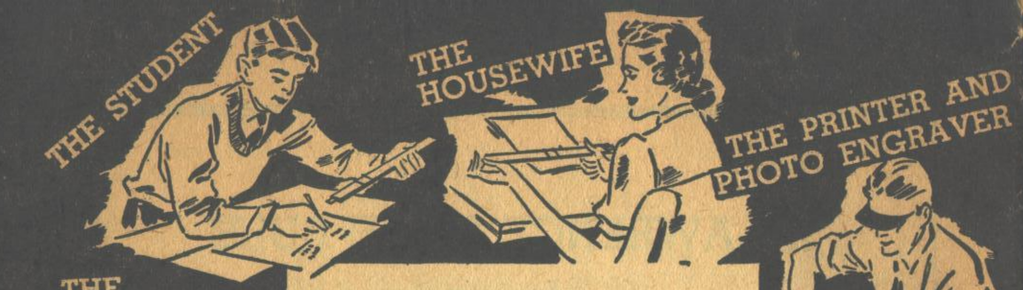



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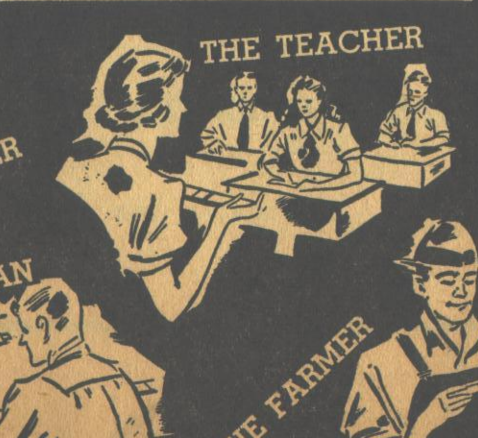


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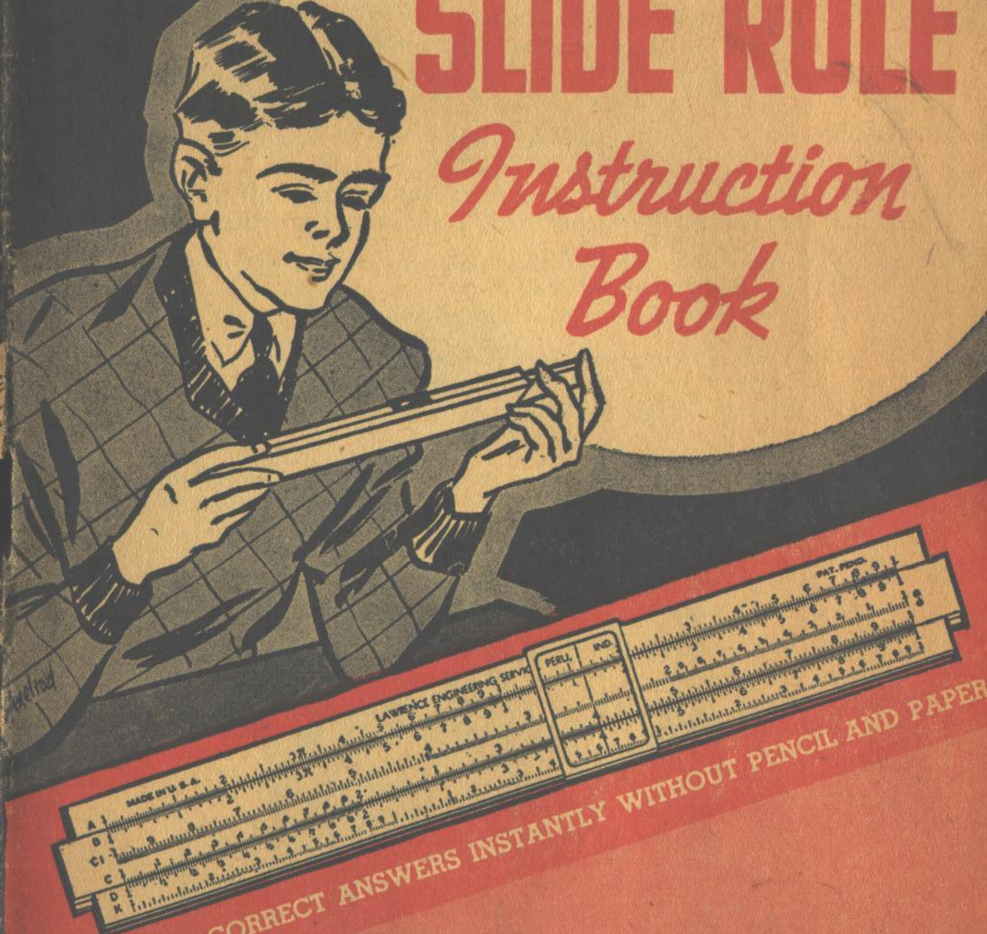

HOW TO GET CORRECT ANSWERS INSTANTLY WITHOUT PENCIL AND PAPER

COMPLETE INSTRUCTIONS ON HOW TO MULTIPLY, DIVIDE, SQUARE, CUBE, EXTRACT SQUARE AND CUBE ROOTS ON THE TIME-SAVING SLIDE RULE


PUBLISHED FOR THE LAWRENCE ENGINEERING SERVICE, PERU, INDIANA

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# SIMPLE RULES for using the SLIDE RULE

By John Poland

*Prof. of Mechanical Engineering and Air Conditioning at the Chicago Technical College*

## FOREWORD

Anyone from a seventh grade student up can learn to use a slide rule properly with just a little study and practice.

There are two methods of learning to use the slide rule:
1. The Mental Survey Method
2. The Digit and Integral Digit Method

The Mental Survey method is quick and practical. It is used by hundred of thousands of slide rule operators. The Digit and Integral Digit method is more thorough and scientific. It is used in schools and colleges.

To the best of our knowledge this is the first time both methods have been made available in one instruction book. If you select the "Mental Survey" method disregard all material on digits and integral digits. If you use the Digit and Integral Digit method, disregard all material on the "Mental Survey" method.

Anyone who will apply himself to the operation of the slide rule and will make its use a practical habit while at work, study or leisure, will find himself richly rewarded in the saving of time and energy—to say nothing of the satisfaction that comes from the mastery of "Man's most useful tool."

*Published for*

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— 1939 —



## THE SLIDE RULE

The Slide Rule is a time and labor saving instrument for quickly solving problems involving multiplication, division, proportion, squares, square roots, cube and cube roots or any combination of these processes.

The operation of a Slide Rule is simple and anyone with a fair understanding of numbers can use one. It should be remembered that the Rule itself is accurate within about one-half of one per cent, and the accuracy of the answers obtained are limited only by the spacing of the lines on the scales and the ability of the user to estimate readings and setting that fall between the lines.

It must also be remembered that only the first three digits of any number can be read-or located on the slide rule except in Units I of the C and D scales, where four digits can be located. A good rule to follow is this: if the fourth digit is less than 5, drop the remaining digits but if the fourth digit is 5 or more, increase the third digit by one and drop the remaining ones.

The Slide Rule consists of three parts (See Fig. 1), namely: the rule proper or body containing the A, D and K scales; the slide containing scales B, C I and C; and the glass "indicator," "runner," or "cursor" with a hair line in the center.

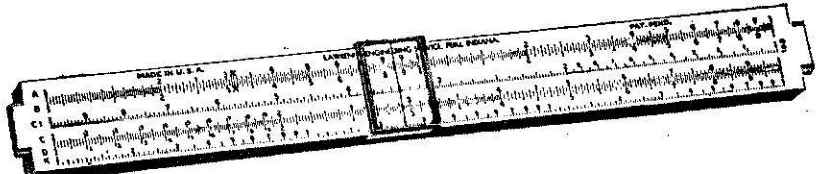


FIG. 1

### Scales and Uses

Scales C and D are used in multiplication, division and their combinations. Scales A and D are used for squaring and for finding the square roots of numbers. Scales K and D are used for cubing and finding the cube root of numbers. The C I scale gives the reciprocal of any number on the scale C. It can be observed from Fig 1 that the scales A and B are identical, scales C and D are also identical and that the C I scale is the C scale in reverse direction.

Before the different operations of multiplication, division, etc., can be accomplished, the operator must know how to read the different scales.

### Scales "C" and "D"

From Fig. 1 it will be seen that these two scales are identical in their divisions and markings. Since most of the operations are based upon scale D we will learn to read this one first, remembering that the discussion to follow can be applied to scale C. Looking at scale D in Fig. 1 we see that it is divided into nine main unequal divisions, starting at the left with number 1 and proceeding to the right to number 9, thence to a second number 1.

These divisions as mentioned before are UNIT divisions and each one is divided into smaller divisions. From Fig. 1 we see that the UNIT 1 (that is from number 1 to number 2 has ten major divisions, each equal to one-tenth (.1) of the unit. These major divisions in turn are divided into ten divisions, each of which is one-tenth (.1) of the major division of one-hundredth (.01) of the UNIT

Examples: 17, 15.3, 1162, and 1.92 would be located as shown in Fig. 2.

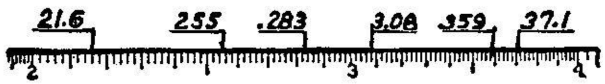

UNIT ONE OF SCALE "D"

FIG. 2

Each of these numbers begin with the digit "one" so each will fall in UNIT 1 of scale D. Number 17 is read at unit 1 plus 7 major divisions; number 15.3 is read at unit 1 plus 5 major divisions plus 3 minor divisions of the following major division; number 1.92 is read at unit 1 plus 9 major divisions plus 2 minor divisions of the following major division. It should be noted that the decimal point is always disregarded when locating a number on the scale.

UNIT 2: Unit 2 is the next main divsion of scale D and from Fig. 1 we see it is divided into ten major divisions as is unit 1 but they are not numbered here. Each of the major divisions of this unit are divided into 5 minor divisions, each of which is one-fifth of two-tenths (.2) of the major division or (.02) of UNIT 2

Examples of UNIT 2: Locate numbers 21.6, .283 and 255. (See Fig. 3.)




UNIT TWO UNIT THREE

FIG. 3

Each of these numbers begins with the digit 2 so it will fall within unit 2. The number 21.6 is read at unit 2 plus 1 major division plus 3 minor divisions of the following major division as each line here equals two-tenths (.2); the number .283 is read at unit 2 plus 8 major divisions plus 1½ minor divisions of the following major division; the number 255 is read at unit 2 plus 5 major divisions plus



2½ minor divisions of the following major division. Here again the decimal point is disregarded when locating a number on the scale.

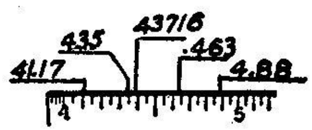
UNIT 3: Unit 3 of the D scale is divided as is unit 2 and the divisions possess the same values. See Fig. 3 for comparing unit 3 and unit 2.

Examples for UNIT 3. Locate numbers 3.08, 37.1 and 359. (See Fig. 3.)

The number of 3.08 is read unit 3 plus 0 major divisions plus 4 minor divisions of the first major division; the number 3.71 is read unit 3 plus 7 major divisions plus ½ of a minor division of the following major division; the number 359 is read unit 3 plus 5 major divisions plus 4½ minor divisions of the following major division.

UNIT 4: Unit 4 is our next main division and from Fig. 1 we see that this unit is divided into ten major divisions as in the preceding units. Each of these major divisions is in turn divided into two minor divisions each having a value of one-half or .5 of the major division or .05 of unit 4. When we have a three digit number in this unit the third digit must be estimated unless it is a 5.

Examples: Number 435 is read unit 4 plus 3 major divisions plus 1 minor division; number 43716 is read unit 4 plus 3 major divisions plus 1 minor division which gives 435 and then add an estimated two-fifths of the next minor division giving 437. The remaining digits, 1 and 6, are too small to be considered so they are ignored as explained under the portion headed "THE SLIDE RULE." See Fig. 4 for these and other readings.




UNIT FOUR

FIG. 4

The remaining units on the scale are the same as unit 4 except that the division lines are closer together. Examples for units 5, 6, 7, 8 and 9 are shown in Fig. 5.

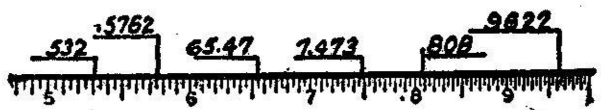
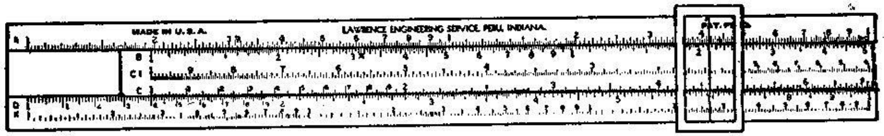



FIG. 5

The number of 5.32 is read unit 5 plus 3 major divisions plus an estimated two-fifths of the next minor division; number .808 is read unit 8 plus 0 major divisions plus 1 minor division which gives 805 and then add three-fifths of the next minor division giving 808; number 9622 is read unit 9 plus 6 major divisions plus two-fifths of the next minor division. (The fourth digit 2 is ommitted on the scale as previously explained.)



MULTIPLYING 14 x 46

FIG. 6

## LOCATION OF DECIMAL POINT IN MULTIPLCATION BY THE MENTAL SURVEY METHOD

**Multiplication**

As stated before, scales C and D are used in multiplication and are identical. Therefore, the divisions and reading of scale C will be the same as those found on scale D. The first line, number 1, at the left of the C scale is called the left index, while the last line at the right end of the scale is called the right index.

When multiplying two numbers together we set either the right or the left index of the C scale directly over one of the numbers on the D scale; move the indicator so the hair line is over the number on the C scale; then read the answer under the hair line on the D scale.

**Example 1:** 3.4 x 7.2

Set the right index of the C scale over 7.2 on the D scale, move the indcator until the hair line is over 3.4 on the C scale Read the 24.5 under the hair line on the D scale.

The most convenient way to locate the decimal point is to make a mental multiplication of the first digits in the factors. Then place the decimal point in the result so that the value is nearest that of the mental multiplication. Thus, 3 and 7, the first digits of our factors will give 21, indicating that the result 245 will become 24.5 instead of 2.45 or 245, as 24 is the nearest to our mental multiplication value of 21.



**Example 2:** 14 x 46 = 644

Set the left index of the C scale over 14 on the D scale, move the indicator so the hair line is over 46 on the C scale. Read the answer 644 under the hair line on the D scale. (See Fig. 6.)

From mental multiplication we see that 14, which is near 10, and 46, which is near 45, would give 10 x 45 or 450, showing that the answer would be in the hundreds, namely 644 instead of 64.4 or 6440.

**Example 3:** 18.72 x .356 = 6.66

Set the left index of the C scale over 1872 on the D scale, move the indicator until the hair line is over 356 on the C scale. Read the answer 666 under the hair line on the D scale. (See Fig 8.)

From observation we see that we are multiplying practically 20 x .3 giving 6. Therefore, our answer becomes 6.66 instead of 66.6 or .666.

**Multiplication by the Integral Digit Method.** (See page 21.)

As stated before scales C and D are used in multiplication and are identical. Therefore, the divisions and readings of scale C will be the same as those found on scale D. The first line, at number 1 at the left of the C scale, is called the left index, while the last line at the right end of the scale is called the right index.

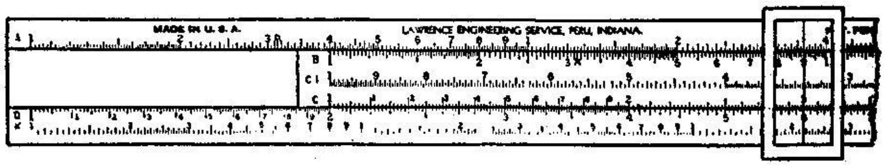
When multiplying two numbers together we set either the right or the left index of the C scale directly over one of the numbers on the D scale; move the indicator so the hair line is over the other number on the C scale; then read the answer under the hair line on the D scale.

**Example 1:** 2 x 3 = 6

Set the slide so that the left index or number 1 of the C scale is directly over UNIT 2 on the D scale. Move the indicator so that the hair line is over UNIT 3 on the C scale, then read the answer 6 directly under the hair line on the D scale. (See Fig. 7.)

**Example 2:** 14 x 46 = 644

Set the slide so the left index of the C scale is over 14 on the D scale. Move the indicator so the hair line is over 46 on the C scale, then read the answer 644 under the hair line on the D scale. (See Fig. 6.)



MULTIPLYING 2 x 3

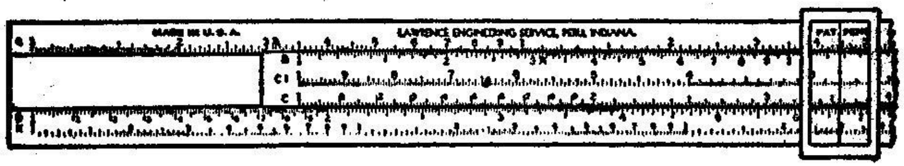
FIG. 7

It will be noted that the slide extended to the right in both of these operation and that the number of integral digits in each answer contained one less integral digit than the sum of the integral digits in both numbers. From this explanation we can establish a rule for multiplication when the slide extends to the right.

RULE: When the slide extends to the right, add the number of integral digits in the multiplier to those in the multiplicand and then subtract one; the result will be the number of integral digits in the answer.

**Example 3: 18.72 x .356 = 6.66**

Set the slide so that the left index of the C scale is over 187 on the D scale. Move the indicator so that the hair line is over 356 on the C scale, then read the answer 666 under the hair line on the D scale. (See Fig. 8.)



MULTIPLYING 18.72 x .356

FIG. 8

The number 18.72 has plus 2 integral digits and .356 has zero integral digits; adding we get plus 2 integral digits. Since the slide extended to the right we subtract 1 leaving plus one integral digit, thus 666 becomes 6.66.

**Example 4: 2351 x 41.2 = 96800**

The left index of the C scale is set over 235 on the D scale; the hair line of the indicator over 412 on the C scale; read the number 968 under the hair line on the D scale. Number 2351 has 4 integral digits and number 41.2 has 2 integral digits; adding we obtain 6 integral digits. Since the slide moved to the right we subtract one leaving 5 integral digits in the answer. As we are only able to locate three numbers on the scale (three numbers are all that we can read in any answer), zeros must be added to complete the necessary number of integral digits. We will need two in this example making the answer 96,800.

**Problems:**

| | |
|---|---|
| 183.2 x 27.42 | Ans. 5020 |
| 31.52 x 19.7 | Ans. 621 |
| 1.248 x 6.57 | Ans. 8.20 |

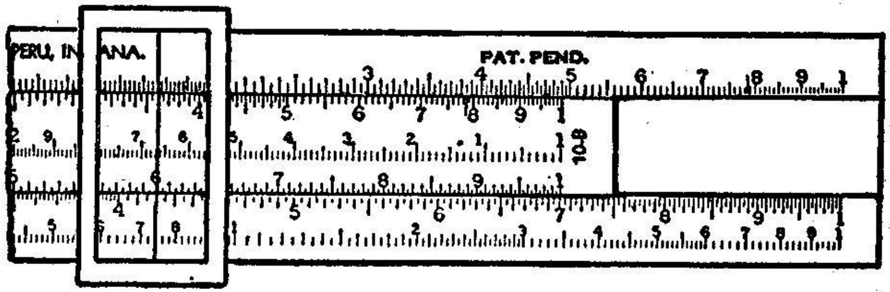


| | |
|---|---|
| 257 x .313 | Ans. 80.4 |
| .037 x 228 | Ans. 8.44 |
| 233.42 x .00196 | Ans. .457 |

It will be noted that the preceding problems in multiplication were such that the slide always extended to the right. We will now use numbers so that the slide will move to the left.

**Example 1: 7 x 6 = 42**

Set the right index of the C scale over 7 on the D scale, move the indicator so that the hair line is over 6 on the C scale, read the answer 42 under the hair line on the D scale. (See Fig 9.)

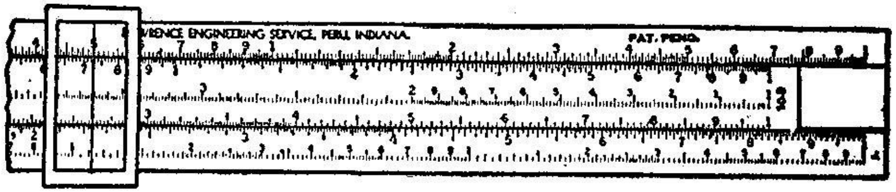



MULTIPLYING 7 x 6

FIG. 9

**Example 2: 8.3 x 27 = 224**

Set the right index of the C scale over 83 on the D scale, move the indicator so that the hair line is over 27 on the C scale, read the answer 224 under the hair line on the D scale. (See Fig 10.)




MULTIPLYING 8.3 x 27

FIG. 10

**Example 3: 9.5 x 4.8 = 45.6**

In the above example the slide extended to the left and the answer has as many integral digits as there were in the numbers themselves. Hence the rule: WHEN THE SLIDE EXTENDS TO THE LEFT, ADD THE NUMBER OF INTEGRAL DIGITS IN

THE MULTIPLIER TO THOSE IN THE MULTIPLICAND AND THIS SUM WILL BE THE NUMBER OF INTEGRAL DIGITS IN THE ANSWER.

**Example 4:** 75.3 x 6.27 = 472

Number 75.3 has 2 integral digits and 6.27 has one integral digit, adding, we will have 3 integral digits in the answer; thus 472.

**Example 5:** 4387 x .0372 = 163

Number 4387 has 4 integral digits and .0372 has minus 1 integral digits, adding 4 to —1 we have 3 integral digits, thus the answer 163.

**Example 6:** .0057 x .0244 = .000139

Number .0057 has minus 2 (—2) integral digits and .0244 has minus 1 (—1) integral digit. Adding —2 to —1 we have —3 integral digits. Therefore, three zeros must be placed before number 138 making the answer .000138.

**Problems:**

| | |
|---|---|
| 75.21 x 485 | Ans. 36,500 |
| .0672 x 3.48 | Ans. .234 |
| 8.052 x 44.72 | Ans. 360 |
| 9.122 x .1488 | Ans. 1.357 |

When multiplying more than two numbers as 6 x 24 x 32, multiply 6 x 24 as has been explained; then take this answer and multiply it by 32 to obtain the final answer. Multiplying 6 x 24 = 144. 144 x 32 = 4610.

In the first operation, the slide extended to the left, therefore the answer will have 3 integral digits since there is 1 integral digit in number 6 and there are 2 integral digits in number 24. In the next operation, the slide extends to the right, so we must use the sum of the integral digits less one. Number 144 (answer of first operation) has 3 integral digits and number 32 has 2 integral digits. Adding we have 5 integral digits and less one leaves 4 integral digits in our final answer. As we were only able to read three numbers on the scale we must add 1 zero to make the necessary 4 integral digits.

**Problems:**

| | |
|---|---|
| 14 x 35 x 8.4 | Ans. 4120. |
| 3.76 x .786 x 185 | Ans. 547. |
| 27.5 x 12.5 x .27 | Ans. 92.8 |



## DIVISION

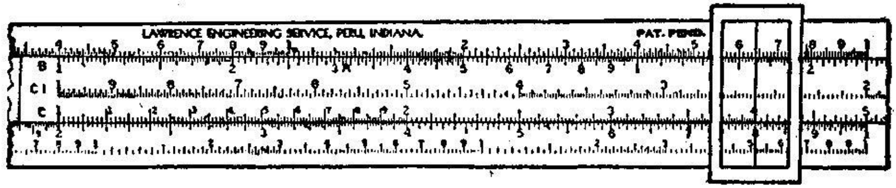
**Location of Decimal Point in Division by the Mental Survey Method**

In division we use the same scales, namely **C** and **D**, as were used in multiplication, only in reverse order.

When dividing, the hair line of the indicator is placed over the number to be "divided into" (numerator) on the **D** scale; the slide is moved to the right or left so that the number we are "dividing by" (denominator) is located on the **C** scale will fall directly under the hair line. The answer will be found under the index of the **C** scale on the **D** scale.

**Example 1:** 8 ÷ 4 = 2

Set the hair line of the indicator over 8 on the **D** scale, move the slide until 4 on the **C** scale is under the hair line; read the answer 2 under the left index on the **D** scale. (See Fig. 11.)




DIVIDING 8 BY 4

FIG. 11

**Example 2:** 845 ÷ 25 = 33.8

From a mental survey we can see we have practically 800 ÷ 20, giving us two places in the answer; thus we obtain 33.8 instead of 338 or 3.38; or we can determine the decimal point in the following manner; 25 will go into 84 one digit and some left over; 25 will go into the left over amount and 5 another digit, thus giving 2 digits in our answer, so we have 33.8. The setting of the scale is shown in Fig. 13.

**Example 3:** 6187 ÷ 24.8 = 249

Here 24 will go into 61 one digit and give a remainder; this remainder and 8 can be divided by 24 making another digit in the answer and a remainder. Again this remainder and 7 can be divided by 24 making a third digit in the answer; thus we have three digits, 249 as the answer. Or we can say we have roughly 6000 ÷ 24, giving three numbers or digits in the answer.

**Division by the Integral Digit Method.** (See page 21.)

In division we use the same scales as are used in multiplication, namely: the **C** and **D** scales because division is the reverse operation to multiplication.

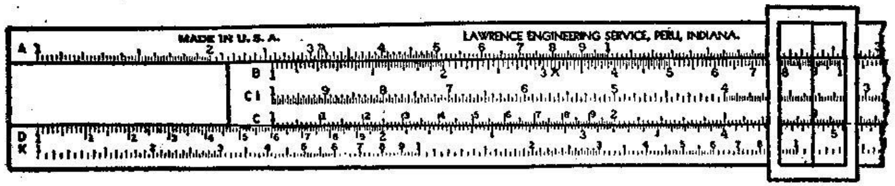
When dividing two numbers the hair line of the indicator is placed over the numerator or dividend on the D scale; the slide is moved to the right or left so that the denominator or divisor located on the C scale will fall directly under the hair line; read the answer under the index of the C scale on the D scale.

**Example 1:** $8 \div 4 = 2$

Set the hair line of the indicator over 8 on the D scale; move the slide until 4 on the C scale is under the hair line; read the answer 2 on the D scale under the left index of th C scale. (See Fig. 11.)

**Example 2:** $48 \div 3 = 16$

Set the hair line of the indicator over 48 on the D scale, move the slide until 3 of the C scale is under the hair line, read the answer 16 on D scale under the left index of the C scale. (See Fig. 12.)

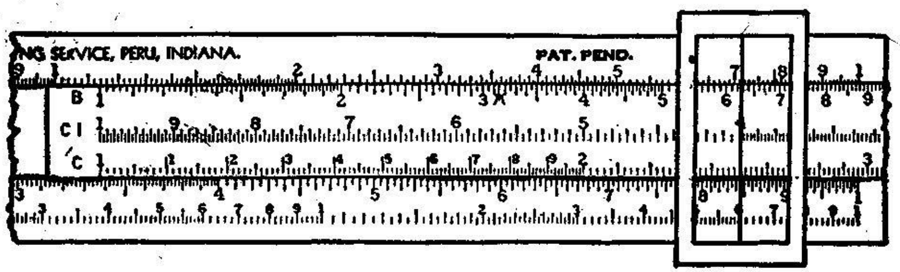



DIVIDING 48 BY 3

FIG. 12

**Example 3:** $845 \div 25 = 33.8$

Set the hair line of the indicator over 845 on the D scale, move the slide until 25 of the C scale is under the hair line, read the answer 33.8 on the D scale under the left index of the C scale. (See Fig. 13.)




DIVIDING 845 BY 25

FIG. 13

The user will note that in the preceding examples the slide moved to the left. When this occurs the rule for finding the number of integral digits in the answer is as follows:



IN DIVISION, WHEN THE SLIDE MOVES TO THE RIGHT, SUBTRACT THE NUMBER OF INTEGRAL DIGITS IN THE DIVISOR FROM THE NUMBER OF INTEGRAL DIGITS IN THE DIVIDEND AND THEN ADD 1. THIS WILL GIVE THE NUMBER OF INTEGRAL DIGITS IN THE ANSWER.

Referring to example No. 1, the dividend 8 has one integral digit and the divisor has one integral digit; subtracting the one integral digit in the dividend leaves zero, but since our slide moves to the right, we add one making $0 + 1 = 1$. Therefore, our answer will have one integral digit.

Using example No. 2, the dividend 48 has two integral digits and the divisor 3 has one intergral digit Subtracting one from two and then adding 1 we obtain two integral digits in the answer.

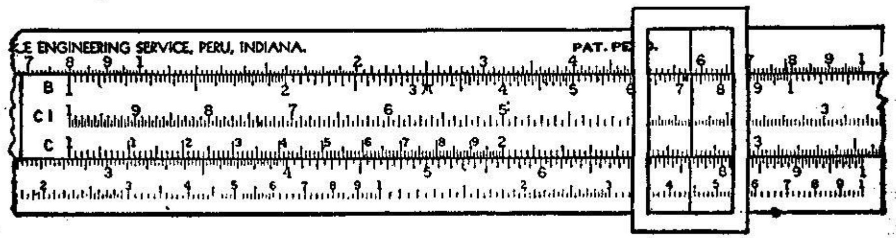
With example No. 3, the dividend 845 has three integral digits and the divisor 25 has two integral digits. Subtracting two from three and then adding 1 we obtain two integral digits in the answer.

**Problems:**

| | |
|---|---|
| $72.6 \div 1.83$ | Ans. 39.7 |
| $6187 \div 24.8$ | Ans. 249 |
| $5.493 \div 37$ | Ans. .1484 |
| $813.6 \div 672$ | Ans. 1.21 |

**Example 4:** $763 \div .027 = 28{,}200$

Set the hair line over 763 on the C scale, move the slide until 27 is under the hair line, read the number 282 on the D scale under the index of the C scale. The number 763 has three integral digits, and .027 has minus one integral digit. Since we are dividing, we subtract the integral digit of the divisor from those in the dividend as stated in the rule. But here we are subtracting a minus one from a plus three, which will give four as explained under "Subtraction of Integral Digits." Also the slide extended to the right, so we must add 1, to the result just obtained by subtracting the integral digits, making 4 + 1 or 5 integral digits in our answer. Therefore, our answer 28200; adding the two zeros to make the necessary five integral digits. (See Fig. 14.)

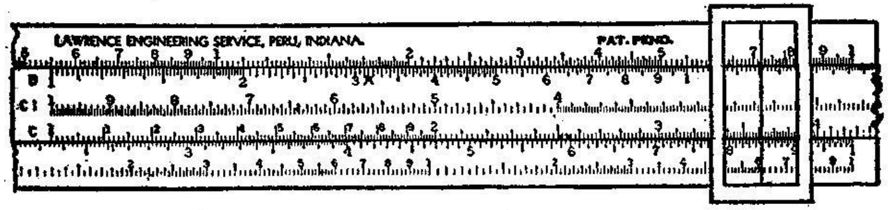



DIVIDING 763 BY .027

FIG. 14

**Example 5:** .0851 ÷ .0362 = 2.35

Set the hair line over 851 on the D scale, move the slide until 362 is under the hair line, read 235 on the D scale under the index. Here the dividend has a minus one integral digit and the divisor also has a minus one integral digit. Subtracting minus one from minus one we get zero, but the slide goes to the right so we must add one to zero making one integral digit in the answer. Therefore, the reading 235 becomes 2.35. (See Fig. 15.)




DIVIDING .0851 BY .0362

FIG. 15

**Example 6:** 3852 ÷ 725 = 5.31

**Example 7:** 143.7 ÷ 9.36 = 15.35

In the examples above, 3852 has four integral digits while 725 described except that the slide will move to the left and the answer will be found under the right index of the C scale. When the slide moves to the left we have the following rule: IN DIVISION, WHEN THE SLIDE MOVES TO THE LEFT, SUBTRACT THE NUMBER OF INTEGRAL DIGITS IN THE DIVISOR FROM THE NUMBER OF INTEGRAL DIGITS IN THE DIVIDEND AND THIS WILL GIVE THE NUMBER OF INTEGRAL DIGITS IN THE ANSWER.

In the example above, 3852 has four integral digits while 725 has three. Subtracting, we have one integral digit in the answer, giving 5.32. In example 7, 143.7 has three integral digits while 9.36 has one. Subtracting one from three gives two integral digits in the answer, so we have 15.36.

**Example 8:** 26.8 ÷ .0652 = 411

Here 26.8 the dividend, has two integral digits and .0652, the divisor, has minus one integral digit. Subtracting minus one from two we obtain three, which is the number of integral digits in the answer.



In this problem the rule of subtraction of integral digits is used as previously explained.

**Problems:**

| | |
|---|---|
| 4873 ÷ 562 | Ans. 8.67 |
| 93.14 ÷ 472 | Ans. .197 |
| .0568 ÷ .027 | Ans. 2.1 |
| 6.35 ÷ 18.2 | Ans. .349 |

**Scale A.**

Scale A is divided into two halves, called the left and the right half. (See Fig. 1.)

The left half is divided into 9 unequal divisions, similar to scale D, and these divisions are also called UNIT divisions.

Unit 1 is divided just as unit 2 is on the D scale, so the divisions will have the same value as did unit 2 of the D scale. Units 2, 3 and 4 are like unit 4 of the D scale and they have the same value as did unit 4 of the D scale. Unit 5 of the A scale is divided in ten major divisions only, so the third digit of any number must be estimated. This is also true of units 6, 7, 8 and 9.

The right half of the A scale is divided as in the left half, therefore the values of the divisions will be the same.

As stated before, scales A and B are identical, as the readings on scale B will be the same as the reading on scale A.

## SQUARING A NUMBER BY THE MENTAL SURVEY METHOD

When we square a number we mean we are to multiply the number by itself, thus $6^2$ is 6 x 6. The small number 2 at the upper right of the figure means the number is to be squared.

When squaring a number on the slide rule we use the D and A scales. The hair line of the indicator is set over the number to be squared on the D scale and the answer is read under the hair line on the A scale.

**Example 1:** $(2)^2 = 4$

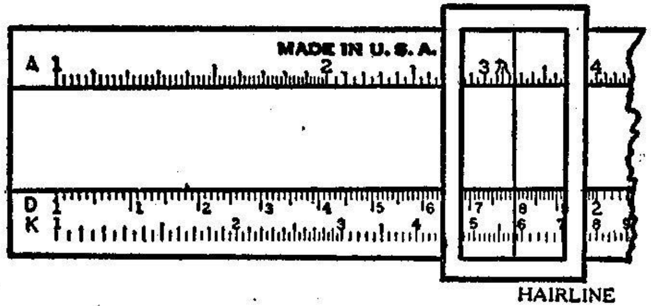
Set the hair line of the indicator over 2 on the D scale and read 4 under the hair line on the A scale.

**Example 2:** $(4)^2 = 16$

Set the hair line of the indicator over 4 on the D scale and read 16 under the hair line on A scale.

### Example 3: $(18)^2 = 324$

Make the setting as has been explained in examples 1 and 2. The number 18 lies between 10 and 20; so $10^2 = 100$ while $20^2 = 400$, but since 18 is nearest to 20 the answer will be near 400; thus we have 324.




SQUARING 18

FIG. 16

### Example 4: $(36.2)^2 = 1310$

The number 36.2 lies between 30 and 40; so $30^2 = 900$ while $40^2 = 1600$, but since 36.2 is closer to 40 we will have four numbers in the answer: thus 1310.

### Example 5: $(18.7)^2 = 66.7$

The number 8.17 lies between 8 and 9; so $8^2 = 64$ while $9^2 = 81$, but 8.17 is closer to 8 than 9 so we have two numbers in the answer; thus 66.8

**Problems:**

$(92.4)^2 = 8540$
$(2.61)^2 = 6.81$
$(158)^2 = 24{,}900$

**Squaring a Number by Integral Digit Method.** (See page 21.)

When we square a number we use the D and A scales. The hair line of the indicator is set over the number to be squared on the D scale and the answer is read under the hair line on the A scale.

### Example 1: $(2)^2 = 4$

Set the hair line over unit 2 on the D scale and read 4 under the hair line on the left half of the A scale.



### Example 2: $(3)^2 = 9$

Set the hair line over 3 on the D scale and read 9 under the hair line on the left half of the A scale.

### Example 3: $(25)^2 = 625$

In the above examples the answers fall in the left half of the A scale, so a rule for squaring in this case is:

WHEN SQUARING A NUMBER, IF THE ANSWER FALLS IN THE LEFT HALF OF THE A SCALE MULTIPLY THE INTEGRAL DIGITS IN THE NUMBER BY 2, AND THEN SUBTRACT 1. THIS WILL GIVE THE NUMBER OF INTEGRAL DIGITS IN THE ANSWER.

In example 3, the number 25 has two integral digits. Multiplying the number of integral digits by 2 we obtain 4 but the answer falls in the left half so we must subtract one, making $4 - 1 = 3$ integral digits in the answer. Therefore, 625 is the answer containing three integral digits.

### Example 4: $(167.3)^2 = 27{,}900$

The number 167.3 has three integral digits; multiplying this by 2 we obtain six integral digits, but it falls in the left half of the A scale so we must subtract 1, leaving five integral digits in the answer. Since we can only read 279 we add the necessary zeros, making 27900.

We will now consider the squaring of a number when it falls in the right half of the A scale.

### Example 5: $(5)^2 = 25$

### Example 6: $(6)^2 = 36$

In the above examples the answer was found under the hair line in the right half of the A scale and in each case we had two times as many integral digits in the answer as in the number to be squared. From this we have the following rule: WHEN SQUARING A NUMBER, IF THE ANSWER FALLS IN THE RIGHT HALF OF THE A SCALE MULTIPLY THE INTEGRAL DIGITS IN THE NUMBER BY 2 AND THIS WILL GIVE THE NUMBER OF INTEGRAL DIGITS IN THE ANSWER.

### Example 7: $(87.3)^2 = 7620$

The number 87.3 has two integral digits. Multiplying by 2 we obtain four which will be the number of integral digits in the answer. As we are only able to read 76 on the A scale we add the two zeros to make the necessary four digits.

**Problems:**

| | |
|---|---|
| $(42.93)^2$ | Ans. 1840 |
| $(305.2)^2$ | Ans. 93100 |
| $(.753)^2$ | Ans. .567 |
| $(613.4)^2$ | Ans. 376,000 |

**Square Root of a Number by Mental Survey Method**

When we are going to find the square root of a number, we mean that we are to find a number which, when multiplied by itself, will equal the given number.

Whenever the sign ($\sqrt{\quad}$) is placed over a number it means that square root is required.

Before the square root can be found we must mark off the number into groups of two digits each starting from the decimal point. For example, 3148 which is a whole number will be marked off into two groups with 4 and 8 together and 3 and 1 together in this manner: $\sqrt{31|48|}$. Here the first group 31 has two digits. Another example 373 will be $\sqrt{3|73}$. with only one digit in the first group. Again in the numbers 538.42 and 6.471 they will be grouped as $\sqrt{5|38.42}$ and $\sqrt{|6.47|10}$.

In the answer to the square root of a number there will be as many numbers in the answer as there are groups in the number itself.

To find the square root of a number is the reverse operation of squaring therefore the A and D scales will be used again. If the first group has one number, as shown by 3|73 or 5|38.42|, set the hair line of the indicator over the number on the left half of the A scale and read the answer on the D scale. If the first group has two numbers as in 31|48. set the hair line of the indicator over 3148 on the right half of the A scale and read the answer under the hair line on the D scale.

**Example 1:** $\sqrt{48} = 6.93$

Since this group has two numbers, set the scale on 48 in the right half of the A scale and read 694 on the D scale. Here we have only one group, therefore we will have only one whole number in our answer; thus 6.94.

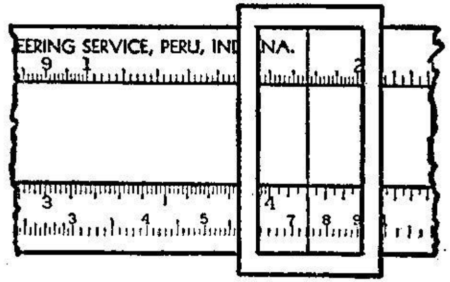
**Example 2:** $\sqrt{1|44} = 12$

Here we have one number in the first group, so we set 144 on the left half of the A scale and read the answer 12 under the hair line on the D scale. The number has two groups so we have two whole numbers in our answer.



**Example 3:** $\sqrt{17|64} = 42.1$

This number has two numbers in the first group so we set the indicator over 1764 on the right half of the A scale. This answer 421 is read under the hair line on the D scale. Our number has two groups, therefore we will have two whole numbers in our answer: thus 42.1. (See Fig. 17.)




SQUARE ROOT OF 17.64

FIG. 17

**Problems:**

$\sqrt{13|82.} = 37.2$

$\sqrt{5|48|17.} = 234.$

$\sqrt{7.38} = 2.72$

**Square Root of a Number by the Integral Digit Method. (See page 21.)**

When we say we are going to find the square root of a given number, we mean that we are going to find an unknown number which, when multiplied by itself, will be equal to the given number.

The sign ($\sqrt{\quad}$) when placed over a number signifies that the square root of that number is required.

Before we can take the square root of a number, we must first divide the number into groups of two digits each, beginning at the decimal point and point off to the right and left as the case may be. For example, the whole number 4257, we begin at the decimal and point off to the left in groups of two digits, thus |42|57. When pointing off, we place the marks above the number so that they will not become confused with the decimal points. In this number we then have the first group as 42 and the second group as 57.

In many cases we will have only one digit in the first group, as in the number 5|87|65. Here the first group is 5, the second group 87 and the third group 65.

In a number containing whole digits and decimals, as 54257.4927, we mark off starting at the decimal point point right and left, thus 5|42|57.49|27|.

Finding the square root is the reverse of squaring on the slide Rule. Therefore, the A and D scales are used again. When squaring a number we had two simple rules to learn, so when finding the square root we will also have two simple rules to learn.

Ist. When the first group contains one digit, set the hair line over the number on the left half of the A scale and read the answer under the hair line on the D scale.

2nd. When the first group contains two digits, set the hair line over the number on the right half of the A scale and read the answer under the hair line on the D scale.

In both cases there will be as many integral digits in the answers as there are whole groups in the numbers.

**Example 1:** $\sqrt{1|44.} = 12$

The number 144 marked off into groups, giving us two groups before the decimal point; therefore, in answer we will have two integral digits, thus 12.

**Example 2:** $\sqrt{31|76.58} = 56.4$

This number has two digits in the first group so we use the right half of the A scale and read 564 on the D scale. But, since there are only two groups in the number before the decimal point we will only have two integral digits in the answer, thus 56.4.

**Example 3:** $\sqrt{.71|30|} = .844$

Again the first group has two digits, but it also follows the decimal point, so our first digit in the answer will follow the decimal point.

**Problems:**

| | |
|---|---|
| $\sqrt{367} =$ | Ans. 19.16 |
| $\sqrt{57.426} =$ | Ans. 7.58 |
| $\sqrt{1476.83} =$ | Ans. 38.5 |

**The "K" Scale.**

The K scale is divided into three equal sections (See Figure 1) which can be easily separated into a left third, a middle third and a right third. Upon examination of the scale the user will see that the divisions and markings are identical in all three thirds. Therefore an explanation of any one of these thirds will apply to the other two also. With this in mind let us examine the left third.



The left third is divided into 9 unequal divisions, as has been found in all the other scales. Here again, each main division acts as a unit. Unit 1 has ten major divisions and each major division has five minor divisions just as was the case of Unit 2 of the D scale. Since the remaining units have divisions similar to other units of preceding scales, the user will be able to determine the division values for his or herself.

## CUBING A NUMBER BY MENTAL SURVEY METHOD

When we cube a number we mean we are to multiply the number by itself three times, thus $(2)^3$ is 2×2×2.

To find the cube we use the D and K scales. Set the hair line of the indicator over the number on the D scale and then read the answer under the hair line on the K scale.

From Figure 1 we see that there are four ones or indexes. When the cube falls in the left third the answer will be between 1 and 10; if the cube falls in the middle third the answer will be between 10 and 100; if the cube falls in the right third the answer will be between 100 and 1000. This is repeated again, increasing each third making the left third read 1000 to 10,000, the middle third 10,000 to 100,000, etc.

**Example 1:** $(2)^3 = 8$

Set the hair line of the indicator over 2 on the D scale and read 8 on the K scale under the hair line. The answer falls in the left third where our numbering is from 1 to 10, therefore our answer is 8.

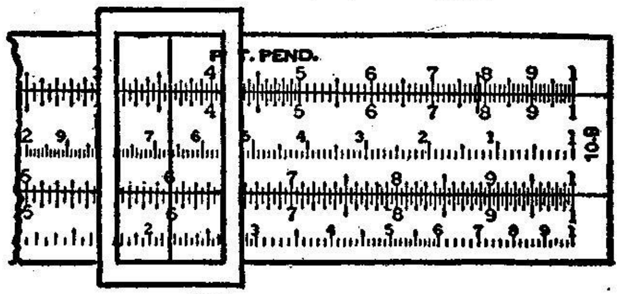
**Example 2:** $(3)^3 = 27$

The answer falls in the middle third where the numbering is from 10 to 100, therefore we have 27.

**Example 3:** $(6)^3 = 216$

The answer falls in the right third where the numbering is from 100 and 1000, therefore we have 216. (See Fig. 18.)

**Example 4:** $(28)^3 = 21,900$



HAIRLINE CUBING 6
FIG. 18

The answer falls in the middle third, which ranges from 10-100, or 10,000 to 100,000. Since 28 is close to 30 and the cube of 30 would be in the 10,000 to 100,000 range, therefore $28^3$ will fall in this range, thus 21,800.

**Problems:**

$(8.45)^3 = 603$
$(12)^3 = 1,730$
$(63.52)^3 = 256,000$

**Cubing a number by Integral Digit Method.** (See page 21.)

When we cube a number we mean we are to multiply the number by itself three times, thus $6^3$ is 6×6×6.

To find the cube of a number on the slide rule we use the **D** and **K** scales. The hair line is set over the number to be cubed on the **D** scale and read the answer under the hair line on the **K** scale. When any number is to be cubed the answer may fall in the left third, the middle third or the right third. Therefore, rules must be established to determine the number of integral digits in the answer.

**Rule No. 1.**

WHEN THE CUBE OF A NUMBER FALLS IN THE RIGHT THIRD, MULTIPLY THE INTEGRAL DIGITS IN THE NUMBER BY 3 AND THIS WILL GIVE THE NUMBER OF INTEGRAL DIGITS IN THE ANSWER.

**Example 1:** $(6)^3 = 6 \times 6 \times 6 = 216$

Set the hair line over the 6 on the **D** scale, read **216** under the hair line on the **K** scale. Following the above rule: number 6 has one integral digit, multiplying one by 3 we have three integral digits required for the answer, thus 216. (See Fig. 18.)

**Example 2:** $(81.5)^3 = 541,000$

The number 81.5 has two integral digits, multiplying this by 3 we will have six integral digits required in the answer. Since we can only read 54 on the K scale we add the four necessary zeros to make six integral digits.

**Example 3:** $(.572)^3 = .187$

The number .572 has zero integral digits, multiplying by 3 we get zero. Thus we place the point in front of the number 186.

**Example 4:** $(.092)^3 = .00078$

The number .092 has minus one integral digit, multiplying minus one by 3 we get minus three integral digits required in the answer. As we learned earlier in the instructions that minus three means three zeros, we place them before the number 76 read on the **K** scale. Therefore, our answer .00076.



**Rule No. 2.**

WHEN THE CUBE OF A NUMBER FALLS IN THE MIDDLE THIRD, MULTIPLY THE INTEGRAL DIGITS IN THE NUMBER BY 3 AND THEN SUBTRACT 1, THIS WILL GIVE THE NUMBER OF INTEGRAL DIGITS IN THE ANSWER.

**Example 1:** $(4)^3 = 64$

The number 4 has one integral digit, multiplying one by 3 we get 3, but the answer falls in the middle third so we subtract one from 3 giving two integral digits in the answer, thus 64.

**Example 2:** $(28.3)^3 = 22,600$

The number 28.3 has two integral digits, multiplying by 3 we get **6**, but we must subtract one making five integral digits for the answer, thus 22,400.

**Example 3:** $(.035)^3 = .0000429$

The number has minus one integral digit, multiplying by 3 we get minus three, but we must subtract one making minus four integral digits, thus .0000428.

**Rule No. 3.**

WHEN THE CUBE OF A NUMBER FALLS IN THE LEFT THIRD, MULTIPLY THE NUMBER OF INTEGRAL DIGITS BY THREE AND THEN SUBTRACT TWO, THIS WILL GIVE THE NUMBER OF INTEGRAL DIGITS IN THE ANSWER.

**Example 1:** $(2)^3 = 8$

Number 2 has one integral digit, multiplying by 3 we get 3 but we must subtract two, leaving one integral digit in the answer, thus **8**.

**Example 2:** $(11)^3 = 1330$

Number 11 has two integral digits, multiplying by 3 we get **6** but we must subtract two, leaving four integral digits in the answer. thus 1330.

**Cube Root of a Number**

The cube root of a number is the reverse of cubing, therefore, we use the **K** and **D** scales.

When finding the cube root we set the hair line of the indicator over the number on the **K** scale and then read the answer under the hair line in the right third over 125 and read 5 on the **D** scale. (See Fig. 19.)

The sign ( $\sqrt{\phantom{xxxx}}$ ) when placed over a number signifies that the cube root is required.

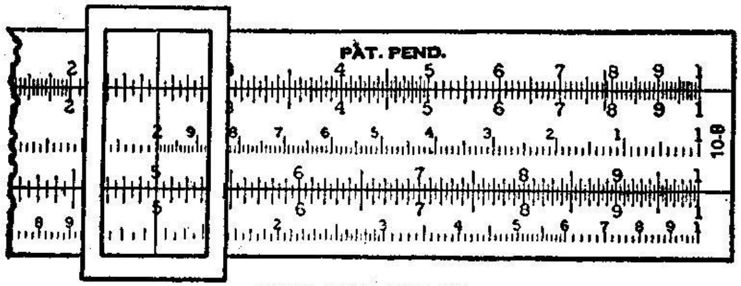
Before we take the cube root of a number, it must be divided into groups of three numbers each, beginning at the decimal point and point off to the right and left just as we did upon taking the square root. In many cases we will have only one number in the first group, others will be two numbers in the first group and others will be three numbers in the first group.

Example: 1|547.632| has one number in the first group; 38|527. has two numbers in the first group; |157.38 has three numbers in the first group.

After the number has been divided into groups and the first group has only one number, set the hair line of the indicator over the number in the LEFT THIRD of the K scale and read the answer on the D scale. Example: $\sqrt{2|450.} = 13.5$. Here the first group has only one number, therefore we use the left third of the K scale.

If the first group contains two numbers as $\sqrt{64}$ we set the hair line in the middle third of the K scale over 64 and read 4 on the D side.

If the first group contains three numbers as $\sqrt{125}$, we set the hair line in the right third over 125 and read 5 on the D scale. (See Fig. 19.)




CUBE ROOT OF 125

FIG. 19

**Problems:**

| | |
|---|---|
| $\sqrt{84.7}$ | Ans. = 4.39 |
| $\sqrt{3.76}$ | Ans. = 1.554 |
| $\sqrt{.106}$ | Ans. = .474 |

## THE C I OR RECIPROCAL SCALE

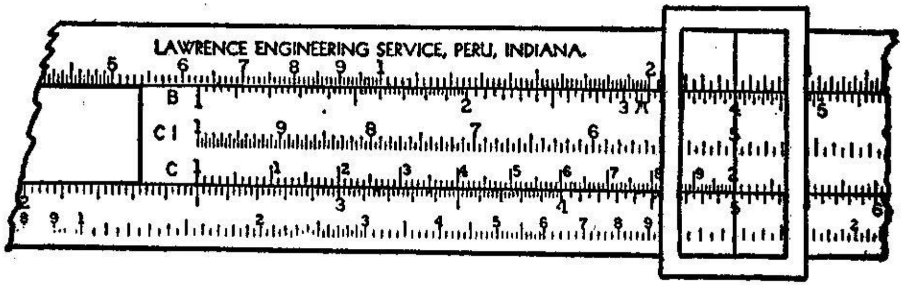
The C I scale is the same as the C scale except that it is numbered from right to left instead of left to right.

If we divide one (1) by any number the answer will be the reciprocal of the number. Thus, one-third is the reciprocal of three, one-sixth the reciprocal of six. The reciprocal of four is one-fourth (¼) or (.25). The number 25 will be found on the C I scale directly above 4 on C scale. For ⅓ or (.333) the number 333 will be found



on the C I scale directly above 3 on the D scale. The decimal point is obvious.

Suppose we wished to multiply 25 by the reciprocal of 5 which would be 25 times one-fifth. Set the left index of C on 25 on D, as in multiplication, move the hair line to 5 on the C I. scale and read the answer 5 under the hair line on the D scale. (See Fig. 20.) Again let us multiply 89.37 by one-sixth. Set the right index of C over 8937 on the D scale, move hair line to 6 on C I scale; read the answer 14.9 under the hair line on the D scale.




USING C I SCALE

FIG. 20

In addition, the C I scale can be used when three factors are to be multiplied to an advantage.

**Example:** $1.62 \times .7 \times 5.63 = 6.38$

Set the hair line of the indicator over 162 on the D scale, move 7 on the C I scale under the hair line, then slide the indicator so the hair line is over 563 on the C scale; read the answer 6.38 under the hair line on the D scale.

### The 3/2 and 2/3 Power

In addition to finding the second power (square) and the third power (cube) of a number on the slide rule, we have also the scales to find the 3/2 power and the 2/3 power of a number.

To find the 3/2 power of a number set the hair line of the indicator over the number on the A scale and read the answer on the K scale.

**Example:** $\sqrt{(4)^3} = 8$

(4) 3/2 is read four raised to the three halves power.

Set the hair line over 4 in the left half of the A scale, read 8 under the hair line on the K scale. (4) 3/2 is the same as the $\sqrt{(4)^3}$, square root of 4 cubed. The square root of 4 is 2, then 2 cubed is 8, which proves our answer in the above example.

**Problems:**

$\sqrt{(28)^3} = 148$

$\sqrt{(6.73)^3} = 17.5$

$\sqrt{(11.84)^3} = 40.7$

To find the 2/3 power of a number set the hair line of the indicator over the number on the K scale and read the answer on the A scale.

**Example 1:** $\sqrt[3]{(27)^2} = 9$

The number $(27)^{2/3}$ is read 27 raised to the two-thirds power. This is the same as the cube root of 27 squared. Set the hair line over 27 on the middle third of the K scale, read the answer under the hair line on the A scale. We know the cube root of 27 is 3 and then squaring 3 we obtain our answer 9.

**Problems:**

$\sqrt[3]{(125)^2} = 25$

$\sqrt[3]{(5.84)^2} = 3.24$

$\sqrt[3]{(64)^2} = 16$

## What Are Digits and Integral Digits?

All our numbering system is made by using the digits 1, 2, 3, 4, 5, 6, 7, 8, 9 and 0 either singly or by combining them into groups as 7, 8, 5, or 16, 35, 856, ets. Numbers may be integral digits (whole number as 75) or they may take the form of a fraction as .685. To illustrate: the numbers 684, 17, 37850 are composed of digits called integral digits as each one is a whole number while the number 68.4 is composed of three digits, with numbers 6 and 8 being integral digits and the number .4 a decimal or fractional portion of an integral digit. The number 3.785 contains four digits but only one integral digit which is the number 3, as it is the only whole number of the group; the number .785 again being a decimal or fractional portion of an integral digit. The number .568 is composed of three digits but here we have no integral digit as none of them are whole numbers.

Now in the number .0568 we again have three digits but because a zero follows the decimal point we must consider this number as having a minus 1 (—1) integral digit. (It must be remembered that zero is not considered a digit unless it is preceded by one of the digits, 1, 2, to 9.) The fractional portion of the number is evident. Again, in the number .00568 we have three digits with two zeros following the decimal point which would mean that this number would have minus 2 (—2) integral digits along with the fractional portion. Therefore, we may say that there are as many integral digits in a number as there are digits before the decimal point and as many minus (—) integral digits as there are zeros following the decimal point. This information will be valuable in performing the different operations.



## The Addition of Integral Digits

As explained above, numbers having zeros following the decimal point have minus (negative) integral digits, while whole numbers or numbers having digits before the decimal point have plus (positive) integral digits.

In order to determine the number of integral digits quickly and accurately in the answers of multiplication problems of all kinds (as we do not always deal in simple whole numbers) the addition of minus and plus integral digits must be understood.

Adding plus integral digits: Examples, (436 x 24.72): 436 has plus 3 and 24,72 has plus integral digits; adding 3 and 2 we have five integral digits (8367 x .1776): 8567 has plus 4 and .1776 has zero integral digits; adding plus 4 and 0 we hace 4 integral digits.

Adding minus integral digits: Examples, (.476 x .00153): .476 has zero and .00153 has minus 2 integral digits, adding 0 and minus 2 we have minus 2 (—2) integral digits.

(.0276 x .000348): .0276 has minus 1 and .000348 has minus 3 integral digits, adding minus 1 and minus 3 we have minus 4 (—4) integral digits.

Adding plus integral digits to minus integral digits or minus integral digits to plus integral digits:

**Examples:**

(74.3 x .0672); 74.3 has plus 2 and .0672 has minus one integral digit, adding plus 2 and minus 1 we have plus 1 (+1) integral digit.

(.00566 x 1873); .00566 has minus 2 and 1873 has plus 4 integral digits, adding minus 2 and plus 4 we have plus 2 (+2) integral digits.

(.000857 x 11.36); .000857 has minus 3 and 11.36 has plus 2 integral digits, adding minus 3 and plus 2 we have minus 1 (—1) integral digits.

From the above explanation we can establish this rule for adding integral digits: when the integral digits are plus or positive we add them and use the plus sign; when the integral digits are minus or negative we add them and use the minus sign; but when we add plus and minus integral digits we subtract the smaller number from the larger and use the sign of the larger number.

**Other Examples:**

| | | |
|---|---|---|
| +6 +3 = 9 | +4 +2 = +6 | —7 + (—2) = —9 |
| —2 + (—4) = —6 | +2 +0 = +2 | —3 +0 = —3 |
| +3 + (—2) = +1 | +3 + (—5) = —2 | —1 +4 = +3 |
| | —6 +1 = —5 | |

**Note:**—A thorough explanation in regard to the terms "digits" and "integral digit" has been mentioned previously on this page.

## The Subtraction of Integral Digits.

In order to perform division correctly and easily it will be necessary to understand the subtraction of plus and minus integral digits.

In the subtraction of plus and minus integral digits the sign of the subtrahend is changed and the two numbers are added as explained under section, "The Addition of Integral Digits."

**Example 1:** $+6 - (+2) = +4$

Here the +2 is the subtrahend, changing its sign to a minus we then add it to +6 giving + (—2) or +4.

**Example 2:** $-1 - (+2) = -3$

Here again the (+2) is the subtrahend, changing its sign to a minus; we then add it to (—1) giving —1 + (—2) or —3.

**Example 3:** $+3 - (-2) = 5$

Here the (—2) is the subtrahend, changing its sign to a plus; we then add it to +3 giving +3 + (+2) or +5.

**Other examples of subtraction:**

| | | | | | |
|---|---|---|---|---|---|
| —2 | +3 | +0 | —1 | +3 | + 2 |
| (+) —4 | (+) —1 | (—) +2 | (+) —3 | (—) +5 | 0 |
| +2 | +4 | —2 | +2 | —2 | +2 |

The signs inside the parenthesis show what the signs become after they are changed.

Note:—Explanation of the digits and integral digits will be found on the preceding page.

**Practice Problems:**

| | | |
|---|---|---|
| 1. 83 x 8 | 8. $\sqrt{12300}$ | 14. $\sqrt[3]{452}$ |
| 2. 322 x 6 | 9. $(145.4)^2$ | 15. 62600 x .05 |
| 3. $37.40 x 16 | 10. $(34.4)^3$ | 16. 796.5 ÷ 18 |
| 4. 285 ÷ 15 | 11. (1.17³ | 17. N07 x 410 |
| 5. 29.97 ÷ 2.7 | 12. $\sqrt[3]{3130}$ | 18. $(6.11)^2$ |
| 6. 729 ÷ 8.1 | 13. $\sqrt[3]{45.7}$ | 19. $(13.7)^2$ |
| 7. $\sqrt{625}$ | | 20. 4832 ÷ 1672 |

**21.** The diameter of a circle is 1.54 inches, what is its circumference? Answer: 3.1416 x 1.54 =

**22.** A voltage of 110 volts is impressed across a lamp and a current of .52 amperes flows.
What is the power. Answer: 110 x .52 =

**23.** What is the area of a triangle whose base is 6.25 and whose altitude is 8.33?

$$\text{Area} = \frac{6.25 \times 8.33}{2} =$$

**24.** There are 24 children in a class room and the sum of all their ages is 384, what is the average age? Answer: 384 ÷ 24 =



25. A lot is 227 by 96 feet. How many acres does it contain if there are 43560 sq ft. in an acre? Answer: (227 x 96) ÷ 43560 =
26. An automobile makes a trip of 280 miles on 16 gallons of gasoline. What was the number of miles per gallon? Answer: 280 ÷ 16 =
27. If a room is 12' x 15' x 8' how many square feet of wall paper would be required to cover the walls and ceiling? Answer: (12 x 15) +2 (8 x 12) +2 (8 x 15) =
28. If the distance between the first floor and the second floor is 8'-9" and there are to be 15 steps, what will be the height of each riser? Answer (8'-9") ÷ 15 =
29. In a certain production job the allowable cutting speed is 3.75 feet per second. When turning a shaft 4 inches in diameter, how fast should the lathe be run? Answer: (3.75 x 12 x 60) ÷ 4π =
30. If the average hiking speed of boy scouts is 3.25 miles per hour, how long will it take to hike 15 miles? Answer: 15 ÷ 3.25 =
31. A right triangle has sides 8.8 and 4.21 inches respectively. What is the length of the hypothenuse? Answer: $\sqrt{8.8^2 + (4.21)^2} =$
32. A motorist makes a trip of 265 miles in 8.75 hours. What is his average speed? Answer: 265 ÷ 8.75 =
33. A water tank is 15.6 x 8.6 x 3.3 feet. How many gallons of water will it hold? There are 7.48 gallons in a cubic foot. Answer: 15.6 x 8.6 x 3.3 x 7.48 =
34. How much is the cost of 3¾ tons of coal at $9.75 per ton? Answer: 3.75 x 9.75 =

**Answers to Practice Problems:**

| | | | |
|---|---|---|---|
| 1. 664 | 10. 40,700 | 19. 187.7 | 28. 7" |
| 2. 1932 | 11 1.6 | 20. 2.89 | 29. 215 RPM |
| 3. $598.00 | 12. 14.63 | 21 4.84" | 30. 4.61 |
| 4. 19 | 13. 3.58 | 22. 57.2 Watts | 31. 9.76 |
| 5. 11.1 | 14. 7.67 | 23. 26 | 32. 30.3 |
| 6. 90 | 15. 3130 | 24. 16 | 33. 3310 |
| 7. 25 | 16. 44.3 | 25. .5 | 34. $36.50 |
| 8. 111 | 17. 45,400 | 26. 17.5 | |
| 9. 21,100 | 18. 37.3 | 27. 612 | |

A careful reading of the foregoing pages will equip the average person with a command of slide rule operations. These are thousands of applications of the slide rule to useful, everyday problems.

A few of these practical everyday tasks are illustrated on the back cover of this book. These sketches illustrate typical problems that can be worked out quickly and accurately by the STUDENT, the HOUSEWIFE, etc. Let us take them up one by one.

**1. The Student. Example.**

How many feet per minute does a 22" wheel cover when making 166 revolutions every minute?

$$\text{Ft. per minute} = \frac{3.14 \times 22 \times 166}{12} = 956$$

2. **The Housewife.** Example.
How much does the housewife realize, if in a week's time she sold 18½ dozen of eggs at 22½ cents per dozen.

Profit = 18.5 x 225 = $4.17

3. **The Salesman.** Example.
If an air conditioning system cost $1,210.50 installed, what would be the saving to the customer if a discount of 16% were allowed, if paid for in full within three months.

Soultion. Saving = 1210.50 x .16 = $193.70

4. **The Draftsman.** Example.
A gear 18" in diameter has a circular pitch of 1¼". How many teeth does the gear have on it?

$$\text{Solution. Number of teeth} = \frac{3.14 \times 18}{1.25} = 45$$

5. **The Machinist.** Example.
At what R.P.M. should a 1¼" high speed drill be run to give a cutting speed of 80 ft. per minute.?

$$\text{R.P.M.} = \frac{80 \times 12}{3.1416 \times 1.25} = 244$$

6. **The Teacher.** Example.
How many pounds of air are in a room 15' x 22' x 12', if 13.5 cubic feet weigh a pound?

$$\text{Pounds of air} = \frac{16 \times 22 \times 12}{13.5} = 312$$

7. **The Timekeeper.** Example.
What is the total expenses of a company for the following labor: Bricklayer 42 hours at $1.10; Carpenter 38 hours at $0.98; and Lather 26 hours at $0.85?

Cost = 42 x 1.10 + 38 x .98 + 26 x .85 = $105.50

8. **The Farmer.** Example.
How many tons of silage will a silo 16 feet in diameter and 30 feet high hold if silage weighs 38 lbs. per cubic foot?

$$\text{Tons} = \frac{3.14 \times 16^2 \times 30 \times 38}{4 \times 2000} = 11.460$$

9. **The Printer.** Example.
How many pictures 2¼" x 3½" can be placed on a sheet 12" x 18"?

$$\text{Number} = \left(\frac{12}{2.25} = 5+\right)\left(\frac{18}{3.5} = 5+\right)\ 5 \times 5 = 25$$

10. **The Office Worker.** Example.
What would be the cost to ship a box weighing 125 lbs. a distance of 176 miles at 4½ cents per pound?

Cost = 125 x .045 = $5.63

11. **The Carpenter.** Example.
How many feet B.M. are there in 16 pieces 1½" x 10" x 26' long?

$$\text{Ft. B.M.} = \frac{3 \times 10 \times 26 \times 16}{2 \times 12} = 520$$