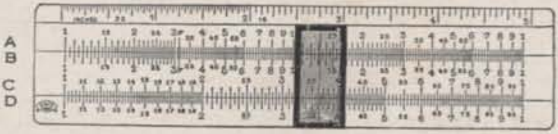
DIRECTIONS

FOR USING

"THE MINIATURE"

VEST POCKET SLIDE RULE



Introduction

By means of the "Miniature" Vest Pocket Slide Rule, various calculations may be made mechanically with greater ease and rapidity than by ordinary arithmetical methods, and usually with sufficient accuracy for all practical requirements.

Slide Rules are used principally for performing multiplication and division, but they may also be used for finding powers, roots, logarithms, and trigonometrical functions, and for various other purposes.

The "Miniature" Vest Pocket Slide Rule consists of three main parts. There is a main body or rule, a slide and a runner or "cursor".

Scales A and D (see fig. 1) are on the Rule, and scales B and C on the Slide. The Runner, which is in the form of a light metal frame that is free to slide endwise along the Rule, is also shown in Fig. 1.

Scales A and B are alike, as are scales C and D—all four scales are of the same length, but the graduations on scales A and B are different from those on scales C and D.

On scales C and D, if 1 at the extreme left is taken as unity then 1 at the extreme right of these scales is 10.

On scales A and B, if 1 at the extreme left is taken as unity, then 1 in the middle of the scale is 10 and 1 at the extreme right is 100.

In order that you may see how the Rule is used, on simple problems where you know the answers, let us take the following:

Example: 2x3

Opposite 2 on scale D set 1 on scale C. Then move the Runner so that the hair line is over 3 on scale C. Directly below this 3 you will find 6, the answer.

Example: 6÷3

Opposite 6 on scale D, set 3 on scale C. Look along C to the left, till you come to 1 at the end of the slide. Under this 1 you will find 2, the answer, on scale D.

HOW TO READ THE SCALES

Graduations on the Slide Rule are not measures of length, but represent figures.

To find a number, always read the first figure to the left on the prime line, the second figure of the number on the secondary line to the right thereof, and the third figure on the subdivision, thus, to read 245 (say two, four, five, not two hundred forty-five) find prime 2, secondary 4 and subdivision 5.

PLACING THE DECIMAL POINT

The decimal point is not considered in operating the Slide Rule. After the work of the Rule has been done, the decimal point can usually be placed by inspection; that is, through a mental survey of the influence of the involved factors upon the result. Where this is not feasible, a rough arithmetical calculation will serve to properly locate the decimal point.

WHICH INDEX TO USE

In most cases the following rule will be found useful in determining which index to use:

If the product of the first figures of the given numbers is less than 10, *use the left index; if this product is greater than* 10, *use the right index.*

Examples: 2.25 x 3.14, 2 x 3 = 6. Use the left index.
8.12 x 4.63, 8 x 4 = 32. Use the right index.
.14 x 5.23, 1 x 5 = 5. Use the left index.

PER CENT

Example: Suppose you are earning 62 cents per hour and you are given an increase of 6 cents. What per cent increase do you receive?

Of course, you will divide 6 by 62.

Set hair line to 6 on scale D, set 62 of scale C under hair line. Under right index of C read 968. The answer is 9.68 per cent.

Example: If your income is $3,400 per year and you save $625, what per cent do you save?

Set hair line to 625 on D, set 34 of scale C under hair line.

Under left index of C read 1838. The answer is 18.38 per cent.

COMBINED MULTIPLICATION AND DIVISION

Example: Find the value of

$$\frac{22.5 \times 39.4}{1860}$$

To 225 on D, set 186 on C. Opposite 394 on C find 476 on D. To obtain the decimal point make a rough calculation as follows:

$$\frac{22.5 \times 39.4}{1860} \text{ is roughly equal to } \frac{20 \times 40}{2000} = \frac{8}{20} = \frac{2}{5} = .4$$

Hence, we must place the decimal point so as to make 476 approximately equal to .4. The result is evidently .476.

PROPORTION

Example: If an aeroplane flying 125 miles an hour travels 25 miles in a given time, how far will an automobile traveling 35 miles an hour go in the same time?

$$125 : 35 = 25 : x$$

Which means that 125 is to 35 as 25 is to the answer.

The work on the Rule is as follows: Opposite 35 on D, set 125 on C. Opposite 25 on C read the answer 7 on D.

SQUARES

Example: Find the area of a square plot of ground measuring 70 yards on a side?

Set hair line at 70 of scale D. Read 4900 under hair line on scale A.

The answer may also be obtained by setting the right index of C to 7 on D. Opposite to 7 on C read 49 on D.

It is well to know these two methods, since different problems may make one method more convenient to use.

FIND THE AREA OF A CIRCLE

Example: Find the area of a circular plot of ground 14.5 feet in diameter.

Set constant c of scale C at 145 on D and opposite left index of B read the result 165 sq. ft. on A.

SQUARE ROOTS

Example: How long must one side of a square garden bed be made in order that it shall contain 16 square yards?

Here we have to find the square root of 16.

Set hair line to 16 on scale A. Under hair line find the result 4 on scale D.

CUBES

$$2^3 = 2 \times 2 \times 2$$

Set 1 of scale C over 2 of D. Opposite 2 of scale B read the result 8 on scale A.

VEST POCKET SLIDE RULE WITH SINE, TANGENT and LOGARITHM SCALES

PLANE TRIGONOMETRY

Sines

Reverse Slide so as to have the scale S (Sines) under scale A (index S opposite to right index of scale A).

The scale S is a scale of Sines. Angles are given on scale S, opposite their Sines on scale A when the indexes of A and S coincide.

Example: Find Sine 30°.

Opposite 30 on scale S is found its Sine on scale A. This reads 5. To place the decimal point, a number read on the right half of scale A has the first significant figure in the first decimal place, except Sine 90°, which is 1; a number read on the left half of scale A has the first significant figure in the second decimal place.

Hence, Sine $30^\circ = .5$.

Example: Find Sine 3°.

The significant figures are 523. The reading is on the left half of scales A and S, therefore the result is .0523.

For angles less than 40′ use formula: Sin a = .000291 a (measured in minutes).

Cosines

The Cosine of an angle is equal to the Sine of the complement of the angle.

Example: Find Cosine 30°.

$$\text{Cos. } 30^\circ = \text{Sin } (90^\circ - 30^\circ) = \text{Sin } 60^\circ = .866$$

Tangents

Scale T gives readings for angles whose tangents are found opposite on scale D. The first significant figure comes in the first decimal place for all values found on the Rule.

Example: Find tang 30°.

Opposite 30 on scale T, find 577 on D. Pointing off we have tan $30^\circ = .577$

The tangent of an angle less than 5° 43′ cannot be directly obtained, but the Sine may be used in place of the tangent, since the Sine and the tangent of any of these angles are identical to three significant figures.

$$\tan 1^\circ\, 40' = \sin 1^\circ\, 40' = .0291$$

The scale gives tangents only as far as 45°.

For larger angles, use the formula: $\tan A = \dfrac{1}{\tan (90^\circ - A)}$

Example: Find the tangent of 75°.

$$\tan 75^\circ = \frac{1}{\tan (90^\circ - 75^\circ)} = \frac{1}{\tan 15^\circ}$$

Opposite the right index of scale D, set 15° on scale T.

Opposite the left index of scale T, read 373 on scale D.

To place the decimal point, make a rough calculation, remembering that tan $45^\circ = 1$.

$$\frac{1}{\tan 15^\circ} = \frac{1}{1/3} = 3$$

Hence the result is 3.73.

Cotangents

The cotangent of an angle is equal to the tangent of the complement of the angle.

Example: Find Cot 60°.

$$\text{Cot } 60^\circ = \tan (90^\circ - 60^\circ) = \tan 30^\circ = .577.$$

Secant and Cosecant

The secant and cosecant may be found by the formulas:

$$\sec A = \frac{1}{\cos A}$$

$$\csc A = \frac{1}{\sin A}$$

LOGARITHMS

The L scale is a scale of equal parts by which the common logarithm of any number may be found.

Example: Find log 40.

Set left index of scale L or T at 4 of scale D. Set hair line above right index of D, read result 602 on scale L under hair line.

This 602 is the mantissa. The characteristic is found by the usual rule, taking one less than the number of figures at the left of the decimal point. Since 40 has two such figures, its characteristic is 1.

Hence, log 40 is 1,602.

SINE, TANGENT and LOGARITHM may be found without reversing slide.

Example: Find sin 30°.

Set 30 of scale S (reverse of Rule) at the mark near right or left end of body.

Under 1 of scale A read .5 on scale B.

Example: Find tan 30°.

Set 30 of scale T (reverse of Rule) on the mark at the left end of the body. Above 1 of scale D read .577 on C.

Example: Find. Log. 40.

Set 1 of scale C over 4 of D on reverse of rule, at the mark near right end of body, read 602 on scale L. This is the mantissa, the characteristic will be found as explained before.

SOLUTION OF TRIANGLES

By the Slide Rule a right triangle or an oblique triangle may be solved in a few seconds.

When great accuracy is required, as in surveying calculations, the work should be done by logarithms, and then checked by the Slide Rule. This check will show any gross error and will locate the error. For classes in Trigonometry it is recommended that the student proceed as follows:

(a) Solve the triangle by logarithms.

(b) Check by solving on the Slide Rule.

(c) If the Slide Rule shows that there is an error, find the error and correct it.

(d) If no error appears and it is desired to check to a greater degree of accuracy apply the usual trigonometric check.

The use of the Slide Rule saves time and locates the error in a particular part of the work.

TYPICAL EXAMPLES
RELATING TO VARIOUS OCCUPATIONS

Secretarial Work

A secretary in checking a traveling man's expense account for one week found the following items:

Railroad fares	$16.50
Hotel bills	$62.00
Total	$78.50

Find what per cent. of the total expense was used in hotel bill.

Solution: $62 \div 78.50 = 79.1$ per cent.

Opposite 62 on D set 785 on C; opposite right index of C read 791 on D.

Excavating

What will be the cost of excavating rock for a cellar measuring 32 feet x 17 feet to an average depth of 7 feet at $2.75 per cubic yard?

$$x = \frac{32 \times 17 \times 7 \times 2.75}{27}$$

(1) To 32 on D set 27 on C.
(2) Hair line to 17 on C.
(3) Right index of C under hair line.
(4) Hair line to 7 on C.
(5) Left index of C under hair line.

Opposite to 275 of C read result, 388 on D.

Per Cent of Profit

A merchant purchased a bill of goods for $420 and sold the same for $480. Find the per cent. of profit reckoned,

(a) On the cost;
(b) On the selling price.

Solution: Profit=$480—$420=$60.

Per cent. of profit reckoned on the cost $= \frac{60}{420} = 14.3\%$

Per cent. of profit reckoned on the selling price

$$= \frac{60}{480} = 12.5\%$$

Discount

Simple discount is set by reading the scales backwards, deducting from 100, thus for a discount of 18%, set right index at 82 (100—18=82), opposite any number on C, the answer will be found on D. This is equivalent to multiplying by 82%.

For a combination of discounts, set by the use of the hair line, thus for 25—15—5%, proceed as follows:

(1) Set right index of C at 75 (100—25) of D.
(2) Set hair line at 85 (100—15) of C.
(3) Set right index of C under hair line.
(4) Set hair line at 95 (100—5) of C.
(5) Set right index of C under hair line.

Opposite any amount on C read the answer on Scale D.

For frequently occurring discounts, a gauge mark should be made.

Compound Interest

How many years will it take a sum of money to double itself if deposited in a savings bank paying 4 per cent. interest, compounded semi-annually.

Using the formula $A=P(1+R)^n$, where A is the amount, P the principal, R the interest on \$1 for six months, and n the number of half years, if we take \$1.00 as P, we have

$$2=(1+.02)^n$$

$$\text{and } n=\frac{\log 2}{\log 1.02}=\frac{.301}{.0086}=35 \text{ half years or } 17\tfrac{1}{2} \text{ years.}$$

Chemistry

By weight 80 parts of sodium hydroxide combine with 98 parts of sulphuric acid—How many grams of sodium hydroxide will neutralize 50 grams of sulphuric acid?

Solution: $98:50=80:x.$

Above 50 on D set 98 on C; under 80 of C read the result, 40.8 on D.

Speeds of Pulleys

The diameter of the driving pulley is 8 inches and its speed is 1400 R.P.M. If the diameter of the driven pulley is six inches, what is its speed?

Solution: The diameter of the driving pulley, multiplied by its speed, is equal to the diameter of the driven pulley, multiplied by its speed.

$$6xX=8x1400$$

$$X=\frac{8x1400}{6}=1866 \text{ R.P.M.}$$

Cutting Speed

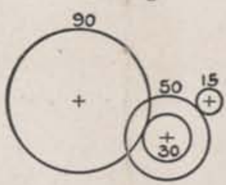
A certain grindstone will stand a surface or rim speed of 850 feet per minute. At how many R.P.M. can it run if its diameter is 57 inches?

Solution: The cutting speed is equal to the circumference of the stone in feet multiplied by the number of Revolutions per minute.

$$\text{or } c=\frac{\pi d \times \text{R.P.M.}}{12} \text{ where d is expressed in inches.}$$

$$\text{Hence R.P.M.}=\frac{12c}{\pi d}=\frac{12x800}{3.14x57}=53$$

Gearing



The gear with 90 teeth (see above fig.) revolves 60 times per minute. Find the speed of the gear with 15 teeth.

Solution: The continued product of the R.P.M. of the first driver and the number of teeth in every driving gear is equal to the continued product of the R.P.M. of last driven gear and the number of teeth in every driven gear.

Hence, 60x90x50=Xx15x30

$$\frac{15x30}{60x90x50} = X = 600 \text{ R.PM.}$$

Casting

A die casting case is made of 8 parts of copper to 92 parts of aluminum by weight; find the weight of each metal if case is weighing eight pounds.

Solution: The copper weighs $\frac{8}{100}$ of 8 = .64 lbs.

The aluminum weighs $\frac{92}{100}$ of 8 = 7.36 lbs.

Surveying

The Slide Rule is used in surveying to check gross errors in computation, to reduce stadia readings, and to solve triangles.

Example: Find the latitude and departure of a course whose length is 525 feet and bearing N 65° 30′E.

Latitude=length of course x cosine of bearing
=525 x cos 65° 30′
=525 x sin 24 ° 30′
=218

Set 24° 30′ of scale S (reverse of Rule) at the mark near right end of body.

Set hair line at 525 of A, read result 218 under hair line on B.

Rectangular Co-ordinates

$$c = \sqrt{a^2+b^2} = \sqrt{1+\frac{b^2}{a^2}}$$

Example: Find the diagonal of a rectangle with the sides 5½ and 9½ feet in length.

$$\text{Diagonal} = \sqrt{(5\tfrac{1}{2})^2+(9\tfrac{1}{2})^2} = 5\tfrac{1}{2}\sqrt{1+\left[\frac{9\frac{1}{2}}{5\frac{1}{2}}\right]^2}$$

To 9½ on D set 5½ on C.
Opposite left index of B read 2.98
Adding 1=3.98.
Set right index of slide to 3.98 on A.
Opposite 5½ of C read result, 10.95 on D.

This solution required only two settings of the Rule. Compare this with the solution required if the equation had remained in its original form. This would have required three settings and an addition on paper.

The useful use of this Slide Rule lies largely in the ability to read the graduations rapidly and correctly—**THIS CAN ONLY BE ACQUIRED BY ACTUAL PRACTICE.**