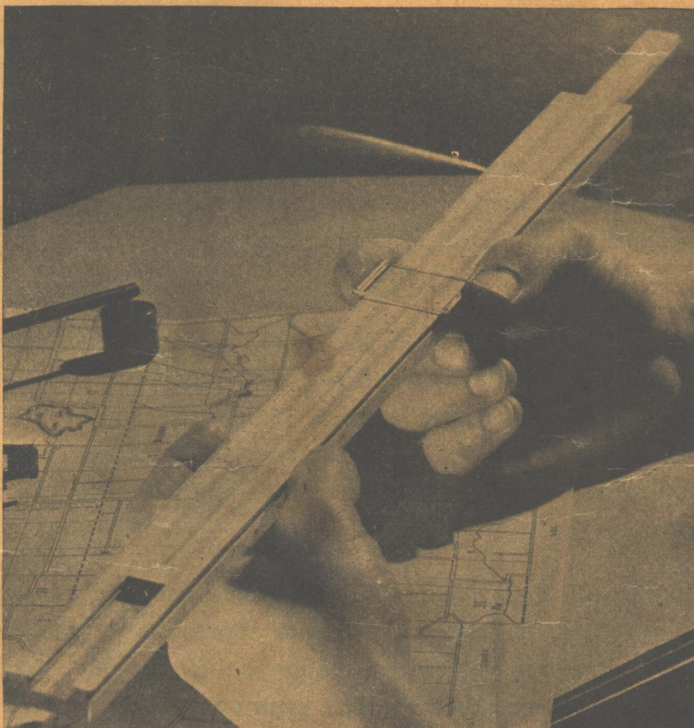
How to Use a SLIDE RULE



DIETZGEN

Eugene Dietzgen Co., Manufacturers of Drafting and Surveying Supplies

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The Slide Rule, an instrument for facilitating calculations, is an indispensable aid, not only to the engineer and scientist with their involved problems, but also to the accountant, statistician, manufacturer, merchant, importer, teacher, student, or anyone who has calculations to solve.

The theory of the Slide Rule is simple, and with little practice proficiency in its operation may be readily attained. A knowledge of the principles which underlie the workings of the Slide Rule is not necessary for its successful operation.

We have, however, published and furnish gratis with each rule, in booklet form, an exhaustive though brief explanation of this subject specifically applicable to each of our rules.

Dietzgen's Slide Rules are made of carefully selected well-seasoned materials, and accurately divided. The long seasoning process, excellent workmanship, scientific methods, and specially designed machines used in their manufacture account for the high quality and accuracy of our rules.

You will find Dietzgen Slide Rules used universally. Engineers, scientists, and students appreciate their accuracy; their sharp, legible graduations; their durable, sturdy construction; and their smooth, even operation.

That these qualities are so necessary in such an instrument as the Slide Rule, causes us to exercise diligent control over every detail in their construction to make them a perfect Slide Rule.

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Brief Elementary Instructions *on* How to Use *a* Slide Rule*

Application and Use

The Slide Rule is of very practical use in every day business and commerce, as well as an indispensable aid in the fields of engineering and science, because it enables quick and convenient mathematical calculations.

It has application to problems involving multiplication and division of numbers, squares, square roots, proportions, percentages, trigonometrical functions, logarithmical functions and combinations involving all of these phases of mathematics.

To the uninstructed student or layman, the slide rule may appear difficult to understand because of the confusion caused by the numerous scales. However, in reality, it is very simple to operate. By far, its greatest use is confined to Multiplication and Division, and the beginner is advised to devote his first study to simple operations in these two phases.

The beginner should have no difficulty in mastering the use of the slide rule if he will study the instructions carefully and follow the directions, step by step. Go slowly and surely, and much time will be saved.

General Description of Slide Rule

The Slide Rule consists of three parts:—The RULE, or "stock", as it is sometimes called; the SLIDE, which moves in the grooves of the rule; and the RUNNER, often referred to as the "indicator."

The RUNNER, or "indicator", is a piece of glass, or other transparent material, mounted in guides, by which means it slides over the face of the rule. On the underside of the glass is etched a hair line, or "marker", which is used for accuracy in setting and marking results.

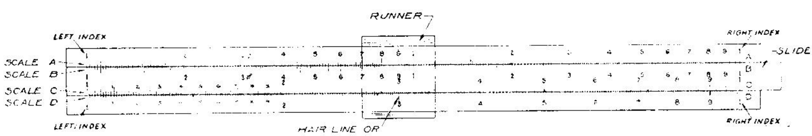


Fig. A

*No attempt is made in this booklet to go into the underlying fundamental theory of the slide rule. It is intended for the beginner and for the layman who has not had extensive training in mathematics. For a more extensive treatise, refer to our Instruction Books on either the Mannheim or Maniphase Slide Rule.

The face of the rule has four scales graduated on it. For convenience, these scales are referred to and marked "A", "B", "C", and "D". You will note that "A" and "B" Scales are duplicates, and the "C" and "D" scales are also duplicates. The "A" and "B" scales are each composed of 2 Scales, exactly alike, placed adjacent to each other. Each of these 2 scales are one-half the size of either the "C" or "D" scales. The total length of either the "A" or "B" scales equals the length of either the "C" or "D" scale.

The "A" and "B" Scales, being double scales are used in conjunction with "C" and "D" scales in obtaining squares and square roots. They are likewise often used for multiplication and division, but because of their size, they do not permit as close and as accurate a reading as can be obtained from the "C" and "D" Scales. Their use will be more fully explained further in this booklet under the heading of "Square and Square Root."

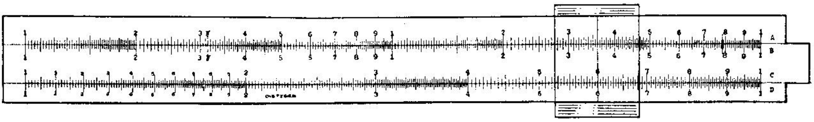


Fig. B

The "C" and "D" Scales are the primary scales, and the ones used chiefly for problems involving multiplication and division, and should be mastered first.

On the back of the slide are three scales: A scale of natural sines marked "S"; a scale of equal parts (logarithms) marked "L"; and a scale of natural tangents, marked "T." These three scales are used in conjunction with the "A", "B", "C" and "D" Scales on the face of the rule in solving problems involving trigonometry and logarithms. A more complete explanation of their use will be found later in this booklet under the headings of "Trigonometry" and "Logarithms."

On those Rules having a "K" and "CI" scale full explanation of these scales will be found on pages 17 and 18 of this book:

Reading the Scales

Before attempting to operate the slide rule, the beginner must first learn how to read the scales. When quick reading of the scales has been entirely mastered, the beginner will find that he can solve problems more rapidly.

Remember you must be able to read the rule quickly and surely before you can hope to use it in a REAL PRACTICAL WAY.

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 numbers—0.001736; 1.736; 17.36; 173.6; 1736000—are all the same; namely, one — seven — three — six.

Due to the manner in which the slide rule is divided, it can only be read accurately to three significant figures.

To illustrate this, we will indicate the location of the three figure number 384 on the "C" and "D" scales in our explanation of the reading of the scales, as follows:

FIRST STEP: The scales on the slide rule are first divided into ten major divisions,* numbering from 1 to 10, *giving us our first significant figure.* Fig. C illustrates the major divisions of the "C" and "D" scales, however the same explanation applies to the "A" and "B" scales.

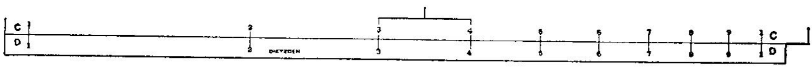


Fig. C

If the first significant figure of a 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. If it is 3, between 3 and 4, etc.

The number 384 lies between the major division 3 and 4 as indicated by the bracket (Fig. C) since the first significant figure of the number is 3.

SECOND STEP: Each of these major divisions are subdivided into ten parts, or secondary divisions, *giving our second significant figure.* (See Fig. D).

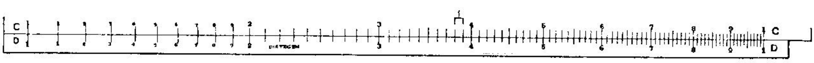


Fig. D

In the number 384, the second significant figure—8—indicates that the location is between the 8th and 9th secondary division in the third major division, as indicated by the bracket in Fig. D.

Note that Fig. D shows a skeleton scale with the major and secondary divisions filled in. On a 10″ rule, owing to lack of space, ***only the secondary divisions between the first and second major divisions are numbered.***

THIRD STEP: Each of these secondary divisions are again subdivided into a third set of divisions (tertiary divisions) *giving us our third significant figure.* (See Fig. E).

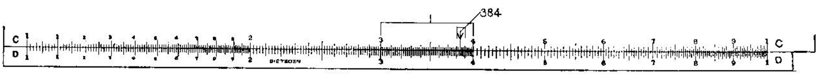


Fig. E.

In the number 384, the third significant figure—4—indicates that the location is the second tertiary division of the 8th secondary division of the third major division as indicated by the brackets and arrow in Fig. E.

You will note that as each major division uniformly progressively decreases in size as you read toward the right, the major divisions 4 to 10 are not as finely subdivided into tertiary divisions as major divisions 1 to 4. If space on the rule permitted, each secondary division would be divided into ten tertiary divisions. Therefore:—

The space between the major division 1 to 2 (Fig. E1) is divided into ten secondary divisions and each secondary division is divided into ten tertiary divisions. Each of these tertiary divisions has a value of one.

*Inasmuch as the "A", "B", "C" and "D" Scales on the slide rule are logarithmic scales, you will note that major divisions steadily decrease in size toward the right in proportion to the logarithm of the number.

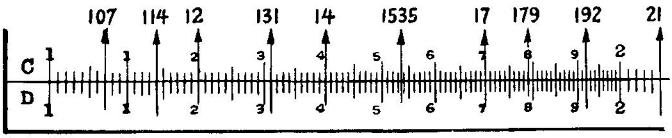


Fig. E1

The major divisions 2 to 4 (Fig. E2) are each divided into ten secondary divisions and each secondary division is divided into five tertiary divisions. Each of these tertiary divisions has a value of two.

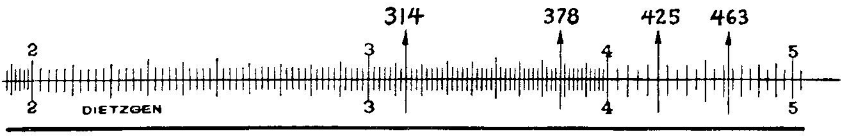


Fig. E2

The major divisions 4 to 10 (Fig. E3) are each divided into ten secondary divisions and each secondary division is divided into one tertiary division. Each of these tertiary divisions has a value of five.

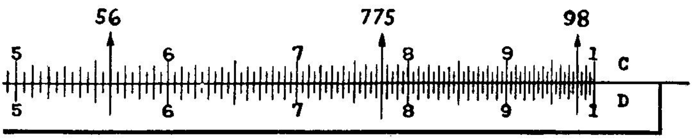


Fig. E3

If it is necessary to read to four significant figures, we are compelled to interpolate, or infer, this fourth figure, which falls between the tertiary divisions.

Fig. F shows the hairline of the indicator of the slide rule set to read 1736, illustrating the interpolation of the fourth significant figure — 6.

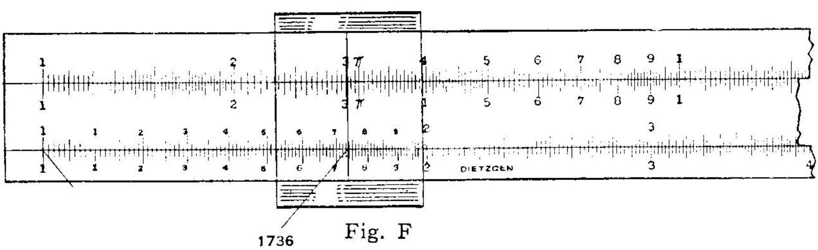


Fig. F

After we have obtained the final significant figures in any answer, the placing of the decimal point must be determined mentally. Any significant figure read on the slide rule can be given a value that is a multiple of, or divisible by 10. For instance, 1 can be 1 or 10 or 100 or 1000 and on up, or 0.1 or 0.01 or 0.001 and on down. 384 on the slide rule can be either 384 or 3840 or 38400 or 384000 and on up, or 38.4 or 3.84 or 0.384 or 0.00384 and on down.

For Example:—Take the problem of 2 x 1.5, which we know is 3 and not 30. The significant figure in the answer is 3, and it would be the same significant figure in the answer if we multiplied 20 x 150, which we know to be 3000. The setting on the slide rule would remain the same if we were multiplying, as suggested above, either 2 x 1.5, 20 x 150, or 200 x 15000, because all we are interested in is the significant figures in the problem. The number of zeros and the placing of the decimal point will have to be determined afterward.

Multiplication

To simplify explanation of the use of the slide rule and to instruct one in making various settings, we will call the No. 1 graduation mark at the beginning of all scales, the "left hand index" of that scale, and the No. 1 graduation mark at the end of the scale the "right hand index". (See Figure A*)

Rule—To multiply one number by another, set either the left or the right index of the "C" scale over one of the numbers on the "D" scale, and read the answer on the "D" scale under the other number on the "C" scale.

EXAMPLE: Multiply 2 x 3 = x. (See Fig. G).

(1ST) SET LEFT "C" INDEX OVER 2 ON "D" SCALE

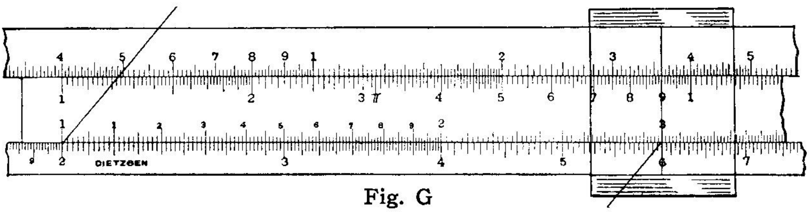


Fig. G

(2ND) UNDER 3 ON "C" SCALE READ 6 ON "D" SCALE

EXAMPLE: Multiply 17 x 23 = x. (See Fig. H).

(1ST) SET LEFT "C" INDEX OVER 17 ON "D" SCALE

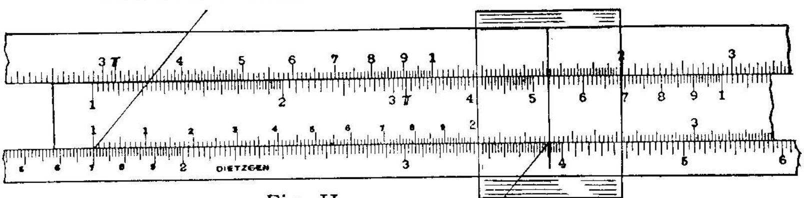


Fig. H

(2ND) UNDER 23 ON "C" SCALE READ 391 ON "D" SCALE

NOTE: If the slide projects too far to the right when using the left index, use the right index, as illustrated in the following example.

EXAMPLE: Multiply 76 x 57 = x. (See Fig. I).

(1ST) SET RIGHT "C" INDEX OVER 76 ON "D" SCALE

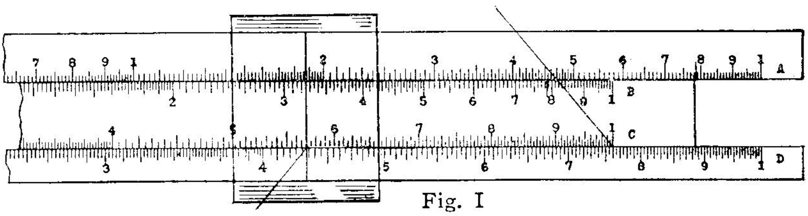


Fig. I

(2ND) UNDER 57 ON "C" SCALE READ 433 ON "D" SCALE

*Some rules are marked at the right hand index as 10 and some rules eliminate cipher and mark as 1. Either marking is correct.

Decimal Point

Heretofore we have not had problems involving fractions. We give below an example of multiplying 2.18 x 27.6, both numbers of which contain fractions.

In making this multiplication, treat these two numbers as if they did not contain a decimal point; that is, 218 and 276, and multiply them together. This multiplication would give you a reading on the slide rule of 602.

The correct value of the answer or the position of the decimal point is determined by mental approximation. By mentally reducing the figures in the problem to the nearest equivalent whole numbers, such as reducing 2.18 to 2 and 27.6 to 28 (nearest whole numbers) and multiplying the two numbers together mentally, we obtain 56.

We therefore know that the decimal point should be set after the first two significant figures; namely, 60, and the correct answer is 60.2.

EXAMPLE: Multiply 2.18 x 27.6 = x. (See Fig. J).

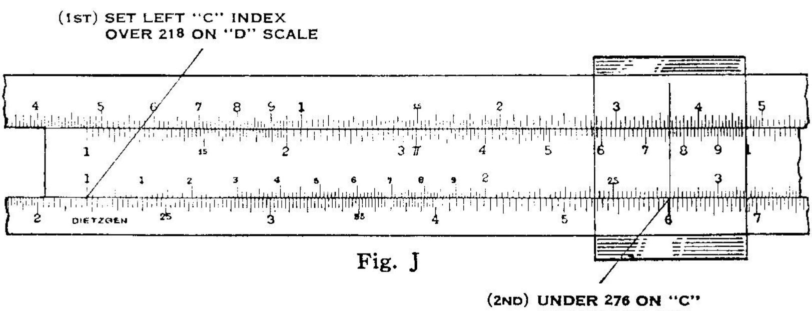


Fig. J

The student in working problems involving fractions will soon learn to make these simple mental approximations to determine the position of the decimal point very rapidly and almost automatically.

Multiplication of Three or More Factors

EXAMPLE: Multiply 71.3 x 36 x 0.0194 = x. (See Fig. K).
The first two factors are multiplied together as shown before.

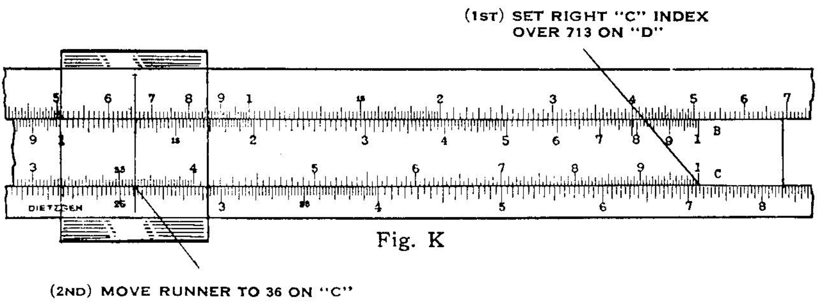


Fig. K

Leave the indicator set over result (256) on "D". There is no need of taking the product of these two numbers as all we are interested in is the final result.

With the indicator remaining in this position, move the index of "C" to the product of the first two factors (256) under the runner hairline and read final result on "D" under 194 on "C". (See Fig. L).

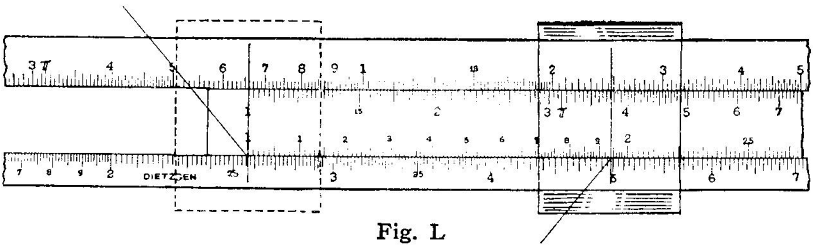


Fig. L

Approximate the decimal point by mentally multiplying 70 x 30 x 0.02, which is 42.

Thus, it is certain that the decimal point is after the first two significant figures and the final answer is 49.8.

Any number of factors can be multiplied together in a similar manner.

Division

Division is the reverse of multiplication.

Rule—To divide one number by another, set the divisor of the "C" scale over the dividend on the "D" scale, and read the quotient or answer on the "D" scale under the index (1) on the "C" scale.

Referring to Fig. G, we note that 2 x 3 equals 6. By the same setting, 6 ÷ 3 equals 2.

EXAMPLE: 6 ÷ 3 = x (See Fig. M).

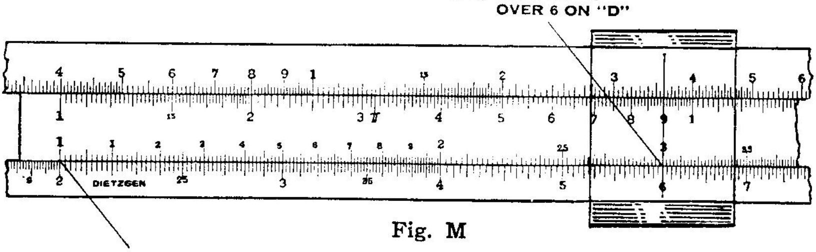


Fig. M

The decimal point is again determined mentally by approximation, as indicated in examples on "Multiplication."

Problems Involving Both Multiplication and Division

In solving a problem of this type, it is not necessary to read intermediate answers of each step as all we are interested in is the final result.

EXAMPLE: $\dfrac{790 \times 575 \times 342}{840 \times 596} = x$ (See Fig. N).

The best way to approach a problem like the above is to perform alternately, first division, then multiplication, then division, then multiplication and continue in this manner until problem is solved. See Fig. N for first steps.

(1ST) SET 840 ON "C" OVER 790 ON "D" (DIVISION)

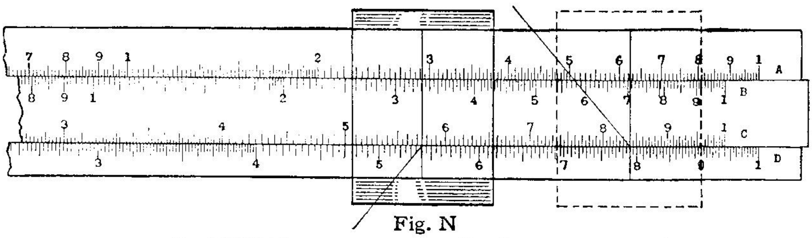


Fig. N

(2ND) MOVE RUNNER TO 575 ON "C" (MULTIPLICATION) AND LEAVE RUNNER AT THIS SETTING

(3RD) SET 596 ON "C" TO RUNNER HAIRLINE (DIVISION)

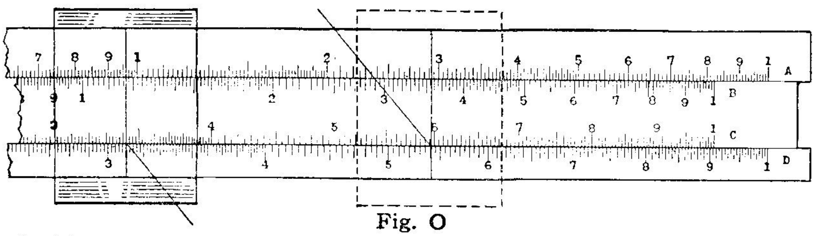


Fig. O

(4TH) MOVE RUNNER TO 342 ON "C" (MULTIPLICATION) AND READ FINAL ANSWER 310 ON "D"

You will note that the above problem required four steps:

(1st) Dividing 790 by 840. The result (0.940) of this division was found on "D" scale under the right "C" index.

(2nd) Multiplying the result of the division (0.940) by 575. To make this multiplication, note it was not necessary to move the slide as the right "C" index was already in position to make this multiplication. The result of this multiplication gave us 541, which was read on the "D" scale under 575 on "C" scale.

(3rd) Dividing the result of the first two steps (541) by 596. Leave the hairline of the runner set at 541 on "D" and move the slide so that 596 on "C" is under the hairline of the runner set at 541 on "D". The result of the third step is (0.908) found on "D" under right "C" index.

(4th) Multiplying results of the previous steps (0.908) by 342. Note that in order to accomplish this multiplication, it was not necessary to move the slide as the right "C" index was already in position over (0.098) on "D", and the final result 310 was read on "D" under 342 on "C".

Square and Square Roots

Due to the fact that the two "A" scales are each half the size of "D" scale, if the runner hairline is set over a number on the "D" scale, the square of the number will be found on the "A" scale under the runner hairline.

Rule—To find the square of a number, set the runner over the number to be squared on the "D" scale, and read the square of the number on the "A" scale under the runner hairline.

EXAMPLE: Find square of 81.5 (See Fig. P).

(1ST) SET THE RUNNER OVER 815 ON "D"

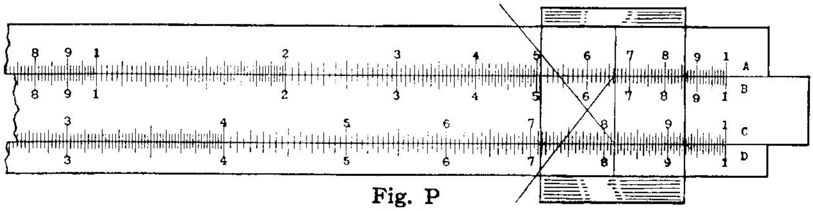


Fig. P

(2ND) UNDER RUNNER HAIRLINE ON "A" READ 664

The decimal point is determined in the manner as described in preceding examples under "Multiplication" and "Division" by mentally squaring 80, (which is the nearest round number to 81.5), giving us 6400. We therefore know that the answer to the above problem is 6640 and not 664, or 66.4, or 66400.

The square root of a number is found by reversing the process used in finding the square of a number.

Rule—To find the square root of a number, set the runner hairline at the number on the "A" scale and read the square root on the "D" scale under the runner hairline.

Note: Use the left half of the "A" scale for numbers with an odd number of figures before decimal point, and the right half for those with an even number of figures before the decimal point.

EXAMPLE: Find the square root of 567. (See Fig. Q).

Use left half of "A" scale (odd number of figures before decimal point).

(1ST) SET RUNNER HAIRLINE TO 567 ON LEFT HALF OF "A"

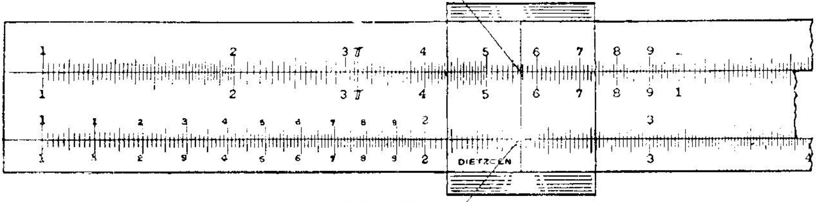


Fig. Q

(2ND) UNDER RUNNER HAIRLINE ON 'D" READ 238

By mental approximation, we locate the decimal point after the second significant figure and arrive at answer 23.8.

EXAMPLE: Find the square root of 5760. (See Fig. R).

Use right half of "A" scale (even number of figures before decimal point).

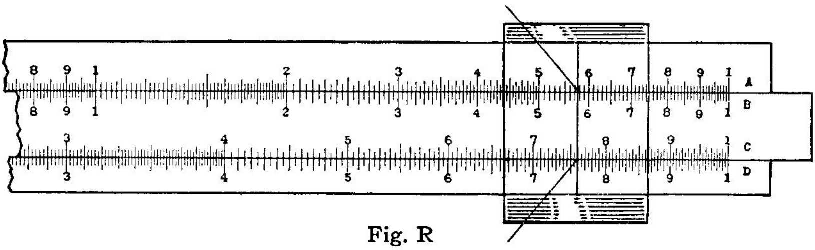


Fig. R

By mental approximation, we locate the decimal point after the second significant figure and arrive at answer 75.9.

Proportion

In daily practice the student will encounter many problems in proportion and conversion, such as:

1. To determine the value of one amount when the value of another amount is known.
2. Conversion of

ounces	to	pounds
meters	"	centimeters
yards	"	meters
pounds	"	kilograms
cubic inches	"	gallons
	etc.	

This proportion and conversion can readily be accomplished on the slide rule due to the fact that when we set a number on "C" scale over a number on "D" scale, all other adjacent numbers are in the same proportion; that is, if we set 3 on "C" scale over 9 on "D" scale, it will be noted that all adjacent numbers on the "C" and "D" scales are in the same ratio as 3:9; such as, 1:3; 2:6; 25:75, etc.

EXAMPLE in proportion:

If we know that 231 cubic inches equals 4 quarts and we wish to ascertain the number of quarts contained in 410 cubic inches, we set 231 on "C" over 4 on "D" and under 410 on "C", we read 7.1 quarts on "D". (See Fig. S).

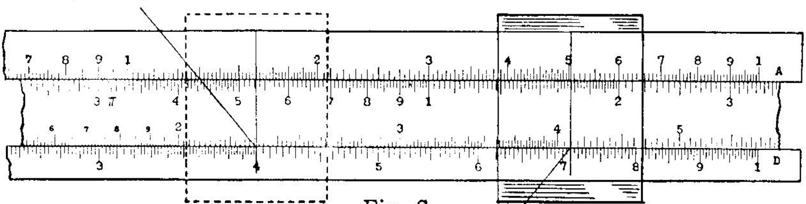


Fig. S

It will be noted from the above setting that for any number of given cubic inches on scale "C", the corresponding number of quarts in same can be read on scale "D". For instance, 260 cubic inches equal 4½ quarts, etc.

On the back of the rule, you will notice proportions which can be used to change one kind of unit into another kind.

EXAMPLE in conversion:

To change yards to meters, we find on the back of the rule the proportion 35:32 (35 on "C" to 32 on "D"). This means:—

If you set 35 on "C" over 32 on "D", you can read yards on "C" and meters on "D". Under any given number of yards on "C", you will find its equivalent in meters on "D".

The reason for the particular numbers in the proportions used in the conversion tables on the back of the rule is because when these conversion tables were worked out, as in the example above, it was first necessary to convert one unit into its equivalent unit of another kind; that is, one yard into its equivalent of meters, which is 0.914 meters.

This proportion of 1:0.914 on the slide rule was set with considerable difficulty and it was desirable to have a more simple means of setting this proportion. By an inspection of the two scales set as above, it was found that the only two graduations which exactly coincide, thereby eliminating the necessity of interpolation, were 35 on "C" scale and 32 on "D" scale.

Therefore, if we wish to convert yards to meters, all we have to do is to set 35 on "C" scale over 32 on "D" scale and the scales are then set in proper proportion to convert any given number of yards on "C" scale to its equivalent meters on "D" scale. Because of this simple setting, we use the figures 35:32 in our conversion table on the back of the rule.

Trigonometry

On the back of the slide is shown an "S" (Sine) scale, an "L" (Logarithm) scale and a "T" (Tangent) scale. These scales are used in the solution of trigonometrical problems.

The sine scale "S" is used in conjunction with scales "A" and "B".

Rule—If we set the upper index line in the right hand slot on reverse side of rule to any angle value on sine scale "S", the right index on scale "A" will coincide with sine value of that angle on scale "B".

EXAMPLE: Find the natural sine of 32 degrees. (See Figs. T and U)

(1st) SET 32° ON "S" TO UPPER INDEX LINE IN RIGHT SLOT ON REVERSE SIDE

(2nd) UNDER RIGHT "A" INDEX READ 53 ON "B"

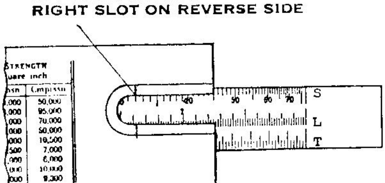


Fig. T

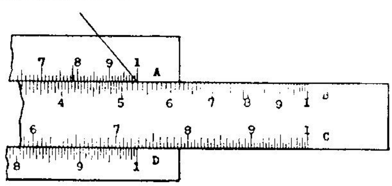


Fig. U

NOTE: The natural sines read on the right half of scale "B" have a decimal point before the first significant figure. Therefore, the correct result of above example is 0.53.

EXAMPLE: Find the natural sine of 2 degrees. (See Figs. V and W).

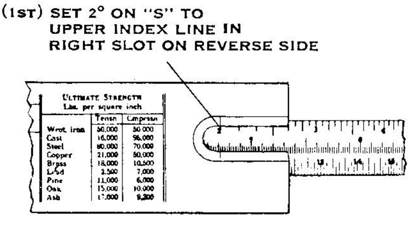


Fig. V

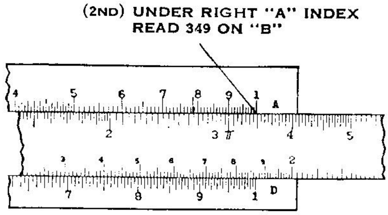


Fig. W

NOTE: The natural sines read on the left half of the "B" scales have a zero between the decimal point and the first significant figure. Therefore, the correct result of the above example is 0.0349.

The tangent scale "T" is used in conjunction with "C" and "D" scales.

Rule—To find the natural tangent of an angle, set the lower index line of the left hand slot on the reverse side of the rule to the angle whose tangent is to be found. Read the tangent on the face of the rule on the "C" scale over the left index on "D" scale.

EXAMPLE: Find tangent of angle 7° 40′. (See Figs. X and Y).

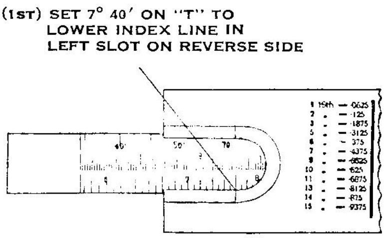


Fig. X

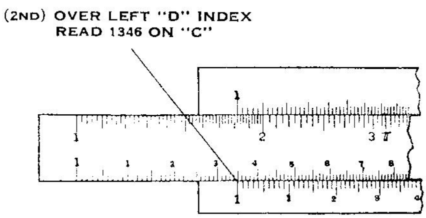


Fig. Y

(Special note: On some Rules the index for the "S" (Sine), "T" (Tangent), and "L" (Logarithmic) scales the index is on the right end of the rule instead of the left end of the rule.)

NOTE: The natural tangent of all angles read on "C" scale has a decimal point before the first significant figure. Therefore, the correct result of the above example is 0.1346.

The co-tangent of the angle 7° 40′ will be found on the "D" scale under the right "C" index; it is 7.43.

The value of the co-tangent of any angle which can be read on the slide rule has a decimal point after the first significant figure.

Angles below 5° 43′ cannot be read on the "T" scale, as you will note. However, for all practical purposes, natural tangents of angles below 5° 43′ are the same as the natural sines of the same angle and can therefore be read from the "B" and "S" scales. Tangents of angles above 45° are found from cot. a = tan (90°-a).

In the case of small angles, the trigonometrical functions, sine and tangent, are almost identical with the arc.

Problems Involving Use of the "S" and "T" Scales

EXAMPLE: Multiply 35 x sin 40°. (See Figs. Z and AA).

(1ST) SET 40° ON "S" TO UPPER INDEX LINE IN RIGHT SLOT ON REVERSE SIDE

(2ND) UNDER 35 ON "A" READ 22.5 ON "B"

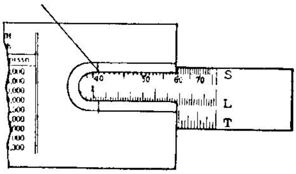


Fig. Z

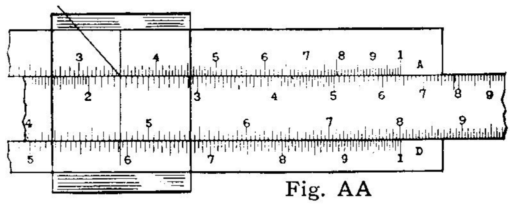


Fig. AA

EXAMPLE: Multiply 2 x tan 7°. (See Figs. BB and CC).

(1ST) SET 7° ON "T" TO LOWER INDEX LINE IN LEFT SLOT ON REVERSE SIDE

(2ND) OVER 2 ON "D" READ 0.246 ON "C"

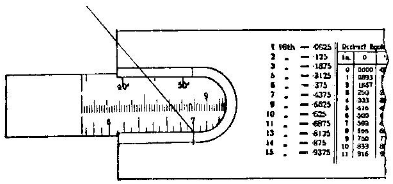


Fig. BB

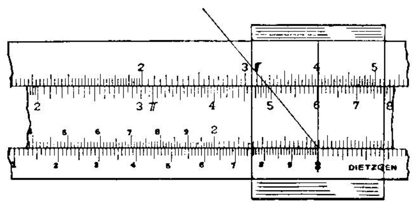


Fig. CC

Another way of reading natural sines and tangents is to reverse the slide and set so that the "S" scale is immediately below the "A" scale and the "T" scale is immediately above the "D" scale, as shown in Fig. DD. By placing the indexes of the "S" and "A" scales together and the "T" and "D" scales together, the numerical value of the sine of any angle on the "S" scale can be found by reading the number immediately above on "A" scale.

The numerical value of the tangent of any angle on "T" scale can be found by reading the number immediately below on "D" scale. In other words, when the scales are set in this manner, they form a table of sines and tangents. In this way, problems involving multiplication, division and proportion of sines and tangents can be more readily solved.

EXAMPLE: Find the sines of angles 2° and 36° and tangents of angles 10° 35′ and 37° 30′. (See Fig. DD).

SIN 2° = 0.0349

SIN 36° = 0.588

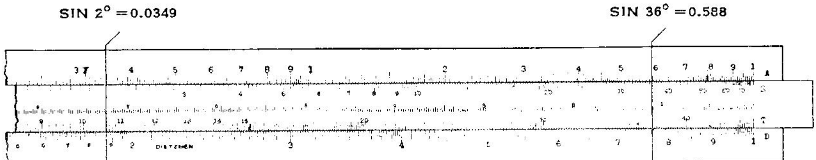


Fig. DD

TAN 10° 35′ = 0.1868

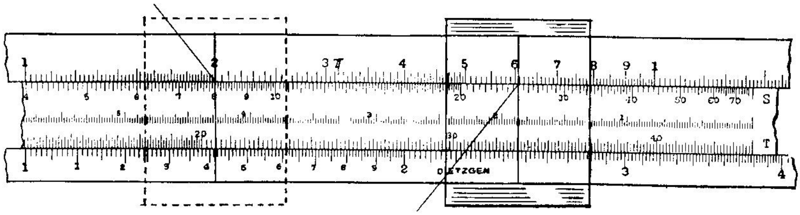
TAN 37° 30′ = 0.767

Again we call your attention to the fact that the numerical value of the sines of angles read on the left half of the "A" scale have a zero to the left of the first significant figure and to the right of the decimal point, as shown in the value of sine 2° = 0.0349.

Using the slide in the reverse manner as shown in Fig. DD permits more convenient solutions of problems involving proportions in trigonometrical functions.

EXAMPLE: Proportion $\frac{2}{\sin 8^\circ} : \frac{x}{\sin 25^\circ}$ (See Fig. EE).

(1ST) SET 8° ON "S" UNDER 2 ON "A"



(2ND) OVER 25° ON "S" READ 6.08 ON "A"

Fig. EE

Logarithms

The scale "L" (a scale of equal parts) on the reverse side of the slide between the "S" and "T" scales is the logarithm scale and permits the reading of the logarithm (mantissa) of numbers on the "D" scale.

*Rule—To find the logarithm (mantissa) of a number, set the left "C" index over the number on "D" scale and read the logarithm (mantissa) of the number on the "L" scale over the lower index line of the right hand slot on the reverse side of the rule.**

EXAMPLE: Find the log of 1.35. (See Figs. FF and GG).

(1ST) SET LEFT "C" INDEX OVER 135 ON "D"

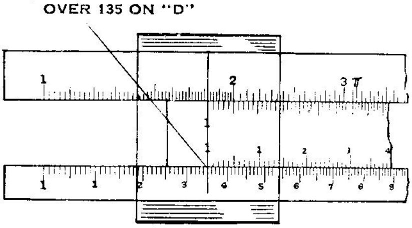


Fig. FF

(2ND) READ 1303 ON SCALE "L" OVER THE LOWER INDEX LINE OF RIGHT HAND SLOT ON REVERSE SIDE OF RULE.

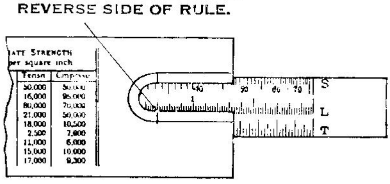


Fig. GG

Every logarithm consists of two parts:—A positive or negative whole number called the "characteristic"; and a positive fraction called the "mantissa." The log of the above problem is 0.1303.

To find the common logarithm of 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.

*Note: On some slide rules the logarithm scale (scale of equal parts) is numbered from left to right. In such cases, set the number on "C" over the right hand index of "D".

To find the number corresponding to a given common logarithm:—If the "characteristic" of a given logarithm is positive, the number of figures in the integral part of the corresponding number 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 of the corresponding number is one less than the number of units in the "characteristic."

ADDITIONAL SCALES

The instructions given so far, apply to the Standard Mannheim type rule which has on its face only the "A," "B," "C," and "D" scale.

We give you below, instructions for the use of rules containing two additional scales, namely the cube scale "K" and the reciprocal scale "CI."

CUBE AND CUBE ROOTS

Use of the "K" scale

The cube scale "K" as its name implies is used for obtaining the cube or cube root of a number, and it is used in conjunction with the "D" scale.

The cube of a given number is found by setting the indicator over the given number on the "D" scale and reading its cube in register on the "K" scale.

Conversely, the cube root of a given number is found by setting the indicator over the given number on the "K" scale and reading its cube root in register on the "D" scale.

The "K" scale is a logarithmic scale of three identical parts, each part is one third as long as the "D" scale.

Rule—To determine which one of these three parts of the "K" scale to use in finding the cube root of a given number, it is first necessary to determine the number of digits (or figures) in the given number, i. e.:—

(a) Use the FIRST third of the "K" scale: if the given number contains one digit or if it contains one plus the multiple of three digits, i. e. 1, 4, 7, etc. digits, as in the numbers 6, 6,000, 6,000,000, etc.

(b) Use the MIDDLE third of the "K" scale: if the given number contains two digits or if it contains two plus the multiple of three digits, i. e. 2, 5, 8, etc. digits, as in numbers 60, 60,000, 60,000,000, etc.

(c) Use the LAST third of the "K" scale: if the given number contains three digits or if it contains three plus the multiple of three digits, i. e. 3, 6, 9, etc. digits, as in numbers 600, 600,000, 600,000,000, etc.

Reciprocal or "CI" Scale

The "CI" scale on the face of the slide is an inverted "C" scale and is in reverse relation to the scales "C" and "D."

The numbers on the "CI" scale are the reciprocals of the numbers directly below on the "C" scale.

Rule—To find the reciprocal of a given number (1 divided by the number), or $\frac{1}{n}$, set the indicator on the given number on the "C" scale and read its reciprocal in register on the "CI" scale.

EXAMPLE: To find the reciprocal of 4, set the indicator on 4 on the "C" scale and read its reciprocal 0.25 in register on the "CI" scale.

MULTIPLICATION BY USE OF THE "CI" SCALE. The "CI" scale besides permitting the reading of reciprocal numbers, can be used in multiplication and division in conjunction with the "D" scale.

Rule—To multiply two numbers together using the "D" and "CI" scales, set the indicator on one of the factors on the "D" scale, and bring into register with the indicator the other factor on the "CI" scale, and read the product on the "D" scale under the right or left hand index.

EXAMPLE: To multiply 2 x 7, using the "D" and "CI" scales as explained above, set the indicator over 2 on the "D" scale and bring 7 on the "CI" scale in register with the indicator and read the product 14 on the "D" scale under the left hand index.

MULTIPLICATION INVOLVING THREE FACTORS. It is well to further observe that multiplication by use of the "CI" scale combination, permits the finding of the product of three factors with one setting of the slide rule.

Rule—To find the product of three factors, set the indicator over one factor on the "D" scale and by use of the slide, bring the other factor on the "CI" scale in register, then move the indicator to the third factor on the "C" scale and read the product in register on the "D" scale.

EXAMPLE: To multiply 2 x 7 x 4, set the indicator over 2 on the "D" scale, bring the 7 on the "CI" scale in register with the indicator, move the indicator to 4 on the "C" scale and read the product 56 in register on the "D" scale.

Division by Use of the "CI" Scale.

Rule—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 indicator to the divisor on the "CI" scale and read the quotient in register on the "D" scale.

EXAMPLE: To divide 6 by 3, set the right hand index of the "CI" scale over 6 on the "D" scale, move the indicator to 3 on the "CI" scale and read the quotient 2 in register on the "D" scale.