.930 1.985 2.043 2.105 2.172	53° 1.280 1.308 1.337 1.365 1.427 1.459 1.429 1.459 1.492 1.526 1.598 1.626 1.598 1.626 1.626 1.716 1.700 1.805 1.902 1.902 1.902 1.905 2.012 2.078 2.137	54° 1.263 1.291 1.329 1.349 1.379 1.410 1.441 1.474 1.508 1.579 1.616 1.665 1.696 1.738 1.782 1.829 1.677 1.830 1.985 2.042 2.106	<b>355°</b> 1.249 1.276 1.305 1.334 1.363 1.363 1.426 1.426 1.426 1.426 1.456 1.456 1.609 1.609 1.676 1.718 1.762 1.807 1.655 1.906 1.906 1.906	56° 1.234 1.262 1.290 1.319 1.319 1.379 1.411 1.443 1.476 1.510 1.545 1.561 1.650 1.659 1.699 1.743 1.787 1.835 1.684 1.937 1.992 2.051	57° 1.220 1.248 1.277 1.305 1.335 1.335 1.366 1.397 1.429 1.429 1.429 1.429 1.429 1.426 1.530 2.567 1.643 1.725 1.770 1.816 1.918 1.970 2.028	58° 1.207 1.235 1.264 1.293 1.353 1.353 1.353 1.354 1.416 1.449 1.482 1.517 1.563 1.590 1.629 1.710 1.754 1.800 1.803 1.662 2.009	50° 1.195 1.223 1.252 1.291 1.310 1.341 1.372 1.404 1.436 1.471 1.505 1.541 1.578 1.616 1.658 1.658 1.696 1.740 1.768 1.633 1.833 1.835 1.991	60° 1.183 1.211 1.240 1.269 1.300 1.330 1.361 1.393 1.426 1.426 1.426 1.426 1.426 1.426 1.426 1.530 1.567 1.605 1.645 1.605 1.645 1.605 1.645 1.729 1.774 1.820 1.670 1.922 1.977	61° 1.172 1.200 1.200 1.200 1.200 1.220 1.252 1.255 1.415 1.455 1.557 <u>1.556</u> <u>1.556</u> <u>1.676</u> <u>1.719</u> <u>1.679</u> <u>1.679</u> <u>1.679</u> <u>1.679</u> <u>1.679</u> <u>1.679</u> <u>1.635</u> <u>1.619</u> <u>1.619</u> <u>1.635</u> <u>1.619</u> <u>1.635</u> <u>1.619</u> <u>1.635</u> <u>1.619</u> <u>1.639</u> <u>1.611</u> <u>1.659</u> <u>1.995</u>	62°           1.162           1.191           1.250           1.250           1.250           1.250           1.250           1.250           1.250           1.250           1.312           1.343           1.375           1.408           1.408           1.408           1.408           1.408           1.408           1.408           1.408           1.408           1.408           1.408           1.608           1.608           1.608           1.608           1.608           1.608           1.608           1.608           1.802           1.851           1.902           1.955	63° 1.152 1.152 1.241 1.272 1.304 1.335 <u>1.368</u> <u>1.470</u> 1.435 1.470 1.506 1.562 1.621 1.662 1.705 1.750 1.750 1.750 1.998 1.845 1.998	64°           1.142           1.172           1.803           1.254           1.265           1.296           1.328           1.329           1.329           1.329           1.329           1.329           1.329           1.329           1.329           1.329           1.329           1.465           1.539           1.617           1.617           1.617           1.617           1.617           1.617           1.617           1.617           1.617           1.617           1.617           1.617           1.617           1.617           1.617           1.617           1.92           1.841           1.9245	65° 1.134 1.164 1.196 1.227 1.258 <u>1.2291</u> 1.323 1.323 1.357 1.390 1.466 1.461 1.498 1.635 1.615 1.615 1.655 1.615 1.655 1.700 1.745 1.791 1.840 1.945	66°' 1.122 1.122 1.125 1.252 1.252 1.255 1.315 1.355 1.357 1.459 1.459 1.459 1.459 1.457 1.614 1.657 1.614 1.657 1.700 1.745 1.893 1.893 1.895 1.895 1.895 1.895 1.948	
	1° 2° 4° 5° 6° 7° 8° 9° 10° 11° 12° 13° 14° 15° 16° 17° 18° 19° 20° 21° 22° 23°	48° 1.375 1.404 1.454 1.465 1.477 1.580 1.605 1.601 1.638 1.677 1.717 1.700 1.9651 1.900 1.9652 2.007 2.131 2.199 2.273 2.441	40° 1.365 1.412 1.443 1.443 1.474 1.508 1.541 1.576 1.612 1.651 1.609 1.731 1.774 1.819 1.867 1.917 1.917 1.917 1.917 1.917 1.917 1.917 1.917 1.920 2.069 2.154 2.302 2.355	50° 1.384 1.362 1.391 1.422 1.463 1.465 1.519 1.553 1.569 1.625 1.604 1.704 1.704 1.707 1.805 1.902 2.061 2.114 2.358	51° 1.314 1.345 1.372 1.403 1.435 1.405 1.406 1.435 1.406 1.551 1.556 1.608 1.641 1.600 1.721 1.764 1.809 1.809 1.807 1.960 2.013 2.077 2.142 2.211 2.287	52° 1.226 1.325 1.325 1.354 1.383 1.414 1.445 1.511 1.548 1.511 1.648 1.658 1.658 1.658 1.658 1.677 1.739 1.783 1.830 1.930 1.985 2.043 2.105 2.172 2.944	53° 1.280 1.308 1.337 1.308 1.337 1.308 1.427 1.452 1.422 1.528 1.626 1.598 1.636 1.675 1.716 1.760 1.805 1.902 1.965 2.012 2.073 2.137 2.207	54° 1.283 1.291 1.320 1.349 1.379 1.410 1.441 1.474 1.508 1.579 1.616 1.655 1.696 1.738 1.782 1.829 1.877 1.930 1.985 2.042 2.106 2.172	<b>35°</b> 1.249 1.276 1.505 1.334 1.363 1.364 1.428 1.428 1.466 1.491 1.528 1.561 1.568 1.699 1.676 1.718 1.762 1.807 1.855 1.906 1.969 2.016 2.076 2.142	56° 1.234 1.262 1.230 1.319 1.319 1.379 1.411 1.443 1.4776 1.510 1.545 1.561 1.620 1.659 1.699 1.743 1.787 1.835 1.664 1.937 1.992 2.051 2.114	57° 1.220 1.248 1.277 1.305 1.335 1.335 1.368 1.367 1.429 2.462 1.498 1.530 2.567 1.604 1.643 1.623 1.725 1.770 1.816 1.970 2.028 2.090	58° 1.207 1.235 1.264 1.293 1.353 1.353 1.353 1.353 1.353 1.446 1.462 1.462 1.563 1.590 1.629 1.710 1.754 1.800 1.648 1.800 1.652 2.008 2.069	50° 1.195 1.223 1.252 1.281 1.310 1.341 1.372 1.404 1.436 1.471 1.505 1.541 1.578 1.618 1.658 1.658 1.658 1.699 1.740 1.788 1.833 1.835 1.991 2.050	<b>60°</b> 1.183 1.211 1.240 1.269 1.300 1.330 1.361 1.363 1.426 1.426 1.426 1.426 1.426 1.426 1.530 1.567 1.605 1.645 1.665 1.645 1.629 1.774 1.820 1.977 2.035	61° 1.172 1.200 1.200 1.220 1.252 1.415 1.557 <u>1.557</u> <u>1.557</u> <u>1.595</u> <u>1.676</u> <u>1.719</u> <u>1.269</u> <u>1.219</u> <u>1.2190</u> <u>1.557</u> <u>1.595</u> <u>1.676</u> <u>1.2199</u> <u>1.2597</u> <u>1.595</u> <u>1.635</u> <u>1.4195</u> <u>1.2199</u> <u>1.557</u> <u>1.595</u> <u>1.676</u> <u>1.919</u> <u>1.269</u> <u>1.2597</u> <u>1.5955</u> <u>1.676</u> <u>1.9911</u> <u>1.9955</u> <u>2.022</u>	62° 1.162 1.191 1.230 1.250 1.250 1.250 1.250 1.312 1.345 1.375 1.408 <u>1.408</u> <u>1.408</u> <u>1.408</u> <u>1.408</u> <u>1.408</u> <u>1.513</u> 1.550 1.668 1.668 1.6292 1.655 1.602 1.655 1.602 1.655 1.602 1.655 1.602 1.655 1.602 1.655	63° 1.152 1.151 1.241 1.272 1.304 1.305 <u>1.305</u> <u>1.401</u> 1.435 1.470 1.506 1.544 1.582 1.621 1.662 1.750 1.750 1.780 1.845 1.698 1.949 2.005	64°           1.142           1.172           1.803           1.255           1.265           1.265           1.329           1.329           1.329           1.329           1.329           1.329           1.450           1.450           1.539           1.617           1.653           1.701           1.746           1.792           1.841           1.892           1.946           2.003	65° 1.134 1.164 1.196 1.227 1.258 <u>1.291</u> 1.323 1.357 1.461 1.498 1.535 1.615 1.615 1.656 1.700 1.745 1.791 1.840 1.891 1.945 2.002	66° 1.12£ 1.12£ 1.252 1.252 1.255 1.255 1.355 1.355 1.355 1.456 1.555 1.557 1.65	
	1° 2° 4° 5° 6° 7° 8° 9° 10° 11° 12° 13° 14° 15° 16° 17° 18° 19° 20° 21° 22° 23° 24°	48° 1.375 1.404 1.454 1.465 1.405 1.505 1.601 1.638 1.677 1.717 1.700 1.804 1.962 2.007 2.131 2.199 2.273 2.355 2.441 2.538	40° 1.254 1.365 1.412 1.443 1.474 1.508 1.576 1.612 1.609 1.731 1.774 1.819 1.867 1.917 1.917 1.917 1.917 1.971 2.029 2.089 2.154 2.302 2.302 2.302 2.476	50° 1.384 1.362 1.391 1.422 1.465 1.485 1.485 1.519 1.553 1.553 1.553 1.563 1.563 1.625 1.664 1.704 1.747 1.790 1.837 1.992 2.051 2.114 2.254 2.353 2.419	51° 1.314 1.343 1.403 1.403 1.403 1.406 1.408 1.531 1.600 1.605 1.605 1.605 1.641 1.600 1.721 1.764 1.609 1.607 1.907 2.013 2.077 2.142 2.211 2.287 2.309	52° 1.296 1.325 1.354 1.383 1.414 1.445 1.511 1.546 1.681 1.618 1.656 1.697 1.739 1.783 1.830 1.920 1.925 2.043 2.105 2.172 2.944 2.323	53° 1.280 1.308 1.337 1.308 1.437 1.459 1.459 1.459 1.452 1.508 1.636 1.636 1.675 1.716 1.760 1.805 1.902 1.905 2.012 2.077 2.207 2.207 2.201	54° 1.283 1.291 1.320 1.349 1.379 1.410 1.441 1.474 1.508 1.643 1.579 1.616 1.655 1.696 1.738 1.782 1.829 2.042 2.105 2.122 2.244	<b>355°</b> 1.249 1.276 1.305 1.334 1.363 1.363 1.426 1.426 1.456 1.456 1.459 1.651 1.598 1.699 1.676 1.718 1.762 1.807 1.655 1.906 1.969 2.016 2.076 2.142 2.211	56° 1.234 1.262 1.290 1.319 1.319 1.379 1.411 1.443 1.478 1.510 1.545 1.581 1.620 1.659 1.609 1.743 1.787 1.635 1.694 1.937 1.992 2.051 2.114 2.162	57° 1.220 1.248 1.277 1.305 1.335 1.335 1.366 1.397 1.429 1.429 1.429 1.429 1.429 1.429 1.496 1.530 2.667 1.604 1.643 1.776 1.770 1.816 1.970 2.028 2.080 2.155	58° 1.207 1.235 1.264 1.293 1.353 1.384 1.416 1.462 1.462 1.517 1.553 1.590 1.629 1.764 1.800 1.629 1.754 1.800 1.629 2.009 2.133	50° 1.195 1.223 1.252 1.281 1.310 1.341 1.372 1.404 1.436 1.471 1.505 1.541 1.578 1.616 1.658 1.658 1.699 1.740 1.786 1.833 1.991 2.050 2.113	60° 1.183 1.211 1.240 1.269 1.300 1.330 1.361 1.363 1.428 1.460 1.465 1.645 1.605 1.645 1.605 1.645 1.605 1.729 1.774 1.820 1.977 2.035 2.096	61° 1.172 1.200 1.200 1.220 1.252 1.415 1.450 1.4557 <u>1.557</u> <u>1.557</u> <u>1.635</u> <u>1.635</u> <u>1.676</u> <u>1.719</u> <u>1.639</u> <u>1.901</u> <u>1.905</u> <u>2.022</u> <u>2.022</u> <u>2.023</u>	62°           1.162           1.191           1.250           1.250           1.250           1.270           1.312           1.343           1.375           1.408           1.402           1.402           1.403           1.550           1.668           1.668           1.668           1.602           1.851           1.935           2.013           2.073	63° 1.152 1.151 1.241 1.241 1.272 1.304 1.335 <u>1.335</u> <u>1.435</u> 1.470 1.605 1.544 1.562 1.621 1.662 1.705 1.750 1.780 1.949 2.006 2.066	64°           1.142           1.172           1.803           1.254           1.265           1.206           1.329           1.322           1.329           1.329           1.320           1.455           1.602           1.539           1.617           1.658           1.701           1.746           1.792           1.841           1.892           1.946           2.003           2.062	65° 1.134 1.164 1.227 1.258 <u>1.221</u> 1.323 1.357 1.360 1.466 1.461 1.498 1.535 1.615 1.615 1.658 1.700 1.745 1.791 1.891 1.945 2.002 2.062	66° 1. 122 1. 125 1. 125 1. 225 1. 235 1. 459 1. 459 1	61 1.1 1.2 1.2 1.2 1.2 1.2 1.2 1.
	1° 2° 3° 4° 5° 6° 7° 8° 9° 10° 11° 12° 13° 14° 15° 16° 17° 18°. 19° 20° 21° 22° 23° 24°	48° 1.375 1.404 1.454 1.455 1.405 1.407 1.456 1.601 1.658 1.677 1.717 1.780 1.904 1.905 2.007 2.067 2.131 2.199 2.273 2.555 2.441 2.538 2.646	40° 1.254 1.365 1.412 1.443 1.474 1.508 1.575 1.612 <b>1.689</b> 1.731 1.774 1.819 1.867 1.917 1.917 1.917 1.917 1.971 2.029 2.059 2.154 2.225 2.302 2.302 2.476	50° 1.384 1.362 1.391 1.422 1.465 1.519 1.553 1.569 1.625 1.664 1.704 1.747 1.790 1.837 1.886 1.902 2.061 2.114 2.254 2.358 2.419 2.515	51° 1.314 1.343 1.372 1.403 1.433 1.465 1.408 1.531 1.566 1.603 1.603 1.603 1.603 1.603 1.603 1.603 1.603 1.605 1.605 1.605 1.607 1.907 1.907 2.013 2.077 2.142 2.211 2.287 2.369 2.459	52° 1.296 1.325 1.354 1.383 1.414 1.445 1.511 1.546 1.551 1.618 1.656 1.657 1.739 1.783 1.830 1.930 1.985 2.043 2.105 2.172 2.944 2.323 2.408	53° 1.280 1.308 1.337 1.366 1.427 1.459 1.459 1.459 1.459 1.458 1.588 1.685 1.685 1.685 1.902 1.865 2.012 2.077 2.207 2.207 2.281 2.383	54° 1.283 1.291 1.329 1.349 1.379 1.410 1.441 1.474 1.508 1.579 1.616 1.665 1.696 1.738 1.782 1.829 1.877 1.930 1.985 2.042 2.105 2.172 2.244 2.322	<b>355°</b> 1.249 1.276 1.305 1.334 1.363 1.363 1.363 1.426 1.426 1.426 1.456 1.456 1.459 1.509 1.509 1.509 1.509 1.509 1.718 1.762 1.807 1.855 1.906 1.969 2.016 2.076 2.142 2.211 2.287	56° 1.234 1.262 1.290 1.319 1.319 1.379 1.411 1.443 1.476 1.510 1.545 1.561 1.620 1.659 1.609 1.743 1.787 1.635 1.684 1.937 1.992 2.051 2.114 2.182 2.254	57° 1.220 1.248 1.277 1.305 1.335 1.366 1.367 1.429 1.429 1.429 1.429 1.429 1.429 1.429 1.429 1.429 1.429 1.429 1.633 1.663 1.643 1.775 1.770 1.816 1.970 2.028 2.090 2.155 2.226	58° 1.207 1.235 1.264 1.293 1.353 1.353 1.384 1.416 1.482 1.517 1.553 1.590 1.629 1.710 1.754 1.800 1.689 1.662 2.008 2.069 2.133 2.201	59° 1.195 1.223 1.252 1.281 1.310 1.341 1.372 1.404 1.436 1.471 1.505 1.541 1.578 1.616 1.658 1.699 1.740 1.768 1.633 1.991 2.050 2.113 2.180	60° 1.183 1.211 1.240 1.269 1.300 1.361 1.363 1.426 1.460 1.465 1.465 1.665 1.665 1.645 1.666 1.729 1.774 1.620 1.977 2.035 2.096 2.163	61° 1.172 1.200 1.405 1.405 1.405 1.6076 1.719 1.0076 1.911 1.905 2.002 2.003 2.1003 2.1003 2.1003	62° 1.162 1.191 1.250 1.250 1.250 1.250 1.250 1.250 1.312 1.343 1.375 1.408 <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.445</u> <u>1.560</u> 1.568 1.668 1.668 1.711 1.756 1.851 <u>1.902</u> 1.955 2.013 2.073 2.137	63° 1.152 1.151 1.211 1.241 1.272 1.304 1.335 <u>1.336</u> <u>1.435</u> 1.435 1.470 1.508 1.544 1.582 1.621 1.662 1.705 1.760 1.780 1.949 2.008 2.068 2.130	64°           1.142           1.172           1.803           1.255           1.265           1.265           1.265           1.265           1.329           1.3262           1.3262           1.3262           1.3262           1.3262           1.465           1.539           1.617           1.617           1.658           1.701           1.745           1.792           1.841           1.892           1.946           2.003           2.062           2.126	65° 1.134 1.164 1.227 1.258 <u>1.2291</u> 1.323 1.357 1.390 1.426 1.461 1.496 1.535 1.615 1.615 1.655 1.655 1.655 1.700 1.745 1.791 1.840 1.891 1.945 2.002 2.062 2.125	66° 1.12£ 1.12£ 1.125 1.252 1.252 1.255 1.255 1.255 1.315 1.355 1.355 1.355 1.45	$\begin{array}{c} 61 \\ 1.1 \\ 1.2 \\ $
	1° 2° 4° 5° 6° 7° 8° 9° 10° 11° 12° 15° 14° 15° 14° 15° 14° 15° 14° 20° 21° 20° 21° 22° 22° 22° 22°	48° 1.375 1.404 1.454 1.465 1.477 1.530 1.605 1.601 1.638 1.677 1.717 1.760 1.804 1.900 1.965 2.007 2.131 2.199 2.273 2.355 2.441 2.538 2.646 2.767	40° 1.365 1.412 1.443 1.474 1.508 1.541 1.576 1.612 1.651 1.639 1.731 1.774 1.619 1.807 1.917 1.917 1.971 2.029 2.059 2.154 2.302 2.305 2.476 2.577 2.689	50° 1.384 1.362 1.391 1.422 1.465 1.519 1.553 1.563 1.563 1.563 1.565 1.564 1.704 1.747 1.790 1.827, 1.886 1.992 2.051 2.114 2.555 2.419 2.515 2.520	51° 1.314 1.343 1.372 1.403 1.433 1.465 1.498 1.531 1.566 1.605 1.641 1.605 1.641 1.609 1.667 1.907 1.960 2.015 2.077 2.142 2.211 2.287 2.369 2.459 2.567	52° 1.296 1.325 1.354 1.383 1.414 1.445 1.478 1.511 1.546 1.659 1.659 1.659 1.739 1.783 1.830 1.878 1.930 1.985 2.043 2.1072 2.944 2.323 2.408 2.502	53° 1.280 1.306 1.337 1.366 1.427 1.459 1.459 1.492 1.526 1.598 1.626 1.598 1.626 1.655 1.716 1.760 1.855 1.902 1.965 2.012 2.078 2.137 2.207 2.201 2.363 2.462	54° 1.263 1.291 1.329 1.349 1.379 1.410 1.441 1.474 1.508 1.579 1.616 1.665 1.696 1.738 1.665 1.696 1.782 1.829 1.829 1.877 1.830 1.985 2.042 2.106 2.172 2.244 2.322 2.408	<b>355°</b> 1.249 1.276 1.305 1.334 1.363 1.363 1.426 1.426 1.426 1.426 1.426 1.426 1.426 1.426 1.426 1.426 1.509 1.509 1.509 1.509 1.509 1.576 1.718 1.762 1.807 1.855 1.906 1.969 2.016 2.076 2.287 2.368	56° 1.234 1.262 1.290 1.319 1.319 1.379 1.411 1.443 1.476 1.510 1.545 1.561 1.669 1.699 1.743 1.787 1.835 1.684 1.937 1.992 2.051 2.114 2.254 2.333	57° 1.220 1.248 1.277 1.305 1.335 1.366 1.397 1.429 1.429 1.429 1.429 1.429 1.429 1.426 1.530 2.567 1.604 1.643 1.725 1.770 1.816 1.970 1.816 1.970 2.028 2.020 2.155 2.226 2.302	58° 1.207 1.235 1.264 1.293 1.353 1.353 1.354 1.416 1.482 1.517 1.553 1.590 1.629 1.710 1.754 1.800 1.629 1.754 1.800 1.629 2.008 2.008 2.133 2.201 2.275	50° 1.195 1.223 1.252 1.291 1.310 1.341 1.372 1.404 1.436 1.471 1.505 1.541 1.578 1.616 1.658 1.658 1.696 1.740 1.786 1.633 1.683 1.693 1.991 2.050 2.113 2.180 2.253	60° 1.183 1.211 1.240 1.269 1.300 1.330 1.361 1.393 1.426 1.426 1.495 1.426 1.495 1.426 1.495 1.605 1.605 1.645 1.605 1.645 1.666 1.729 1.774 1.820 1.922 1.977 2.036 2.096 2.163 2.233	61° 1.172 1.200 1.280 1.485 1.416 1.597 1.596 1.635 1.676 1.719 1.859 1.811 1.859 1.811 1.859 1.911 1.901 1.859 2.002 2.003 2.108 2.218	62°           1.162           1.250           1.250           1.250           1.250           1.250           1.250           1.312           1.332           1.343           1.375           1.408           1.408           1.408           1.408           1.408           1.408           1.408           1.408           1.408           1.408           1.408           1.408           1.408           1.408           1.408           1.408           1.408           1.658           1.658           1.658           1.658           1.802           1.851           1.902           1.935           2.013           2.073           2.137           2.205	63° 1.152 1.152 1.161 1.211 1.241 1.272 1.304 1.335 1.368 1.470 1.508 1.562 1.621 1.662 1.705 1.750 1.750 1.750 1.750 1.750 1.298 2.006 2.006 2.130 2.196	64°           1.142           1.172           1.803           1.254           1.265           1.265           1.328           1.329           1.329           1.329           1.329           1.329           1.329           1.329           1.329           1.465           1.539           1.617           1.617           1.617           1.617           1.617           1.617           1.617           1.617           1.617           1.617           1.617           1.617           1.617           1.617           1.617           1.617           1.617           1.618           1.702           1.841           1.946           2.003           2.002           2.126           2.193	65° 1.134 1.164 1.196 1.227 1.258 <u>1.221</u> 1.323 1.337 1.390 1.426 1.461 1.498 1.635 1.615 1.615 1.656 1.700 1.745 1.791 1.840 1.891 1.945 2.002 2.062 2.125 2.183	66° 1.122 1.122 1.125 1.252 1.252 1.255 1.255 1.315 1.315 1.355 1.355 1.45	61 1.1 1.2 1.2 1.2 1.2 1.2 1.2 1.2 1.2 1.2 1.2
	1° 2° 4° 5° 6° 7° 8° 9° 10° 11° 12° 13° 14° 15° 16° 17° 18° 10° 21° 22° 23° 24° 24° 24° 24° 25° 24°	48° 1.375 1.404 1.454 1.465 1.477 1.530 1.605 1.601 1.638 1.677 1.717 1.760 1.651 1.900 1.9651 1.900 1.9652 2.007 2.131 2.199 2.273 2.358 2.441 2.538 2.646 2.767 2.903	40° 1.365 1.412 1.443 1.474 1.508 1.541 1.576 1.612 1.609 1.731 1.774 1.819 1.867 1.917 1.977 1.977 1.977 1.977 1.977 2.029 2.059 2.154 2.302 2.476 2.476	50° 1.384 1.362 1.391 1.422 1.463 1.485 1.519 1.553 1.563 1.569 1.553 1.569 1.625 1.604 1.747 1.780 1.837 1.886 1.992 2.051 2.114 2.254 2.419 2.515 2.620 2.738 2.738	51° 1.314 1.343 1.372 1.403 1.433 1.405 1.405 1.408 1.531 1.506 1.603 1.603 1.603 1.603 1.603 1.603 1.603 1.605 1.907 2.013 2.015 2.605 2.657 2.657 2.657 2.656 2.657 2.657 2.657 2.657 2.657 2.657 2.657 2.657 2.657 2.657 2.657 2.657 2.657 2.657 2.658 2.657 2.657 2.658 2.657 2.658 2.657 2.658 2.657 2.658 2.657 2.658 2.657 2.658 2.658 2.657 2.658 2.657 2.658 2.657 2.658 2.657 2.658 2.657 2.658 2.657 2.658 2.657 2.658 2.657 2.658 2.557 2.658 2.557 2.658 2.557 2.658 2.557 2.557 2.658 2.557 2.55	52° 1.296 1.325 1.354 1.383 1.414 1.445 1.511 1.546 1.618 1.656 1.697 1.739 1.783 1.830 1.935 2.043 2.105 2.172 2.244 2.323 2.408 2.502 2.603	53° 1.280 1.308 1.337 1.308 1.337 1.308 1.427 1.459 1.427 1.459 1.422 1.526 1.598 1.626 1.675 1.716 1.760 1.805 1.905 1.905 2.012 2.073 2.137 2.207 2.281 2.363 2.462 2.561 2.363	54° 1.283 1.291 1.320 1.349 1.379 1.410 1.441 1.474 1.508 1.579 1.616 1.655 1.695 1.695 1.695 1.738 1.829 2.042 2.244 2.322 2.408 2.601 2.601 2.601 2.601 2.605 2.042 2.244 2.529 2.601 2.501 2.601 2.501 2.605 2.042 2.504 2.501 2.50	<b>35°</b> 1.249 1.276 1.305 1.334 1.333 1.304 1.428 1.428 1.456 1.491 1.528 1.609 1.609 1.609 1.609 1.609 1.609 1.609 1.609 1.609 1.609 1.609 1.609 1.609 1.609 1.609 1.606 1.906 1.906 1.906 2.016 2.016 2.016 2.221 2.2308 2.459 2.459 2.459 2.459 2.459 2.459 2.505 2.459 2.459 2.505 2.459 2.505 2.459 2.505 2.459 2.505 2.459 2.607 2.207 2.208 2.459 2.508 2.459 2.505 2.505 1.906 2.609 2.609 2.016 2.211 2.227 2.308 2.459 2.509 2.505 2	56° 1.234 1.262 1.290 1.319 1.319 1.379 1.411 1.443 1.476 1.510 1.545 1.560 1.650 1.650 1.609 1.743 1.787 1.635 1.609 1.743 1.787 1.635 1.604 1.937 1.992 2.051 2.114 2.254 2.254 2.254	57° 1.220 1.248 1.277 1.305 1.335 1.335 1.366 1.397 1.429 1.429 1.429 1.429 1.429 1.429 1.435 1.567 1.604 1.643 1.725 1.770 1.816 1.970 2.028 8.090 2.155 2.226 2.302 2.302 2.305	58° 1.207 1.235 1.264 1.293 1.353 1.353 1.354 1.416 1.482 1.517 1.553 1.590 1.629 1.710 1.754 1.800 1.800 1.808 1.808 1.962 2.008 2.009 2.133 2.201 2.275 2.355 2.355 3.558 3.590 3.59	59° 1.195 1.223 1.252 1.281 1.310 1.341 1.372 1.404 1.436 1.471 1.505 1.541 1.578 1.616 1.658 1.658 1.699 1.740 1.786 1.833 1.833 1.863 1.991 2.050 2.113 2.180 2.253 2.230	60° 1.183 1.211 1.240 1.209 1.300 1.330 1.361 1.393 1.426 1.495 1.495 1.495 1.495 1.567 1.605 1.645 1.606 1.729 1.774 1.820 1.670 1.977 2.035 2.096 2.163 2.233 2.310	61° 1.172 1.200 1.200 1.220 1.252 1.557 1.557 1.557 1.557 1.557 1.557 1.595 1.201 1.200 1.220 1.220 1.220 1.220 1.220 1.220 1.220 1.220 1.220 1.220 1.220 1.220 1.220 1.2521 1.557 1.557 1.557 1.557 1.595 2.022 2.022 2.083 2.148 2.218 2.218 2.228 2.218 2.228	62°           1.162           1.191           1.220           1.250           1.280           1.280           1.312           1.343           1.375           1.302           1.408           1.408           1.408           1.408           1.408           1.408           1.408           1.408           1.408           1.408           1.408           1.408           1.408           1.408           1.408           1.408           1.408           1.408           1.608           1.608           1.608           1.851           1.955           2.013           2.073           2.137           2.206           2.207	63° 1.152 1.151 1.241 1.241 1.272 1.304 1.335 1.470 1.508 1.470 1.508 1.544 1.582 1.621 1.662 1.750 1.750 1.780 1.845 1.898 1.949 2.006 2.130 2.198 2.271 0.557 1.576 1.949 2.068	64°           1.142           1.172           1.803           1.255           1.265           1.265           1.329           1.329           1.329           1.329           1.329           1.450           1.455           1.539           1.617           1.618           1.746           1.746           1.922           1.841           1.932           2.062           2.128           2.103	65° 1.134 1.164 1.196 1.227 1.258 <u>1.2291</u> 1.323 1.3357 1.3300 1.466 1.461 1.498 1.535 1.615 1.655 1.655 1.655 1.655 1.655 1.700 1.745 1.701 1.840 1.891 1.945 2.002 2.125 2.125 2.125 2.125	66° 1.122 1.125 1.125 1.255 1.255 1.255 1.255 1.315 1.355 1.355 1.455 1.455 1.455 1.574 1.614 1.677 1.700 1.745 1.893 1.948 2.005 2.064 2.129 2.129 2.276	$\begin{array}{c} 01 \\ 1.1 \\ 1.2 \\ 1.2 \\ 1.2 \\ 1.2 \\ 1.2 \\ 1.2 \\ 1.3 \\ 1.4 \\ 1.4 \\ 1.4 \\ 1.5 \\ 1.4 \\ 1.4 \\ 1.5 \\ 1.6$
	1° 2° 4° 5° 6° 7° 8° 9° 10° 11° 12° 13° 14° 15° 16° 17° 18° 10° 21° 22° 23° 24° 25° 24° 25°	48° 1.375 1.404 1.434 1.465 1.497 1.580 1.601 1.638 1.677 1.717 1.700 1.804 1.962 2.007 2.131 2.199 2.273 2.355 2.441 2.538 2.646 2.767 2.903 3.061 2.903	40° 1.365 1.412 1.443 1.474 1.508 1.576 1.612 1.609 1.731 1.774 1.819 1.867 1.917 1.917 1.917 1.917 1.971 2.029 2.154 2.225 2.302 2.302 2.355 2.476 2.577 2.689 2.476	50° 1.384 1.362 1.422 1.422 1.422 1.423 1.422 1.453 1.519 1.553 1.553 1.553 1.553 1.564 1.704 1.747 1.780 1.837 1.992 2.051 2.114 2.353 2.419 2.515 2.625 2.671 3.023	51° 1.314 1.343 1.433 1.403 1.433 1.405 1.408 1.531 1.566 1.605 1.605 1.605 1.605 1.605 1.641 1.600 1.721 1.764 1.609 1.607 1.907 2.013 2.077 2.142 2.211 2.287 2.309 2.459 2.567 2.068 2.791 2.922	52° 1.296 1.325 1.354 1.383 1.414 1.445 1.511 1.546 1.651 1.618 1.656 1.697 1.739 1.783 1.830 1.930 1.985 2.043 2.105 2.172 2.844 2.323 2.408 2.502 2.608 2.722 2.852	53° 1.280 1.308 1.337 1.308 1.337 1.308 1.427 1.459 1.462 1.561 1.598 1.636 1.675 1.716 1.760 1.865 1.902 1.965 2.012 2.078 2.137 2.207 2.207 2.207 2.201 2.363 2.462 2.561 2.060 2.782	54° 1.283 1.291 1.320 1.349 1.379 1.410 1.441 1.474 1.508 1.643 1.579 1.616 1.655 1.696 1.738 1.738 1.829 2.042 2.105 2.720 2.244 2.829 2.601 2.605 2.720	<b>355°</b> 1.249 1.276 1.305 1.334 1.363 1.363 1.364 1.426 1.456 1.456 1.456 1.456 1.698 1.695 1.676 1.718 1.762 1.607 1.655 1.906 2.016 2.076 2.142 2.287 2.368 2.456 2.656 2.656	56° 1.234 1.262 1.290 1.319 1.319 1.379 1.411 1.443 1.478 1.510 1.545 1.561 1.620 1.659 1.609 1.743 1.787 1.635 1.604 1.937 1.962 2.051 2.114 2.162 2.254 2.333 2.419 2.513 2.617	57° 1.220 1.248 1.277 1.305 1.335 1.336 1.366 1.397 1.429 1.429 1.429 1.498 1.630 1.657 1.604 1.643 1.725 1.770 1.816 1.915 1.970 2.028 2.090 2.155 2.202 2.306 2.476 2.476	58° 1.207 1.235 1.264 1.293 1.322 1.353 1.384 1.416 1.482 1.517 1.553 1.590 1.629 1.7649 1.710 1.754 1.898 1.662 2.008 2.009 2.133 2.201 2.275 2.355 2.443 2.539	50° 1.195 1.223 1.252 1.281 1.310 1.341 1.372 1.404 1.436 1.471 1.505 1.641 1.656 1.656 1.666 1.656 1.666 1.656 1.666 1.740 1.786 1.605 1.991 2.050 2.113 2.180 2.416 2.579	60° 1.183 1.211 1.240 1.269 1.300 1.330 1.361 1.363 1.426 1.460 1.496 1.496 1.496 1.496 1.496 1.496 1.496 1.605 1.645 1.605 1.645 1.605 1.645 1.605 1.729 1.774 1.800 1.972 1.977 2.035 2.096 2.163 2.235 2.345 2.483	61° 1.172 1.200 1.200 1.200 1.220 1.252 1.416 1.557 1.557 1.557 1.635 1.676 1.719 1.201 1.252 1.635 1.676 1.219 1.202 2.022 2.022 2.022 2.023 2.148 2.218 2.2203 2.374 2.429	62° 1.162 1.191 1.230 1.250 1.250 1.250 1.230 1.312 1.343 1.375 1.408 1.408 1.402 1.442 1.442 1.442 1.442 1.442 1.442 1.442 1.442 1.442 1.442 1.445 1.500 1.566 1.668 1.668 1.602 1.851 1.955 2.013 2.073 2.137 2.206 2.230 2.437 2.408	63° 1.152 1.161 1.211 1.241 1.241 1.272 1.304 1.335 1.470 1.605 1.470 1.605 1.544 1.562 1.602 1.750 1.750 1.750 1.949 2.006 2.196 2.196 2.211 2.366	64°           1.142           1.172           1.803           1.254           1.265           1.265           1.329           1.329           1.329           1.329           1.329           1.329           1.455           1.602           1.539           1.617           1.658           1.701           1.746           1.702           1.841           1.892           1.946           2.003           2.062           2.128           2.344           2.429	65° 1.134 1.164 1.227 1.258 <u>1.221</u> 1.323 1.357 1.360 1.426 1.461 1.498 1.535 1.615 1.615 1.655 1.655 1.655 1.655 1.655 1.655 1.700 1.945 2.002 2.002 2.125 2.183 2.266 2.344 2.428	66° 1.122 1.125 1.126 1.126 1.126 1.126 1.126 1.225 1.252 1.255 1.255 1.315 1.355 1.355 1.456 1.45	$\begin{array}{c} 61\\ 1.11\\ 1.2\\ 1.3\\ 1.2\\ 1.3\\ 1.2\\ 1.3\\ 1.3\\ 1.3\\ 1.3\\ 1.3\\ 1.3\\ 1.3\\ 1.3$
	1° 2° 4° 5° 6° 7° 8° 9° 10° 11° 12° 13° 14° 15° 16° 17° 18° 19° 20° 21° 28° 23° 24° 23° 28° 28° 28° 28° 28° 28° 28° 28° 28°	48° 1.375 1.404 1.454 1.465 1.477 1.580 1.601 1.658 1.677 1.717 1.780 1.904 1.901 1.902 2.067 2.067 2.131 2.199 2.273 2.555 2.441 2.538 2.646 2.767 2.903 3.041 3.244	40° 1.254 1.365 1.412 1.443 1.474 1.508 1.575 1.612 5.651 1.659 1.731 1.774 1.819 1.867 1.917 1.917 1.917 1.917 1.971 2.029 2.059 2.154 2.225 2.302 2.302 2.355 2.476 2.669 2.815 2.900 3.128	50° 1.384 1.362 1.391 1.422 1.465 1.519 1.553 1.569 1.625 1.664 1.704 1.747 1.790 1.837 1.896 1.902 2.061 2.114 2.254 2.358 2.419 2.515 2.620 2.738 2.871 3.023	51° 1.314 1.343 1.372 1.403 1.433 1.465 1.408 1.531 1.566 1.603 1.605 1.603 1.605 1.605 1.605 1.605 1.607 1.907 1.900 2.013 2.077 2.142 2.2309 2.557 2.668 2.791 2.668 2.791 2.668	52° 1.296 1.325 1.354 1.383 1.414 1.445 1.511 1.546 1.656 1.657 1.739 1.783 1.830 1.930 1.965 2.043 2.105 2.172 2.944 2.323 2.408 2.502 2.608 2.722 2.852	53° 1.280 1.308 1.337 1.366 1.427 1.459 1.459 1.459 1.459 1.458 1.588 1.685 1.902 1.865 2.012 2.078 2.078 2.207 2.207 2.289 2.586 2.586 2.581 1.585 1.685 2.012 2.078 2.586 2.586 2.581 1.585 1.685 2.012 2.078 2.586 2.581 2.692 1.585 2.187 2.207 2.207 2.280 2.586 2.581 2.581 2.585 2.585 2.581 2.585 2.58	54° 1.283 1.291 1.329 1.349 1.379 1.410 1.441 1.474 1.508 1.543 1.579 1.616 1.665 1.696 1.738 1.696 1.738 1.696 1.738 1.695 2.042 2.106 2.172 2.244 2.322 2.408 2.601 2.605 2.720 0.001 0.005 0.00	<b>355°</b> 1.249 1.276 1.305 1.334 1.363 1.363 1.426 1.426 1.456 1.456 1.459 1.655 1.669 1.676 1.718 1.762 1.607 1.655 1.906 1.969 2.016 2.076 2.142 2.211 2.287 2.368 2.458 2.558 2.458 2.558 2.458 2.558 2.458 2.5588 2.5588 2.5588 2.5588 2.5588 2.55888 2.558888 2.558	56° 1.234 1.262 1.290 1.319 1.319 1.379 1.411 1.443 1.476 1.510 1.545 1.561 1.620 1.659 1.609 1.743 1.787 1.625 1.635 1.664 1.937 1.992 2.051 2.114 2.182 2.254 2.333 2.419 2.513 2.617	57° 1.220 1.248 1.277 1.305 1.335 1.335 1.366 1.397 1.429 1.643 1.725 1.700 1.816 1.970 2.028 2.302 2.326 2.302 2.326 2.476 2.302 2.476 2.302 2.476 2.302 2.302 2.306 2.476 2.302 2.302 2.306 2.476 2.302 2.302 2.306 2.476 2.302 2.302 2.306 2.476 2.302 2.306 2.476 2.302 2.306 2.476 2.302 2.306 2.476 2.302 2.306 2.476 2.302 2.306 2.476 2.302 2.306 2.476 2.302 2.306 2.476 2.302 2.306 2.476 2.302 2.306 2.476 2.302 2.306 2.476 2.302 2.306 2.476 2.302 2.306 2.476 2.302 2.306 2.476 2.575 2.302 2.306 2.476 2.575 2.302 2.575 2.57	58° 1.207 1.235 1.264 1.293 1.353 1.384 1.416 1.462 1.462 1.517 1.553 1.590 1.629 1.710 1.754 1.800 1.689 1.689 1.689 1.689 1.208 2.008 2.008 2.201 2.275 2.355 2.443 2.539	59° 1.195 1.223 1.252 1.281 1.310 1.341 1.372 1.404 1.436 1.471 1.578 1.615 1.658 1.658 1.699 1.740 1.768 1.663 1.699 1.740 1.768 1.633 1.991 2.050 2.113 2.180 2.253 2.230 2.416 2.509	60° 1.183 1.211 1.240 1.269 1.300 1.330 1.361 1.363 1.426 1.460 1.465 1.465 1.465 1.665 1.665 1.665 1.665 1.665 1.665 1.665 1.670 1.977 2.035 2.096 2.103 2.233 2.310 2.345 2.463	61° 1.172 1.200 2.002 2.003 2.100 2.20	62° 1.162 1.191 1.230 1.250 1.230 1.312 1.343 1.375 1.408 <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.442</u> <u>1.4560</u> <u>1.8551</u> <u>1.955</u> <u>2.013</u> <u>2.073</u> <u>2.1377</u> <u>2.206</u> <u>2.3399</u> <u>2.446</u>	63° 1.152 1.151 1.241 1.272 1.304 1.335 <u>1.336</u> <u>1.435</u> 1.435 1.470 1.508 1.544 1.562 1.621 1.662 1.765 1.765 1.765 1.765 1.765 1.765 1.949 2.008 2.108 2.108 2.130 2.198 2.271 2.350 2.435	64°           1.142           1.172           1.803           1.254           1.265           1.265           1.265           1.265           1.265           1.265           1.329           1.3262           1.3262           1.265           1.465           1.539           1.617           1.658           1.701           1.658           1.701           1.746           1.792           1.841           1.692           1.946           2.003           2.062           2.126           2.103           2.2662           2.344           2.429	65° 1.134 1.164 1.196 1.227 1.258 <u>1.2291</u> 1.323 1.357 1.380 1.468 1.461 1.498 1.535 1.615 1.655 1.655 1.655 1.655 1.655 1.655 1.700 1.745 1.791 1.840 1.691 1.945 2.002 2.103 2.266 2.344 2.428 0.555 2.193 2.266 2.344 2.428 0.555 2.193 2.266 2.344 2.428 0.555 2.193 2.266 2.344 2.428 0.555 2.193 2.266 2.344 2.428 0.555 2.193 2.266 2.344 2.428 0.555 2.193 2.266 2.344 2.428 0.555 2.193 2.266 2.344 2.428 0.555 2.193 2.266 2.344 2.428 0.555 2.193 2.266 2.344 2.428 0.555 2.193 2.266 2.344 2.428 0.555 2.193 2.266 2.344 2.428 0.555 2.193 2.266 2.344 2.428 0.555 2.193 2.266 2.344 2.428 0.555 2.5555 2.5555 2.555	66° 1.122 1.122 1.125 1.125 1.252 1.252 1.255 1.255 1.255 1.255 1.315 1.355 1.355 1.45	$\begin{array}{c} 61\\ 1.1\\ 1.2\\ 1.2\\ 1.2\\ 1.2\\ 1.2\\ 1.2\\ 1.$

A

TABLE 2  $M_{o} = \left(\frac{5X}{6-X}\right)^{l} 2 \operatorname{cosec} \alpha$ 

20	29°	30°	31*	æ	<b>33</b> •	34°	36°	36°	37°	38°	39°	<b>40°</b>	41°	42°	43°	44°	<b>45°</b>	46°	47°
P 1.18	6 2.116 4 2.171	2.050 2.102	1.989 2.039	1.932 1.979	1.679 1.925	1.830 1.872	1.783	1.740	1.698	1.660° 1.697	1.623	1.589 1.694	1.567 1.591	1.527	1.498	1.471	1.445	1.420 1.420	1.397
6 2.30	7 2.230 4 2.295	2.158 2.217	2.091 2.147	2.029 2.082	1.972 2.085	1.919 1.906	1.869 1.914	1.821 1.805	1.777 1.819	1.736 1.776	1.698 1.736	1.001 1.006	1.627 1.663	1.594 1.629	1.563 1.598	1.534 1.508	1.507 1.540	1.481 1.514	1.457
£ 2.44	7 2.380 8 2.433	2.980 2.349	2.207 2.271	2.138 2.198	2.078 2.138	2.017 2.071	1.982 2.013	1.911 1.959	1.864 1.910	1.819 1.965	1.777 1.820	1.738 1.779	1.701 1.740	1.667 1.705	1.654 1.671	1.604 1.640	1.875	1.547 1.585	1.522
E 2.00	9 2.511 2 2.8.7	2.421	2.539	2,265	2.192	2.128 3.199	2.067	2.065	1.959	1.910	1.005	<u>1,982</u> 1.968	1.785	1.745 1.700	1.710	1.678	1.005	1.018	1.591
2 8.91 E 8.0	8 2.793 3 2.907	2.681	2.679	2.467	2.402	2.824	2.253	2.187	2.125	2.012 2.068	2.016	1.905	1.672	1.879	1.70	1.802	1.767	1.735	1.705
8.10 8.30	5 3.035 8 3.180	2.901 3.030	2.780 2.898	2.672	2.573	2.45	E:401 2.404	2.325	2.256	2.192	2.133	2.021 2.078 2.140	2.027 2.086	1.921	1.000	1.068	1.812	1.623	1.746
0 8.55 E 8.75	7 <b>3.36</b> 8 9 <b>3.</b> 538	3.178 3.348	3.080	2.898	2.780 2.902	2:673	2.578	2.48	2.408 2.495	2.325	2.288 2.344	2.205	2.148 2.215	2.005	2.048 2.107	2.002	1.959	1.920	1.884
€ 4.02 // 4.3€	7 3.767	3.546 3.781	3.365 3.567	3.187 3.366	3.059 3.197	2.909 3.049	2.792 2.919	2.666 2.602	2. <b>80</b> 1 2. <b>6</b> 97	2.5(6 2.002	2.426 2.516	2.854 2.489	:2 <b>.298</b> 2 <b>.36</b> 7	2.228 2.302	2.172 2.242	2.121 8.197	2.073 2.187	2.080	1.960 2.047
6 <b>5.</b> 30	7 4.390 3 4.839	4.057	3.800 4.098	3.574 3.826	3.380 3.596	3.211 3.399	3.063 3.230	2.932 3.080	2.815 2.949	2.711 2.3 <b>32</b>	2.617 2.728	2.581 2.684	2.454 2.549	<b>2.38</b> 2 2.471	2.318 2.401	2.807 2.807	2.205 2.278	2.155 2.224	2.109 2.176
7 8.22 R 7.66	2 5.457 9 6.388	4.901 5.564	4.475	4:136	3.867 4.182	3.623	3.424	3.263 3.454	3,108 3,280	2.971 3.128	2.053	2.748 2.877	2.654 2.771	2.569 2.678	2.492 2.592	2.422	2.359	2.800 2.388	2.248
6) 11	12.431	8.512 14.720	6.835 9.133	5.846 7.137	5.175 6.031	4.003 5.503	4.301 4.778	3.995 4.377	3.743 4.068	3.532 3.798	3.250 3.579	3.025 3.195 3.394	2.905 3.067 3.234	2.937 3.096	2.704 2.830 .2.974	2.619 2.735 2.866	2.043 2.00 2.770	2.473 2.573 2.684	2.411 2.504 2.607
e			19.514	9.973 43.870	7.516 11.198	5.254 7.993	5.454	4.890	4.405	4.131 4.568	3.880 4.215	3.636 3.931	3.445	3.281 3.502	3.140 3.334	3.016 3.189	<b>8-906</b> 3-063	2.610	2.728
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1						13.162	8.504 17.063	6.654 9.495	5.847	5.173 - <b>5.104</b>	4.687 5.365	4.313 4.825	4.015 4.424	3.770 4.108	3.567 3.853	3.394 3.641	3.246 <b>8.46</b> 2	3.116 5.309	3.003 3.176
								22.120	10.771	7.809	6.420 8.531	6.812	4.988 5.831	5.178	4.218 4.705	3.948 4.344	_3•725 4•054	5.889 3.882	3.380 3.628
1												· · · ·							
61°	62°	63°	64°	<b>65°</b>	66°	67°	68°	69°	70°	71°	72•	73 <sup>•</sup>	74°	76°	78 <sup>9</sup>	77*	78°	79°	80°
£ 1.17 € 1.20	2 1.162 1 1.191	1.152 1.181	1.142 1.172	1.134 1.164	1.125 1.156	1.118 1.150	1.111 1.144	1.105 1.139	1.099 1.134	1.094 <u>1.130</u>	1.0 <del>09</del> 1.126	1.085 1.124	1.122	1.078	1.077	1.075	1.075	1.075	1.077

=	01-	62	63	64	60	66*	67-	68*	69-	70*	71*	72	73*	74*	76°	76*	77-	78*	79	80°
ź	1.172	1.162	1.152	1.142	1.134	1.125	1.118	1.111	1.105	1.099	1.094	1.009	1.086	1.081	1.078	1.077	1.075	1.075	1.075	1.077
é	1.201	1.191	1,181	1.172	1.164	1.156	1.150	1.144	1.139	1.134	1.130	1.126	1.124	1.122	1.122	1.122	1.124			
ė.	1.220	1.220	1.811	1.203	1.195	1.188	1.182	1.177	1.173	1.169	1.166	1.10	1.145	1.106	1.165	1,168	i i			
0	1.280	1.250	1.241	1.254	1.227	1.220	1.215	1.210	1.207	1.204	1.203	1.202	1.205	1.206	1.208	1.214				
2	1.290	1.280	1.272	1.265	1.258	1.252	1.248	1.244	1.242	1.240	1.239	1.20	1.243	1.247	1.252	1.200				
6	1.320	1.312	1.304	1.296	1.291	1.255	1.281	1.278	1.276	1.278	1.277	1.279	1.265	1.289	1.297	1.307				
ć	1.362	1.343	1.335	1.328	1.323	1.319	1.815	1.313	1.512	1.313	1.314	1.318	1.324	1.831	1.841	1.254				
2	1.383	1.375	1.368	1.362	1.357	1.362	1.360	1.348	1.348	1.350	1.353	1.358	1.365	1.375	1.886	1.492				
?	1.416	1.408	1.401	1.395	1.390	1.387	1.385	1.384	1.385	1.586	1.392	1.398	1-407	1.418	1.438	1.450				,
5	1 450	1 1112	1 175	1.1975	1 000	4.400	1 491	4 421	1 497	1.428	1 472	1 440	1.450	1.585	1 470	1 500				
0	1 495	1 1127	1.400	1 465	1.460	1 450	1.459	1.450	1 482	1.466	1.473	1.495	1.404	1,500	1.594	1.551				
Ē	1 501	1 512	1.500	1.400	1.400	1 498	1 408	1.497	1.501	1.507	1.514	1.525	1.530	1.555	1.577	1.001				
5	1 552	1 550	1.544	1.630	1.635	1.575	1.535	1.537	1.541	1.548	1.557	1.540	1.584	1.604	1.627	1.007				
ī	1.596	1.548	1.582	1.577	1.575	1.574	1.575	1.578	1.585	1.591	1.601	1-615	1.652	1.655	1.679	1.712		-		
i.				1.0/1	1.0.0	1.074	1.0.0				4	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		1.000			· · ·			
	1.635	1.628	1.621	1.617	1.615	1.614	1.616	° <b>1,6</b> 20	1.626	1.665	1.647	1.662	1.681	1.704	1.785	1.768				
	1.676	1.668	1.652	1,658	1.658	1.657	1.659	,1.663	1.670	1.690	1.594	1.710	1.731	1.787	1.788	1.827				
]	1.719	1,711	1.705	1.701	1.700	1.700	1.703	1.708	1.716	1.727	1.742	1.760	1,783	1.811	1.846	1.886				
2	1.764	1.756	1.750	1.746	1.745	1.745	1,749	1.755	1.764	1.776	1.792	1.812	1.837	1.868	1.906	1.962				
	1.811	1.802	1.796	1,792	1.791	1.798 :	1.796	1.804	1.813	1.827	1.844	1.666	1.895	1.927	1.968	2.019				
	1.859	1.851	1.845	1.841	1.840	1.842	1.846	1.854	1.865	1.879	1.899	1.923	1.963	1.969.	2.033	2.088			L.	
ŝ	1.911	1.902	1.898	1.892	1.891	1.893	1.398	1.907	1.919	1.935	1.956	1.982	2.014	2.054	2.102	2.161		-		
	1-965	1.955	1.949	1-946	1.945	1.948	1.963	1.962	1.975	1.993	2.016	2.043	2.079	2.122	2.174	2.239				
	2.022	2.013	2.008	2.003	2.002	2.005	2.011	2.021	2.035	2.054	2.079	2.109	2.147	2.195	2.251	2.321			(	
IJ	2.053	2.073	2.066	2.062	2.062	2.064	2.071	2.063	2.098	2.119	2.145	2.178	2.219	2.269	2.332	2.410				ĺ
	0 100	9 1977	0 120	0 198	9 195	2 120	2.134	2.148	2 165	1.187	2.216	2,251	2.298	2.351	8.4:9	2.504				
şĮ	2 218	2 208	9 109	2,103	2,107	2,107	2.205	2.218	2.236	2.280	2.290	2.329	2.378	2.437	2.512	2.004				
	2.293	2.280	2.271	2.266	2,266	2.270	2.278	2.292	2.311	2.357	2.370	2.413	2.468	2.531	2.612	2.715				
	2.774	2.359	2.350	2.344	2.344	2.348	2.367	2.872	2.395	2.420	2,457	2.603	2.500	2.631	2.720	2.833				
	2.462	2:446	2.435	2.429	2.428	2.432	2.441	2.457	2.481	2.511	2.549	2.599	2.652	2.740	2.889	2.906				
i			0.000	0.501	0.000	0.507	0.577	0 584	0.876	0.000	0.451	9 20 5	2 2774	2 9 <b>9</b> 0	2.070	8.110				<del></del>
l	84000	2.541	2.020	2.041	6.000	2.003	2.003	2.001	č•D /D	2.000	2.001	£+ 100	### F / <b>*</b> #		~	-u1				

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									·					M	ı = (	5 6X-1	-)'2	cose	ec (a	:-w]	)		
α+		24°	ઽઽ૾	26°	27°	æ°	29°	<b>30°</b>	31°	32°	33°	34°	36°	36°	37°	38°	39°	<b>40°</b>	41°	42°	43°	44°	<b>1</b> 5° <b>A</b> °
₩ Ŧ	1° 2° 3° 4°	2.487	2.390 2.420	2.303 2.329 2.367	2.222 2.244 2.270 2.298	2.147 2.167 2.169 2.214	2.077 2.095 2.114 2.135	2.014 2.028 2.045 2.065	1.953 1.966 1.961 1.998	1.897 1.998 1.921 1.936	1.844 1.864 1.865 1.878	1.795 1.804 1.812 1.825	1.749 1.752 1.763 1.774	1.705 1.711 1.718 1.726	1.085 1.609 1.675 1.082	1.626 1.530 1.633 1.660	1.590 1.592 1.596 1.600	1.558 1.567 1.558 1.562	1.523 1.524 1.524 1.527	1.452 1.452 1.492 1.494	1.463 1.461 1.451 1.461	1.438 1.433 1.432 1.431	1.409 .063 1.407 .063 1.406 .061 1.403 .008
	5° 6° 7° 8 <sup>3</sup> 8°		5			2.242	2.181 2.189	2.057 2.111 2.139	2.018 2.039 2.063 2.650	1.954 1.973 1.994 2.018 2.045	1.894 1.910 1.930 1.961 1.974	1.837 1.862 1.869 1.888 1.910	1.786 1.798 1.813 1.830 1.848	1.738 1.748 1.760 1.776 1.792	1.690 1.700 1.711 1.734 1.739	1.646 1.656 1.006 1.676 1.689	1.605 1.613 1.621 1.631 1.642	1.567 1.573 1.580 1.588 1.599	1.531 1.585 1.541 1.548 1.567	1.495 1.500 1.504 1.510 1.517	1.463 1.466 1.470 1.474 -1.480	1.432 1.434 1.438 1.441 1.445	1.403 405 1.403 409 1.408 403 1.408 400 1.412
	10° 11° 12° 13° 14°		•	-							2.001	1.933 1.959	1.869 1.893 1.918	1.819 1.831 1.864 1.879	1.755 1.774 1.794 1.217 1.842	1.704 1.720 1.738 1.759 1.751	1.655 1.670 1.585 1.704 1.724	1.610 1.622 1.637 1.663 1.671	1.566 1.578 1.591 1.605 1.621	1.528 1.536 1.547 1.560 1.574	1.488 1.496 1.506 1.517 1.630	<b>i.451</b> 1.459 1.467 1.477 1.488	1.417 1.42 1
	15° 16° 17° 18° 19°	-					-	-					-			1-806	1.748	1.691 1.712 1.736	1.638 1.358 1.630 1.708 1.729	1.589 1.607 1.626 1.646 1.671	1.543 1.559 1.578 1.696 1.617	1.500 1.514 1.529 1.546 1.565	1.459 1.472 1.495 1.500 1.517
	20° 21° 22° 23° 24°										-								1.759 1.791 1.825 1.865 1.909	1.697 1.726 1.757 1.792 1.531	1.640 1.665 1.694 1.725 1.759	1.586 1.609 1.654 1.662 1.693	1.536 1.555 1.579 1.600
	26° 27° 28° 29°	-									,								1.967 2.011 2.071 2.139 2.217	1.873 1.921 1.974 2.033 2.100	1.797 1.839 1.685 1.938 1.996	1.726 1.764 1.805 1.651 1.902	1.662 1.695 1.731 1.772 1.818
	30°						~												2.306	2.177	2.082	1.950	1.868
		54°	55°	560	57°	59°	50°	en°	610	e2°	63 <sup>0</sup>	R4 <sup>0</sup>	65°	380	87 <sup>0</sup>	69 <sup>0</sup>	60 <sup>0</sup>	~ 70°	71 <sup>0</sup>	72 <sup>0</sup>	772 <sup>0</sup>	774 0	750
	1° 2° 3° 4°	1.225 1.215 1.206 1.199	1.209 1.199 1.189 1.181	1.194 1.183 1.173 1.164	1.179 1.167 1.156 1.147	1.165 1.153 1.141 1.130	1.152 1.138 1.126 1.115	1.139 1.125 1.112 1.100	01 1.127 1.112 1.098 1.086	1.115 1.099 1.085 1.072	1.104 1.087 1.072 1.0E8	1.093 1.076 1.060 1.045	1.083 1.084 1.048 1.032	1.074 1.054 1.033 1.020	1.064 1.043 1.025 1.008	08 1.055 1.033 1.014 .9958	1.046 1.023 1.003 .9837	1.037 1.014 .9520 .9722	71 1.030 1.004 .9815 .9604	-1.C21 994£ .£70£ .9495	73 1.014 .9257 .9603 .9339	74 1.007 .9764 .9493 .9253	• 9952 127 • 9671 112 • 9384 008 • 9130 008
	5° 8° 7° 8° 9°	1.192 1.186 1.181 1.177 1.174	1.173 1.167 1.161 1.156 -1.153	1.155 1.148 1.142 1.136 1.132	1.138 1.130 1.123 1.117 1.112	1.121 1.113 1.105 1.099 1.093	1.105 1.098 1.088 1.081 1.075	1.089 1.080 1.071 1.084 1.056	1.074 1.084 1.055 1.047 1.039	1.000 1.049 1.039 1.030 1.022	1.046 1.034 1.024 1.014 1.005	1.032 1.020 1.009 .9984 .9891	1.018 1.005 .9938 .9829 .9735	1.005 .9915 .9790 .9681 .9675	.9920 .9778 .9649 .9528 .9422	.9794 .9644 .9507 .9382 .9269	.9665 .9511 .9367 .9235 .9115	.9542 .9376 .9225 .9088 .8962	.9416 .9244 .9037 .8910 .8810	.9291 .9109 .8944 .6793 .6655	.9160 .8974 .8800 .8642 .8498	.9031 .8833 .8854 .8487 .8339	.8900.074 .6689.064 .3501.065 .8330.047 .8172.059
-	10° 11° 12° 13° 14°	1.171 1.170 1.169 1.169 1.170	1.150 1.147 1.146 1.145 1.145	1.128 1.125 1.125 1.123 1.122 1.121	1.108 1.104 1.102 1.100 1.099	1.058 1.084 1.081 1.078 1.076	1.069 1.064 1.060 1.057 1.055	1.061 1.045 1.041 1.037 1.034	1.032 1.027 1.022 1.018 1.014	1.015 1.009 1.003 .9982 .9943	.9978 .9911 .9849 .9794 .9749	.9609 .9736 .9669 .9612 .9612	.9844 .9588 .9495 .9433 .9374	.9483 .9397 .9321 .9252 .9192	.9322 .9233 .9150 .9077 .9013	.9162 .9070 .8964 .8904 .6834	.9008 .8906 .8813 .8732 .8656	.8848 .8741 .8645 .6559 .8479	.3668 .8677 .8477 .8384 .8301	.8529 .8412 .8307 .8211 .8122	.8364 .8245 .8135 .8034 .7942	.8200 .8074 .7959 .7853 .7758	.8030 082 .799 9.027 .7777 022 .7669 018 .7567 014
	15° 18° 17° 18° 19°	1.171 1.174 1.177 1.182 1.186	1.148 1.148 1.150 1.154 1.158	1.122 1.123 1.124 1.127 1.130	1.098 1.099 1.100 1.101 1.104	1.075 1.075 1.075 1.077 1.077	1.053 1.052 1.052 1.052 1.052	1.032 1.030 1.030 1.029 1.030	1.011 1.009 1.007 1.007 1.006	.9907 .9881 .9860 .9646 .9640	.9710 .9878 .9653 .9632 .9622	.9517 .9479 .9448 .9424 .9407	.9327 .9284 .9248 .9219 .9196	.9138 .9091 .9053 .8019 .8991	.8953 .8902 .8857 .8819 .8787	.8771 .8714 .8666 .8622 .8584	.8588 .8528 .8475 .8426 .8586	.8407 .8343 .8285 .8232 .8187	.8225 .8155 .8094 .8040 .7990	.8041 .7969 .7903 .7844 .7791	.7856 .7760 .7711 .7648 .7591	.7689 .7588 .7514 .7449 .7388	.7475.01 .7393.009 .7315.007 .7245.007 .7182.008
	20° 21° 22° 22° 23° 24°	1.192 1.200 1.207 1.216 1.226	1.163 1.169 1.176 1.163 1.192	1.134 1.140 1.145 1.152 1.160	1.107 1.112 1.116 1.122 1.129	1.081 1.084 1.088 1.093 1.099	1.058 1.058 1.061 1.066 1.071	1.031 1.033 1.038 1.039 1.043	1.007 1.008 1.010 1.013 1.016	.9940 .9848 .9661 .9878 .9908	.9614 .9615 .9622 .9636 .9655	.9395 .9389 .9391 .9398 .9413	.9179 .9169 .9164 .9166 .9174	.8968 .8963 .8943 .8939 .8943	.8780 .8740 .8725 .8716 .8714	.8554 .8630 .8611 .8497 .8489	.8350 .8521 .8299 .8279 .8268	.8149 .8116 .8087 .8065 .8048	.7946 .7909 .7876 .7851 .7830	.7743 .7703 .7668 .7637 .7612	.7540 .7498 .7455 .7421 .7394	.7334 .7286 .7243 .7206 .7174	.7125 007 .7074.006 .7028.010 .6967.013 .6951.016
-	<b>25°</b> 26° 27° 28° 29°	1.237 1.249 1.263 1.278 1.294	1.202 1.213 1.225 1.238 1.253	1.169 1.178 1.189 1.201 1.214	1.137 1.145 1.155 1.165 1.177	1.106 1.113 1.122 1.131 1.142	1.078 1.083 1.090 1.099 1.108	1.048 1.053 1.060 1.067 1.075	1.020 1.025 1.031 1.037 1.044	.9939 .9979 1.003 1.008 1.015	.9682 .9716 .9756 .9602 .9856	.9432 .9459 .9491 .9531 .9578	.9188 .9209 .9234 .9267 .9308	.8949 .8963 .8983 .9010 .9042	.8717 .8725 .8738 .8759 .8786	.8487 .8490 .8499 .8513 .8534	.8260 .8258 .8262 .8271 .8285	.8037 .8030 .8029 .8033 .8041	.7813 .7803 .7797 .7797 .7801	.7592 .7577 .7588 .7582 .7582	.7370 .7351 .7336 .7327 .7323	.7146 .7124 .7106 .7093 .7085	.6920.020 .6995.025 .6874.031 .6857.087 .6845.044
	30°	1.312	1.269	1.228	1.190	1.153	1.118	1.085	1.053	1.022	.9919	.9631	.9352	.9082	.8819	.8559	.8305	.8057	•7810	.7566	.7323	.7081	.6837 053



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	32°	33°	34°	35°	36°	37°	38°.	39°	<b>40°</b>	41°	ť\$°	43°	44°	<b>₫5°</b>	43°	47°	48°	49 <sup>.».</sup>	50°	51°	52°	53°
9.853	1.697	1.844	1.795	1.749	1.705	1.665	1.626	1.590	1.556	1.523	1.492	1.463	1.435	1.409	1.366	1.381	1.339	1.317	1.297	1.278	1.230	1.242
A 681	1.921	1.665	1.812	1.763	1.718	1.675	1.633	1.596	1.658	1.524	1.492	1.461	1.432	1.404	1.361 1.378	1.357	1.329	1.303	1.284	1.271	1.251	1.224
5 6	1.954	1.894	1.837	1.785	1.736	1.690	1.646	1.605	1.567	1.531	1.495	1.463	1.432	1.403	1.375	1.348	1.323	1.298	1.275	1.253	1.231	1.211
	1.973 1.994	1.910	1.862	1.798	1.748 1.760	1.700 1.711	1.656 1.646	1.613 1.621	1.573 1.590	1.535 1.541	1.509 1.504	1.400 1.470	1.434 1.436	1.403 1.405	1.375 1.375	1.347 1.347	1.321 1.320	1.298 1.294	1.272 1.275	1.249 1.246	1.22*	1.209 1.202
	2.019 2.045	1.961	1.988	1.830	1.778 1.792	1.734	1.670	1.631 1.542	1.588 1.589	1.548 1.567	1.510 1.517	1.474 1.480	1.441 1.445	1.406	1.372 1.380	1.348 1.350	1.320 1.322	1.294 1.294	1.268	1.244 1.243	1.221	1.199 1.199
		2.001	1.933 1.959	1.869 1.893	1.810 1.831	1.755 1.774	1.704 1.725	1.665 1.670	1.610 1.622	1.566 1.578	1.526 1.536	1.498 1.496	1.461 1.459	1.417 1.423	1.384 1.389	1.363 1.367	1.323 1.327	1.296 1.298	1.209 1.270	1.242 1.243	1.219 1.216	1.194 1.193
				1.918	1.654 1.879	1.794 1.817	1.738 1.759	1.786 1.704	1.637 1.653	1.591 1.605	1.547 1.560	1.506 1.517	1.467 1.477	1.430 1.439	1.396 1.400	1.362 1.368	1.331 1.338	1.301 1.305	1.272 1.275	1.245 1.247	1.219 1.220	1.193 1.194
HB1						1.542	1.781	1.724	1.671	1.621	1.574 1.589	1.530 1.543	1.488	1.448	1.411	1.376	1.342	1.310	1.272	1.250	1.222	1.195
72 35								1.770	1.712 1.736	1.358	1.607	-1.559 1.576	1.514	1.472	1.431	1.395	1.368	1.323	1.290	1.259 1.26E	1.230	1.201
2.2										1.705 1.729	1.649 1.671	1.595 1.617	1.546	1.500 1.517	1.457 1.472	1.418 1.429	1.377	1.340 1.351	1.306 1.315	1.272 1.281	1.241 1.248	1.211 1.217
38				-						1.759	1.697	1.640	1.586	1.536	1.489	1.444	1.402	1.363	1.325	1.290	1.256	1.224
79										1.791	1.726	1.685	1.609	1.556. 1.579	1.507 1.527	1.451 1.479	1.417	1.376	1.337	1.300	1.2%5	1.231
31			- <u></u>							1.909	1.831	1.759	1.693	1.631	1.550	1.521	1.451	1.400	1.380	1.338	1.259	1.262
2 2 5										1.957 2.011	1.873	1.797	1.726	1.662	1.601	1.545	1.493	1.444	1.397	1.354	1.313	1.274
3										2.071	1.974	1.625	1.805	1.731	1.664	1.601	1.543	1.488	1.438	1.390	1.345	1.303
18										2.217	2.100	1.995	1.902	1.818	1.740	1.669	1.603	1.542	1.486	1.434	1.384	1.338
68×										2.308	2.177	2.062	1.930	1.868	1.785	1.708	1.638	1.574	1.514	1.459	1.407	1.256
•	62°	63°	64°	65°	66°	57°	69°	69°	70°	71°	72°	73°	74°	75°	76°	77°	78°	79°	80°			<b>1</b>
5 <b>2 12</b> 7	1.115	1.104	1.093	1.083	1.074	1.064	1.055	1.046	1.037	1.030	1.021	1.014	1.007	• 9972	.9916	.9844	.9771	.9697				
71 <b>.11</b> 2 84 <b>.09</b> 8	1.099 1.085	1.087 1.072	1.076 1.060	1.064 1.048	1.054 1.038	1.043 1.025	1.033 1.014	1.023 1.003	1.014 .9920	1.004 .9815	.994£ .£70£	.9857 .9603	.9764 .9493	.9671 .9384	.9577 .9274							
30 <b>.08</b> 6	1.072	1.058	1.032	1.032	1.020	1.008	•9958	.9637	.9722	-9604	•9490	.9369	.9253	•9130	•9004	-				,		
18 <b>9.084</b>	1.049	1.034	1.020	1.005	· 9916	.9778	•9644	.9511	•9376	.9244	.9109	.8974	.8833	.8589	.8542							
30 <b>.04</b> 7 72.069	1.030 1.022	1.014 1.005	.9964 .9891	.9629 .9735	•9681 •9675	.9528 .9422	.9382 .9268	.9235 .9115	5809. 5808.	.6910 .6810	.8793 .8655	.8642 .8498	.8487 .6338	.8330 .5172	.8167 .8004							
20.052	1.015	.9978	•9809	.9644	•9483	.9322	.9162	.9006	.8848	.8688	.8529	.8364	.8200	.6030	.7853							
77 022	1.003	•9911 •9849	•9669	.9000 .9495	.9321	.9200 .9150	•8964 •8964	.8900 .8813	•8741 •8645	.8477 .8384	.8307 8211	.8135 .8074	•7959	.7099 .7777 .7689	•7710 •7593							
67,014	.9943	.9749	.9561	.9374	.9192	.9013	. 8834	.8656	.8479	.8301	.8122	.7942	.7758	.7567	.7373				]			
75 011 95 009	.9907 .9881	.9710 .9678	.9517 .9479	.9327 .9284	.9138 .9091	.8953 .8902	•8771 •8714	.8588 .8528	.8407 .8343	.8225 .8155	.6041 .7969	.7856 .7780	.7689 .7588	•7475 •7393	.7279 .7190							
45,007	.9860 .9846	•9653 •9632	•9448 •9424	•9248 •9219	•9018	.8857 .8819	.8685 .8622	.8475 .8426	.8285 .8232	.8094 .8040	•7903 •7844	.7711 .7648	•7514 •7449	.7315 .7245	.7110 .7038							
25 007	.9840	.9614	:9395	.9196	• 9968	.8787	•8554	.8350	.8149	•7940 •7948	.7743	.7540	•7334	•7182 •7125	.0911							
77 <b>4.00</b> 6 28 <b>.01</b> 0	.9846 .9861	.9615 .9622	.9389 .9391	.9169 .9164	.6963 .8943	•8740 •8725	.8530 .8511	.8321 .8299	.8116 .8087	.7909 .7876	.7703 .7668	.7496 .7455	.7286 .7243	.7074 .7028	.6857 .6808							
967 <b>01</b> 3 951 <b>01</b> 6	•9878 •9908	.9636 .9655	.9398 .9413	.9166 .9174	.8939 .8943	.8716 .8714	.8497 .8489	.8279 .8268	.8065 .8048	.7851 .7830	.7637 .7612	.7421 .7394	.7208 .7174	.6987 .6951	.6764 .6725							
20.020 395.005	.9939	.9682	•9432	.9188	.8949	.8717 .8725	-8487	.8260	.8037	.7813	.7592	.7370	.7146	.6920 .6925	.6692 .6663							
374 081 357 037	1.003	.9758	.9491 .9531	.9267	.8963 .9010	.8738	.8499 .8513	.8262	.8029	.7797	.7566 .7562	.7336 .7327	.7106 .7093	.6874 .6857	.6638 .6619				ĺ			
346.044	1.015	.9856	.9578	.9306	.2012	.8786	.8534	.8285	.8041	.7801	.7562	,7323	.7085	.6845	.6603							ļ
53/1053	1.022	.9919	.9631	.9352 j	.9032	.8818	.8559	•8305	.8057	.7810	.7566	.7523	.7081	.6837	5860.							
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   | 11.573   | 4.014<br>29.425  | 2.763   
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  | 1.`51  | 1.775<br>1.174   | 1.14   
   | 1.771  | 152   | 1. 752<br>1. 1 <sup>-77</sup>  | 1. 7.   
   | 1. **  | 1E<br>1.1-1  |           |
| 1°<br>2°<br>3°   | 34 <sup>2</sup><br>1. 61<br>1. 107<br>1. 165  | 40°<br>1.051<br>1.105<br>1.163   | 41°<br>1.051<br>1.1°4<br>1.162   
   | 42°<br>1.051<br>1.104<br>1.160   | 43°<br>1. 51<br>1.104<br>1.159   | 44 <sup>°</sup><br>1.151<br>1.154<br>1.159  
  | 45°<br>1.451<br>1.102<br>1.159   | 40°<br>1. 71<br>1.122<br>1.157<br>1.216   | 4 <sup>71</sup><br>1.081<br>1.132<br>1.157  | 45<br>1.151<br>1.104<br>1.15-   
  | 1.151<br>1.151<br>1.14<br>1.15-<br>1.016   | 1.775<br>1.174<br>1.183<br>1.215   | 1.771<br>1.14<br>1.14<br>1.14  
   | 1.771<br>1.177<br>1.177<br>1.171   | 152<br>1177<br>1.177<br>1.177   | 1.752<br>1.177<br>1.165<br>1.623   | 1. 7~<br>1.1.*<br>1.1**<br>1.1**  
   | 1.1  | 1E<br>1.1.1<br>1.: 11<br>1.: 11  |           |
| 1°<br>2°<br>3°<br>4°   | 34 <sup>2</sup><br>1.151<br>1.107<br>1.105<br>1.225   | 40°<br>1.051<br>1.105<br>1.103<br>1.224  | 41°<br>1.051<br>1.1°4<br>1.1°2<br>1.222  
   | 42°<br>1.051<br>1.104<br>1.219<br>1.219  | 43°<br>1. 51<br>1.104<br>1.104<br>1.219<br>1.219   | 44 <sup>4</sup><br>1. 51<br>1.134<br>1.159<br>1.21-<br>1.2-1  
  | 45°<br>1.051<br>1.102<br>1.159<br>1.11°<br>1.260   | 40°<br>1. 71<br>1.122<br>1.157<br>1.215<br>1.215  | 4 <sup>7°</sup><br>1.051<br>1.132<br>1.157<br>1.216<br>1.278  | 44<br>1.151<br>1.134<br>1.154<br>1.214<br>1.214   
  | 1.°51<br>1.1°51<br>1.1°4<br>1.18-<br>1.61°<br>1.8°°+   | 1.755<br>1.174<br>1.183<br>1.215<br>1.255  | 1.771<br>1.171<br>1.14<br>1.14<br>1.14<br>1.14   
   | 1.771<br>1.771<br>1.175<br>1.171<br>114<br>114   | 1. 52<br>1.1 <sup></sup><br>1.1 <sup></sup><br>1.1 <sup></sup><br>1.1 <sup></sup>   | 1. 752<br>1. 177<br>1. 165<br>1. 121<br>1. 26  | 1. 55<br>1. 57<br>1.1<br>1.1**<br>1.1**<br>1.1**<br>1.4**   
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| 1°<br>2°<br>3°<br>4°<br><b>5°</b>  | 34 <sup>2</sup><br>1. 61<br>1.107<br>1.165<br>1.225<br>1.235<br>1.235   | 40°<br>1.051<br>1.105<br>1.103<br>1.224<br>1.289<br>1.359<br>1.359   | 41°<br>1.051<br>1.1°4<br>1.1°2<br>1.22°<br>1.266<br>1.354  
   | 42°<br>1.051<br>1.104<br>1.104<br>1.219<br>1.294<br>1.251<br>1.425   | 43°<br>1. 51<br>1.104<br>1.159<br>1.219<br>1.23<br>1.348<br>1.420  | 44 <sup>4</sup><br>1.151<br>1.104<br>1.159<br>1.21-<br>1.2-1<br>1.347<br>1.415  
  | 45°<br>1.051<br>1.102<br>1.159<br>1.119<br>1.260<br>1.345<br>1.415   | 40°<br>1. 11<br>1.12<br>1.15°<br>1.215<br>1.27*<br>1.344<br>1.414   | 4 <sup>20</sup><br>1.051<br>1.102<br>1.157<br>1.216<br>1.278<br>1.244<br>1.344<br>1.412   | 44<br>1.151<br>1.104<br>1.15-<br>1.216<br>1.274<br>1.342<br>1.412   
  | 1.°51<br>1.1°4<br>1.1°4<br>1.1°-<br>1.2°°-<br>1.3°4<br>1.3°4   | 1.075<br>1.104<br>1.155<br>1.215<br>1.255<br>1.254<br>1.244<br>1.418   | 1.771<br>1.14<br>1.14<br>1.14<br>1.14<br>1.14<br>1.745<br>1.345  
   | 1.771<br>1.77<br>1.17<br>1.17<br>1.17<br>1.27<br>1.47  | 152<br>1.1 <sup></sup><br>1.1 <sup></sup><br>1.1 <sup></sup><br>1.1 <sup></sup><br>1.1 <sup></sup><br>1 <sup>-</sup> 4<br>1.349<br>1.41 <sup></sup>   | 1. 752<br>1. 177<br>1. 165<br>1. 123<br>1. 12-9<br>1. 351<br>1. 42   |
1.55<br>1.1.4<br>1.1.4<br>1.1.4<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.1.5<br>1.5   | 1.1.   | 1. 15<br>1.111<br>1.111<br>1.21<br>1.21<br>1.24<br>1.144   |           |
| 1 <sup>°</sup> 2° 3° 4° 5° 4° 7° 8°  | 34 <sup>2</sup><br>1. 61<br>1. 107<br>1. 165<br>1.225<br>1.233<br>1.364<br>1.440<br>1.524   | 40°<br>1.051<br>1.105<br>1.103<br>1.224<br>1.289<br>1.359<br>1.434<br>1.516  | 41°<br>1.051<br>1.1°4<br>1.1°2<br>1.229<br>1.266<br>1.354<br>1.429<br>1.509<br>1.509   
   | 42°<br>1.051<br>1.104<br>1.219<br>1.284<br>1.251<br>1.425<br>1.555<br>1.595  | 43°<br>1. 51<br>1.104<br>1.159<br>1.219<br>1.257<br>1.348<br>1.420<br>1.428<br>1.428<br>1.428<br>1.428   | 44 <sup>1</sup><br>1. 51<br>1.124<br>1.159<br>1.21-<br>1.2-1<br>1.347<br>1.415<br>1.425<br>1.574  
  | 45°<br>1.751<br>1.122<br>1.159<br>1.159<br>1.250<br>1.345<br>1.415<br>1.450<br>1.564   | 40°<br>1. 71<br>1.122<br>1.15°<br>1.215<br>1.278<br>1.344<br>1.414<br>1.467<br>1.369  | 47<br>1.051<br>1.12<br>1.157<br>1.216<br>1.278<br>1.344<br>1.412<br>1.465<br>1.564  | 44<br>1.051<br>1.104<br>1.15-<br>1.216<br>1.216<br>1.219<br>1.342<br>1.412<br>1.412<br>1.456  
  | 1.751<br>1.751<br>1.174<br>1.15-<br>1.27-<br>1.344<br>1.412<br>1.463<br>1.571  | 1.07)<br>1.174<br>1.150<br>1.215<br>1.255<br>1.255<br>1.255<br>1.254<br>1.412<br>1.498<br>1.2551   | 1.771<br>1.14<br>1.14<br>1.14<br>1.14<br>1.14<br>1.745<br>1.345<br>1.345<br>1.344<br>1.446<br>1.541  
   | 1.771<br>1.77<br>1.17<br>1.14<br>1.14<br>1.47<br>1.47<br>1.47  | 152<br>1.1 <sup></sup><br>1.1 <sup></sup><br>1.1 <sup></sup><br>1.1 <sup></sup><br>1.1 <sup></sup><br>1.349<br>1.41 <sup></sup><br>1.4 <sup></sup><br>1.5 <sup></sup>   | 1. 752<br>1. 167<br>1. 165<br>1. 123<br>1. 2-9<br>1. 351<br>1. 42<br>1. 437<br>1. 655  | 1.55<br>1.74<br>1.14<br>1.14<br>1.47<br>1.47<br>1.47<br>1.47<br>1.47  
   | 1. = = = = = = = = = = = = = = = = = = =   | 1E<br>1.111<br>1.111<br>1.21<br>1.21<br>1.21<br>1.24<br>1.44<br>1.4  |           |
| 1°<br>2°<br>3°<br>4°<br>5°<br>4°<br>5°<br>4°<br>2°<br>2°   | 34 <sup>2</sup><br>1. 61<br>1.107<br>1.165<br>1.225<br>1.235<br>1.235<br>1.364<br>1.440<br>1.524<br>1.614<br>1.711  | 40°<br>1.051<br>1.105<br>1.105<br>1.289<br>1.359<br>1.434<br>1.516<br>1.632<br>1.632<br>1.637  | 41°<br>1.051<br>1.14<br>1.162<br>1.222<br>1.266<br>1.354<br>1.429<br>1.509<br>1.594<br>1.697   
   | 42°<br>1.051<br>1.104<br>1.219<br>1.204<br>1.351<br>1.425<br>1.503<br>1.597<br>1.677   | 43°<br>1. 51<br>1.104<br>1.159<br>1.219<br>1.247<br>1.348<br>1.430<br>1.498<br>1.591<br>1.659  | 44<br>1. 51<br>1.151<br>1.159<br>1.21-<br>1.247<br>1.415<br>1.425<br>1.574<br>1.662   
  | 45°<br>1.151<br>1.122<br>1.159<br>1.159<br>1.267<br>1.267<br>1.345<br>1.415<br>1.459<br>1.655  | 4.2°<br>1. ±1<br>1.12<br>1.15<br>1.27<br>1.27<br>1.344<br>1.414<br>1.5%<br>1.5%   | 4 <sup>-1</sup><br>1.051<br>1.132<br>1.157<br>1.216<br>1.278<br>1.344<br>1.412<br>1.455<br>1.5%<br>1.5%   | 44<br>1.751<br>1.154<br>1.754<br>1.754<br>1.275<br>1.275<br>1.275<br>1.242<br>1.412<br>1.412<br>1.425<br>1.571<br>1.645   
  | 1.75:<br>1.174<br>1.15-<br>1.27-<br>1.27-<br>1.344<br>1.443<br>1.761<br>1.644  | 1.075<br>1.174<br>1.185<br>1.215<br>1.255<br>1.474<br>1.412<br>1.425<br>1.544<br>1.412<br>1.541  | 1. 771<br>1. 14<br>1. 14   
  | 1.771<br>1.775<br>1.175<br>1.171<br>1.175<br>1.171<br>1.175<br>1.477<br>1.417<br>1.477<br>1.574  | 152<br>1177<br>1175<br>1174<br>1174<br>1174<br>1174<br>1417<br>1447<br>1447   | 1.7%<br>1.7%<br>1.177<br>1.165<br>1.221<br>1.422<br>1.422<br>1.437<br>1.457<br>1.457<br>1.757  | 1 55<br>1. Fo<br>1.1 1<br>1.1 1<br>1.1 1<br>1.4 1<br>1.4 1<br>1.5  | -<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-<br>-   
  | 16<br>16<br>1.1-1<br>1.1-1<br>1.2-1<br>1.2-1<br>1.2-1<br>1.4-4<br>1.4-4<br>1.4-4<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1<br>1.4-1. |           |
| 1°<br>2°<br>4°<br>5°<br>4°<br>5°<br>4°<br>7°<br>8°<br>3°<br>10°<br>11°   | 34 <sup>2</sup><br>1. 51<br>1. 107<br>1. 105<br>1.225<br>1.225<br>1.225<br>1.225<br>1.235<br>1.364<br>1.440<br>1.524<br>1.514<br>1.711<br>1.012<br>.524<br>1.711  | 40°<br>1.051<br>1.105<br>1.105<br>1.224<br>1.289<br>1.359<br>1.434<br>1.516<br>1.602<br>1.697<br>1.61<br>1.012   | 41°<br>1.051<br>1.104<br>1.227<br>1.228<br>1.228<br>1.228<br>1.228<br>1.228<br>1.229<br>1.209<br>1.509<br>1.504<br>1.097<br>1.799<br>1.097   
   | 42°<br>1.051<br>1.104<br>1.219<br>1.219<br>1.294<br>1.351<br>1.425<br>1.503<br>1.587<br>1.677<br>1.776<br>1.677  | 43°<br>1. 51<br>1.104<br>1.109<br>1.219<br>1.237<br>1.348<br>1.420<br>1.420<br>1.498<br>1.551<br>1.639<br>1.764<br>1.829   | 44 <sup>1</sup><br>1. <sup>5</sup> 51<br>1.174<br>1.179<br>1.21-<br>1.2-1<br>1.347<br>1.415<br>1.435<br>1.574<br>1.662<br>1.6755<br>1.859   
  | 45°<br>1.551<br>1.102<br>1.159<br>1.260<br>1.260<br>1.345<br>1.460<br>1.5%<br>1.655<br>1.749<br>1.655  | 4.2°<br>1. ±1<br>1.12<br>1.15<br>1.27<br>1.27<br>1.24<br>1.44<br>1.467<br>1.5%<br>1.6%<br>1.742<br>1.578  | 4 <sup>47</sup><br>1.051<br>1.132<br>1.157<br>1.216<br>1.278<br>1.278<br>1.278<br>1.412<br>1.465<br>1.5%<br>1.5%<br>1.5%  | 44<br>1.351<br>1.154<br>1.354<br>1.274<br>1.274<br>1.342<br>1.412<br>1.425<br>1.571<br>1.645<br>1.773<br>1.625  
  | 1.751<br>1.174<br>1.15-<br>1.415-<br>1.415-<br>1.415-<br>1.444<br>1.442<br>1.443<br>1.750<br>1.644   | 1.775<br>1.174<br>1.215<br>1.215<br>1.215<br>1.215<br>1.554<br>1.425<br>1.544<br>1.412<br>1.544<br>1.541<br>1.642<br>1.750<br>1.750  | 1.771<br>1.14<br>1.14<br>1.14<br>1.74<br>1.745<br>1.345<br>1.314<br>1.64<br>1.541<br>1.544   
   | 1.731<br>1.75<br>1.45<br>1.45<br>1.45<br>1.45<br>1.47<br>1.47<br>1.47<br>1.554<br>1.75<br>1.654  | 152<br>152<br>1   | 1. %2<br>1. %2<br>1.177<br>1.165<br>1.223<br>1.279<br>1.371<br>1.42<br>1.42<br>1.42<br>1.45<br>1.777<br>1.777<br>1.45<br>1.777   |
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  |           |
| 1 <sup>5</sup><br>2°<br>4°<br>7 <sup>5</sup><br>8°<br>3°<br>10°<br>11°<br>12°<br>13°   | 34 <sup>2</sup><br>1. 61<br>1.10 <sup>7</sup><br>1.105<br>1.225<br>1.235<br>1.364<br>1.440<br>1.524<br>1.618<br>1.335<br>2.005  | 40°<br>1.651<br>1.105<br>1.163<br>1.224<br>1.289<br>1.359<br>1.434<br>1.516<br>1.697<br>1.601<br>1.915<br>2.040  | 41°<br>1.051<br>1.104<br>1.102<br>1.222<br>1.266<br>1.354<br>1.423<br>1.509<br>1.509<br>1.594<br>1.697<br>1.789<br>1.897<br>2.016  
   | 42°<br>1.051<br>1.104<br>1.219<br>1.219<br>1.294<br>1.251<br>1.425<br>1.503<br>1.597<br>1.677<br>1.776<br>1.643<br>1.998<br>1.998  | 43°<br>1. 51<br>1.104<br>1.159<br>1.219<br>1.217<br>1.218<br>1.420<br>1.420<br>1.429<br>1.429<br>1.639<br>1.639<br>1.669<br>1.669<br>1.952   | 44 <sup>1</sup><br>1. <sup>5</sup> 51<br>1.154<br>1.159<br>1.21-<br>1.2-1<br>1.415<br>1.425<br>1.425<br>1.652<br>1.652<br>1.947<br>1.947  
  | 45°<br>1.551<br>1.122<br>1.159<br>1.250<br>1.250<br>1.250<br>1.345<br>1.415<br>1.480<br>1.5%<br>1.655<br>1.749<br>1.640<br>1.540<br>1.540<br>1.555<br>1.749<br>1.640<br>1.555<br>1.749<br>1.540<br>1.555<br>1.759<br>1.555<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.7555<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.7555<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.7555<br>1.755<br>1.755<br>1.755<br>1.755<br>1.755<br>1.   | 4.6°<br>1. ±1<br>1.12<br>1.15<br>1.21<br>1.27<br>1.244<br>1.414<br>1.467<br>1.5%<br>1.742<br>1.639<br>1.945<br>2.95   | 4-**<br>1.051<br>1.132<br>1.17<br>1.21F<br>1.276<br>1.344<br>1.412<br>1.654<br>1.554<br>1.647<br>1.533<br>1.633<br>1.633  | 44<br>1.051<br>1.104<br>1.205<br>1.205<br>1.205<br>1.205<br>1.412<br>1.425<br>1.445<br>1.501<br>1.645<br>1.703<br>1.625<br>1.825<br>0.005   
  | 1. '5:<br>1. 14<br>1. 15:<br>1. 14<br>1. 15:<br>1. 14<br>1. 15:<br>1. 44<br>1. 442<br>1. 463<br>1. 5:<br>1. 5:  | 1.775<br>1.174<br>1.125<br>1.215<br>1.215<br>1.255<br>1.554<br>1.425<br>1.554<br>1.425<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554  | 1. 51<br>1. 51<br>1. 14<br>1. 14<br>1. 14<br>1. 14<br>1. 14<br>1. 345<br>1. 345<br>1. 345<br>1. 442<br>1. 51<br>1. 644<br>1. 77<br>1. 621<br>1. 621  |
1.771<br>1.771<br>1.77<br>1.17<br>1.17<br>1.17<br>1.47<br>1.47<br>1.47<br>1.544<br>1.644<br>1.644<br>1.644<br>1.644<br>1.644<br>1.644<br>1.644<br>1.654<br>1.651<br>1.651<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.755<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.655<br>1.6555<br>1.6555<br>1.6555<br>1.6555<br>1.6555<br>1.6555<br>1.6555<br>1.6555<br>1.6555   | 1.52<br>1.17<br>1.17<br>1.17<br>1.17<br>1.47<br>1.47<br>1.47<br>1.47  | 1.72<br>1.72<br>1.17<br>1.167<br>1.27<br>1.27<br>1.371<br>1.42<br>1.42<br>1.42<br>1.42<br>1.47<br>1.45<br>1.77<br>1.45<br>1.77<br>1.45<br>1.45<br>1.77   | 1.55<br>1.54<br>1.14<br>1.14<br>1.45<br>1.45<br>1.45<br>1.45   
  | -<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1  | 1, 2<br>1, 17<br>1, 17<br>1, 17<br>1, 17<br>1, 2<br>1,   |           |
| 1°<br>2°<br>3°<br>4°<br>7°<br>8°<br>3°<br>10°<br>11°<br>12°<br>13°<br>14°  | 34 <sup>2</sup><br>1. 61<br>1.107<br>1.105<br>1.225<br>1.235<br>1.235<br>1.364<br>1.440<br>1.524<br>1.414<br>1.618<br>1.335<br>2.065<br>2.210   | 40°<br>1.051<br>1.105<br>1.205<br>1.224<br>1.269<br>1.359<br>1.434<br>1.516<br>1.632<br>1.632<br>1.637<br>1.632<br>1.697<br>1.601<br>1.915<br>2.040<br>2.178   | 41°<br>1.051<br>1.104<br>1.227<br>1.228<br>1.228<br>1.228<br>1.228<br>1.229<br>1.228<br>1.229<br>1.229<br>1.209<br>1.509<br>1.594<br>1.697<br>1.789<br>1.697<br>1.789<br>1.697<br>2.016<br>2.151   
   | 42°<br>1.051<br>1.104<br>1.219<br>1.219<br>1.231<br>1.251<br>1.425<br>1.503<br>1.597<br>1.677<br>1.776<br>1.673<br>1.999<br>2.126  | 43°<br>1. 51<br>1.104<br>1.159<br>1.219<br>1.219<br>1.217<br>1.348<br>1.420<br>1.420<br>1.498<br>1.591<br>1.699<br>1.952<br>2.105  | 44 <sup>1</sup><br>1. '51<br>1.174<br>1.159<br>1.21-<br>1.2-1<br>1.41-<br>1.425<br>1.425<br>1.662<br>1.947<br>2.069<br>2.220  
  | 45°<br>1.751<br>1.122<br>1.159<br>1.159<br>1.250<br>1.345<br>1.480<br>1.504<br>1.655<br>1.749<br>1.655<br>1.749<br>1.655<br>2.772<br>2.201   | 4.6°<br>1. ±1<br>1.12<br>1.15<br>1.21<br>1.27<br>1.344<br>1.414<br>1.457<br>1.742<br>1.639<br>1.945<br>2.055<br>2.135   | 4 <sup>-1</sup><br>1.051<br>1.12<br>1.157<br>1.21F<br>1.276<br>1.276<br>1.276<br>1.425<br>1.594<br>1.425<br>1.594<br>1.425<br>1.594<br>1.425<br>1.594<br>1.425<br>1.594<br>2.1757<br>2.1757   |
44<br>1.351<br>1.15<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.42<br>1.42<br>1.445<br>1.55<br>1.55<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.55<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.25<br>1.42<br>1.425<br>1.425<br>1.425<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.56<br>1.5   | 1.75:<br>1.14<br>1.15:<br>1.14<br>1.15-<br>1.61 <sup>6</sup><br>1.44<br>1.445<br>1.644<br>1.73 <sup>6</sup><br>1.625<br>1.824<br>2.033<br>2.149  | 1.773<br>1.174<br>1.215<br>1.215<br>1.215<br>1.215<br>1.44<br>1.442<br>1.442<br>1.541<br>1.442<br>1.541<br>1.442<br>1.541<br>1.462<br>2.727<br>2.142   | 1. 51<br>1. 51<br>1. 14<br>1. 14<br>1. 14<br>1. 14<br>1. 14<br>1. 51<br>1. 54<br>1.   | 1.771<br>1.771<br>1.77<br>1.17<br>1.17<br>1.17<br>1.17<br>1.47<br>1.47<br>1.47<br>1.47<br>1.544<br>1.647<br>1.64<br>1.641<br>1.46<br>1.61<br>1.46<br>2.124<br>2.124   
  | 1.52<br>1.17<br>1.17<br>1.17<br>1.17<br>1.47<br>1.349<br>1.447<br>1.447<br>1.447<br>1.447<br>1.447<br>1.445<br>1.447<br>1.455<br>1.647<br>1.455<br>1.647  | 1.752<br>1.177<br>1.165<br>1.217<br>1.217<br>1.217<br>1.217<br>1.422<br>1.422<br>1.422<br>1.424<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.4577<br>1.4577<br>1.4577<br>1.4577<br>1.4577<br>1.4577<br>1.4577<br>1.45777<br>1.4577 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  | 1. 5<br>1. 11<br>1. 11<br>1. 11<br>1. 21<br>1. 21<br>1. 44<br>1. 44<br>1. 5-7<br>1. 44<br>1. 5-7<br>1. 45<br>1. 45<br>1. 45<br>1. 45<br>1. 15-7<br>1. 45<br>1. 15-7<br>1. 15-7   |           |
| 1°<br>2°<br>4°<br><b>5°</b><br>4°<br>7°<br>8°<br>3°<br>10°<br>11°<br>12°<br>13°<br>14°   | 34 <sup>2</sup><br>1. 61<br>1.107<br>1.165<br>1.225<br>1.235<br>1.235<br>1.235<br>1.235<br>1.264<br>1.440<br>1.524<br>1.410<br>1.524<br>1.414<br>1.514<br>1.711<br>1.818<br>1.335<br>2.065<br>2.210<br>2.371<br>2.524   | 40°<br>1.051<br>1.105<br>1.103<br>1.224<br>1.269<br>1.359<br>1.434<br>1.516<br>1.632<br>1.632<br>1.632<br>1.632<br>1.632<br>2.040<br>2.178<br>2.331<br>2.505   | 41°<br>1.051<br>1.174<br>1.162<br>1.222<br>1.266<br>1.354<br>1.423<br>1.505<br>1.594<br>1.697<br>1.769<br>1.897<br>2.016<br>2.151<br>2.296<br>2.441  | 42°<br>1.051<br>1.104<br>1.219<br>1.219<br>1.219<br>1.251<br>1.425<br>1.503<br>1.507<br>1.677<br>1.776<br>1.673<br>1.998<br>2.126<br>2.269<br>2.427<br>  | 43°<br>1. 51<br>1.104<br>1.159<br>1.219<br>1.247<br>1.348<br>1.420<br>1.498<br>1.591<br>1.659<br>1.764<br>1.669<br>1.952<br>2.105<br>2.243<br>2.338  | 44 <sup>1</sup><br>1. <sup>5</sup> 51<br>1.104<br>1.159<br>1.21-<br>1.247<br>1.415<br>1.483<br>1.574<br>1.662<br>1.947<br>2.069<br>2.220<br>2.365  | 45°<br>1.751<br>1.122<br>1.159<br>1.159<br>1.267<br>1.267<br>1.415<br>1.415<br>1.415<br>1.457<br>1.655<br>1.749<br>1.655<br>1.749<br>1.655<br>2.772<br>2.201<br>2.341<br>0.407<br>1.264  | 4.2°<br>1. ±1<br>1.12<br>1.15 <sup></sup><br>1.21 <sup></sup><br>1.21 <sup></sup><br>1.24 <sup></sup><br>1.44 <sup></sup><br>1.4 <sup></sup><br>1.4 <sup></sup><br>1.6 <sup></sup><br>1.6 <sup></sup><br>1.6 <sup></sup><br>1.6 <sup></sup><br>2.0 <sup></sup><br>2.1 <sup></sup> | 4 <sup></sup><br>1. (51<br>1.132<br>1.157<br>1.216<br>1.276<br>1.276<br>1.276<br>1.412<br>1.455<br>1.455<br>1.455<br>1.477<br>1.533<br>1.477<br>2.376<br>2.375<br>2.459<br>2.459  | 44<br>1.551<br>1.154<br>1.554<br>1.554<br>1.415<br>1.425<br>1.445<br>1.445<br>1.445<br>1.773<br>1.425<br>1.425<br>1.425<br>1.425<br>2.040<br>2.159<br>2.047<br>0.47  | 1.75:<br>1.14<br>1.15:<br>1.27-<br>1.544<br>1.465<br>1.644<br>1.674<br>1.644<br>1.571<br>1.644<br>1.571<br>1.625<br>1.824<br>2.033<br>2.149<br>2.276<br>2.415  | 1.773<br>1.174<br>1.153<br>1.215<br>1.215<br>1.255<br>1.444<br>1.412<br>1.425<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.554<br>1.5544<br>1.5556<br>1.5546<br>1.5546<br>1.5566<br>1.5566<br>1.55666<br>1.556666 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51<br>1.14<br>1.14<br>1.14<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.55<br>1.54<br>1.55<br>1.54<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55 | 1.771<br>1.775<br>1.175<br>1.175<br>1.171<br>1.175<br>1.475<br>1.447<br>1.447<br>1.447<br>1.544<br>1.75<br>1.641<br>1.64<br>2.754<br>2.154<br>2.154  | 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| 1 <sup>5</sup><br>2°<br>3°<br>4°<br>7 <sup>5</sup><br>8°<br>3°<br>10°<br>11°<br>12°<br>13°<br>14°<br>15°<br>16°<br>17°<br>18°  | 34 <sup>2</sup><br>1. 51<br>1.107<br>1.105<br>1.225<br>1.235<br>1.235<br>1.235<br>1.264<br>1.440<br>1.524<br>1.410<br>1.524<br>1.614<br>1.618<br>1.335<br>2.065<br>2.210<br>2.371<br>2.524<br>2.739<br>2.997  | 40°<br>1.051<br>1.105<br>1.105<br>1.289<br>1.353<br>1.434<br>1.516<br>1.632<br>1.637<br>1.601<br>1.915<br>2.040<br>2.178<br>2.331<br>2.505<br>2.700<br>2.822   | 41°<br>1.051<br>1.104<br>1.222<br>1.228<br>1.354<br>1.423<br>1.505<br>1.504<br>1.697<br>1.788<br>1.897<br>2.016<br>2.151<br>2.298<br>2.491<br>2.646<br>2.656   
   | 42°<br>1.051<br>1.104<br>1.219<br>1.219<br>1.284<br>1.351<br>1.425<br>1.503<br>1.587<br>1.677<br>1.776<br>1.673<br>1.998<br>2.126<br>2.269<br>2.427<br>2.602<br>2.798  | 43°<br>1. 51<br>1.104<br>1.159<br>1.219<br>1.247<br>1.348<br>1.420<br>1.438<br>1.420<br>1.498<br>1.591<br>1.659<br>1.764<br>1.659<br>1.952<br>2.105<br>2.243<br>2.338<br>2.502<br>2.750  | 44 <sup>1</sup><br>1. <sup>1</sup> 51<br>1.174<br>1.179<br>1.21-<br>1.2-1<br>1.415<br>1.415<br>1.415<br>1.497<br>1.415<br>1.497<br>1.662<br>1.947<br>2.069<br>2.220<br>2.365<br>2.526<br>2.526<br>2.708   
  | 45°<br>1.751<br>1.122<br>1.159<br>1.117<br>1.267<br>1.315<br>1.415<br>1.415<br>1.415<br>1.490<br>1.5°9<br>1.655<br>1.749<br>1.655<br>2.772<br>2.201<br>2.341<br>2.49°<br>2.49°<br>2.770  | 4.2°<br>1. ±1<br>1.12<br>1.15<br>1.27<br>1.21<br>1.27<br>1.344<br>1.414<br>1.457<br>1.742<br>1.639<br>1.945<br>2.05<br>2.127<br>2.427<br>2.427  | 4 <sup></sup><br>1.051<br>1.132<br>1.157<br>1.216<br>1.278<br>1.278<br>1.278<br>1.412<br>1.455<br>1.594<br>1.442<br>1.465<br>1.594<br>1.594<br>2.475<br>2.204<br>2.445<br>2.445<br>2.445<br>2.445   | 44<br>1.551<br>1.154<br>1.554<br>1.275<br>1.275<br>1.245<br>1.415<br>1.415<br>1.445<br>1.551<br>1.645<br>1.773<br>1.625<br>1.425<br>2.040<br>2.159<br>2.247<br>2.475<br>2.475   
  | 1.75:<br>1.14<br>1.15:<br>1.27-<br>1.344<br>1.412<br>1.442<br>1.422<br>1.443<br>1.75'<br>1.444<br>1.75'<br>1.444<br>2.033<br>2.149<br>2.27'<br>2.415<br>5.555  | 2.775<br>1.174<br>1.215<br>1.215<br>1.215<br>1.455<br>1.454<br>1.412<br>1.475<br>1.475<br>1.475<br>1.475<br>2.475<br>2.147<br>5.476<br>2.4.4<br>2.551  | 1. 51<br>1. 51<br>1. 14<br>1.   |
1.731<br>1.731<br>1.75<br>1.45<br>1.45<br>1.47<br>1.47<br>1.47<br>1.47<br>1.47<br>1.47<br>1.47<br>1.54<br>1.47<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.54<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55 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| 1 <sup>5</sup><br>2°<br>4°<br>7 <sup>5</sup><br>8°<br>3 <sup>7</sup><br>10°<br>11°<br>12°<br>13°<br>14°<br>15°<br>16°<br>17°<br>18°<br>19°   | 34 <sup>2</sup><br>1. 51<br>1.107<br>1.105<br>1.225<br>1.235<br>1.235<br>1.235<br>1.235<br>1.264<br>1.440<br>1.524<br>1.514<br>1.618<br>1.335<br>2.065<br>2.210<br>2.371<br>2.524<br>2.759<br>2.997<br>3.272  | 40°<br>1.051<br>1.105<br>1.105<br>1.289<br>1.353<br>1.434<br>1.516<br>1.632<br>1.637<br>1.601<br>1.915<br>2.040<br>2.178<br>2.331<br>2.505<br>2.700<br>2.662<br>3.177  | 41°<br>1.051<br>1.104<br>1.222<br>1.228<br>1.228<br>1.228<br>1.228<br>1.228<br>1.228<br>1.229<br>1.509<br>1.509<br>1.504<br>1.697<br>1.788<br>1.897<br>2.016<br>2.151<br>2.298<br>2.491<br>2.646<br>2.656<br>3.096   
   | 42°<br>1.051<br>1.104<br>1.219<br>1.219<br>1.294<br>1.351<br>1.425<br>1.503<br>1.587<br>1.677<br>1.776<br>1.673<br>1.998<br>2.126<br>2.427<br>2.602<br>2.798<br>3.527  | 43°<br>1. 51<br>1.104<br>1.159<br>1.219<br>1.247<br>1.348<br>1.420<br>1.428<br>1.420<br>1.498<br>1.591<br>1.659<br>1.659<br>1.952<br>2.105<br>2.243<br>2.338<br>2.502<br>2.351<br>2.351  | 44 <sup>1</sup><br>1. <sup>1</sup>
51<br>1.174<br>1.271<br>1.271<br>1.271<br>1.477<br>1.415<br>1.482<br>1.574<br>1.662<br>1.947<br>2.069<br>2.220<br>2.365<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.526<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.556<br>2.5567 | 45°<br>1.751<br>1.122<br>1.159<br>1.117<br>1.267<br>1.315<br>1.415<br>1.415<br>1.415<br>1.490<br>1.5°9<br>1.655<br>1.749<br>1.655<br>2.772<br>2.201<br>2.341<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°<br>2.49°   | 4.2°<br>1. ±1<br>1.12<br>1.15<br>1.27<br>1.21<br>1.27<br>1.344<br>1.414<br>1.457<br>1.742<br>1.639<br>1.945<br>2.05<br>2.127<br>2.427<br>2.635<br>2.477<br>2.635<br>2.427   | 4
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| 1.752<br>1.752<br>1.177<br>1.165<br>1.217<br>1.257<br>1.277<br>1.42<br>1.42<br>1.42<br>1.437<br>1.45<br>1.777<br>1.45<br>1.777<br>1.45<br>1.277<br>2.14<br>2.277<br>2.14<br>2.770<br>2.841   | 1.55<br>1.55<br>1.15<br>1.15<br>1.15<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1.55<br>1 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  | 1. 76<br>1. 76<br>1. 17<br>1.   |           |
| 1 <sup>5</sup><br>2°<br>4°<br>7 <sup>5</sup><br>8°<br>3°<br>10°<br>11 <sup>6</sup><br>13°<br>14°<br>15°<br>16°<br>17°<br>18°<br>19°<br>20°<br>21°  | 342           1.751           1.107           1.155           1.225           1.235           1.235           1.236           1.364           1.440           1.524           1.618           1.335           2.065           2.210           2.371           2.524           2.907           3.272           3.594           3.97*   | 40°<br>1.651<br>1.105<br>1.105<br>1.289<br>1.359<br>1.359<br>1.434<br>1.516<br>1.632<br>1.697<br>1.601<br>1.915<br>2.040<br>2.178<br>2.331<br>2.505<br>2.700<br>2.662<br>3.177<br>3.472<br>3.922   | 41°<br>1.051<br>1.104<br>1.222<br>1.288<br>1.354<br>1.423<br>1.505<br>1.505<br>1.504<br>1.697<br>1.789<br>1.897<br>2.016<br>2.151<br>2.296<br>2.401<br>2.656<br>3.096<br>2.371<br>3.430  
   | 42°<br>1.051<br>1.104<br>1.219<br>1.219<br>1.219<br>1.219<br>1.219<br>1.251<br>1.425<br>1.503<br>1.503<br>1.507<br>1.677<br>1.776<br>1.693<br>2.126<br>2.427<br>2.602<br>2.796<br>3.281<br>2.579   | 43°<br>1. 51<br>1.104<br>1.159<br>1.219<br>1.237<br>1.348<br>1.420<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.443<br>2.438<br>2.502<br>2.337<br>3.202<br>7.440  | 44 <sup>1</sup><br>1. <sup>5</sup> 51<br>1.174<br>1.179<br>1.21-<br>1.2-1<br>1.347<br>1.415<br>1.437<br>1.415<br>1.437<br>1.415<br>1.437<br>1.455<br>1.655<br>1.655<br>1.947<br>2.069<br>2.220<br>2.325<br>2.524<br>2.708<br>2.909<br>3.134<br>(.354)   
  | 45°<br>1.551<br>1.152<br>1.159<br>1.172<br>1.260<br>1.345<br>1.415<br>1.4260<br>1.559<br>1.4260<br>1.559<br>1.4260<br>1.559<br>2.702<br>2.201<br>2.341<br>2.497<br>2.707<br>2.707<br>2.707<br>2.727  | 4.6°<br>1. ±1<br>1.12<br>1.15<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.216<br>1.260<br>1.244<br>1.446<br>1.360<br>2.059<br>2.127<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.427<br>2.4272<br>2.427<br>2.427<br>2.4272<br>2.4272<br>2.4272<br>2.4272<br>2.4272<br>2.4272<br>2.4272<br>2.4272<br>2.4272<br>2.4272<br>2.4272<br>2.4272<br>2.4272<br>2.4272<br>2.4272<br>2.4272<br>2.4272<br>2.4272<br>2.4272<br>2.4272<br>2.4272<br>2.4272<br>2.4272<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.4772<br>2.477  | 4-**<br>1.051<br>1.132<br>1.157<br>1.21F<br>1.226<br>1.344<br>1.412<br>1.465<br>1.544<br>1.442<br>1.465<br>1.544<br>1.442<br>1.465<br>1.544<br>2.444<br>2.049<br>2.344<br>2.444<br>2.010<br>2.747<br>2.344<br>3.504   | 44<br>1.151<br>1.174<br>1.15-<br>1.275<br>1.342<br>1.412<br>1.425<br>1.445<br>1.571<br>1.645<br>1.773<br>1.625<br>1.825<br>2.040<br>2.159<br>2.471<br>2.597<br>2.475<br>2.597<br>2.597<br>2.545<br>2.545  
  | 1.75:<br>1.14<br>1.15:<br>1.14<br>1.15-<br>1.412<br>1.443<br>1.443<br>1.720<br>1.443<br>1.720<br>1.824<br>2.033<br>2.149<br>2.276<br>2.415<br>   | 1.775<br>1.174<br>1.125<br>1.215<br>1.215<br>1.255<br>1.441<br>1.412<br>1.425<br>1.442<br>1.442<br>1.442<br>1.442<br>1.442<br>1.442<br>1.442<br>1.442<br>1.442<br>1.442<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1. |
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1.52<br>1.52<br>1.17<br>1.17<br>1.17<br>1.52<br>1.47<br>1.47<br>1.47<br>1.47<br>1.47<br>1.47<br>1.47<br>1.47<br>1.47<br>1.57<br>1.47<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1.57<br>1 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| 1 <sup>5</sup><br>2°<br>3°<br>4°<br>7 <sup>5</sup><br>8°<br>7 <sup>7</sup><br>8°<br>3°<br>10°<br>11°<br>11°<br>13°<br>14°<br>15°<br>16°<br>17°<br>18°<br>19°<br>20°<br>21°<br>22°  | 34 <sup>2</sup><br>1. 61<br>1.107<br>1.165<br>1.225<br>1.235<br>1.235<br>1.235<br>1.244<br>1.440<br>1.524<br>1.410<br>1.524<br>1.410<br>1.524<br>1.414<br>1.618<br>1.335<br>2.065<br>2.210<br>2.371<br>2.524<br>2.730<br>2.997<br>3.272<br>3.594<br>3.977<br>4.445<br>5.020   | 40°<br>1.051<br>1.105<br>1.105<br>1.224<br>1.269<br>1.359<br>1.434<br>1.516<br>1.032<br>1.637<br>1.637<br>1.632<br>1.697<br>1.601<br>1.915<br>2.040<br>2.178<br>2.331<br>2.505<br>2.700<br>2.682<br>3.177<br>3.472<br>3.472<br>3.472<br>4.240  | 41°<br>1.051<br>1.104<br>1.227<br>1.288<br>1.354<br>1.423<br>1.505<br>1.505<br>1.504<br>1.697<br>1.789<br>1.897<br>2.016<br>2.151<br>2.226<br>2.481<br>2.656<br>3.096<br>2.371<br>3.490<br>4.771<br>4.527  
   | 42°<br>1.051<br>1.104<br>1.219<br>1.219<br>1.294<br>1.251<br>1.425<br>1.503<br>1.597<br>1.677<br>1.776<br>1.673<br>1.998<br>2.126<br>2.269<br>2.427<br>2.602<br>2.799<br>3.426<br>3.221<br>3.281<br>7.579<br>3.426<br>4.747  | 43°<br>1. 51<br>1.104<br>1.159<br>1.219<br>1.218<br>1.420<br>1.420<br>1.428<br>1.420<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.429<br>1.420<br>1.429<br>1.420<br>1.429<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.420<br>1.440<br>1.420<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.440<br>1.44 | 44 <sup>1</sup><br>1. 51<br>1.104<br>1.159<br>1.21-<br>1.241<br>1.347<br>1.415<br>1.493<br>1.574<br>1.493<br>1.574<br>1.662<br>1.947<br>2.069<br>2.325<br>2.524<br>2.909<br>3.134<br>2.355<br>2.524<br>2.909<br>3.134<br>2.355<br>2.524<br>2.909  
  | 45°<br>1.351<br>1.122<br>1.159<br>1.159<br>1.345<br>1.455<br>1.450<br>1.55%<br>1.455<br>1.749<br>1.655<br>1.749<br>1.655<br>2.772<br>2.201<br>2.341<br>2.497<br>2.497<br>2.751<br>2.49<br>3.722<br>3.725<br>2.49   | 4.6°<br>1. ±1<br>1.12<br>1.157<br>1.215<br>1.215<br>1.215<br>1.215<br>1.215<br>1.257<br>1.414<br>1.444<br>1.457<br>1.742<br>1.639<br>1.742<br>1.639<br>1.745<br>2.053<br>2.197<br>2.635<br>2.197<br>2.635<br>2.197<br>2.635<br>2.479<br>2.635<br>2.475<br>3.527<br>3.527<br>3.521   | 4 <sup></sup><br>1.051<br>1.132<br>1.157<br>1.21F<br>1.278<br>1.284<br>1.412<br>1.465<br>1.594<br>1.465<br>1.594<br>1.465<br>1.594<br>2.345<br>2.345<br>2.444<br>2.444<br>2.444<br>2.444<br>2.444<br>2.444<br>3.597<br>2.597<br>2.597<br>3.597<br>2.597   |
44<br>1.151<br>1.151<br>1.251<br>1.274<br>1.215<br>1.274<br>1.245<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.445<br>1.465<br>1.465<br>2.040<br>2.154<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447<br>2.447 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1.752<br>1.752<br>1.165<br>1.277<br>1.277<br>1.427<br>1.422<br>1.422<br>1.422<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>1.457<br>2.14<br>2.524<br>2.777<br>2.14<br>2.524<br>2.777<br>2.14<br>2.777<br>2.14<br>2.777<br>2.741<br>2.777<br>2.741<br>2.777<br>2.741<br>2.777<br>2.741<br>2.777<br>2.741<br>2.777<br>2.741<br>2.777<br>2.741<br>2.777<br>2.741<br>2.777<br>2.741<br>2.777<br>2.777<br>2.741<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.777<br>2.7777<br>2.7777<br>2.7777<br>2.7777<br>2.7777<br>2.7777<br>2.7777<br>2.7777<br>2.77777<br>2.777777<br>2.7777777777  | 55<br>1. 55<br>1. 55<br>1. 100<br>1. 1  | 1. 54<br>1.1 - 1<br>1.1 - 1<br>1.1 - 1<br>1.1 - 1<br>1.5 - 1<br>1.5 - 1<br>1   | 1. 15<br>1. 17<br>1.   |           |
1 <sup>5</sup> 2 <sup>8</sup> 3 <sup>6</sup> 3 <sup>7</sup> 8 <sup>9</sup> 3 <sup>10</sup> 10 <sup>7</sup> 11 <sup>2</sup> 13 <sup>4</sup> 15 <sup>9</sup> 18 <sup>9</sup> 21 <sup>9</sup> 22 <sup>9</sup> 23 <sup>9</sup> 22 <sup>9</sup>	34 <sup>2</sup> 1. 61 1.107 1.165 1.225 1.235 1.235 1.235 1.235 1.24 1.440 1.524 1.440 1.524 1.410 1.524 1.410 1.618 1.335 2.065 2.210 2.371 2.524 2.739 2.937 3.272 3.594 3.977 4.445 5.020 5.753	40° 1.051 1.105 1.105 1.224 1.269 1.359 1.434 1.516 1.632 1.632 1.637 1.632 1.632 1.637 1.632 2.040 2.178 2.331 2.505 2.700 2.662 3.177 3.472 3.922 4.140 4.754 5.347	41° 1.051 1.14 1.12 1.22 1.288 1.354 1.429 1.505 1.504 1.429 1.505 1.504 1.697 2.016 2.151 2.298 2.481 2.646 2.656 3.096 7.371 3.401 4.57 F.74P	42° 1.051 1.104 1.219 1.219 1.284 1.351 1.425 1.503 1.597 1.677 1.776 1.673 1.999 2.126 2.269 2.427 2.602 2.799 3.027 3.281 7.579 3.281 7.579 3.281 7.579	$\begin{array}{c} 43^{\circ} \\ 1.^{\circ} 51 \\ 1.104 \\ 1.109 \\ 1.219 \\ 1.219 \\ 1.219 \\ 1.243 \\ 1.498 \\ 1.420 \\ 1.498 \\ 1.591 \\ 1.699 \\ 1.992 \\ 2.105 \\ 2.243 \\ 2.336 \\ 2.592 \\ 2.756 \\ 2.351 \\ 3.202 \\ 3.460 \\ 3.414 \\ 4.14 \\ 4.14 \\ 4.14 \\ 1.44 \\ \end{array}$	44" 1. "51 1.104 1.159 1.21- 1.241 1.497 1.497 1.498 1.574 1.498 1.574 1.662 1.947 2.069 2.220 2.325 2.524 2.708 2.909 3.124 (.374 2.909 3.124 (.374 2.909 3.124 (.374 (.374) (.374) (.374) (.374) (.374) (.374) (.374) (.374) (.374) (.374) (.374) (.375) (.3	45° 1.351 1.122 1.159 1.159 1.260 1.315 1.415 1.415 1.415 1.450 1.5% 1.655 1.742 1.655 1.742 1.655 2.772 2.201 2.341 2.49°	4.6° 1. ±1 1.12 1.15 <sup></sup> 1.21 <sup>6</sup> 1.27 <sup>4</sup> 1.344 1.457 1.742 1.639 1.945 2.05 <i>J</i> 2.127 2.636 2.477 2.636 2.427 3.202 3.521 4.147	4 <sup></sup> 1. (51 1.132 1.157 1.216 1.278 1.278 1.278 1.278 1.425 1.554 1.554 1.554 1.554 1.554 1.554 2.175 2.304 2.405 2.175 2.304 2.405 2.757 2.350 2.757 2.350 2.757 2.350 2.757 2.350 2.757 2.350 2.757 2.350 2.757 2.350 2.757 2.350 2.757 2.350 2.757 2.350 2.757 2.350 2.757 2.350 2.757 2.350 2.757 2.350 2.757 2.350 2.757 2.350 2.757 2.357 2.757 2.357 2.757 2.357 2.757 2.357 2.757 2.357 2.757 2.357 2.757 2.357 2.757 2.357 2.7577 2.7577 2.7577 2.7577 2.7577 2.7577 2.7577 2.75777 2.75777 2.757777 2.7577777777777777777777777777777777777	44 1.151 1.154 1.254 1.275 1.275 1.342 1.425 1.445 1.561 1.645 1.561 1.645 1.562 1.625 2.040 2.159 2.289 2.289 2.289 2.289 2.289 2.289 2.289 2.289 2.289 2.289 2.289 2.289 2.440 2.289 2.490 2.4000 2.4000 2.4000 2.4000 2.4000 2.4000 2.4000 2.40000 2.4	1.75: 1.14 1.15: 1.14 1.15- 1.54 1.40 1.4	1.773 1.174 1.174 1.215 1.215 1.215 1.255 1.444 1.412 1.475 1.642 1.750 2.442 2.727 2.142 2.727 2.142 2.755 2.442 2.551 2.455 2.455 2.455 2.455 2.455 2.455 2.455 2.455 2.455 2.555 2.455 2.455 2.455 2.555 2.455 2.	1. 51 1. 51 1. 14 1. 14 1. 14 1. 14 1. 51 1. 345 1. 34	1. 1731 1. 175 1. 175 1. 175 1. 175 1. 175 1. 175 1. 175 1. 47 1. 54 1. 47 1. 54 1. 54	1.52 1.52 1.17 1.17 1.17 1.17 1.47 1.47 1.47 1.47 1.47 1.47 1.47 1.47 1.47 1.45 1.47 1.45 1.47 1.45 1.47 2.57 2.57 2.57 2.74	1. 52 1. 52 1.177 1.165 1.217 1.42 1.42 1.42 1.42 1.42 1.42 1.45	55 1. 55 1. 55 1. 10 1. 10	- 1. 56 1.1 - 1.1 - 1.1 - 1.1 - 1.1 - 1.1 - 1.2 -	1 E 1 E 1 11 1 11 1 21 1 21 1 24 1 44 1 3 1 3 1 3 1 3 1 3 1 3 1 3 1	
1 <sup>5</sup> 2 <sup>5</sup> 3 <sup>4</sup> 5 <sup>6</sup> 3 <sup>7</sup> 10 <sup>9</sup> 11 <sup>1</sup> 12 <sup>5</sup> 13 <sup>1</sup> 14 <sup>1</sup> 15 <sup>6</sup> 11 <sup>2</sup> 13 <sup>1</sup> 14 <sup>1</sup> 15 <sup>9</sup> 11 <sup>2</sup> 13 <sup>2</sup> 11 <sup>2</sup> 13 <sup>2</sup> 11 <sup>2</sup>	342           1. 61           1.107           1.105           1.225           1.235           1.235           1.235           1.235           1.235           1.235           1.235           1.235           1.235           1.235           1.241           1.514           1.618           1.335           2.065           2.210           2.371           2.524           2.937           3.594           3.977           4.445           5.020           5.753           6.718           8.015	40° 1.051 1.105 1.1283 1.224 1.289 1.359 1.434 1.516 1.632 1.637 1.631 1.915 2.040 2.178 2.331 2.505 2.700 2.662 3.177 3.472 3.922 4.140 4.757 5.347 2.3	41° 1.051 1.104 1.222 1.228 1.228 1.228 1.228 1.229 1.228 1.229 1.229 1.229 1.229 1.505 1.534 1.429 1.505 1.534 1.429 1.505 1.534 1.429 1.505 1.534 1.429 1.505 1.534 2.016 2.016 2.298 2.491 2.646 2.656 3.096 2.371 3.430 4.77 4.577 5.049 3.430 4.774 5.049 3.430 4.774 5.049 3.430 4.774 5.049 3.430 4.774 5.049 3.430 4.774 5.049 3.430 4.774 5.049 3.430 4.774 5.049 3.430 4.774 5.049 3.430 4.774 5.049 3.430 4.774 5.049 3.430 4.774 5.049 3.430 4.774 5.049 3.430 4.774 5.049 3.430 4.774 5.049 3.430 4.774 5.049 3.430 4.774 5.049 3.430 4.774 5.049 3.430 3.430 5.049 3.450 5.049 3.430 5.049	42° 1.051 1.104 1.219 1.219 1.219 1.219 1.251 1.425 1.503 1.50	43° 1. 51 1.154 1.219 1.258 2.205 2.305 2.35	44" 1."51 1.174 1.179 1.21- 1.2-1 1.415 1.2-1 1.457 1.415 1.457 1.457 1.457 1.662 1.947 2.069 2.220 2.325 2.526 2.555 2.556 2.556 2.5555 2.5555 2.5555 2.5555 2.5555 2.5555 2.5555 2.5555 2.5	45° 1.351 1.122 1.159 1.112 1.260 1.315 1.415 1.415 1.429 1.655 1.749 1.655 1.749 1.655 2.772 2.201 2.341 2.497 2.530 2.530 2.530 2.530 2.575 2.530 2.575 2.530 2.575 2.57	4.6° 1. ±1 1.12 1.157 1.215 1.215 1.215 1.215 1.215 1.257 1.344 1.414 1.457 1.742 1.639 1.945 2.055 2.197 2.655 2.321 2.477 2.625 2.524 3.544 3.5444 3.5444 3.5444 3.5444 3.5444 3.5444 3.54444 3.54444 3	4 <sup></sup> 1. (51 1.132 1.157 1.216 1.278 1.216 1.278 1.412 1.455 1.442 1.455 1.544 1.442 1.455 1.544 1.544 2.345 2.345 2.444 2.747 2.346 2.346 2.747 2.347 2.346 2.747 2.347	44 1.551 1.154 1.554 1.275 1.275 1.275 1.412 1.425 1.425 1.425 1.425 1.425 1.425 1.425 1.425 1.425 1.425 1.425 2.040 2.159 2.040 2.159 2.475	44           1.15:           1.14           1.5:           1.15:           1.27:           1.412           1.412           1.412           1.412           1.412           1.412           1.412           1.412           1.412           1.412           1.412           1.412           1.412           1.412           1.412           1.422           1.422           1.422           1.422           1.422           1.422           1.422           1.422           1.422           1.422           1.422           1.422           1.422           1.422           1.427           1.427           1.427           1.427           1.427           1.427           1.427           1.427           1.427           1.427           1.427           1.427           1.427      1.4217	2.775 1.775 1.174 2.155 1.215 1.215 1.255 1.425 1.425 1.425 1.425 1.425 1.425 1.425 1.425 1.425 1.425 2.425 2.727 2.143 2.755 2.436 2.436 2.456 2.456 4.551 2.551 2.551 2.556 2.456 2.456 4.555 4.555 4.556 4.557 4.556 4.557 4.557 4.557 4.557 4.557 4.557 4.576 4.576 4.577 4.576 4.577 4.57577 4.57577 4.57577 4.575777 4.5757777777777777777777777777777777777	-1           1.171           1.14           1.14           1.14           1.14           1.51           1.345           1.345           1.44           1.51           1.644           1.71           1.644           1.72           1.621           1.644           1.72           1.621           1.621           1.621           1.621           1.621           1.621           1.725           2.140           1.725           2.141           1.725           2.141           1.725           2.141           1.725           2.141           1.725           2.171           3.512           4.1442	1.731 1.731 1.75 1.15 1.15 1.47 1.47 1.47 1.47 1.54 1.47 1.54 1.54 1.54 1.54 1.54 1.54 1.54 1.54 1.54 1.54 1.54 1.55 1.55 1.55 2.7544 2.754 2.7	1.52 1.52 1.17 1.17 1.17 1.17 1.17 1.47 1.47 1.47 1.47 1.47 1.47 1.47 1.57 1.47 1.57 1.57 1.57 2.57 2.57 2.57 2.57 2.030 7.73 2.47 7.45 2.47 7.45 2.47 7.45 2.47 7.45 2.47 7.45 2.47 7.45 2.47 7.45 2.47 7.45 2.47 7.45 2.47 7.45 2.47 2.57	1.752           1.175           1.165           1.277           1.427           1.427           1.421           1.421           1.421           1.421           1.421           1.421           1.421           1.422           1.4231           1.422           1.4231           1.422           1.4231           1.422           1.4231           1.422           1.4231           1.422           1.424           2.207           2.44           2.207           2.44           2.44           2.44           2.45           2.44           2.457           2.447           2.447           3.427           3.427	55 1. 5. 1. 5.	- - - - - - - - - - - - - -	1 E 1 E 1 1 1 1 1 1 1 2 1 4 1	
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-	2	2.040	<i></i>	4.140	2.005	2	1.540	1.58/	1.000	1.818	1.765	1.755	1.730	1.708	1.666	1.679	1.062	1.2	1.524
3.147	2.891	2.693	2.540	2.410	2.306	2.216	2.141	2.078	2.020	1.973	1.929	1.892	1.890	1.830	1.804	1.781	1 761	1	1 74
3.859	3.455	3.155	2.915	2.743	2.596	2.475	2.373	2.288	2.214	2,151	2.098	2.048	2.05	1.97	1.925	1.000	1 879	1.5.	· 5725
4.950	4.264	3.786	3.438	3.17:	2.903	2.794	2.655	2.541	2.4.2	2.359	2.289	2.225	2.172	2.12	2.081	2 C4B	2.0.0	9 64.9	1 20
.5 ( 6.650	5.527	4.708	4.149	3.741	3.437	<b>3.19</b> 3	3.00:	2.847	2.715	2.66	2.512	2.432	2 243	2 302	2 240	2 202	2 160	- 100	1.000
10.957	7.797	6.179 .	5.200	4.542	4.072	3.720	3.447	3.228	3.051	2.504	2.779	2.674	2.525	2.508	2.440	2.281	5 720	5 200	C C.15
0,2	<u> </u>		<u> </u>						<b> </b>										2.010
.0, 26.528	13.022	8.305	6.921	5.745	4.977	4.432	4.023	3.714	3.46?	3.23?	3.103	2.933	2.847	2.749	2.061	2.587	2.522	2.464	£.415
*	38.025	15.712	10.23:	7,763	6.359	5.453	4.623	4.758	4.303	3.725	3.501	3.313	3.160	3.030	2.919	2.925	2.741	2.00	2.635
1		ez.ez7	19.326	11.848	9.743	7.050	5.982	5.254	4.720	4.318	4.003	3.749	3.542	3.371	3.225	3.103	2.597	2.3.8	2.82.
ì			151.658	24.488	13.841	9.686	7.834	6.576	÷.725	5.118	- 558	4.303	4.017	3.787	3.594	3.434	3.299	3.192	3.064
į	1				32.419	16.383	11.259	8.737	7.243	6.255	5.551	5.031	4.629	4.309	4.049	3.637	3.658	3.50e	3.391
						48.233	0 75	12 010	0.000	9.000	8 P70	8 022	5 479	4 000	·	4 774			
÷.	1	]				10.003	78 262	26 200	8.75/	41.000	6 6229	17 CM2	8 607	4.802 5.005	4.002	*.004	4.098	3.901	3.738
*	1	1		1			10.000	102 24	14.958	11.023	12 10	1.505	0.007	3.835	0.5/1	4.9(5	4.642	4.350	4.160
*	1	1	1					196.004	31.19;	17.553	20.000	9.000	0.201	163	0.001	5.798	5.342	4.979	4.827
ŧ		ļ	<b> </b> ,		. 1					42.23	AU-900	15.220	11.052	8-100	1.00%	5.534	6.265	5.753	5.349
· · · · · · · · · · · · · · · · · · ·	<u> -</u>			L			]				0.054	610.02	10.52	16.521	10.098	0.595	7.555	6.792	6.212
												117.675	32.419	19.381	14.103	11.250	9.473	8.257	7.379
10	l				•							[	630.384	43.22A	23.142	16.168	12.617	10.485	9.080
r	1											1			63.02:	28.381	19.770	14.278	11.668
	[	[														111.845	25.169	22.167	16.307
										-							115.687	48.659	28.822
													d						
						~		L				i							73.395
			·																
8	- 0°	<b>50</b> 0	me	<b></b> °	~~°	070		~ 0	~~°			600	~~°	<b>n</b> 4 <sup>0</sup>		0	~ °	~0	
	- <sup>54</sup>	59	<u> </u>	61	02	60	57	60	66	67	68	00	-70°	-71	72	73	74	10	76
CE.	4.955							4.000	4.000	4.200		4.075					4.00%	1.000	4 4 9 7
.11	1.055	1.056	1.058	1.059	1.061	1.062	1.064	1.065	1.065	1.069	1.072	1.075	1.078	1.081	1.085	1.089	1.053	1.135	1.10
.17 1.111	1.112	1.115	1.117	1.120	1.122	1.125	1.128	1.133	1.136	1.141	1.146	1.152	1.157	1.165	1.172	1.181	1.191	1.205	1.216
.27 .1.171	1.174	1.177	1.180	1.182	1.187	1.192	1.197	1.202	1.208	1.215	1.222	1.231	1.240	1.249	1.263	1.277	1.23	1.311	1.331
1.231	1.236	1.239	1.243	1.249	1.254	1.260	1.267	1.275	1.283	1.282	1.302	1.315	1.327	1.3;2	1.358	1.378	1.398	1.423	1.452
.30	1.301	1.305	1.312	1.318	1.324	1.331	1.341	1.350	1.361	1.373	1.386	1.401	1,417	1.436	1.456	1.482	1.509	1.540	1.577
1.364	1.368	1.375	1.381	1.389	1.398	1.407	1.417	1.429	1.442	1.456	1. 172	1.490	1.511	1.533	1.559	1.589	1.624	1.002	1,709
. 1.434	1.440	1.447	1.455	1.464	1.474	1.465	1.496	1.511	1.527	1.543	1.563	1.584	1.609	1.635	1.667	1.702	1.743	1.752	1.548
.5. 1.509	1.516	1.524	1.532	1.541	1.553	1.566	1.581	1.597	1.614	1,635	1.658	1.662	1.711	1.743	1.780	1.821	1.870	1.320	1,991
1.587	1.594	1.602	1.614	1.624	1.637	1.652	1.669	1.686	1.708	1.730	1.755	1.785	1.818	1.855	1.697	1.946	2.002	2.068	2.143
.6																			
76 1.669	1.677	1.687	1.697	1.711	1.725	1.742	1.761	1.781	1.604	1.830	1.850	1.592	1.829	1.973	2.020	2.078	2.141	2.216	2.306
, AF 1, 755	1.764	1.776	1.788	1.801	1.818	1.835	1.856	1.577	1.906	1.535	1.967	2.005	2.048	2.096	2.151	2.214	2.288	2.373	2.475
.95 1.848	1.856	1.669	1.663	1.697	1.915	1.935	1.958	1.984	2.013	2.046	2.081	<.124	2.172	2.228	2.288	2.359	2.442	2.541	2.655
.0 1.945	1.955	1.957	1.982	1.998	2.015	:040	2.065	2.092	2.126	2.162	2.202	2.249	2.302	2.362	2.432	2.512	2.608	2.715	2.947
-2.0.8	2,069	2.072	2.089	2.106	2.126	2.151	2.178	2.210	2.245	2.284	2.329	2.381	2.440	2.508	2.585	2.674	<b>3.7</b> 79	2.904	3.351
.1 9, 158	2,170	2,183	2:201	2,220	2,243	2,200	2,298	2.331	2.371	2.415	2.464	2,522	2,597	2.661	2.748	2,847	2,963	3.103	3.287
21 2 270	2.288	2.201	2.301	2.341	2.365	2,302	2,427	2.461	2.505	2,524	2,609	2.670	2.741	2,505	2,910	3.020	3.160	3.313	3,501
-41 2.403	2,415	2.430	2.448	2,470	2.497	2,528	2.562	2.602	2.848	2,700	2.759	2.827	2,906	2,997	3,103	3,225	3.371	3.542	3.749
.5 2.511	2.551	2.569	2,587	2.610	2.638	2,670	2,708	2.750	2.798	2.858	2,922	2,997	3.054	3,180	3,299	3:434	3.594	3,787	4.017
2.687	2,698	2.713	2.737	2.759	2,787	2.821	2.851	2,008	2.963	3.023	3.096	3.177	3.272	3.381	3,508	3.658	3.837	4.049	4.309
80.00		~~~~~																	
2.845	2.858	2.872	2.892	2.917	2.949	2.986	3.028	3.079	2.961	3.203	3.281	3.371	3.472	3.594	3.738	3.901	4.098	4.334	4.622
3.018	3.030	3.044	3.065	3.091	3.124	3.162	3.208	3.262	3.323	3.396	3.480	3.579	3.690	3.824	3.977	4.160	4.380	4.642	4.965
3.208	3.218	3.232	3.252	3.252	3.279	3.311	3.353	3.401	3.459	3.526	3.605	3.695	3.801	3.926	4.240	4.445	4.687	4.979	5.342
3.416	3.424	3.437	3.457	3.483	3.519	3.560	3.613	3.674	3.747	3.831	3.829	4.048	4.180	4.340	4.526	4.753	5.020	5.349	5.753
3.645	3.650	3.661	3.679	3.706	3.741	3.787	3.840	3.907	3.983	4.075	4.183	4.309	4.457	4.632	4.839	5.086	5.386	5.753	6.212
N 2	<u> </u>																{	ł	1
.1 53.898	3.898	3.807	3.926	3.952	3.989	4.034	4.092	4.163	4.246	4.343	4.460	4.600	4.759	4.955	5.182	5.457	5.792	6.204	6.718
4. 4.183	4.177	4.183	4.198	4.222	4.261	4.306	4.367	4.442	4.533	4.638	4.766	4.917	5.094	5.305	5.559	5.864	6.238	8.700	7.283
4.501	4.488	4.488	4.501	4.526	4.561	4.609	4.674	4.753	4.849	4.965	5.101	5.265	5.460	5.694	5.978	6.320	8.737	7.258	7.928
.2 4.863	4.843	4.836	4.843	4.863	4.897	4.948	5.013	5.097	5.200	5.323	5.475	5.655	5.868	6.128	6.442	6.825	7.298	7.889	8.650
5.276	5.243	5.229	5.229	5.243	5.278	5.327	5.393	5.483	5.593	5.725	5.889	6.090	6.328	0.613	6.963	, 7.395	7.928	8.608	9.487
76 753	5.708	5.874	5' 687	5.874	5.706	5.753	5.824	5.917	6.032	6.178	6.359	6.576	6.839	7.163	~. 565	8.015	5.850	9.470	10.455
-	0.700	0.0/4	0.007														0.000	00406	
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A COMPANY AND A DESCRIPTION OF A DESCRIP					A DESCRIPTION OF THE OWNER OF	19.00 10.00 10.00				Contraction of the local division of the loc			- ,						

μ	<u>f</u> (μ)	g(μ)	h(µ)	μ	f (µ)	g(μ)	h(μ)
90°	130,45°	.5283	-6339	440	120.32°	.2971	4203
89°	130.45	5282	.6339	43°	119.54	2860	4059
. 05 88°	130.45	.5279	.6336	42°	118.71	.2746	3972
87°	130.45	.5274	6332	41°	117.83	.2630	3352
ŭ6°	130.45	5268	6326	-40°	116.90	.2512	3797
85°	130.44	.5259	.6319	39°	115.92	.2391	.3599
81°	130.44	.5249	-6310	38°	114.88	.2269	.3467
83°	130.42	.5236	.6300	37°	113.77	.2146	.3331
·82°	130.41	.5222	.6287	36°	112.61	.2022	.3192
81°	130.39	.5206	.6274	35°	111.37	.1897	.3050
50°	130.37	.5188	.6258	34°	110.07	.1772	.2905
79°	* 130.34	.5168	.6241	33°	108.70	.1647	.2757
78°	130.31	.5146	.6222	32°	107.23	.1522	.2607
77°	130.27	.5122	.6201	31°	105.69	.1399	.2454
76°	130.22	.5096	.6178	30°	104.08	.1278	.2301
75°	130.16	.5067	.6154	29°	102.36	.1159	.2145
74°	130.10	.5037	.6127	· 28°	100.56	.1043	.1990
73°	130.03	.5005	.6099	27°	98.65	.09313	.1835
72°	129.95	.4970	.6069	26° .	96.64	.08237	.1681
71°	129.85	.4933	.6037	25°	94.53	.072i1	.1529
70°	129.75	.4894	.6003	24°	92.30	.06243	.1379
69°	129.64	.4853	.5966	23°	89.96	.05338	.1233
68°	129.51	.4809	. 5928	22°	87,50	.04502	.1092
67°	129.37	.4763	.5887	21°	84.91	.03739	.09562
66°	129.22	.4715	.5845	20°	82.19	.03054	.08274
65°	129.05	. 4664	.5800	19°	79.34	.02447	.07063
64°	128.87	.4611	.5752	18°	76.31	.01919	.05937
63°	128.67	.4555	.5702	.17°	73.21	.01469	.04905
62°	128.45	.4497	.5650	- 16°	69.94	.01095	.03977
61°	128.22	.4436	.5595	15°	66.51	.00791	.03153
60°	127.97	.4372	.5538	14°	62.95	.00552	.02438
59°`	127.69	.4306	.5478	13°	59.23	.00370	.01832
58°	127.40	.4237	.5415	12°	55.37	.00237	.01331
·57°	127.08	.4165	.5349	11°	<b>51.37</b> ,	.00143	.00931
56°	126.74	.4090	.5281	. 10°	47.22	.00081	.00621
55°	126.38	.4013	.5209	9°	42.94	.00043	.00392
54°	125.99	.3933	.5135	8°	38.53	.00020	.00232
53°	125.57	.3850	.5057	7°	34.00	.00009	.00126
520	125.12	.3763	.4976	6°	29.36	.00003	.00061
51°	124.64	.3675	.4891	5°	24.63	.00001	.00026
50°	124.14	.3583	.4804	4°	19.81	.00000	.00009
49°	123.59	.3488	.4713	3°	14.92	.00000	.00002
48°	123.02	.3390	.4618	2°	9.98	.00000	.00000
47°	122.40	.3289	.4520	1°	5,00	.00000	.00000
46°	121.75	.3186	.4418	0°	0.00	.00000	.00000
45°	121.06	.3080	.4312		1		

 TABLE 5

 Functions for Calculations of Expansive Flow

Ma Wm W. W<sub>20</sub> w, M. 1S.12° 0.05° 0.05°  $1.75 \\ 1.76$ 17.76° 1.01 18.34 18.55 18.76 0.15 0.26 0.13 17.98 1.02 9.24 18.20 18.41 1.77 1.78 1.03 0.40 1.04 18.63 18.84 0.56 18.97 0.52 0.67 1.05 1.79 19.18 1.80 1.81 1.66 19.04 19.05 19.26 0.84 1.02 1.21 1.41 19.39 0.91 1.07 19.59 1.10 1.08 1.9219.46 19.67 1.83 1.84 1.85 1.86 19.SO 1.30 1.09 20:00 1.10 1.51 19.07 19.87 20.07 20.27 20.47 1.731.962.1920.20 1.61 1.11 20.40 1.82 1.12 20.59 20.78 1.87 1.88 1.89 1.90 1.13 2.43 2.20 2.49 1.14 2.67 20.67 20.98 1.15 2.92 3.17 3.42 20.86 21.05 21.24 2.73 21.17 1.16 2.97 21.36 1.91 1.17 21.54 1.18 3.21 1.92 21.2421.4321.6221.8121.9921.73 21.91 3.68 1.93 1.19 3.45 $1.19 \\ 1.20 \\ 1.21 \\ 1.22 \\ 1.23 \\ 1.24 \\ 1.25 \\ .00$ 1.94 3.94 4.21 3.70 22.09 3.9522.27 4.21 4.48 1.96 22.137 222.35 222.35 222.53 22.71 22.88 23.40 23.56 23.73 23.90 24.02 24.38 24.54 24.51 22.45 4.46 4.74 1.97 22.6322.8022.974.725.01 1.98 1.99 2.00 2.01 2.02 4.995.291.26 1.27 1.28 1.29  $5.25 \\ 5.52$ 5,56 23.1423.315.835.78 6.11  $\begin{array}{c} 2.03\\ 2.04\\ 2.05\\ 2.06\\ 2.06\\ 2.09\\ 2.10\\ 2.12\\ 2.13\\ 2.14\\ 2.15\\ 2.16\\ \end{array}$ 23.48 6.05 6.3923.65 23.81 23.98 1.30 6.326.66 6.94 7.22 1.31 6.59 1.32 6.86 24.14 24.30 7.49 1.33 1.34 7.13 7.40 7.7724.46 8.05 1.35 7.67 24.61 24.77 24.92 1.36 7.94 8.32 8.60 1.37 8.21 1.38 8.43 8.88 24.79 24.85 25.01 25.16 25.31 25.46 25.61 25.76 24.92 25.08 25.23 25.38 25.52 25.67 25.82 25.96 9.15 1.39 8.76 1.40 9.03 9.431.41 9.30 9.70 9.57 9.97 1.42 10.25 10.52 2.17 1.43 9.84 2:18 10.10 1.44 25.76 25,90 2.1910.37 10.79 1.45 26.10  $2.20 \\ 2.21$ 1.46 10.64 11.05 26.24 26.38 26.05 10.90 11.32 1.47 2.212.222.232.242.2526.19 11.17 11.59 1.48 26.55 26.66 26.33 26.47 26.61 1.49 11.43 11.85 12.11 11.69 1.50 26.80 1.51 11.96 12.37 12.21 12.63 1.52 27,28 28.53 29.67 30.70  $2.3 \\ 2.4 \\ 2.5 \\ 0.10 \\ 0.1$ 27.45 1.53 12.47 12.89 27.45 28.68 29.80 30.81 31.74 32.59 12.73 13.151.54 1.55 12.99 13.402:6 2:7 2.8 1.56 13.24 13.66 31.6432.5033.291.57 13.49 13.91 14.16 1.58 13.74 33.36 2.9 1.59 13.99 14.41 34.07 3.0 34.01 14.24 14,65 1.60 1.61 14.49 14.90 38.77 38.75 15.14 4 1.62 14.73  $41.11 \\ 42.44$ 41.12 42.44 5 1.63 14.98 15.38 1.64 15.22 15,62 6 1.65 15.46 15.86 43.79 43.79 8 15.70 16.09 1.66 1.67 15.93 16.32 44.43 44.43 1.68 10 16.55 16.17 16.40 16.78  $1.79 \\ 1.71$ 15 45.07 45.07 16.63 17.01 16.86 17.24 $1.72 \\ 1.73$ 17.09 17.31 45.29 45.29 17.46 20 17.68 45.58 45.58 1.74 17.90 8 17.54

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TABLE 6 Wedge Angle for Sonic Flow Behind Shock Ware (w.). Maximum Wedge Angle (w.)

$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	us The theory and proctice of two-dimensional supersonic pressure calculations, Bunhlabee report No. 26 ML:	DGO AGENCY: Tho Johns Hopkins University, Applied Physics Laboratory, Silver Spring, 1004. 11. LANGLAGE OCCENELASS U. SCLASS, Dare Ages HUS, Laboratory, Giagramics Phys. 104. Accessed and the second second	As been demonstrated that an artitrary curve intersecting once and only once sech straight-line patching or characteristic curves in an exymaive supersonic flow straight-line patching or characteristic curve. This fact leads to the formules treated as if it upses a characteristic curve. This fact leads to the formules loulating pressure distributions over dirfoils inwerved in two-dimensional super- flows, and hence to lift, drug, and accent computations. The Analysis from the super- sted also outenaive tables for facilitating obliques shock from computations. The be report includes these corputation tables and the discussion of the principles dimensional supersonic flow.	, NO, AD KATEZA COMMAND / La VECHNICAI UNDER WRIGHT FIELD, OND, USAAF
Amogen, D. 25 (D. 27 (C. 27 (C	Alean muli. The th Burble Pocory. muli	CCECHATICA ACENC TRANSLATICA COUNTRY LANG	It has been of the streight can be treated for calculating muldial also Bumblabee repor but tro-dimonale	1-2, HQ, AD A

	CONENENTIAL		
TILE: The Theory and Practice of Two-Dimer	sionai Superso	onic Pressure Calculations	MTI- 5333
AUTHOR(S): Edmonson, N.: Murnaghan, F. D.: S	inow. R. M.		(JUDIE)
ORIGINATING AGENCY: Johns Hopkins Universi	ity. Silver Spri	ing, Md.	(None)
PUBLISHED BY: (Same)			PUBLISHERED AGENCY NO. (NORE)
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ABSTRACT:			
Extensive tables are calculated for facil	litating oblique	e shock front calculation on	atrfoils
of infinite span at supersonic speeds. E to formulas for calculating pressure dis	Explicit demon stributions and	stration of mathematical appresent the strategy and more the state of the strategy and more the strategy and more strate	proach ment
computations is presented for the first principles of supersonic aerodynamics.	time in a conci Report is ess	ise and accurate discussion sentially a manual for the tw	of 0-
dimensional case on theory and practice flow as far as present state of subject h	e of computatic as advanced.	m in supersonic, aerodynam	ltc
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