The Slide Rule Manual.

Instructions for using the MIDGET SLIDE RULE

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DIETZGEN

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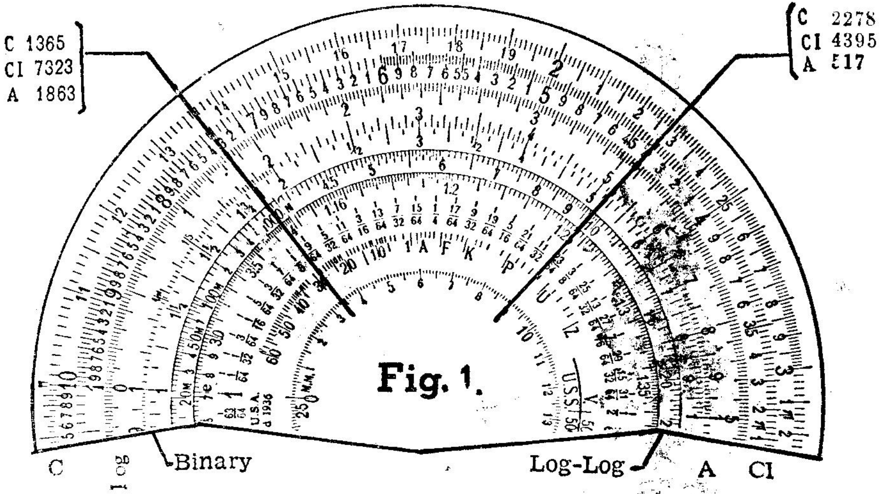
C 1365
CI 7323
A 1863
C 2278
CI 4395
A 517
C
Log
Binary
Log-Log
A
CI

Fig. 1.

Midget

dicate the answer, 6.

To Solve 35 ÷ 15 x 3. Set L at 35 and S at 15. Turn L until S is at 3 and read the answer 7 under L.

TO SOLVE PROPORTION 7:35::5:x. Set L at 35 and S at 7. Turn L until S is at 5 and L will give the answer, 25.

Try these examples several times until you are familiar with the operation of the slide rule. Try other simple examples using the C scale.

READING THE SCALES.

These examples were made very simple, because when using larger numbers, the operator must be able to read the Scales. This can be learned by studying their construction. Taking the C Scale, it will be noted that beginning at the index and reading clockwise, the long lines are numbered 11, 12, 13, etc., to 2. Then each of these spaces if further divided into 10 subdivisions. Tenths of these subdivisions must be estimated if required by the problem. To locate any number beginning with 1, as 1365, move an Indicator to 13, then move it six more subdivisions to 136 and the center of the next subdivision gives 1365.

To locate a number beginning with 2, as 2247 (22.47. .022,470. 2,247,000, etc.) move the Indicator two large divisions from 2, which gives 22. then move it 4 divisions and estimate .7 of the next subdivision. Fig. 1 shows the location of these settings. Study this figure until you are familiar with it. Locate various numbers on the different scales and learn the name of the scales and their location on the face of the rule.

THE CI OR C INVERTED SCALE.

The second Scale is the CI or C Inverted Scale, which is graduated and read in a counter-clockwise direction. The two numbers on the C and CI Scales under an Indicator are reciprocals of each other and when multiplied (neglecting the decimal point) always equal 1. Using the C and CI Scales, three numbers can be handled at each setting of the rule.

To Multiply 77 x 842 x 128. Set L at 77 on C Scale and S at 842 on CI Scale. Turn L until S is at 128 on C and L will give the answer as 83 or 8,300,000 on C.

Example: 13 X 23 X 86 Answer 25,700

To Solve 72.8 ÷ (31 x 42.5). Set L at 728 on C and S at 31 on C. Turn L until S is at 425 on CI and read the answer 552 or .0552 on C.

Example: 24 divided by 2.8 X 3.4 Answer 2.5 2

To solve 37 X 45 divided by 16. Set L at 37 on the C scale and S at 45 on the CI scale. Move L until S is at 16 on the CI scale and read the answer 10 4.1 on the C scale.

Example: 85 X 7.3 divided by 62 Answer 10.01

LOGARITHMS.

This scale gives the Logarithms of all numbers (Base 10). To find the Logarithm of any number set L at the number on the C Scale and read the Logarithm of the number under L on the Log. Scale. Thus Log. 2 is .301; Log. 7.5 is .875; Log 845 is 2.927. The Log. Scale can be used for addition and subtraction. To add set L at one number and S at 00. Turn L until S is at the second number and L will give the sum. To Subtract, set L at the minuend and S at the subtrahend. Turn L until S is at 00 and L will indicate the remainder.

ROOTS AND POWERS.

The A scale is a two turn C scale and is used with the C scale to obtain squares and square roots of numbers. It can be used for multiplication and division exactly the same as the C scale but its accuracy will be less because it is only half as long. It can also be used with the C scales in solving problems where one of the factors is either squared or handled as a square root.

Example: 45 X (square root 2.5). Set L to 2.5 on the A scale and S at 10. Move L until S is at 45 on the C scale and read the answer 71.2 under L on the C scale.

To square a number set L at the number on the C scale and read the answer on the A scale.

To extract the Square Root of a number, first separate the number into groups of two figures each, beginning at decimal point and going either to the left or right as required as 2'34'27 or .00'64. If the left hand group contains one significant figure, use the first half of the A Scale, reading the square root on the C Scale. Use the second half of the A Scale if the left hand group contains two significant figures. Thus the Square Root of 2.5 is 1.58 and the Square Root of 25 is 5. This is for numbers larger than 1. For numbers smaller than 1, the first half of the A scale is used for numbers with odd numbers of ciphers. When the number of ciphers is even the second half of the A scale is used.

Example: Find the square root of 324. Since the number of digits in the left hand group is odd, set L at 324 in the first half of the A scale and read the answer 18 on the C scale.

Example: Find the square root of .054. Since there is one cipher the first half of the A scale is used. Setting L at 54 in this half of the A scale the answer .232 is read on the C scale.

MULTIPLYING AND DIVIDING MIXED NUMBERS

The Binary Scale is used for handling fractions and mixed numbers between the limits of 7/64ths and 10. It is used to multiply and divide fractions together or mixed numbers and fractions. The problem can be handled directly on the scale without using a computation sheet to reduce the fraction to the least common denominator.

Example: 7/8 X 3/4. Set L on 7/8 and S at 10. Move L until S is at 3/4 and read the answer 21/32 under L on the Binary Scale.

Example: 5/8 X $1\frac{1}{4}$ Answer 25/32

$\frac{1}{4}$ X $1\frac{7}{8}$ Answer 15/32

Example: 3/4 divided by 1/8. Set L at 3/4 and S at 1/8 on the Binary scale. Move L until S is at 10 and read the answer 6 under L on the same scale.

Example: 1 7/8 ÷ 5/8 Answer 3

$\frac{5}{8}$ ÷ $\frac{1}{2}$ Answer $1\frac{1}{4}$

When desired the answer to any problem solved on the Binary scale can be read as decimal, on the A scale. Also decimals on the A scale can be used with fractions and mixed numbers on the Binary scale and the results read on either scale.

Example: 3.7×7/8. Set L at 3.7 on the A scale and S at 10. Turn L until S is at 7/8. Now read the answer, 3.24 on A Scale

THE LOG-LOG SCALE.

The Log-Log scale, near the center of the rule, consists of several turns and extends slightly above 1 to a million. It is used to find any power or root of a number that appears on its coils.

Referring to Fig. 1, the C, CI, A, and Binary Scales were constructed by laying off distances proportional to the Common Logarithms (Base 10) of the numbers on the Scales. Therefore multiplication on these Scales consists of adding the distances of the two factors. Subtraction consists of subtracting the distance of divisor from the distance of the dividend. All distances being measured from the Index. The Log-Log Scale was constructed by first getting the Natural Logarithm (base e, 2.71828) of the number and then getting the Common Logarithm (base 10) of the Natural Logarithm and laying off the distance proportional to this quantity. Thus the Natural Log. of 20 is 2.99573 and the Common Log. of 2.99573 is .476503. Therefore 20 on the Log-Log Scale would be located under an indicator set 2.99573 or 3.00 on the C Scale and .476503 or 477 on the Log Scale.

The Log-Log Scale gives the position of the decimal point and extends from slightly above 1 to 1,000,000. If a number or its desired root falls below the limit of the Scale, multiply the number by some convenient factor. Then, the root of the product, divided by the root of the factor, gives the root of the number. If the number or its desired power is greater than 1.000,000, resolve the number into two or more convenient factors that can be handled by the scale. Then the product of the powers of the factors gives the power of the number.

To Find the Power of a Number, Set L at the exponent and S at 10 on C Scale. Turn L until S is at the number on the Log-Log Scale. Read power at L on Log-Log Scale. Find the value of 4.65 raised to the 3.7 power. Set L at 37 and S at 10 on C. Turn L until S is at 4.65 on Log-Log and L will give the answer as 290 on the Log-Log Scale.

To Extract the Root of a Number, Set L at 10 and S at the Index of the Root, on C, turn L until S is at the number on the Log-Log and L will give the root on the Log-Log Scale. Find the value of $\sqrt[7.3]{5,000}$. Set L at 10 and S at 7.3 on C Scale. Turn L until S is at 5,000 on Log-Log Scale and read 3.2 at L. For numbers which fall off the end of the scale, use same method as for "Powers."

To Find Natural Logarithms. (Base e) Set L at the number on the Log-Log Scale and read Logarithm on C Scale. Thus the Natural Log. of 1.68 is .519; of 675 is 6.52; of 32000 is 10.37.

The Log-Log scale can be used to find the various powers and roots of numbers below 1 by using the reciprocal of the number and then finding the power or root of the reciprocal. The reciprocal of this answer is the desired solution.

Example: Find the 2.5 root of .688 Set L at .688 on the C scale and read 1.454 on the CI scale. Now set L at 10 and S at 2.5 on the C scale. Turn L until S is at 1.454 on the Log-Log scale and read 1.161 under L on the Log-Log scale. Now set L on 1.161 on the C scale and read the answer 86 on the CI scale.

ADDING AND SUBTRACTING FRACTIONS.

The **Fraction Scale** is used for adding and subtracting fractions and is divided from 1/64 to 1 inch. The complete Log Scale may be considered as equal to 1 inch. Therefore, combinations of fractions and decimals may be added and subtracted on these two scales.

To add **7/64+19/32** set **L** at **7/64** and S at 1. Turn L until **S** is at **19/32** and L will give **45/64**

Example:	3/8+27/64	Answer.	51/64
	5/16+9/32	Answer.	19/32

To subtract: **31/64 – 3/8.** Set **L** at 31/64 and S at 3/8. Turn L until **S** is at 1 and read 7/64 under L.

Example:	19-32. – 7-64	Answer:	31-64
	45-64. – 9-32	Answer:	27-64.

Solve 9-64 + 13/32 – 27/64. **Set L** at 9/64 and S at 27/64. Turn L until **S** is at 13/32 and L will give 1/8.

If desired, decimals on the Log Scale may be substituted for any of the fractions in the above three types of problems. Then the answer can be read, exactly, as a decimal or to the nearest 64th.

THE DRILL AND THREAD SCALE.

The Drill Scale uses the first half of the circle and the Thread Scale uses the second half. To find the size of a numbered or lettered drill place L at the number or letter on the Drill Scale and read the size as a decimal on the Log. Scale or as a fraction on the fraction scale. Thus, an I drill is .273". I is the third division clockwise from F.

To find the size of drill to use for tapping a perfectly full thread use the Thread Scale. Set L at 5 on the Log. Scale and S at the number of threads on the Thread Scale (either U. S. S. or V form). Turn L until S is at the bolt size on the Fraction Scale and L will give the drill size on the Log., Fraction, or Drill Scale, as desired.

EXAMPLE: What drill should be used for a hole to tap a ½" 13 U. S. S. Thread? Set L at 5 on the Log. Scale and S at 13 on U. S. S. Thread Scale. Turn L until S is at ½ on Fraction Scale and L reads .406" on Log. Scale, 13/32 on Fraction Scale and Y on Drill Scale.

Tap breakage is often caused by using a drill too small for the tap. Therefore if the hole will give a thread that is longer than twice the diameter of the bolt, use a drill that is one or two sizes larger than given by the rule. A larger hole may be drilled in steel or wrought iron, as the metal flows into the thread while tapping.

THE DECIMAL POINT.

If the C Scale of the Rule is used for multiplication and division and L turned clockwise to set S then the following rules will give the number of figures in the result. To simplify the rules the following terms are used. "Sum" is the number of figures in the multiplier plus the number of figures in the multiplicand. "Difference" is the number of figures in the dividend minus the number of figures in the divisor.

Rule 1. In multiplication, if **L** is moved to, or past, 10 to set S, the number of figures in the product equals the sum. Example: 75 X 62 equals 4650. There are four figures in the two factors and, as L crosses 10, there are four figures in the result.

Rule 2. If L does not reach 10, one figure should be deducted from the Sum. Example: 75 X 124 equals 9300. The Sum adds to 5 figures but, since L does not pass 10, one figure is deducted making 4 figures in the result.

For division the following rules apply:

Rule 1. When the Divisor lies clockwise between the dividend and 10, the number of figures in the quotient equals the figures in the dividend less those in the divisor. Example: 5950 divided by 70 equals 85. Since 70 lies between 5950 and 10, there are 4 minus 2 equals 2 figures in the result.

Rule 2. If the dividend lies closer to 10 than the divisor, add 1 to the Difference for the number of figures in the quotient. Example: 852 divided by 12 equals 71. Since the dividend lies closer to 10 than the divisor, there are 3 minus 1 plus 1 equals 2 figures in the result.

In adding the number of figures in the factors the following rules apply:

Rule 1. Units in front of the decimal points are plus numbers.

Rule 2. Each zero directly after the decimal point is a minus number.

TYPE PROBLEMS AND SHORT CUTS.

Pi, or 3.1416 is given on the C and CI Scales, also ¼ Pi, or .7854 is given on these scales by the small mark near 8. The small mark at c on the Log. Scale is at .3937" which is equal to one centimeter. Further calculation gives 39.37" (1000 Cm) as the Meter.

The operator must be able to solve a problem by ordinary methods before attempting to use the Rule, which is an aid and a time-saver. The following type problems show how to handle the usual combination of factors which are met in practice. The operator should choose the type which is required by his problem and solve it accordingly. Only a few of the many possible combinations of the nine scale are given as others will suggest themselves to the operator as he becomes more familiar with the instrument. In the following problems, M. N, O, P and Q will represent known quantities and R the result. When any result is given by L, this result may be used as a factor in further calculations. It is not necessary to read the number under L until the final answer is obtained.

Solve M x N ÷ O = R. Use C. Scale. Set L at M and S at O. Turn L until S is at N and read R under L.

Example: 4.6 X 3.7 divided by 2.14 Answer 7.95

Solve M ÷ (N x O) = R. Set L at M and S at N on C Scale. Turn L until S is at O on CI Scale and read R at L on C Scale.

Example: 25.4 divided by 3.9 X 2.3 Answer 2.835

Solve M ÷ (N x O^2) = R. Set L at M and S at N on A Scale. Turn L until S is at O on CI Scale and L will give R on A Scale.

Example: 34.9 divided by 3.1 X 2.2^2 Answer 2.32

To Find Reciprocals, Set L at the number on the C or CI Scale and read the reciprocal on the other scale.

To solve any quadratic equation of the form $x^2 + bx + c = 0$, set L at 1 and S at c on CI Scale. Turn L until the (sum or difference as the case may be) of the values under L on the C scale and S on the CI scale equals b and their product equals c. These are the roots or values of x. The position of the decimal point may be located by inspection.

Example: X^2-3X-88 equals 0. Set L at 10 and S at 88 on C scale. Now turn L and watch the values under both indicators. Mentally check their difference and when S reaches 11 on the C scale L will be on 8 on the CI scale. Since their difference is 3 and their product is 88, 8 and 11 are the required answers. (X-11)(X + 8) equals 0.

To find the value of $\sqrt{x^2+y^2}=z$, set L at y and S at x on C Scale. Move L to 1 on A Scale. (This reduces y^2 to 1 and reduces x^2 in the same proportion). Now read the value under S on the A scale and reset S to this value plus 1 on the A scale. Move L back to y on the C scale and read z under S on the C scale.

Example: Given two sides of a right triangle as 4 and 3. Find the Hypotenuse. Set L at 3 and S at 4 on the C scale. Move L to 10 and note 1.78 under S on the A scale. Add 1 to this value and set S to 2.78 on the A scale. Move L back to 3 on the C scale and read the answer 5 under S on the same scale.

Example: Given 5 and 8 as two sides of a right triangle. Find the Hypotenuse. Answer: 9.44.

COMMERCIAL PROBLEMS.

The C Scale is used for solving most commercial problems so if no scale is mentioned the C Scale should be used.

OVERHEAD. A merchant has $15,200 sales for a year with a $3,800 overhead. What is his percent of overhead? Set **L** at $15,200 (or 152) and **S** at $3,800. Turn L until S is at 10 and read 25 or 25% at L.

If an article costs the above merchant $2.50 and he wishes to make a 10% net profit, with a 25% overhead. What should be the selling price of the article? Add 10% and 25% and subtract them from 100% which gives 65%. Set L at 10 and S at 65. Turn L until S is at $2.50 (or 25) and L will give $3.85 as the correct selling price. If the selling price of other articles is desired (25% overhead and 10% profit) turn L until S is at the invoiced cost and L will give the selling price.

If a case of 48 articles cost the above merchant $145, what should be the selling price of one article so that he will make a 10% net profit with an overhead of 25%? Set L at 48 on CI Scale and S at 65 on C Scale. Turn L until S is at 145 on C Scale and L will indicate 465 on C Scale. Therefore the correct selling price for each article would be $4.65. The above method may be used for finding selling price of articles bought by quantities, including dozen and gross lots. When finding the selling price of an article when the unit cost is known, set L at 10. If the cost of the lot is known, set L at the quantity, on the CI Scale and proceed in the same manner.

TRIGONOMETRIC FUNCTIONS.

The back side of the Rule has one indicator, which will be referred to as T. It has three separate Sets of scales. The outer scale of each Set is Degrees, the middle scale is Sines and the inner scale is Tangents. Each degree graduation has one or two figures on each side of the line, as 53|37. The figures at the left of each line give the degrees for Sines and Tangents and increase from 0 to 90 degrees in a clockwise direction, while the figures at the right of the line give the degrees for Cosines and Cotangents and increase from 0 to 90 degrees in a counter-clockwise direction. Each of the larger degree divisions is divided into .1 degree or six minute divisions.

To read the function of any angle, set the hair-line, T, to degrees and read the function on its scale. The co-functions are read on their corresponding scales but the degrees must be read in a clockwise direction. Thus:- Sine 65° 42′ is .9114 Tangent 18° 30′ is .3346 Cos. 51° 54′ is .617[illegible]

To read to one Minute

It will be noticed that the divisions on the three Degree scales are not on radial lines but differ by 2 minutes. To increase 2 minutes, move the hair-line to the next outer degree scale, moving to the center if necessary. By going halfway between the degree divisions of any two adjacent (or the outer and inner) graduations, the hair-line can be set to one minute.

(PERMANENTLY ACCURATE) THE BINARY SLIDE RULE (WITH ENGINE-DIVIDED SCALES)

is used exactly like the Midget, but this Slide Rule is 8 5/16 inches in diameter. The Scales are C, CI, A, K (Cube Scale), Log, LL1, LL2, LL3, LL4, Binary, Fraction, Drill, Thread and Millimeter. The C,CI, A, K and Log Scales are divided as closely as a 20 Inch straight slide rule and give answers to a high degree of precision. The Log Scale of the Binary is divided into 1,000 divisions. Also, the C Scale of the Binary is more than 25 inches long, with graduations 25% farther apart than the graduations of a 20 Inch straight slide rule. Accurate estimations between lines can be made and the rule can be used for hours without eye-strain. The Binary will be a comfort to anyone who is handicapped by weak eye-sight. The four Log-Log Scales are divided closer than the corresponding scales of a 10 Inch Log-Log rule.

The Trig. Scales of the Binary are longer than those of the Midget.

Price of the Binary with Instructions, and Case $10.25

Your Money back if You are not satisfied.