SLIDE RULE

A Quality instrument for student or professional

INSTRUCTION MANUAL

1. INTRODUCTION.

The slide rule is an accurate mechanical device for rapidly and accurately making calculation. Problems involving multiplication, division, proportion, percentage, squares and square roots, cubes and cube roots, diameter, reciprocals, areas, logarithms and exponents, trigonometric formula and combinations can be solved by means of a slide rule, regardless of one's mathematical knowledge. Accuracy can be obtained if the body, slide and indicator are carefuly set, say, to three figures adequate for most practical application.

Speed in using this slide rule will follow as the result of practice.

Read the instructions with the most care and attention to details over several times. The first important step is to learn to locate numbers accurately upon the several scales. The numbers often fall between graduation lines on the rule when you read answer. In this case, we must judge the distance to obtain the last decimal place. Try problems which can be checked with simple arithmetic for the begining.

The calculations on the rule will check the numeral results within three places. You can master each operation quickly if you work out such "Check Problem" according to each manipulation.

2. GENERAL DESCRIPTION OF SCALES.

The following is a brief description of the various scales of the log log rule ;

- S Scale- A Trigonometric scale used with the A and B scales for problems involving the sine of angles.
- K Scale- Used with C and D scales for finding Cubes and Cube Roots.
- A Scale- Used with C and D for finding Squares and Square Roots.
- B Scale- Identical to the A scale and also used with the C and D scales for finding Squares and Square Roots.
- CI Scale- A reciprocal scale used with the C, D and T scales.
- C Scale- Identical to the D scale and used with the D scale for Multiplication and Division.
- D Scale- Used with the C scale for Multiplication and Division.
- L Scale- Used with the C and D scales for finding Logarithms.
- T Scale- A Trigonometric Scale used with C, D and CI scales for problems involving the Tangent of angles.

Problems are worked by comparing two of the scales with each other. The operation of slide rule consists in moving the slide along the boby and in sliding the indicator to right and left.

It is important for the hair line on the indicator to be placed exactly at the right angles to the direction in which the scale runs.

The purpose of the indicator is to enable one to read the figures easily on any scale which lie with reading on any other scale. When the center slide is too tight, use a little parafin wax or grease on the grooves of center slide.

3. READING THE SCALES.

Before attempting to operate the slide rule, the beginner must first learn how to read the scales. The various scales are not graduated uniformly (except L scale) and the marks on the scales do not measure lengths—they represent only numbers. As the reading of all scales is done in much the same manner, it will be sufficient to illustrate the procedure with one scale. A slide rule only enables one to work with significant figures of a number. The significant figures are the ones that remain after the zeros to the right or left of a given number have been removed. For example : —

— The significant figures of the following number 0.0359, 0.359, 3.59, 35.9, 35900 -are all the same, namely three-five-nine ; making a total of three siginificant figures, due to the manner in which the slide rule is divided.

To illustrate this, we will indicate the location of the three figure number 254 on the C and D scales in our explanation of the reading of the scales, as follows :

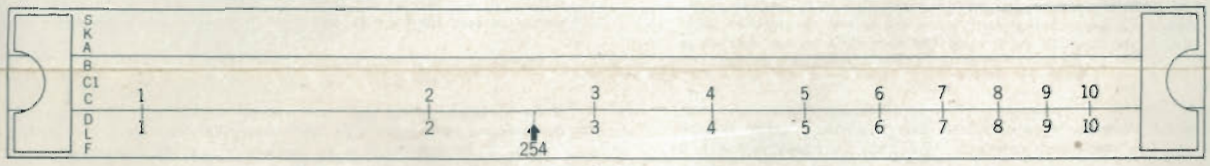


Fig. 1

FIRST STEP : The C and D scales are divided into ten major divisions, numbered from 1 to 10, giving us first significant figure. Figure 1 illustrates the major divisions of the C and D scales, however, the same explanation applies to the A and B scales. If the first significant figure of number is 1, the number will lie between the major division 1 and 2. If it is 2, the number will lie between 2 and 3, etc. The number 254 lies between the major division 2 and 3 as indicated by the bracket (Fig. 1) since the first significant figure of the number is 2.

SECOND STEP : Each of these major divisions is subdivided into ten parts or secondary divisions, giving our second significant figure (See Fig. 2) In the number 254, the second significant figure—5—indicates that the location is between the 5th and 6th secondary division, as indicated by the bracket in Fig. 2.

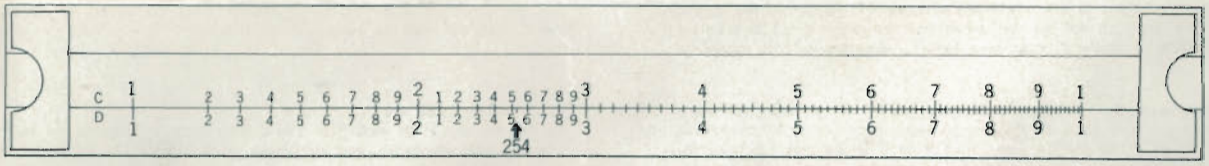


Fig. 2

THIRD STEP : Each of these secondary divisions is again subdivided into a third set of divisions, giving us our third significant figure (See Fig. 3)

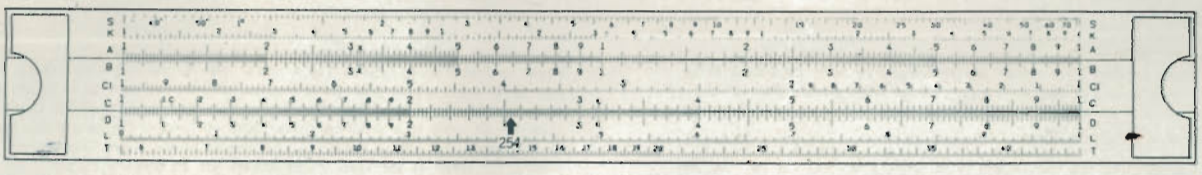


Fig. 3

In the number 254, the third significant figure —4— indicates that the location is the second tertiary division of 5th secondary division of the third major division as indicated by the arrow in Fig. 3.

The secondary subdivisions between 1 and 2 are each divided into 10 tertiary divisions. The shorter secondary divisions between 2 and 3 and between main 3 and 4 are divided only into 5 tertiary divisions. The still shorter secondary divisions between main divisions beyond 4 are divided into two tertiary divisions, because of short of space. Had the number been 2543, we should then have located it 3/10 of the tertiary division between 2540 and 2550. This last shift is made by estimating the 3/10 by eye as there are no fourth order divisions.

The captioned procedure is the same in the any other number on the scale, excepted that it should be noted that the tertiary divisions toward the right end of scale represent fifths (between main 2 and 4) and halves (between main 4 and 10).

For example, the number 853 lies, first on the main division between 8 and 9, second on the secondary division 850 and 860, and third 3/5 of the first tertiary division between 850 and 855, this 3/5 being estimated by eye.

The decimal point is ignored in opertaing the slide rule, because of being graduated with the theory of logarithms, but the location can be estimated without difficulty by estimating the answer from rounding off the factors and divisions.

4. SLIDE RULE OPERATIONS.

MULTIPLICATION. Use the C-D combination. To multiply one number by another, set either the left or the right index of the "C" scale over one of the number on "D" scale. Read the answer on the "D" scale under the other number on "C" scale. Example : Multiply 1.65 × 2.4 = X (see Fig. 4

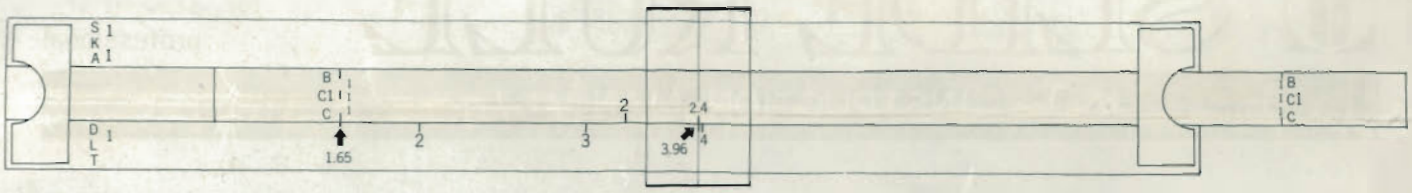
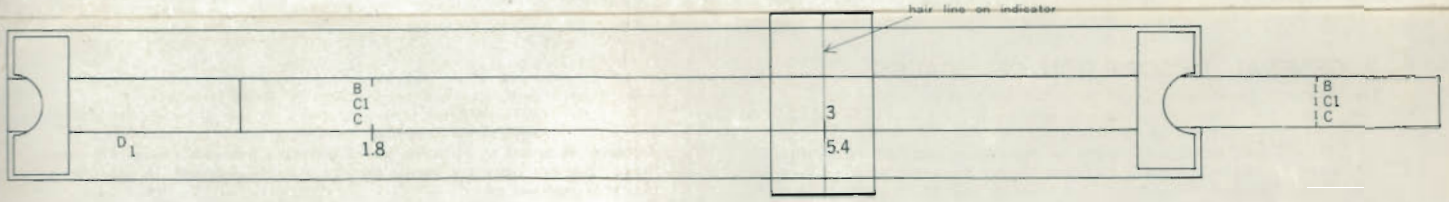


Fig. 4

Set the left index of C on the number 1.65 of the D scale. Read the answer 3.96 on the D scale under the number 2.4 on C scale. If the multiplier on C scale is off the D scale, the slider is to be pulled to the left in the ruler until the right index of C is in register with the first factor appearing on D, and then read the answer on the D scale under the multiplier on C scale.

DIVISION. Division is the reverse of multiplication. Use the C-D combination. Set either the left or the right index on the C scale over one of the numbers on the D scale. Read the answer on the D scale under the other number on C scale. (with whichever index of C, left or right, that appears on the D scale)



Example : 5.4 ÷ 3 (see Fig. 5)
Set 3 on C over 5.4 on D scale and read 1.8 on D under left C index

Fig. 5

(Read answer 1.8 on D scale under left index of C scale)

SQUARES AND SQUARE ROOTS. Use the A-D comaination of scales. To find the square of a number, set the indicator hairline over the number to be squared on the D scale, and read the square of the number on the A scale under the indicator hairline. To find the square root of a number graeter than unity—if there are an odd number of figures before the decimal point, set the hairline over the number on 'A-Left" and read the square root under the hairline on D scale. If the number has an even number of figures before the the decimal point, set the hairline over the number on 'A-Right" and read the answer under the hairline on the D scale. Determine the location of decimal point by mental approximation.

CUBES AND CUBE ROOTS. Use the D-K combination of scales. K scale is so constructed that when the indicator hairline is set over a number on the D scale, the cube of the number is under the hairline on the K scale.
To find the cube roots of a number, use the D-K combination in the reverse order.
The K scale consists of three identical parts placed end to end, the combined length of which is equal to the length of the D scale. The three parts of this scale will be refered to as 'K-Left", 'K-Middle" and 'K-Right".
To find the cube root of a number between 1 and 10, set the indicator hairline over the number on 'K-Left" and read the answer under the hairline on D. of a number between 10 and 100, set the hairline on 'K-Middle" and read the answer on D, of a number between 100 and 1000, set it on 'K-Right" and read the answer on D.

PROPORTION. Use the C-D combination of scales. Problems of proportion arise, for example, in the convention of yards to feet, dollar to pounds, gallons to cubic feet, and so on. They are written for example, $\frac{A}{B} = \frac{C}{D}$ and are usually as A is to B as C is to D.
Opposite the numerator of the known relationship on the D scale, set the denominator of the known relationship on C scale. If the unknown is in the numerator, opposite the remaining known quantity on the C scale, read the value of the unknown on the D scale. If the unknown is in the denominator, opposite the remaining known quantity on the D scale, read the value of the unknown on the C scale.

FURTHER USE OF THE CI SCALE. (Multiplication by using the D-CI combination) To multiply two numbers together using the D and CI scales, set the hairline on one of the factors on the D scale, and bring the other factor on the CI scale under the hairline. Read the product on the D scale under whenever index of the CI scale is on the rule. Since either the left or right index of CI will always be found upon the scale, this method of multiplication never requires the reversal of the slider which is frequently necessary when multiplying by using the C-D combination. To find the product of three factors, set the hairline over one factor on the D scale and bring the other factor on the CI scale under hairline. Move the indicator hairline to the third factor on the C scale and read thd product under the hairline on the D scale. As an example, let us calculate the volume of a wall 12.5 feet long, 6 feet high and 0.34 feet thick. Solution : Set the hairline at 125 on D, bring 6 on CI under the hairline, move the indicator hairline to 34 on C, read the product 25.5 cubic feet in register on D.
To divide one number by another using the CI scale, set the index of the CI scale over the number to be divided on the D scale, move the hairline to the divisor on the CI scale and read the quotient on the D scale.

THE SINE SCALE, S. The scale is used with the A and B scales for finding the sines of angles from 34' to 90°. The sine of angles from 5°44' to 90° can be read directly on 'A-Right". The sines of angles from 34' to 5° 44' are read directly on 'A-Left". Since for all practical purposes, the sine and tangent are the same for angles less than 5°44', the tangent of angles from 34' to 5°44' may also read on 'A-Left". To find the sine or tangent of angle from 34' to 5°44', set the hairline over the angle on the S scale, under the hairline read the answer on 'A-Left". The answer will be between 0.01 and 0.1.
To find the sine of an angle from 5°44' to 90°, set the hairline over the angle on the S scale, under the hairline read the answer on 'A-Right". The answer will be between 0.1 and 1.0.
Given the sine of the angle, to find the angle, use the scales A and S in the reverse order. Thus, locate the numerical value of the sine on the A scale, and read off the angle in register on the S scale.

THE TANGENT SCALE, T. The scale is used with the D and T scales. The tangents of angles between 5°44' and 45° can be founded by using the T scale in conjunction with the D scale. To find the Tangent for an angle greater than 45° the T scale is used with the CI scale, and the following relationship must be remembered.

$$\text{Tangent } A = \text{Cotangent } (90°-A) \qquad \text{Cotangent } A = \frac{1}{\text{Tangent } A}$$

Angles less than 45° : To find the Tangent of an angle from 5°44' to 45°, set the hairline over the angle on the T scale, under hairline read the answer on the D scale. The range of the value of the answer will be between 0.1 and 1.0.
Angles greater than 45°: Since Tan A = Cot (90°-A) and Tan A = 1/Cot A, if tangent of an angle greater than 45° is required, subtract the angle from 90° and find Cotangent of the remainder. Since the Cotangent is the reciprocal of the Tangent, and since the CI scale is a reciprocal scale, value of Tangent can be read directly on the CI scale when the rule is closed, i.e., the indices of the C and D scale are in alignment. The range of the value of the answer will be between 1.0 and 10.0

LOGARITHM OF A NUMBER. The L scale (a scale of equal parts) permits the reading of the logarithm (mantissa) of numbers on the D scale. Set the hairline over the number on the D scale and read the logarithms (mantissa) under the hairline on the L scale. To find the common logarithm if a given number : — If the number is greater than 1, the "Characteristic" of the logarithm is one unit less than the number of figures to the left of the decimal point. If the number is less than 1, the 'Characteristic" of the logarithm is negative and one unit more than the number of zeros between the decimal point and the first significant figure of the given number.
To find the number corresponding to a given common logarithm : — If the 'Characteristic" is positive, the number of figures before the decimal point is one more than the number of units in the 'Characteristic". If the 'Characteristic" is negative, the number of zeros between the decimal point and the first significant figure is one less than the number of units in the 'Characteristic".

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