S-M

Slide Rule

BOOK OF INSTRUCTIONS

11-CS
100

Foreword

The Slide Rule is a most convenient, inexpensive calculator that is used extensively in professional fields, colleges, many high schools and some few elementary schools. It is not used for addition or subtraction of numbers but rather for multiplication, division, proportion, powers, roots and any combination of these **functions.**

The S-M Slide Rule is a simplified, multi-purpose calculating instrument designed especially for the beginner. It contains the basic scales of professional slide rules (C, D, CI) as used by engineers for 80 to 90 percent of their work. And, in addition to the basic scales, the S-M Slide Rule has two Special-Purpose scales for teaching the beginner the mechanics of the slide rule and to aid him in reading the conventional C, D and CI scales. Mechanics, housewives, students and others who frequently work with numbers in their daily chores will find that the S-M Slide Rule will greatly simplify their calculations and prove itself a great time saver.

It is the purpose of the following instructions to show as clearly as possible just how simple it is to learn the use of the slide rule. One learns by DOING. Make up problems of your personal interest — solve them by using the slide rule — and soon, very soon, you will have acquired confidence in your ability to solve problems the easy, quick way: WITH THE SLIDE RULE.

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Harvey, Illinois

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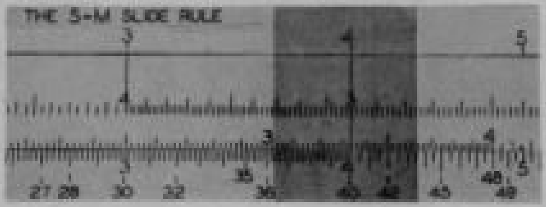
1. There are three parts to a slide rule, the BODY, SLIDE and INDICATOR. The SLIDE is a movable part which fits into grooves of the BODY. The SLIDE may be moved either to the left or to the right to any desired position. Both the Body and Slide have numbers and divisions called scales. The INDICATOR also is a movable part. It is made of glass or other transparent material with a hairline at its middle. The INDICATOR assists in reading numbers from one scale to another.

2. There are two scales on the SLIDE. They are clearly marked CI and C. Each end of the scale, where the numeral (1) appears, is called the INDEX. There is a left-hand INDEX and a right-hand INDEX on the SLIDE.

The BODY has the D scales on it. At the top, there is a special-purpose D scale, marked DS, that reads 1, 2, 3, 4, etc. to 10. At the bottom, there is another special-purpose D scale, marked DM, that reads 10, 12, 14, 15, etc. The third D scale is the one adjacent to the SLIDE where the C scale is found.



3. MULTIPLICATION BY USE OF THE CI SCALE. Refer to the illustration, then set your slide rule the same as shown by the illustration. Here are the steps to follow:

First, Move the INDICATOR to 4 on DS. Be careful to align the hairline on the INDICATOR with the mark that shows the exact position of the 4.

Second, Move the SLIDE to the position where the 3 on the CI scale is directly under the hair-line on the INDICATOR.

Third, Move the INDICATOR to the left to the position where the hair-line is over the INDEX of the CI scale.

Read 12 on the DM scale under the hair-line of the INDICATOR. You have thus used the slide rule to show that 12 is the product of 4 x 3. This problem and instructions can briefly be stated as follows: Multiply 4 x 3. Instructions: To 4 on DS, set 3 on CI. Read 12 on DM under the INDEX. In following these instructions it is understood that you will use the INDICATOR for correctly positioning the SLIDE and for making reference from one scale to another.

Use the instructions given above and do these problems:

5 x 4 = 2 x 9 = 8 x 7 = 6 x 5 =

4. DIVISION. In the problem 42 ÷ 6 = 7, 42 is the dividend, 6 is the divisor and 7 is the quotient. Here is how the slide rule is used to find the quotient of 42 divided by 6. Set the INDICATOR to 42 on DM.

Move the SLIDE to a position where the 6 is under the hair-line. Find 7 on DS **over** the INDEX of the SLIDE. Briefly, the instructions are these: To 42 on DM, set 6 on C. Read 7 on DS over the INDEX. Do these exercises:
25 ÷ 5 = 81 ÷ 9 =

5. NOTE: The special-purpose DS and DM scales have been used in the preceding exercises and instructions to show how easy it is to do multiplication and division by the use of the slide rule. Steps will be taken in the instructions to follow to do away with using the DS and DM scales by substituting the conventional D scale in place of both DS and DM. Reading the scales is the most important part of study in the successful use of the slide rule. A thorough understanding of the following instructions will be worth all the time necessary for you to master this one thing.

6. READING THE UNIT DIVISIONS FROM THE D SCALE. The special-purpose DS scale shows ten- UNIT DIVISIONS numbered 1 to 10. By use of the indicator set to each of the 10- UNIT DIVISIONS on DS, you will find that like numbers, similarly spaced, are found on the D scale. Therefore, reading the UNIT DIVISIONS on the D scale simply means reading one, two, three, four, five, six, seven, eight, nine, and the right index, ten.

You will notice that the distance between the index and 2 on the D scale is greater than the distance between the 2 and 3, however, the **numerical** value between the index and the 2, or between the 2 and the 3, is the same. Also noticeable, is the fact that the distance between each succeeding UNIT DIVISION, 3 to 4, 4 to 5, etc. decreases progressively — however, the **numerical value** between each of them is the same. The scales of the slide rule represent numbers — not lengths, or distances — therefore, do not be concerned with the different lengths between the UNIT DIVISIONS.

7. READING THE D SCALE TO TWO SIGNIFICANT FIGURES. It was explained in the preceding paragraph that the numbers 1 to 10 can be read from the D scale by simply reading the UNIT DIVISIONS. Thus, you have learned to read the D scale to ONE significant figure.

Before attempting to read TWO figures on the D scale, it will be advisable to make some observations of that scale. Notice the UNIT DIVISION between the index and the 2. It is divided into 10 numbered divisions (TENTH-DIVISIONS) and each of the TENTH-DIVISIONS is further divided by means of small lines — but, for the time being, concentrate only on the TENTH-DIVISIONS. Observe also that there are TENTH-DIVISIONS between the 2 and the 3. And, there are TENTH-DIVISIONS between each succeeding UNIT DIVISION to the right index.

The special-purpose DM scale shows the figure 10 at the left index and reads to the right, the numbers progress 12, 14, 15, etc. to 100 at the right index. When you have learned to read from the D scale the numbers on the DM scale, you will then be capable of reading the D scale to TWO significant figures.

Assume a value of 10 for the left index of the D scale; the 2 on D will then have a value of 20; the 3, 30; the 4, 40; and so on.

Set the indicator to 10 on DM then read the D scale at the hair-line, not as 10 but one, zero. Now move the indicator to 12 on DM then read one, two on D. (Observe that the hair-line is over the second (marked 2) of the TENTH-DIVISIONS between the index and 2.)

Move the indicator to one, three on the D scale. This position is found by setting the indicator with its hair-line to the third (marked 3) TENTH-DIVISION between the index and 2. Observe that the hair-line on DM is midway between 12 and 14. Practice reading from the D scale other numbers from the DM scale such as 15, 16 and 18 and, when reading the D scale remember to read these numbers as one, five; one, six; and one, eight.

Move the indicator to 21 on DM and read two, one, from the D scale.

Every number on the DM scale can be read on the D scale by means of the TENTH-DIVISIONS between the UNIT DIVISIONS on the D scale. Practice reading from the D scale every number shown on the DM scale and remember that it is VERY IMPORTANT THAT YOU READ THE D SCALE two, one — not twenty-one; four, eight — not forty-eight; and so on. After you have read each of the numbers on DM from the D scale, find all the other numbers on D that are not shown on DM such as one, one; two, two; two, nine; five, eight; eight, five; and nine, seven. You should be able to read every number, one, one to nine, nine on the D scale before going further with these instructions.

8. You have SUCCEEDED to a much further degree in learning to use the slide rule than you probably realize at this time. You have learned the principles by which both multiplication and division are done by the use of the scales. At the time you were learning these principles, you were instructed to use the DS and DM scales. You learned under paragraph 6 that all of the numbers on the DS scale are found on the D scale. Also you learned under paragraph 7 that all of the numbers on the DM scale are found on the D scale. You have learned to read TWO significant figures from the D scale. When you have learned to read THREE significant figures from the D scale (AND THAT WILL BE SURPRISINGLY SOON) you will have completed your study of the scales and will then be ready to enjoy the practical use of the slide rule.

Turn back to paragraph 3 and go through all the exercises, substitute in each, the D scale where the DS or DM scale has been called for.

9. READING THE D SCALE TO THREE SIGNIFICANT FIGURES. Assume a value of 100 for the left index of the D scale. The 2 will then have a value of 200; the 3, 300; and so on to the right index which will have a value of 1000. By means of the UNIT DIVISIONS the numbers 100, 200, 300 (read one, zero, zero; two, zero, zero; three, zero, zero) are read.

The TENTH-DIVISIONS are used to read the values between the UNIT DIVISIONS. For example, the numbers one, one, zero; one, two, zero; and so on are read from the TENTH-DIVISIONS between the index and 2.

SUBDIVISIONS are used for reading the numbers between the TENTH-DIVISIONS. By means of the SUBDIVISIONS every number between the index and 2 (one, zero, one to one, nine, nine) can be read. The UNIT DIVISION between the index and 2 is divided into 10- TENTH-DIVISIONS and each TENTH-DIVISION is divided into 10- SUBDIVISIONS. There are 100 SUBDIVISIONS between the index and 2.

10. EXERCISE IN READING THE D SCALE. Multiply 12 x 9. Set the indicator to 12 (one, two) on D. As you do this, think — "THE ONE IS THE LEFT INDEX. THE TWO IS THE SECOND OF THE TENTH-DIVISIONS BETWEEN THE INDEX AND 2." Next, set 9 on CI

to the hair-line. As this is being done, think — "The CI SCALE IS INVERTED. THEREFORE THE 9 IS THE FIRST UNIT DIVISION TO THE RIGHT OF THE LEFT INDEX." Move the slide so that the 9 on CI is set to the hair-line. Now, move the indicator to the left index of the slide and read the product of 12 x 9 on the D scale. Here are the steps to follow in reading the D scale to three figures: REMEMBER THAT THE NUMBERS YOU ARE SEEKING ARE READ FROM THE POSITION ON THE HAIR-LINE AT THE D SCALE.

1st. The first figure is found by reading the UNIT DIVISION to the left of the hair-line. The UNIT DIVISION to the left of the hair-line is the index. It is read ONE.

2nd. The second figure is found by reading the TENTH-DIVISION to the left of the hair-line. There are no TENTH-DIVISIONS to the left of the hair-line. Therefore, the second figure is ZERO.

3rd. The third figure is found by reading the SUBDIVISION at the hair-line. The hair-line is set to the 8th SUBDIVISION between the index and the 1st of the TENTH-DIVISIONS. Therefore, the third figure is EIGHT.

You have thus read ONE, ZERO, EIGHT as the product of 12 x 9.

In reading the three figures from the D scale, think FIRST of UNIT DIVISIONS, then TENTH-DIVISIONS then SUBDIVISIONS.

11. FURTHER EXERCISE IN READING THE D SCALE. You have been instructed to do multiplication by use of the CI and D scales. Multiplication can also be done by using the C and D scales which is sometimes more convenient. It is important to practice using both methods. Use the C and D scales for finding the product of 12 x 12. To 12 on D (one, two) set the left index of the slide. Set the indicator to 12 (one, two) on C and read the product (one, four, four) under the hair-line on D.

In reading the product, look first to the left of the hair-line for the UNIT DIVISION. It is ONE.

Next, look to the left of the hair-line for the TENTH-DIVISION. It is FOUR.

Next, look for the SUBDIVISION at the hair-line. It is the 4th to the right of the 4th TENTH-DIVISION. It is FOUR.

Thus you have read one, four, four for the product of 12 x 12.

Multiply 12 x 13 with the left index of the C scale set to 12 (one, two) on D, move the indicator to 13 (one, three) on C, then read one, five, six on D.

Similarly, multiply 12 x 14. Read one, six, eight for the product.

Multiply 12 x 16. Do you find the product to be one, nine, two?

12. MORE ABOUT READING THE D SCALE. Multiply 21 x 12. To 21 on D, set 12 on CI. Read two, five, two on D under the index of the CI scale. The method for reading two, five, two is the same as previously explained. To the left of the hair-line is the UNIT DIVISION, 2. Also to the left of the hair-line is the 5th of the TENTH-DIVISIONS. The hair-line is one SUBDIVISION to the right of the 5th TENTH-DIVISION. Observe that there are 50 SUBDIVISIONS between the 2 and 3, therefore each SUBDIVISION between the 2 and 3 has a value of 2. The 3rd figure is thus 2.

Multiply 21 x 35. Set the left index of C to 21 on D. Set the indicator to 35 on C, then read seven, three, five on D. Notice that there are only

20 SUBDIVISIONS between the UNIT DIVISIONS 7 and 8. Each SUBDIVISION therefore has a value of 5. The product of 21 x 35 may be read as previously explained or, if you choose, you may prefer this line of thought: (the indicator is set to seven, three, five on D).

1. The hair-line is between the 7th and 8th UNIT DIVISIONS, therefore the first figure is 7.
2. The hair-line is between the 3rd and 4th TENTH-DIVISION, therefore the second figure is 3
3. The hair-line is on the SUBDIVISION between the 3rd and 4th TENTH-DIVISION, therefore the 3rd figure is 5.

Multiply 21 x 38. To 21 on D, set 38 on CI. Read 798 on D. In reading this product you will find that the 3rd figure must be read by approximating its position from the SUBDIVISIONS whose values are known. For example, the 3rd figure 8 is located between the 19th SUBDIVISION to the right of the 7th UNIT DIVISION. The value at the 19th SUBDIVISION is 795 and the value at the 8th UNIT DIVISION is 800. The product of 21 x 38 is between 795 and 800 — it is approximated at 798.

13. COMPARING THE D SCALE WITH DOLLARS AND CENTS. If each of the UNIT DIVISIONS of the D scale was assumed to have a value of $1.00, the left index would be read $1.00, the second UNIT DIVISION would be read $2.00, and so on. The TENTH-DIVISIONS would each have a value of 10- cents or $0.10. The SUBDIVISIONS would have a value of one cent ($0.01) or 2- cents ($0.02) or a nickel ($0.05) depending on the location of the SUBDIVISIONS. Between the left index ($1.00) and 2 ($2.00) there are 100 SUBDIVISIONS. Between the 2nd and 3rd UNIT DIVISIONS, also between the 3rd and 4th UNIT DIVISIONS, there are 50- SUBDIVISIONS. Between each of the remaining UNIT DIVISIONS 4 to 5, 5 to 6, 6 to 7, 7 to 8, 8 to 9 and 9 to the right index, there are only 20 SUBDIVISIONS.

Therefore, by means of the SUBDIVISIONS between the left index and 2, every value between $1.00 and $2.00 can be read to the cent. For example $1.13 is read at the 13th SUBDIVISION to the right of the index.

Between the 2nd and 4th UNIT DIVISION, by means of the SUBDIVISIONS, every value can be read to 2-cents, for example, $2.02 is read at the 1st SUBDIVISION to the right of the 2nd UNIT DIVISION, and $3.56 is read at the 28th SUBDIVISION to the right of the 3rd UNIT DIVISION.

Between the 4th and 5th UNIT DIVISIONS and all other UNIT DIVISIONS to the right, the SUBDIVISIONS have a value of 5-cents, for example $7.05 is read at the 1st SUBDIVISION to the right of the 7th UNIT DIVISION and $9.95 is read at the 19th SUBDIVISION to the right of the 9th UNIT DIVISION.

14. COMPARISON OF SCALES. The D scale on the body is identical to the C scale on the slide. The CI scale on the slide is identical to both the C and D scales except that the CI scale is inverted and reads progressively from right to left, whereas both C and D scales read progressively from left to right.

15. MULTIPLICATION OF DECIMALS. The dollar and cent monetary system is probably the most familiar form of decimals known. Following are five equations which show the value of a dollar equalized with familiar denominations of coins.

ONE DOLLAR (Written $1.00)	EQUALS 2-HALF-DOLLARS (Written 2 x $.50)
" " "	EQUALS 4-QUARTERS ....(Written 4 x $.25)
" " "	EQUALS 10-DIMES ....(Written 10 x $.10)
" " "	EQUALS 20-NICKELS ....(Written 20 x $.05)
" " "	EQUALS 100-PENNIES ......(Written 100 x $.01)

Each of the above equations can be proved to be accurate by multiplication. It will be shown by multiplication that the values on the left are equal to those on the right which is 1.00 in each equation. THE MULTIPLICAND TIMES THE MULTIPLIER EQUALS THE PRODUCT.

MULTIPLICANDS	.50	.25	.10	.05	.01
MULTIPLIERS	2	4	10	20	100
PRODUCTS	1.00	1.00	1.00	1.00	1.00

There is a rule that must be applied to each of the multiplication problems above; here it is: THERE MUST BE AS MANY DECIMAL PLACES IN THE PRODUCT AS THERE ARE IN THE MULTIPLICAND AND MULTIPLIER ADDED TOGETHER. In each of the above problems there are 2 decimal places in the multiplicand. There are zero decimal places in each of the multipliers. (THE PRODUCT WILL CONTAIN THE SUM OF THE DECIMAL PLACES IN THE MULTIPLICAND AND MULTIPLIER). Therefore, 2 plus 0 = 2, the required number of decimal places in the product. Decimal places are counted to the right of the decimal point. In the multiplicand, .50 for instance, the first decimal place is the 5 and 0 is the second decimal place.

Study the following problem to make certain that you understand pointing off the number of decimal places in the product:

MULTIPLICAND	12.1	The number of decimal places is 1
MULTIPLIER	1.03	The number of decimal places is 2
PRODUCT	12.463	The sum of decimal places is 3

The slide rule when used for multiplication does not show or indicate where the decimal point belongs in the product, for example, when the slide rule is used to multiply 12 x 12, the product is read one, four, four. The same product is read when the problem is 1.2 x 1.2 or 1.2 x 12 or 12 x 120 or 120 x 1.2 or 120 x 120. Rules for locating the decimal point are available in some slide rule instruction books but such rules are long and easily confused or forgotten. Engineers and others who frequently use the slide rule prefer to locate the decimal point in products by mental calculation or by inspection which is the fastest and simplest way to determine the location of the decimal point. The following tabulation shows how this is done:

APPROXIMATE THE PRODUCT BY SUBSTITUTING ROUNDED
NUMBERS HAVING THE SAME NUMBER
OF DECIMAL PLACES, SUCH AS:

12 x 12	10 x 15 = 150	144.
1.2 x 12	1 x 15 = 15	14.4
1.2 x 1.2	1 x 1.5 = 1.5	1.44
12 x 120	10 x 150 = 1500	1440.
120 x 1.2	150 x 1 = 150	144.
120 x 120	100 x 150 = 15000	14400.

Do each of the following problems using the D and CI scales then write your answers in the space provided. When the problems are completed, check each one by using the D and C scales. In using the D and C scales you will find some problems require the left index of C set to D, others will require the right index. Check your answers with the answers in the back of the book.

EXERCISE 1

1) 11 x .7 = ____________
2) 90 x 1.3 = ____________
3) 4 x 21 = ____________
4) 19.5 x .5 = ____________
5) .003 x 155 = ____________
6) 42.5 x .12 = ____________
7) 1.01 x .002 = ____________
8) 3.14 x 5 = ____________
9) 95 x 140 = ____________
10) .24 x .15 = ____________

If Mr. Jones' automobile is capable of traveling 15.5 miles on one gallon of gasoline, how many miles will it travel after using 16 gallons of gasoline?

This problem can be quickly and accurately solved by using the slide rule for multiplying 15.5 x 16. The answer is read two, four, eight. Is it 2.48 or 24.8 or 248 or 2480 or 24,800? There is no need for guessing; the correct answer can be selected from the above values by mental calculation by substituting rounded numbers in place of those given. For example, suppose the car traveled only 10 miles per gallon (10 x 16 = 160) or suppose it traveled 20 miles per gallon (20 x 16 = 320). Either of these estimated values point to 248 as being the correct product.

If you make an error in pointing off the decimal place in your answer by only **one** place, your answer will be 10 times too large or it will be 10 times too small. Therefore, the estimating necessary for you to do need not be very close for practical purposes.

Estimating products is good mental exercise, it aids your understanding of numerical values and it adds confidence to your ability to use the slide rule to its fullest extent.

Turn back to EXERCISE 1 and cover the products you wrote in the spaces provided. Did you **first** estimate the product you were seeking, or did you do the multiplication first? It is better to estimate first. There are different ways of making an estimate, some of which are given here:

1) 11 x .7 = that is about 11 x 1 or 11. This is a pretty rough estimate but it is much closer to the correct answer 7.7 than .77 or 77 which are two examples of an incorrectly placed decimal point.
2) 90 x 1.3 = about 100
3) 4 x 21 = about 80
4) 19.5 x .5 = about ½ of 20 or 10
5) .003 x 155 =
$$\begin{array}{r} 150 \\ .003 \\ \hline .450 \end{array}$$
6) 42.5 x .12 = about 1/8 of 40 or 5
7) 1.01 x .002 = about 1 x .002 or .002
8) 3.14 x 5 = about 5 x 3 or 15
9) 95 x 140 = about 100 x 140 or 14000
10) .24 x .15 = about ¼ x .16 or .04

It matters not just how you do your estimating of the product but if in doubt — write figures accurately to the decimal place and substitute approximate values, then multiply as shown in example 5) above.

EXERCISE 2

When doing the following multiplication problems, estimate the product first then use your slide rule to determine the correct answer. Practice using both the C and CI scales. Sometimes it is possible to read the scale to four places quite accurately, provided the number to be read is between the left index and 2. The products to this list of problems is found in the back of the book.

1) .7854 x 36.75
2) 837 x .00034
3) 3.1416 x 56.25
4) 32.2 x 73
5) 99.25 x 1.07
6) 3.28 x 39.5
7) .031 x .008
8) 75 x .75
9) 963 x 4022
10) 132 x .8375

16. DIVISION OF DECIMALS. Following are five equations which show the value of a dollar equalized with familiar denominations of coins:

ONE DOLLAR (1.00) EQUALS	2-HALF-DOLLARS	(2 x .50)
" " " "	4-QUARTERS	(4 x .25)
" " " "	10-DIMES	(10 x .10)
" " " "	20-NICKELS	(20 x .05)
" " " "	100-PENNIES	(100 x .01)

Each of the above equations can be proved to be accurate by division. (A) If 1.00 is divided by 2, the answer or quotient is .50 — in this case 1.00 is the DIVIDEND, 2 is the DIVISOR and .50 is the QUOTIENT. (B) On the other hand, if 1.00 is divided by .50, .50 is the DIVISOR and 2 is the QUOTIENT. These problems are written as follows:

(A)

$$\begin{array}{r} .50\ \text{QUOTIENT} \\ \text{DIVISOR } 2\ \overline{)\ 1.00\ \text{DIVIDEND}} \end{array}$$

(B)

$$\begin{array}{r} 2.\ \text{QUOTIENT} \\ \text{DIVISOR } .50\ \overline{)\ 1.00_{\wedge}\ \text{DIVIDEND}} \end{array}$$

In problem (A) the divisor (2) is a whole number, therefore THE DECIMAL POINT IN THE QUOTIENT IS LOCATED DIRECTLY ABOVE THE DECIMAL POINT IN THE DIVIDEND as shown in the example. In problem (B) the divisor (.50) is a decimal. Notice that the decimal point in the quotient is not directly above the decimal point in the dividend. Here is the rule to follow for determining the decimal place in the quotient when the divisor is a decimal: PLACE A CARET (∧) TO THE RIGHT OF THE DECIMAL POINT IN THE DIVIDEND THE SAME NUMBER OF PLACES AS THERE ARE DECIMAL PLACES IN THE DIVISOR, THEN MARK THE DECIMAL POINT IN THE QUOTIENT DIRECTLY ABOVE THE CARET.

Remember that the decimal point in the quotient is directly above the decimal point in the dividend when the divisor is a whole number.

Remember to mark the dividend with a caret (∧) for indicating the decimal point in the quotient when the divisor is a decimal — the caret (∧) will be marked as many places to the right of the decimal point in the dividend as there are decimal places in the divisor.

Following are three examples of division for showing the application of the rules for pointing off the decimal place in the quotient.

(C)
Divisor
Whole Number

$$\begin{array}{r} 50. \\ 25\ \overline{)\ 1250.} \end{array}$$

(D)
Divisor
One Decimal Place

$$\begin{array}{r} 40. \\ 3.2\ \overline{)\ 128.0_{\wedge}} \\ 128 \end{array}$$

(E)
Divisor
Four Decimal Places

$$\begin{array}{r} 20. \\ 1.0012\ \overline{)\ 20.0240_{\wedge}} \\ 20.024 \end{array}$$

Division problems can be checked for accuracy by multiplication. Divisor times quotient equals dividend.

$$\begin{array}{r} 25 \\ 50 \\ \hline 1250 \end{array} \qquad \begin{array}{r} 3.2 \\ 40 \\ \hline 128.0 \end{array} \qquad \begin{array}{r} 1.0012 \\ 20 \\ \hline 20.0240 \end{array}$$

If an automobile used 16 gallons of gasoline on a trip of 296 miles, what was the average miles per gallon of gasoline?

DIVIDEND 296 ÷ DIVISOR 16 = QUOTIENT

the problem may also be written

$$\frac{\text{DIVIDEND } 296}{\text{DIVISOR} \quad 16} = \text{QUOTIENT (in miles per gallon)}$$

To use the slide rule for this problem of division — to 296 on D, set 16 on C. Read the quotient one, eight, five on D under the left index of C. 18.5 is the quotient.

The following exercise shows the records of ten different automobiles. The dividend shows the number of miles traveled and the divisor shows the number of gallons of gasoline used. Determine the average miles per gallon attained by each of the automobiles. Check your answers with those in the back of the book.

EXERCISE 3

1) $\frac{495}{31.3}$ = ________
2) $\frac{3025}{142}$ = ________
3) $\frac{675}{43.3}$ = ________
4) $\frac{9600}{503}$ = ________
5) $\frac{890}{50}$ = ________
6) $\frac{904}{54}$ = ________
7) $\frac{1545}{72.6}$ = ________
8) $\frac{1110}{63.8}$ = ________
9) $\frac{1740}{96.2}$ = ________
10) $\frac{1005}{69.8}$ = ________

The slide rule makes easy the work of doing problems in long division, however one must be careful in pointing off the decimal places in the quotient. A reasonably close estimate of the quotient can be determined by inspection in some of the problems in the following exercise, for example 1) $\frac{19.26}{2.14}$ and 8) $\frac{333}{55}$ may respectively be rounded to read $\frac{18}{2} = 9$ and $\frac{300}{50} = 6$ In other problems such as 2) $\frac{.0136}{.008}$ and 10) $\frac{3,386,700}{795}$ estimating the quotient is considerably more difficult. By writing these problems in the usual form for division, the exact number of decimal places in the quotient can be quickly determined, for example 2) $.008\ \overline{)\ .013_{\wedge}6}$ this shows that the first number of the quotient will be one place to the left of the decimal point. In problem 10) $795\overline{)\,3{,}386{,}700.}$ it is shown that the first number of the quotient will be above the 6 in the dividend which is four places to the left of the decimal point in the quotient.

In solving the problems in the following exercise, write the quotient from the figures read from the scale of your slide rule, then place the decimal point from inspection of the problem. Go through as many of the problems as possible pointing off the quotient by inspection.

EXERCISE 4

1) $\frac{19.47}{2.14} = \underline{\qquad\qquad}$

2) $\frac{.0136}{.008} = \underline{\qquad\qquad}$

3) $\frac{320}{12.8} = \underline{\qquad\qquad}$

4) $\frac{283}{9.05} = \underline{\qquad\qquad}$

5) $\frac{5.43}{.62} = \underline{\qquad\qquad}$

6) $\frac{29.12}{3.71} = \underline{\qquad\qquad}$

7) $\frac{18.75}{.06} = \underline{\qquad\qquad}$

8) $\frac{333}{55} = \underline{\qquad\qquad}$

9) $\frac{22.3}{.433} = \underline{\qquad\qquad}$

10) $\frac{3{,}386{,}700}{795} = \underline{\qquad\qquad}$

Following are some suggestions which may be helpful in estimating the quotient. In problem 2) for example, the quotient would not be changed if both dividend and divisor are multiplied by the same number. Here is proof: $\frac{1000 \text{ x } .0136}{1000 \text{ x } .008} = \frac{13.6}{8}$, the quotient of $\frac{13.6}{8.}$ is the same as the quotient of $\frac{.0136}{.008}$ (To multiply the dividend and divisor by 1000, simply move the decimal point three places to the right in each of them therefore $\frac{.0136}{.008}$ becomes $\frac{13.6}{8.0}$ which results in an easier problem from which to estimate the quotient.)

17. FRACTIONS are used to identify a part of a unit. A piece of pie is an example of a fraction. The fraction identifying the piece of pie may be ¼ or 1/6 or other fraction. The fraction describes the piece or part of the whole. For example, ¼ means that the whole is 4 times as large as the part identified as ¼. If the part is 1/6, the whole is 6 times as large as the part. Fractions such as ¼ and 1/6 and all others whose values are less than 1, are called PROPER FRACTIONS. IMPROPER FRACTIONS are those such as 9/9, 5/4, 8/3, 2/1 etc. whose values are equal to or greater than 1. All fractions are symbols of division; ¼ means 1 ÷ 4, 1/6 means 1 ÷ 6. There are two terms to a fraction; the NUMERATOR above the line and the DENOMINATOR below the line. A PROPER FRACTION therefore is one in which the NUMERATOR is smaller than the DENOMINATOR. An IMPROPER FRACTION is one in which the NUMERATOR is equal to or greater than the DENOMINATOR.

Coins may be expressed as fractions of a dollar as well as decimal parts of a dollar:

1 Penny $= \frac{1}{100}$ dollar $= 1 \div 100 = .01$
1 Nickel $= \frac{1}{20}$ " $= 1 \div 20 = .05$
1 Dime $= \frac{1}{10}$ " $= 1 \div 10 = .10$
1 Quarter $= \frac{1}{4}$ " $= 1 \div 4 = .25$
1 Half-Dollar $= \frac{1}{2}$ " $= 1 \div 2 = .50$
1 Dollar $= \frac{1}{1}$ " $= 1 \div 1 = 1.00$

18. WORK WITH FRACTIONS.

A fraction may be changed to a decimal by dividing the numerator by the denominator, for example, $\frac{1}{20} = \begin{array}{r} .05 \\ 20\overline{)\,1.00} \\ \underline{1\;00} \end{array}$ therefore $\frac{1}{20} = .05$

The value of a fraction is not changed when both numerator and denominator are multiplied by the same number, for example:

$$\frac{12}{12} \text{ x } \frac{1}{4} = \frac{12}{48} \qquad \begin{array}{r} .25 \\ 48\overline{)\,12.00} \\ \underline{9\;6} \\ 2\;40 \\ \underline{2\;40} \end{array} \quad \text{Therefore } \frac{1}{4} = \frac{12}{48} = .25$$

One fraction may be divided by another by inverting the terms of the divisor and multiplying, for example:

$$\frac{5}{10} \div \frac{2}{1} = \frac{5}{10} \text{ x } \frac{1}{2} = \frac{5}{20} = .25 \qquad \begin{array}{r} .25 \\ 20\overline{)\,5.00} \\ \underline{4\;0} \\ 1\;00 \\ \underline{1\;00} \end{array}$$

This problem $\frac{5}{10} \div 2$ or $\frac{5}{10} \div \frac{2}{1}$ may be solved by substituting the decimal (.5) for the dividend $(\frac{5}{10})$ for example

$$\begin{array}{r} .25 \\ 2\overline{)\,.50} \\ \underline{4} \\ 10 \\ \underline{10} \end{array}$$

The value of a fraction is not changed when both numerator and denominator are divided by the same number, for example

$$\frac{25}{100} \div \frac{5}{5} = \frac{5}{20} \qquad \begin{array}{r} .25 \\ 20\overline{)\,5.00} \\ \underline{4\;0} \\ 1\;00 \\ 1\;00 \end{array} \qquad \begin{array}{r} .25 \\ 100\overline{)\,25.00} \\ \underline{20\;0} \\ 5\;00 \\ 5\;00 \end{array}$$

therefore $\frac{25}{100} = \frac{5}{20} = .25$

The following problem is taken from the 2nd example from exercise 4. $\frac{.0136}{.008}$ This problem may also be written .0136 ÷ .008

If both the dividend and the divisor of this problem were written as fractions, the problem would be $\frac{136}{10000} \div \frac{8}{1000}$

The rule for dividing one fraction by another is: INVERT THE TERMS OF THE DIVISOR AND MULTIPLY.

Problem Divisor Inverted Cancellation Answer

$$\frac{136}{10000} \div \frac{8}{1000} = \frac{136}{10000} \times \frac{1000}{8} = \frac{\overset{17}{\cancel{136}}}{\underset{10}{\cancel{10000}}} \times \frac{\cancel{1000}}{\cancel{8}} = \frac{17}{10} = 1.7$$

Cancellation was used in the above problem to simplify the terms of the fractions. The numerator 136 was divided by the denominator 8, also the denominator 10,000 was divided by the numerator 1,000. If cancellation had not been used the results of the problem would be $\frac{136,000}{80,000}$ which, of course results in the same answer, 1.7.

19. MULTIPLICATION OF FRACTIONS. Multiply $\frac{15 \times 7}{35 \times 20}$

solution:

$$\frac{15 \times 7}{35 \times 20} = \frac{105}{700} = \begin{array}{r} .15 \text{ answer} \\ 700 \,\overline{)\,105.00} \\ \underline{70\,0} \\ 35\,00 \\ \underline{35\,00} \end{array}$$

The use of cancellation simplifies the problem, thus:

$$\frac{\overset{3}{\cancel{15}}}{\underset{5}{\cancel{35}}} \times \frac{\cancel{7}}{\underset{4}{\cancel{20}}} = \frac{3}{20} = .15 \text{ answer}$$

Solve this problem by the use of the slide rule. To 15 on D, set 7 on CI. Move the indicator to the left index of C. Set 35 on C to the hair-line. Move the indicator to the right index of C. Set 20 on C to the hair-line then read one, five on D under the left index of C. To determine the placing of the decimal point in the product think of 15/35 as about 1/2, think of 7/20 as about 1/3. The approximate product is therefore about 1/2 x 1/3 or 1/6 which is about .17. Another thought regarding the estimated product is to think of 15/35 as about .5 and 7/20 as about .3. The estimated product would then be .5 x .3 or .15. Each of the estimates of products indicate that the correct answer would be .15.

In following the instructions for using the slide rule for multiplying $\frac{15 \times 7}{35 \times 20}$ as given above, 15 was multiplied by 7 and **that product** (remember that you were not instructed to read **that product**) was divided by 35 and the quotient thus obtained was divided by 20. Using the slide rule for combinations of multiplication and division has a big advantage over arithmetical methods because neither a product nor a quotient need be determined until after the last operation is completed. Again referring to the above problem $\frac{15 \times 7}{35 \times 20}$ and to the instructions given for the use of the slide rule, the steps taken to solve the problem were these:
15 x 7 ÷ 35 ÷ 20 = .15.

This problem can also be solved by using only the C and D scales. To 15 on D, set 35 on C. Move the indicator to 7 on C, set 20 on C to the indicator then read one, five on D under the left index of C. The steps thus taken were 15 ÷ 35 x 7 ÷ 20 = .15.

Another way for obtaining the same product is by the combination of operations 7 ÷ 35 ÷ 20 x 15. To 7 on D, set 35 on C. Move the indicator to the left index of C. Set 20 to the indicator. Move the indicator to 15 on C and read 15 on D under the hair-line.

Estimate the product in each of the problems given in Exercise 5 before using the slide rule for determining the exact answer. When the answer is found by use of the slide rule, check your work by using a different means for obtaining the answer. For example, if you used the CI scale for multiplication the first time, check your work by doing multiplication by use of the C scale. Correct answers will be found in the back of the book.

EXERCISE 5

1) $\frac{170 \times 4}{5} =$ ____________

2) $\frac{3 \times 18}{9 \times 6} =$ ____________

3) $\frac{10 \times 108}{9} =$ ____________

4) $\frac{72 \times 3.14}{.785 \times 12} =$ ____________

5) $\frac{96 \times 3}{6 \times 8} =$ ____________

6) $\frac{117 \times .88}{13.2 \times 130} =$ ____________

7) $\frac{22 \times 7}{77 \times .002} =$ ____________

8) $\frac{3 \times 6 \times 10}{4 \times 2} =$ ____________

9) $\frac{144}{81} \times 72 =$ ____________

10) $\frac{144 \times 84}{36} =$ ____________

20. RATIO AND PROPORTION. A ratio is used to show the relationship of two numbers. A fraction such as 1/3 shows the ratio of 1 to 3. The ratio of 50 to 5 may be written as a fraction 50/5.

A six-ounce can of tomato juice costs 5c. The ratio of cost to quantity may be stated 5 to 6 or 5/6. The ratio may also be inverted to quantity to costs whereby the ratio would then be 6 to 5 or 6/5.

Proportion shows the equality of two ratios. If, for example, a 6-ounce can of tomato juice cost 5c, 10c would buy 12-ounces. These two ratios, 6 to 5 and 12 to 10 are proportional to each other. The usual form for writing problems of ratio and proportion is this: 6 : 5 = 12 : 10. It is read, 6 is to 5 as 12 is to 10. There are two important terms to problems of ratio and proportion, they are the MEANS and the EXTREMES. In the problem $\overbrace{6 : \underbrace{5 = 12}_{\text{MEANS}} : 10}^{\text{EXTREMES}}$ the outside figures are the EXTREMES and the inside figures are the MEANS. In all problems of ratio and proportion, THE PRODUCT OF THE MEANS IS EQUAL TO THE PRODUCT OF THE EXTREMES.

21. SOLVING PROBLEMS BY RATIO AND PROPORTION.

How much will 20 pounds of nails cost if 5 pounds cost 60c? In this problem, there is one known ratio which is 5 to 60. The second ratio is 20 to (how many cents?) The problem is expressed:

5 is to 60 as 20 is to (how many cents?)
written, it is thus:
$5 : 60 = 20 : x$ (x is substituted for the unknown quantity)
To solve this problem, the rule for ratio and proportion must be applied: THE PRODUCT OF THE MEANS IS EQUAL TO THE PRODUCT OF THE EXTREMES. Therefore 5 times x = 60 times 20

$$5x = 1200$$
$$x = 1200 \div 5$$
$$x = 240$$

The slide rule is ever so convenient for solving problems of proportion. To use the slide rule for the problem $5 : 60 = 20 : x$, set 5 on C to 60 on D. Move the indicator to 20 on C and read 240 on D. In this problem you have used C and D for showing the ratio of 5 to 60. The C scale shows 5 pounds set directly above 60c on the D scale. In this problem, every figure on C represents pounds and every figure on D represents cents.

An automobile travels 2 miles in 3 minutes. How far will it travel in 9 minutes? Solution: To 3 on D, set 2 on C. Move the indicator to 9 on D and read 6 on C. Observe that the C scale in this problem represents miles and the D scale represents minutes.

The same results will be obtained by inverting the ratio: set 3 on C to 2 on D. Move the indicator to 9 on C and read 6 on D. In this case the C scale represents minutes and the D scale represents miles.

How much will 9.5 tons of coal cost if 13 tons cost 143 dollars? To 143 on D, set 13 on C. (Remember, the C scale represents tons and the D scale represents dollars.) Move the indicator to 9.5 on C and read 104.5 on D under the hairline. Is this confusing? When 13 on C is set to 143 on D, 9.5 on C will be beyond the right index of D, therefore it will be impossible to read D under 9.5 on C. Here are the steps to take: Move the indicator to the left index of C. Then move the slide to the left so that its right index is set to the hair-line. Now move the indicator to 9.5 on C and read 104.5 on D.

The CI scale may be convenient to use for this problem. To 143 on D, set 13 on C. Move the indicator to the left index of C and notice that 1 ton on C is set to 11 dollars on D. Therefore, 1 ton of coal costs 11 dollars; 9.5 tons would cost 9.5 x 11. Complete this problem by setting 9.5 on CI to 11 on D then read 104.5 on D under the left index of CI.

Use the instructions given above for solving the following problems of ratio and proportion.

EXERCISE 6

1) How much will 5 quarts of oil cost if 2 quarts cost $1.10?
2) A steel rail weighing 384 pounds is 12 feet long. How much will a similar rail weigh if its length is 33 feet?
3) How much should a 6.5 ounce jar of paste cost if a 3.5 ounce jar cost $.56?
4) If 5 gallons of gasoline cost $1.60, how many gallons can be purchased for $5.60?
5) A man walks 5.75 miles in 8 hours. At the same rate of speed, how many hours would it take him to walk 5 miles?
6) A pump delivers 7500 gallons of water in 60 minutes. How many minutes will it take the pump to fill a tank having a capacity of 27,500 gallons?

7) 123 bolts weigh .75 pounds. How many bolts of the same size would be contained in 6 pounds?
8) How many bags of cement will be required for 28 cubic feet of concrete if 3.5 bags were used for 12 cubic feet of concrete?
9) Two kilograms is equal to 4.4 pounds. How many kilograms are there in 12 pounds?
10) How much would 12 bags of potatoes weigh if 18 bags weigh 196 pounds?

Answers to these questions will be found in the back of the book.

22. INVERSE PROPORTION. The preceding instructions for proportion have dealt with direct proportion. An example of direct proportion follows: Two balls weigh 3 pounds. How many balls will it take to weigh 6 pounds?

$$2 : 3 = x : 6$$

Using the slide rule for this problem: to 3 on D, set 2 on C. Over 6 on D, read 4 on C. Observe that in this problem of DIRECT PROPORTION, the C scale represented balls and the D scale represented pounds.

Study the following problem of INVERSE PROPORTION: Two men can complete a certain job in 8 days. How many days will it take four men to complete the job? Obviously, four men can do the job in ½ the time required for two men. Writing this problem in ratio and proportion, it becomes:

$$4 : 2 = 8 : x$$

Applying the rule for ratio and proportion: THE PRODUCT OF THE MEANS IS EQUAL TO THE PRODUCT OF THE EXTREMES.

$$4x = 16$$
$$x = 4$$

Use the slide rule to solve this problem. To 2 on D, set 4 on C. Under 8 on C, read 4 on D. Observe that the C scale represented men in the first ratio (4) and days (8) in the second ratio. Therefore in this problem of INVERSE RATIO C has been used to represent men in one ratio and days in the other ratio.

23. USE OF CI SCALE IN SOLVING PROBLEMS OF INVERSE PROPORTION. An automobile traveling 60 miles per hour reaches its destination in 12 minutes. What would have been the rate of speed in miles per hour if the trip had been made in 16 minutes? To 60 on D, set 12 on CI. Under 16 on CI, read 45 on D. In this problem of INVERSE PROPORTION, the CI (C Inverted) scale represents minutes, the D scale represents MPH. It is not necessary to write this problem to solve it, however it is important to understand just how the slide rule has been used for the calculations.

$$16 : 12 = 60 : x$$
$$16x = 720$$
$$x = 45$$

In following the operations of the slide rule in the above problem, CI and D were used to multiply 12 x 60. The product of 12 x 60 (720) was divided by 16 by means of the CI and D scales. Here, for the first time, the scales of CI and D have been used for division. You were instructed under paragraph 16 to use C and D scales for division. Here is how CI and D scales are used to divide 8 by 2. To 8 on D, set the right index of CI. Under 2 on CI read 4 on D.

24. PRACTICAL PROBLEMS IN PROPORTION. The following exercise lists problems in both DIRECT AND INVERSE PROPORTIONS. Use the C and D scales for solving problems of direct proportion and use CI and D scales for those of inverse proportion. As you decide which of the following problems of proportion are direct or inverse, you might be helped by thinking — MORE PIECES MEANS MORE POUNDS; FEWER PIECES MEANS FEWER POUNDS — that is DIRECT. But, when **MORE** MEN MEANS **LESS** TIME, or **LESS** MEN MEANS **MORE** TIME — that is INVERSE.

EXERCISE 7

1) A lot of 250 pieces of stone weighs 1020 pounds. How many pounds would 375 pieces of stone weigh?
2) An army depot has supplies for 2000 men for 90 days. If 1200 are shipped out, how many days will the supplies last the remaining 800 men?
3) Four trucks haul 175 tons of stone in 8 hours. How many hours would it take 3 trucks to do the job?
4) A construction job can be completed in 60 days with a crew of 32 men. How many men are required to complete the job in 24 days?
5) If 5 bags of cement cost $6.25, how much will 60 bags cost?
6) A pump having a capacity for pumping 110 gallons per minute will fill a tank in 13.5 hours. How many hours would it take a pump having 85 gallons per minute capacity to fill the tank?
7) If a supply of gasoline is sufficient to fuel 150 planes for 30 days, how many planes could be fueled for 50 days?
8) If $6.00 pays for the cost of 18.5 gallons of gasoline, how many gallons can be purchased for $5.00?
9) A large gear is engaged with a small gear. If the large gear has 160 teeth and turns 6 revolutions per minute, how many revolutions per minute will the small gear turn if the small gear has 24 teeth?
10) An electric motor is used to turn a circular saw. The belt pulley on the motor is 5.75" diameter and the belt pulley on the saw is 3.25" diameter. What is the RPM of the saw if the motor RPM is 1750?
11) If a 10 ton Skip requires a 150 H.P. motor for hoisting, how much H.P. is required for hoisting a similar Skip weighing 12 tons?
12) If 90 seconds are required for a 150 H.P. motor to hoist a 10 ton Skip, how many seconds will it require for 150 H.P. motor to hoist a 12 ton Skip?

25. RECIPROCALS. A reciprocal of a number is the quotient of 1 divided by that number. For example, the reciprocal of 1 $= \frac{1}{1} = 1$

" " " 2 $= \frac{1}{2} = .5$

" " " 42 $= \frac{1}{42} = .0238$

26. USING RECIPROCALS. It is sometimes necessary to know the percentage of parts making up a whole. Suppose, for instance, it was necessary to know the percentage of three parts of a concrete mix.

	CUBIC FEET	CU. FT. %
Cement	1.25	15.6
Sand	2.50	31.3
Stone	4.25	53.1
Total	8.00	100.0%

Here is the arithmetic necessary for determining the percentage of cement, sand and stone from the above problem:

$$\frac{1.25}{8.00} \text{ x } 100 = 15.6$$

$$\frac{2.50}{8.00} \text{ x } 100 = 31.3$$

$$\frac{4.25}{8.00} \text{ x } 100 = \frac{53.1}{100.0\%}$$

Another method for determining the percentages is to find the reciprocal of 8 and multiply its reciprocal by the number of cubic feet in each part times 100.

```
      .125
8 ) 1.000
     8
     20
     16
      40
      40
```

.125 x 1.25 x 100 = 15.6
.125 x 2.50 x 100 = 31.3
.125 x 4.25 x 100 = 53.1

8.00 100.0

The following exercise shows 10 weights totaling 718.7 pounds. Determine, by use of the slide rule, the percentage of each weight. Set 718.7 on C to the right index of D. (On D, under the left index of C is the reciprocal of 718.7 — DO NOT BOTHER TO READ IT — go ahead with the next step in the problem.) Move the indicator to 627 on C and read 87 on D under the hairline. Point off 87 by inspection. (The total pounds in the whole amounts to 718.7. One percent of the total would amount to 7.187 pounds. 62.7 pounds, the first weight given, is about 8 times as much as 1%, therefore, point off 87 at 8.7%.) Next, move the indicator along to other weights on C such as 38.2, 21.6, etc. and read the percentage from D under each of the weights set to on C. Only two of the 10 weights on C will be beyond the right index of D. The percentage for these two can be found after moving the right index of C to the exact position the left index occupies (over 139 on D). Check your answers with those in the back of the book.

EXERCISE 8

	POUNDS	WT. %
1)	62.7	8.7
2)	38.2	______
3)	21.6	______
4)	51.4	______
5)	100.0	______
6)	72.9	______

7)	114.0	______
8)	82.6	______
9)	70.3	______
10)	105.0	______
Total	718.7	100.0%

In problems such as the one above, the sum of the percentages does not always add to exactly 100.0% due to the dropping of the 3rd place figures. Usually, however, the total will be 99.9 or perhaps 100.1 in which case an adjustment is made by adding .1% or subtracting .1% from one of the percentages of higher values such as 15.9 or 14.6.

27. SQUARES AND SQUARE ROOTS. The square of a number is the product of a number multiplied by itself. 16 is the square of 4. 4 is the square root of 16.

Squaring a number can be done very easily with the slide rule — simply multiply a number by itself, for example:

the square of 5 is 25 (5 x 5)
the square of 60 is 3600 (60 x 60)

The square root of a number can be determined by use of CI and D scales.

Problem: Find the square root of 4 (written $\sqrt{4} = ?$). Solution: Set the **RIGHT** index of CI to 4 on D. Move the indicator to the left of the CI index until it aligns with like numbers on both CI and D (find 2 as the square root of 4).

What is the square root of 64 ($\sqrt{64}$)? Set the **LEFT** index of CI to 64 on D. Move the indicator to the right of the CI index and find 8 on both CI and D aligns with the hair-line. 8 then is the square root of 64.

In the following exercise SET THE **LEFT** INDEX OF CI TO ALL NUMBERS WHOSE WHOLE NUMBERS ARE IN MULTIPLES OF 2, such as in problems 5) and 6). IF THE NUMBER IS A DECIMAL SET THE **LEFT** INDEX OF CI TO ALL SUCH NUMBERS WHOSE CIPHERS (0's) TO THE RIGHT OF THE DECIMAL POINT ARE NONE OR IN MULTIPLES OF 2, such as in problems 1), 2) and 4).

SET THE **RIGHT** INDEX OF CI TO ALL OTHER NUMBERS.

Extract the square root of each of the numbers in the following exercise by using the CI and D scales of your slide rule.

EXERCISE 9

1) $\sqrt{.18}$ = ______
2) $\sqrt{.9}$ = ______
3) $\sqrt{6.12}$ = ______
4) $\sqrt{.007}$ = ______
5) $\sqrt{62.5}$ = ______
6) $\sqrt{84}$ = ______
7) $\sqrt{192}$ = ______
8) $\sqrt{33000}$ = ______
9) $\sqrt{1.56}$ = ______
10) $\sqrt{04}$ = ______

Check your answers with those in the back of the book.

EXERCISE 10
BOWLING

Determine the average number of pins for the 10 bowlers listed below. To Total Pins on D, set total games on C. Read the average under the index on D.

	Total Pins	Games	Average		Total Pins	Games	Average
1)	3596	27	______	6)	4169	27	______
2)	5124	30	______	7)	4487	27	______
3)	4407	30	______	8)	3595	24	______
4)	4049	24	______	9)	3597	21	______
5)	3933	30	______	10)	4164	30	______

EXERCISE 11
BASKETBALL

Player	Number Shots At Basket	Goals Made	% Made	Free Throw Attempts	Free Throws Made	% Made
1)	6	3	______	12	10	______
2)	38	10	______	8	7	______
3)	17	5	______	3	2	______
4)	23	6	______	11	8	______
5)	12	4	______	9	8	______

EXERCISE 12
BASEBALL BATTING AVERAGES

(A perfect hitter bats 1000)

To Times at bat on D, set number of hits on C. Read batting average on D under the C index.

Player	Times At Bat	Number Of Hits	Average	Player	Times At Bat	Number Of Hits	Average
1)	81	29	______	6)	77	21	______
2)	60	14	______	7)	23	8	______
3)	87	27	______	8)	69	20	______
4)	82	17	______	9)	75	24	______
5)	79	27	______	10)	53	17	______

EXERCISE 13
FLOOR COVERING

a) How many 9" square floor tiles are needed to cover the floors of rooms given below? b) If 6" square tiles are used, how many of them will be required?

NOTE: one 9" x 9" tile = 81 sq. inches. $\frac{81}{144}$ = .5625 Sq. Ft.
one 6" x 6" tile = 36 sq. inches. $\frac{36}{144}$ = .25 Sq. Ft.
one square foot = 12 x 12 = 144 square inches.

To solve a) by use of the slide rule, in problem 1) To 8 on D, set 13.5 on CI. Move the indicator to the index of CI. Set .5625 on C to the hair-line, then read 192 on D under the left index of CI.

	Size of Room	a) 9" tile req'd.	b) 6" tile req'd.
1)	8' x 13.5'	______	______
2)	11" x 12"	______	______
3)	7.5' x 9.25'	______	______
4)	12' x 14'	______	______
5)	10.5' x 11.25'	______	______
6)	6' x 6'	______	______

EXERCISE 14
FLOOR COVERING

Carpets are sold by the square yard. One square yard = 3 ft. x 3 ft. = 9 square feet. How many square yards of carpet are needed to floor the rooms listed below.

	Size of Room	Sq. Yds. Req'd.		Size of Room	Sq. Yds. Req'd.
1)	14' x 22'	______	4)	16.5' x 17'	______

2) 16' x 18' ________ 5) 12' x 19.5' ________
3) 12.5'' x 17.3' ________ 6) 13' x 15.5' ________

EXERCISE 15
WIND PRESSURE

p = pounds per square foot of surface
V = velocity of wind, miles per hour
$p = .004\ V^2$

Find the pressure in pounds on a surface having an area of one square foot exerted by the wind blowing at 15 miles per hour.

$p = .004 \times 15 \times 15$
$p = .004 \times 225$
$p = .9$ pounds

In using the slide rule for this problem: set 15 on CI to 15 on D. Move the indicator to the CI index. Set 4 on CI to the hair-line, then read .9 on the D scale under the index. Use the slide rule for determining the pounds per square foot resulting from wind velocities as listed below:

	Wind Velocity Miles Per Hour	Pounds Sq. Ft.		Wind Velocity Miles Per Hour	Pounds Sq. Ft.
1)	20	____	4)	60	____
2)	35	____	5)	75	____
3)	45	____	6)	100	____

EXERCISE 16
WATER PRESSURE

A cubic foot of water weighs about 62.4 pounds. If a vessel 12'' high x 12'' wide x 12'' deep (contents 1 cubic foot) is filled with water, the water will exert a pressure of 62.4 pounds on the bottom of the vessel. The bottom of the vessel has an area of 12 x 12 = 144 square inches. The pressure on each square inch of the bottom is $\frac{62.4}{144} = .433$ pounds. Therefore, one foot head of water (the **head** in this case, is the distance from the bottom of the vessel to the water level) is equal to a pressure of .433 pounds per square inch.

Use the slide rule for finding the equivalent pressure in pounds per square inch for each of the water heads given below. Note: To find the pressure, equivalent to a 3 foot head of water, set the right index of C to 433 on D. Move the indicator to 3 on C and read 1.3 on D.

	Ft. Head	Lbs. Per Sq. In.		Ft. Head	Lbs. Per Sq. In.
1)	5	____	6)	66	____
2)	17	____	7)	40	____
3)	80	____	8)	2	____
4)	30	____	9)	99	____
5)	70	____	10)	50	____

EXERCISE 17
CIRCLES

The circumference of a circle is equal to its diameter multiplied by 3.1416. The number 3.1416 is called pi and is written π.

The area of a circle is equal to the square of its diameter multiplied by .7854.

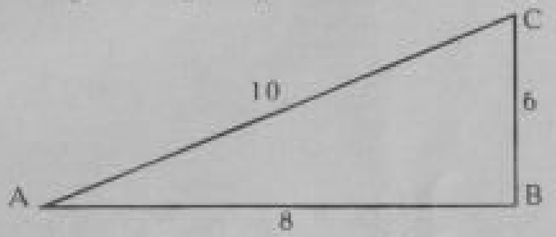
The circumference of a 6'' diameter circle = 6 x 3.1416 = 18.85''
The area of a 6'' diameter circle = 6 x 6 x .7854 = 28.27 sq. in.

Use the slide rule for calculating the circumference and area of each of the following circles:

	Dia.	Cir.	Area		Dia.	Cir.	Area
1)	30	____	____	4)	.39	____	____
2)	24	____	____	5)	.75	____	____
3)	72	____	____	6)	12	____	____

EXERCISE 18
TRIANGLES

The figure below represents a right triangle. It has a base AB, side BC and the hypotenuse AC. The side BC is square with the base AB, and forms a 90 degree or right angle with it.



The right triangle is sometimes used in construction work for squaring one line from another by measurements. The base AB is measured off at 8 feet. The point C is established by the intersection of a measurement of 6 feet from point B and a measurement of 10 feet from point A. Therefore the 3 sides, 8 feet, 6 feet and 10 feet make a right triangle.

The triangle in the figure above may be made larger or smaller by direct proportion of its sides. Suppose it is desired that AC should be 50 feet or 5 times as long as shown in the figure, then AB will be 40 feet (5 x 8) and BC will be 30 feet (5 x 6).

If two sides of a right triangle are known, the third side can be computed. Assume side AB to be 20 and side BC to be 15. Find the length of side AC.

$$AC = \sqrt{20^2 + 15^2}$$
$$AC = \sqrt{400 + 225}$$
$$AC = \sqrt{625}$$
$$AC = 25$$

The above problem has been solved by the rule: THE HYPOTENUSE OF A RIGHT TRIANGLE IS EQUAL TO THE SQUARE ROOT OF THE SUM OF THE SQUARES OF ITS SIDES.

AN UNKNOWN SIDE OF A RIGHT TRIANGLE IS EQUAL TO THE SQUARE ROOT OF THE SQUARE OF THE HYPOTENUSE MINUS THE SQUARE OF THE KNOWN SIDE.

$$AB = \sqrt{AC^2 - BC^2}$$
$$AB = \sqrt{25^2 - 15^2}$$
$$AB = \sqrt{625 - 225}$$
$$AB = \sqrt{400}$$
$$AB = \sqrt{20}$$

Similarly

$$BC = \sqrt{AC^2 - AB^2}$$
$$BC = \sqrt{25^2 - 20^2}$$
$$BC = \sqrt{625 - 400}$$
$$BC = \sqrt{225}$$
$$BC = \sqrt{15}$$

NOTE: Refer to paragraph 27 for instructions for finding the square root of a number then proceed to find the length of the sides in the table below:

	Side a	Side b	Side c
1)	7.8	24	——
2)	30	——	52

EXERCISE 19
APPROXIMATE EQUIVALENT HOUSEHOLD MEASUREMENTS

Use your slide rule for determining the equivalents that are not shown in the table below. Check your answers with those in the back of the book.

Ounces Water	Tea-Spoons	Table-Spoons	Cups	Pints	Quarts	Gallons
——	3	1	——	——	——	——
——	6	2	——	——	——	——
——	——	4	.25	——	——	——
——	——	8	.5	——	——	——
——	——	——	1	.5	——	——
——	——	——	——	1	.5	——
——	——	——	——	2	1	——
——	——	——	——	——	2	.5
128	——	——	——	——	4	1

A detergent is to be added to water at a ratio of 1 to 200; one part detergent to 200 parts of water. How much detergent should be added to 2.5 gallons of water at the ratio of 1 to 200?

2.5 x 128 ounces = 320 ounces of water

$\frac{320}{200}$ = 1.6 ounces of detergent required.

If the table above is completed, 1.6 ounces can be converted to teaspoons or tablespoons.

EXERCISE 20
AUTOMOBILE TIRES

A careful inspection of 4 tires removed from an automobile revealed that the maximum wear on one tire was 36% and the minimum wear shown by another tire was only 14½%. If the tires had been periodically switched, it is reasonable to assume that the wear on each tire would be an average of minimum and maximum wear or

$$\frac{36 + 14.5}{2} = 20.25\%$$

The life expectancy of the average tire, from the above, = 100% less 20.25% = 79.75% while the life expectancy of the tire of maximum wear is equal to 100% less 36% = 64%.

If the life of a tire is 30,000 miles when periodically switched, what would be the mileage of the tire that had not been switched and showed maximum wear? By ratio and proportion: 79.75 : 30,000 = 64 : x

x = 24,100

In using the slide rule for this problem: To 3 on D, set 7975 on C. Under 64 on C, read 241 on D.

Using the ratio as given above, what is the value of x if

1) 20,000 miles is the life of tires that are switched.

2) 35,000 miles is the life of tires that are switched.

3) 45,000 miles is the life of tires that are switched.

4) An automobile manufacturer recommends that tires be rotated every 2500 miles. If the life of 4 tires, when rotated or switched, is 37,500 miles, what would be the life expectancy of 5 tires when rotated as recommended?

$\frac{5}{4}$ x 37,500 = ____________

EXERCISE 21
AUTOMOBILE WHEEL SPEEDS

If the wheels of an automobile are 28" in diameter, how many revolutions per minute (RPM) will the wheels turn when the automobile is driven at the rate of 50 miles per hour?

1 mile = 5280 feet
1 hour = 60 minutes
28" = 2.33 feet
2.33 x 3.1416 = 7.33 feet circumference of wheel

$$\text{RPM} = \frac{50 \times 5280}{60 \times 7.33}$$

RPM = 600

To use the slide rule for this problem: Set the right index of C to 5 on D, move the indicator to 528 on C. Set 6 on C to the indicator Move the indicator to the right index of C. Set 733 on C to the hair-line. Read 6 on D under the C index.

What is the RPM of wheels of 28" diameter on automobiles traveling

1) 40 miles per hour?
2) 60 miles per hour?
3) 80 miles per hour?
4) 100 miles per hour?

EXERCISE 22
CENTRIFUGAL FORCE

Wheel balancing machines, as used by automobile mechanics, will automatically determine the position and amount of weight necessary to balance a wheel. The formula for centrifugal force given below can be used to show the effect of unbalanced wheels.

$F = .00034\ W\ R\ N^2$
F = force in pounds
W = weight in pounds
R = radius in feet
N = revolutions per minute

What is the centrifugal force caused by an unbalanced wheel turning at 600 RPM if a balancing machine indicates that 5 ounces of weight is required to be attached to the wheel 8" from the wheel's center.

5 ounces = $\frac{5}{16}$ = .312 pounds

8 inches = $\frac{8}{12}$ = .67 feet

$F = .00034\ W\ R\ N^2$
$F = .00034 \times .312 \times .67 \times 600 \times 600$
$F = 25.6$ pounds.

To use the slide rule: To 34 on D, set 312 on CI. Move the indicator to 67 on C. Set 36 on CI to the hair-line. Read 256 on D under the left index of C.

What would be the force (F) in the above problem if

1) the RPM = 720?
2) the RPM = 960?
3) the RPM = 1200?

EXERCISE 23
LUMBER

1 Foot Board Measure (FBM) of lumber is equal to a piece that is 1" thick x 12" wide x 1'-0" long. In other words, one FBM = 1 square foot, 1" thick.

$$1 \text{ FBM} = \frac{1'' \text{ x } 12'' \text{ x } 1'\text{-}0''}{12}$$

$$1\ 2'' \text{ x } 4'' \text{ x } 14'\text{-}0'' = \frac{1 \text{ x } 2 \text{ x } 14}{12} = 9.33 \text{ FBM}$$

Determine the FBM in each of the following items:

1) 28 pcs. 2" x 4" x 8'-0"
2) 14 pcs. 2" x 4" x 12'-0"
3) 2 pcs. 2" x 6" x 16'-0"
4) 32 pcs. 1" x 8" x 12'-0"
5) If 1" x 6" clear white pine sells for 20c per lineal foot, what is its cost per 1000 FBM?

EXERCISE 24

SOLVING FOR TWO UNKNOWNS is more often done by the use of Algebra, however, there are many problems having two unknowns that can be solved by simple arithmetic.

Problem: There were 100 adults and children in a theatre. The adults paid 85c for admission and each child paid 50c. If the average paid admission was 57c, how many adults were there? How many children?

There are three values of admission in the above problem: the maximum 85c, the minimum 50c and the average 57c. The average price of admission is determined from all, or 100% of the admissions paid, therefore, less than 100% paid 85c, and less than 100% paid 50c.

The **percent of minimum price** admission is found by dividing the **difference between maximum and average** by the **difference between maximum and minimum,** for example: $\frac{85 - 57}{85 - 50} = \frac{28}{35} = .80$ or 80%

The percentage of minimum price admission has been found to be 80, therefore the maximum price admission is equal to 100 minus 80 = 20%

The **percent of maximum price admission** can be found by dividing the **difference between average and minimum** by the **difference between maximum and minimum,** for example: $\frac{57 - 50}{85 - 50} = \frac{7}{35} = .20$ or 20%

The percentage of maximum price admission has been found to be 20, therefore the percentage of minimum price admission is equal to 100 − 20 = 80%.

The percentages have been found to be 80 and 20; the number of people representing these percentages is found by multiplying, percent times total number of people:

80% or .80 x 100 = 80
20% or .20 x 100 = 20

100% or 1.0 x 100 = 100

Proof of the answers is given below:

Number People	x	Price Paid	=	Amount
80	x	.50	=	$40.00
20	x	.85	=	17.00
100	x	(*)	=	$57.00

(*) The average (.57) is found by dividing the total amount in dollars by the total number of people $\frac{57.00}{100} = .57$

To digress briefly — the form above is used to prove that 57c is the average price of admission. A similar form is often used for finding other unknowns — for example:

Suppose the problem were this: The average paid attendance was 57c. Twenty percent paid 85c each, how much did each of the others pay?

	% People	x	Price	=	Amount
	100	x	.57	=	$57.00
	20	x	.85	=	17.00
Difference	80		(*)	=	$40.00

(*) $\frac{40}{80} = .50$

The same results will be attained if decimals are used for percentages, thus:

	1.00	x	.57	=	.57
	.20	x	.85	=	.17
Difference	.80	x	(*)	=	.40

(*) $\frac{.40}{.80} = .50$

Problem: Two grades of coffee, valued at 72c and 80c per pound, are mixed to make a grade whose value is 75c per pound. The supply of 80c coffee is limited to 12 pounds. How many pounds of 72c coffee must be used? How many pounds of 75c coffee will there be in the mixture?

	Maximum	.80	Maximum	.80
Subtract	Average	.75	Minimum	.72
	Difference	.05	Difference	.08

$\frac{.05}{.08} = .625 = 62.5\%$ the amount of 72c grade

100% less 62.5% = 37.5% the amount of 80c grade

37.5% = 12 pounds
62.5% = 20 pounds answer
100.0% = 32 answer

Proof:

	pounds	x	cost	=	amount
	12	x	.80	=	$ 9.60
	20	x	.72	=	14.40
Total	32	x	.75	=	$24.00

1) A city clerk's office collected $13,000.00 from vehicle tax on 2500 automobiles. All of the 8-cylinder automobiles were taxed $6.00 each all others were taxed $5.00 each.

   a) How many 8-cylinder cars were there?
   b) How many others were there?
   c) Prove your answers.

2) Raw coal from a mine has an ash content of 15%. The raw coal

is processed through a coal washing machine which is used to remove impurities from the raw coal. After the coal is processed, the cleaned coal has an ash content of 10% and the impurities or refuse has an ash content of 60%.

a) What is the percent of cleaned coal?
b) What is the percent of refuse?
c) Prove your answers.

3) One U.S. gallon = 3.785 liters
One U.S. gallon = 4 quarts
One quart = .946 liters
One liter = 1.057 quarts
One liter = 1000 milliliters

A liquid of 2.84 specific gravity is to be mixed with a liquid of 1.58 specific gravity to make a liquid of 2.00 specific gravity. If the quantity of 2.00 liquid is 2000 **milliliters how many**

a) milliliters of 2.84 S.G. are required?
b) milliliters of 1.58 S.G. are required?
c) check your answers.

4) How much water, having a specific gravity of 1.00 must be mixed with how much alcohol having a specific gravity of .79 to make 1800 milliliters of .90 specific gravity liquid?

a) milliliters of alcohol =
b) milliliters of water =
c) prove your answers.

EXERCISE 25
PROPORTIONS AND QUANTITIES FOR CONCRETE

The amount of cement, sand and stone required for one cubic yard of concrete for a 1 : 2 : 4 mix is given below:

6 bags cement = 6 cubic feet
.44 cu. yds. sand = 12 cubic feet
.89 cu. yds. stone = 24 cubic feet

From the above, the quantity of dry material necessary for one cubic yard of concrete is 42 cu. ft (6 plus 12 plus 24) One cubic yard = 27 cu. ft. Therefore, the ratio of volumes, dry material to concrete = $\frac{42}{27}$ = 1.56

1 barrel (bbl.) cement = 4 bags = 4 cu. ft.
1 bag cement = 94 pounds

1) Fill in the values for quantities required for 1 cubic yard of concrete:

MATERIALS FOR ONE CU. YD. CONCRETE

	Proportion		barrels	cu. yds.	cu. yds.
Cement	sand	stone	cement	sand	stone
1	: 1½	: 3	______	______	______
1	: 2	: 3	______	______	______
1	: 2	: 4	1.50	.44	.89
1	: 3	: 5	______	______	______
1	: 3	: 6	______	______	______

USE THE COMPLETED TABLE ABOVE FOR SOLVING PROBLEMS 2 and 3

2) Determine the quantity of material required for 16 cu. yds. of 1 : 3 : 5 concrete.
3) Determine the quantity of material required for 14 cu. yds. of 1 : 2 : 4 concrete.

4) Two bags of cement are used for one batch of 1 : 2 : 4 concrete. How many cubic feet of concrete will one batch make?

EXERCISE 26
CEMENT MORTAR PROPORTIONS AND QUANTITIES

If 12.8 cu. ft. of cement is mixed with 25.6 cu. feet of sand to make one cubic yard of 1 : 2 mix, mortar, how many cubic feet each of cement and sand are required for

1) 1 cu. yd. mortar 1 : 1 mix?
2) 1 cu. yd. mortar 1 : 3 mix?
3) 1 cu. yd. mortar 1 : 4 mix?
4) 1.8 cu. yds. of 1 : 2 mortar will require
   a) how many bbl. cement?
   b) how many cu. yds. sand?

ANSWERS
EXERCISE 1

1) 7.7 2) 117. 3) 84.0 4) 9.75 5) .465
6) 5.1 7) .00202 8) 15.7 9) 13,300 10) .036

EXERCISE 2

1) 28.863 2) .2846 3) 176.72 4) 2350.6 5) 106.2
6) 129.56 7) .000248 8) 56.25 9) 3,873,186 10) 110.55

The products in exercise 2 have been carried out to four or more places in order to show comparison of actual values with slide rule products which are somewhat limited to three places. Does your product in 8) agree with 56.25?

EXERCISE 3

1) 15.8 2) 21.3 3) 15.6 4) 19.1 5) 17.8
6) 16.75 7) 21.3 8) 17.4 9) 18.1 10) 14.4

EXERCISE 4

1) 9.1 2) 1.7 3) 25 4) 31.3 5) 8.76
6) 7.85 7) 312.5 8) 6.05 9) 51.5 10) 4260

EXERCISE 5

1) 136 2) 1 3) 120 4) 24 5) 6
6) .06 7) 1,000 8) 22.5 9) 128 10) 336

EXERCISE 6

1) 2.75 2) 1056 3) $1.04 4) 17.5 5) 6.95
6) 220 7) 984 8) 8.16 9) 5.45 10) 131

EXERCISE 7

1) 1530 lbs. 2) 225 days 3) 10.67 hrs. 4) 80 men 5) $75.
6) 17.5 hrs. 7) 90 planes 8) 15.4 gal. 9) 40 RPM
10) 3100 RPM 11) 180 H.P. 12) 108 seconds

EXERCISE 8

1) 8.7 2) 5.3 3) 3.0 4) 7.2 5) 13.9
6) 10.1 7) 15.9 8) 11.5 9) 9.8 10) 14.6

EXERCISE 9

1) .424 2) .948 3) 2.47 4) .084 5) 7.9
6) 9.17 7) 13.85 8) 181.5 9) 1.25 10) .2

EXERCISE 10

1) 133 2) 171 3) 147 4) 169 5) 131
6) 154 7) 166 8) 150 9) 171 10) 139

EXERCISE 11

1) 50.0% Goals 83.3% Free Throws
2) 26.3% Goals 87.5% Free Throws

ANSWERS

3) 29.4% Goals 66.7% Free Throws
4) 26.1% Goals 72.7% Free Throws
5) 33.3% Goals 89.0% Free Throws

EXERCISE 12

1) 358 2) 233 3) 310 4) 207 5) 342
6) 273 7) 348 8) 290 9) 320 10) 320

EXERCISE 13

	9" Tiles	6" Tiles		9" Tiles	6" Tiles
1)	192	432	2)	235	528
3)	124	278	4)	299	672
5)	210	473	6)	64	144

EXERCISE 14

1) 34.2 2) 32.0 3) 24.0
4) 31.2 5) 26.0 6) 22.4

EXERCISE 15

1) 1.6 2) 4.9 3) 8.1
4) 14.4 5) 22.5 6) 40.0

EXERCISE 16

1) 2.16 2) 7.36 3) 34.6 4) 13 5) 30.3
6) 28.6 7) 17.3 8) .87 9) 43.0 10) 21.7

EXERCISE 17

1) 94.2 707 4) 1.23 .119
2) 75.4 452 5) 2.36 .442
3) 226 4070 6) 37.7 113

EXERCISE 18

1) 22.7 2) 60

EXERCISE 19

Ounces Water	Tea-spoons	Table-spoons	Cups	Pints	Quarts	Gallons
.5	3	1	.063	.031	.015	.0038
1	6	2	.125	.063	.031	.0075
2	12	4	.25	.125	.063	.015
4	24	8	.5	.25	.125	.031
8	48	16	1	.5	.25	.063
16	96	32	2	1	.5	.125
32	192	64	4	2	1	.25
64	384	128	8	4	2	.5
128	768	256	16	8	4	1

EXERCISE 20

1) 16,050 2) 28,100 3) 36,100 4) 46,900

EXERCISE 21

1) 480 2) 720 3) 960 4) 1200

EXERCISE 22

1) 36.8 Lbs. 2) 65.4 Lbs. 3) 102 Lbs.

EXERCISE 23

1) 149 2) 112 3) 32 4) 256 5) $400.00

EXERCISE 24

1) a) 500 b) 2000

c)

cars	x	tax	=	amount
2000	x	$5	=	$10,000
500	x	$6	=	3,000

ANSWERS

Total	2500	x	$5.20 =	$13,000

2) a) 90% b) 10%

c)

	Wt. %	x	Ash %	=	Units
	90	x	10	=	900
	10	x	60	=	600
Totals	100	x	15	=	1500

or

c)

Wt.	x	Ash	=	Units
.90	x	.10	=	.09
.10	x	.60	=	.06
1.00	x	.15	=	.15

3) a) 666 b) 1334

c)

MI	x	SG	=	Units
1334	x	1.58	=	2108
666	x	2.84	=	1892
2000	x	2.00	=	4000

4) a) 875 b) 925

c)

MI	x	SG	=	Units
857	x	.79	=	677
943	x	1.00	=	943
1800	x	.90	=	1620

EXERCISE 25

1)

cement	sand	stone
1.91	.43	.85
1.75	.52	.78
1.50	.44	.89
1.17	.52	.86
1.05	.47	.93

2) 19 bbl. cement; 8.3 cu. yd. sand; 13.8 cu. yd. stone
3) 21 bbl. cement; 6.2 cu. yd. sand; 12.5 cu. yd. stone
4) 9 cu. ft.

EXERCISE 26

1)	19.2 cu. ft. cement	19.2 cu. ft. sand
2)	9.6 cu. ft. cement	28.8 cu. ft. sand
3)	7.7 cu. ft. cement	30.7 cu. ft. sand

4) a) 5.76 bbl. b) 1.7 cu. yd.

NOTES