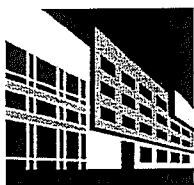
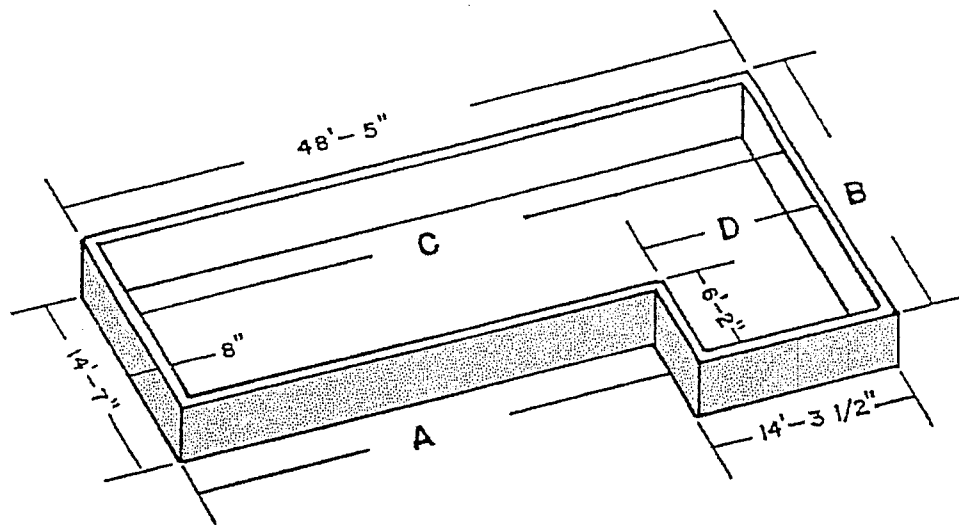


# Carpentry

## Basic Mathematics



**CARPENTERS  
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20012M





# **Carpentry**

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# **Basic Mathematics**



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# Introduction

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## CARPENTRY BASIC MATHEMATICS

This unit on Basic Mathematics is intended as a review of the basic fundamentals of the arithmetic that we need in our everyday work.

The carpenter, when reading a rule, making a layout, or figuring his income tax, is undertaking tasks which involve knowledge and understanding of these basic fundamentals.

For those students who have discovered a weakness in their knowledge of the basic fundamentals of mathematics or for those students in need of review, it is suggested that a review of this unit is in order before proceeding to the Mathematics for Carpenters unit.

For maximum effectiveness, the text and examples should be studied thoroughly and the problems at the end of each section, along with all review problems, should be worked.

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REVIEW MATHEMATICS FOR CARPENTERS

The arabic system of numbers includes ten numerals: 0 1 2 3 4 5 6 7 8 9.

A number is made up of one or more numerals.

A whole number contains no decimals or fractions.

Numerals are arranged in a certain way to make numbers larger than 9.

The number system is classified:

Ten Millions	Millions	Hundred Thousands	Ten Thousands	Thousands	Hundreds	Tens	Units
6	1	3	5	4	2	8	9
1	3	5	4	2	8	9	
	3	5	4	2	8	9	
		5	4	2	8	9	
			4	2	8	9	
				2	8	9	
					8	9	
						9	

*Read:* Sixty-one million, three hundred fifty-four thousand, two hundred eighty-nine

*Read:* One million, three hundred fifty-four thousand, two hundred eighty-nine

*Read:* Three hundred fifty-four thousand, two hundred eighty-nine

*Read:* Fifty-four thousand, two hundred eighty-nine

*Read:* Four thousand, two hundred eighty-nine

*Read:* Two hundred eighty-nine

*Read:* Eighty-nine

*Read:* Nine

*Term:*

*Symbol:*

Addition

+ (plus)

Subtraction

- (minus)

Multiplication

× (times)

Division

÷ (divided by); also / ( $\frac{1}{4}$ ) or ( $\frac{1}{2}$ )

Equals

= (the same as)

Addition of Whole Numbers

WHOLE NUMBERS

Addition is the process of uniting two or more numbers to make one number. The answer to an addition problem is called the *sum*. The following series contain all combinations of two numbers. The mastering of these combinations will assist in the solution of more difficult problems of addition.

9	2	3	1	4	5	4	3	2	3	7	5	3	2	4
1	5	8	6	2	7	9	5	1	6	8	5	4	2	6
9	7	8	2	1	7	8	9	5	3	1	2	8	1	2
5	7	9	6	5	2	4	7	6	3	8	9	5	1	3
4	9	7	9	8	4	7	4	1	6	1	8	2	9	4
5	9	6	6	8	1	3	4	7	6	3	6	8	3	7

The initial step in setting up a problem in addition is to place the numbers to be added in such a manner that the last digit of each number is directly under the last digit of the previous number. By doing this, it is possible to add each of the columns of numbers accurately.

Example: Add  $8749 + 693 + 75 + 3 + 2891$

Thousands	Hundreds	Tens	Units
(2)	(3)	(2)	
8	7	4	9
	6	9	3
		7	5
			3
2	8	9	1
1	2	4	1

*Step 1.* Place all numbers under each other with the unit numbers in the unit column, the tens in the tens column, etc.

*Step 2.* Add the numbers in the unit column:  $9 + 3 + 5 + 3 + 1 = 21$ . The 1 is in the units column and the 2 is in the tens column. Write the 1 below the line in the units column and place the 2 above the 4 in the tens column. You may prefer to place the 2 below the 9 in the tens column; either way is acceptable.

*Step 3.* Add the numbers in the tens column including the 2 you placed at the top of the column.  $(2) + 4 + 9 + 7 + 9 = 31$ . The 1 is in the tens column and the 3 is in the hundreds column. Write the 1 below the line in the tens column and the 3 above the 7 in the hundreds column.

*Step 4.* Add the numbers in the hundreds column including the 3 you placed at the top of the column.  $(3) + 7 + 6 + 8 = 24$ . The 4 is in the hundreds column and the 2 is in the thousands column. Write the 4 beneath the line in the hundreds column and place the 2 above the 8 at the top of the thousands column.

*Step 5.* Add the numbers in the thousands column, including the 2 you placed at the top of the column.  $(2) + 8 + 2 = 12$ . As the problem does not extend beyond the thousands column, write the 12 beneath the line. The sum of  $8749 + 693 + 75 + 3 + 2891 = 12,411$ .

To check your answer, add the columns from top to bottom and from bottom to top. If your answer is the same, you can be reasonably sure that you have the correct answer.

It is important to remember that only quantities of the same kind can be added. Thus, you cannot add  $1 \times 12$ 's and  $2 \times 4$ 's together by simply adding the numbers. The addition of 150 feet and 65 inches would give a sum of 225, but this would be neither feet nor inches.

When you add real things, the answer should contain the name of the things added, *for example*:  $25 - 2 \times 4$ 's +  $15 - 2 \times 4$ 's =  $40 - 2 \times 4$ 's. If this idea is carried out in all computations—addition, subtraction, multiplication and division, many errors may be avoided.

Solving problems when you have been told to find the sum is not too difficult but sometimes you run across a problem in which you have trouble deciding on the process to use to solve it.

Example:

A house is framed using  $114 - 2 \times 4$  studs on the east wall,  $126 - 2 \times 4$  studs on the west wall,  $88 - 2 \times 4$  studs on the north wall,  $92 - 2 \times 4$  studs on the south wall,  $124 - 2 \times 10$  floor joists and  $68 - 2 \times 8$  ceiling joists. How many  $2 \times 4$  studs were used in framing the house?

Solution:

The  $2 \times 10$  floor joists and the  $2 \times 8$  ceiling joists play no part in the solution of the problem and should be disregarded. The number of studs can be found as follows:

East Wall	114 Studs
West Wall	126 Studs
North Wall	88 Studs
South Wall	92 Studs
<hr/>	
	420 Studs

Solve the Following Problems:

1.  $\begin{array}{r} 27 \\ 14 \\ 72 \\ \hline \end{array}$
2.  $\begin{array}{r} 97 \\ 88 \\ 64 \\ \hline \end{array}$
3.  $\begin{array}{r} 423 \\ 157 \\ 14 \\ \hline \end{array}$
4.  $\begin{array}{r} 1368 \\ 7365 \\ 1250 \\ \hline \end{array}$
5.  $\begin{array}{r} 3841 \\ 802 \\ 3 \\ \hline \end{array}$
6.  $\begin{array}{r} 4511 \\ 8213 \\ 92 \\ 4960 \\ 42 \\ \hline 3 \end{array}$
7.  $17 + 81 + 44 + 192 =$
8.  $5280 + 1760 + 16 =$
9. Find the sum of 491 and 988.

Subtraction of Whole Numbers:

Subtraction is the process of finding the difference between two numbers. The larger of the two numbers is called the *minuend*. The smaller number which is to be taken or subtracted from the larger number is called the *subtrahend*. The result or answer of a subtraction is called the *difference* or *remainder*. The sign  $-$  (minus) indicates subtraction.

Example 1: Subtract 5421 from 8634.

Thousands	Hundreds	Tens	Units
8	6	3	4
5	4	2	1
<hr/>			
3	2	1	3

- Step 1.* Write the larger number as the minuend.
- Step 2.* Write the smaller number (the subtrahend) under the minuend with the units under units, tens under tens, etc.
- Step 3.* Start with the units columns and subtract the subtrahend (bottom number) from the minuend (top number). What number added to 1 will equal 4?  
 $3 + 1 = 4$ . Place the 3 under the line in the units column.
- Step 4.* Continue to the tens column. What number added to 2 will equal 3?  $1 + 2 = 3$ . Place the 1 in the tens column.
- Step 5.* Continue to the hundreds column. What number added to 4 will equal 6?  $2 + 4 = 6$ . Place the 2 in the hundreds column.
- Step 6.* Continue to the thousands column. What number added to 5 will equal 8?  $3 + 5 = 8$ . Place the 3 in the thousands column.

The difference between 8634 and 5421 is 3213.

To check your answer add the subtrahend and the difference  $5421 + 3213 = 8634$ . If your answer is correct, the sum will equal the minuend.

Example 2: Find the difference between 9231 and 5654.

Thousands	Hundreds	Tens	Units
9	2	3	1
5	6	5	4
<hr/>			

- Step 1.* Write the larger number as the minuend.
- Step 2.* Write the smaller number as the subtrahend keeping the unit numbers under the unit column of the minuend, the tens column under the tens column of the minuend, etc.

		2	11
9	2	3	1
5	6	5	4
<hr/>			
			7

- Step 3.* Start with the units column (right hand column). Since 4 is larger than 1, you cannot subtract. Borrow ten from the tens column which then increases the 1 to 11. Change the 3 in the tens column to 2 (1 has been borrowed from the 3).

Subtract the 4 from 11.  $11 - 4 = 7$ . Place the 7 under the line in the units column.

		12	
	1	2	11
9	2	3	1
5	6	5	4
<hr/>			
		7	7

- Step 4.* Move to the tens column. Since the 5 is larger than the 2, again borrow, this time from the hundreds column. This will increase the 2 to 12 and decrease the 2 in the hundreds column by 1. Subtract the 5 from 12.  $12 - 5 = 7$ . Place the 7 below the line.

	11	12	
	1	2	11
9	2	3	1
5	6	5	4
<hr/>			
3	5	7	7

- Step 5.* Move to the hundreds column. Since 6 is larger than 1 (you have taken 1 from 2 in step 4), again borrow, this time from the thousands column which will increase the 1 to 11. Change the 9 in the thousands column to 8 (1 has been borrowed from the 9).

Subtract the 6 from the 11 in the hundreds column,  $11 - 6 = 5$ . Place the 5 below the line in the hundreds column.

*Step 6.* Move to thousands column. Subtract the 5 from the 8.  
 $8 - 5 = 3$ . Place the 3 below the line in the thousands column.  
 The difference between 9231 and 5654 is 3577.  
 Check the accuracy of your answer by adding the difference (3577) and the subtrahend (5654). If your answer is correct, the sum will equal the minuend.  $3577 + 5654 = 9231$  (minuend).

Problems:

1. $\begin{array}{r} 485 \\ - 293 \\ \hline \end{array}$	2. $\begin{array}{r} 7492 \\ - 3625 \\ \hline \end{array}$	3. $\begin{array}{r} 68452 \\ - 50737 \\ \hline \end{array}$	4. $\begin{array}{r} 987 \\ - 789 \\ \hline \end{array}$	5. $\begin{array}{r} 2398 \\ - 99 \\ \hline \end{array}$
--	--	--	--	--

Multiplication of Whole Numbers

Multiplication is a short method of adding the same number a certain number of times.  
 4 multiplied by 2 is the same as 4 taken 2 times or  $4 + 4 = 8$ .

In multiplication there are three terms used, the *multiplicand*, the *multiplier* and the *product*.

5 The number multiplied is called the *multiplicand*  
 $\times 3$  The number by which you multiply is called the *multiplier*

15 The result of the multiplication is called the *product*

The sign  $\times$  (multiplied by) means *multiplication*.

The mastery of the multiplication tables to  $12 \times 12$  is necessary to solve problems of multiplication involving larger numbers.

$1 \times 1 = 1$	$2 \times 1 = 2$	$3 \times 1 = 3$	$4 \times 1 = 4$
$1 \times 2 = 2$	$2 \times 2 = 4$	$3 \times 2 = 6$	$4 \times 2 = 8$
$1 \times 3 = 3$	$2 \times 3 = 6$	$3 \times 3 = 9$	$4 \times 3 = 12$
$1 \times 4 = 4$	$2 \times 4 = 8$	$3 \times 4 = 12$	$4 \times 4 = 16$
$1 \times 5 = 5$	$2 \times 5 = 10$	$3 \times 5 = 15$	$4 \times 5 = 20$
$1 \times 6 = 6$	$2 \times 6 = 12$	$3 \times 6 = 18$	$4 \times 6 = 24$
$1 \times 7 = 7$	$2 \times 7 = 14$	$3 \times 7 = 21$	$4 \times 7 = 28$
$1 \times 8 = 8$	$2 \times 8 = 16$	$3 \times 8 = 24$	$4 \times 8 = 32$
$1 \times 9 = 9$	$2 \times 9 = 18$	$3 \times 9 = 27$	$4 \times 9 = 36$
$1 \times 10 = 10$	$2 \times 10 = 20$	$3 \times 10 = 30$	$4 \times 10 = 40$
$1 \times 11 = 11$	$2 \times 11 = 22$	$3 \times 11 = 33$	$4 \times 11 = 44$
$1 \times 12 = 12$	$2 \times 12 = 24$	$3 \times 12 = 36$	$4 \times 12 = 48$
$5 \times 1 = 5$	$6 \times 1 = 6$	$7 \times 1 = 7$	$8 \times 1 = 8$
$5 \times 2 = 10$	$6 \times 2 = 12$	$7 \times 2 = 14$	$8 \times 2 = 16$
$5 \times 3 = 15$	$6 \times 3 = 18$	$7 \times 3 = 21$	$8 \times 3 = 24$
$5 \times 4 = 20$	$6 \times 4 = 24$	$7 \times 4 = 28$	$8 \times 4 = 32$
$5 \times 5 = 25$	$6 \times 5 = 30$	$7 \times 5 = 35$	$8 \times 5 = 40$
$5 \times 6 = 30$	$6 \times 6 = 36$	$7 \times 6 = 42$	$8 \times 6 = 48$
$5 \times 7 = 35$	$6 \times 7 = 42$	$7 \times 7 = 49$	$8 \times 7 = 56$
$5 \times 8 = 40$	$6 \times 8 = 48$	$7 \times 8 = 56$	$8 \times 8 = 64$
$5 \times 9 = 45$	$6 \times 9 = 54$	$7 \times 9 = 63$	$8 \times 9 = 72$
$5 \times 10 = 50$	$6 \times 10 = 60$	$7 \times 10 = 70$	$8 \times 10 = 80$
$5 \times 11 = 55$	$6 \times 11 = 66$	$7 \times 11 = 77$	$8 \times 11 = 88$
$5 \times 12 = 60$	$6 \times 12 = 72$	$7 \times 12 = 84$	$8 \times 12 = 96$

$9 \times 1 = 9$	$10 \times 1 = 10$	$11 \times 1 = 11$	$12 \times 1 = 12$
$9 \times 2 = 18$	$10 \times 2 = 20$	$11 \times 2 = 22$	$12 \times 2 = 24$
$9 \times 3 = 27$	$10 \times 3 = 30$	$11 \times 3 = 33$	$12 \times 3 = 36$
$9 \times 4 = 36$	$10 \times 4 = 40$	$11 \times 4 = 44$	$12 \times 4 = 48$
$9 \times 5 = 45$	$10 \times 5 = 50$	$11 \times 5 = 55$	$12 \times 5 = 60$
$9 \times 6 = 54$	$10 \times 6 = 60$	$11 \times 6 = 66$	$12 \times 6 = 72$
$9 \times 7 = 63$	$10 \times 7 = 70$	$11 \times 7 = 77$	$12 \times 7 = 84$
$9 \times 8 = 72$	$10 \times 8 = 80$	$11 \times 8 = 88$	$12 \times 8 = 96$
$9 \times 9 = 81$	$10 \times 9 = 90$	$11 \times 9 = 99$	$12 \times 9 = 108$
$9 \times 10 = 90$	$10 \times 10 = 100$	$11 \times 10 = 110$	$12 \times 10 = 120$
$9 \times 11 = 99$	$10 \times 11 = 110$	$11 \times 11 = 121$	$12 \times 11 = 132$
$9 \times 12 = 108$	$10 \times 12 = 120$	$11 \times 12 = 132$	$12 \times 12 = 144$

Rules for multiplying whole numbers:

1. When setting up the problem, place units under units, tens under tens, etc.
2. If the multiplier has only one figure, multiply each and every figure in the multiplicand by this figure, starting from the right and working in order to the left.

$$\begin{array}{r} 64 \\ \times 8 \\ \hline 612 \end{array}$$

3. When the multiplier has more than one figure, find the partial products by multiplying all the figures in the multiplicand by each figure in the multiplier, working from the right. Place the partial products under each other so that the right hand figure of each partial product is directly under its corresponding figure in the multiplier. Then add the partial products.

$$\begin{array}{r} 371 \text{ Multiplicand} \\ \times 253 \text{ Multiplier} \\ \hline 1113 \text{ Partial Product} \\ 1855 \text{ Partial Product} \\ 742 \text{ Partial Product} \\ \hline 93863 \text{ Product} \end{array}$$

Example 1: Multiply  $64 \times 8$

$$\begin{array}{r} (3) \\ 64 \text{ Multiplicand} \\ \times 8 \text{ Multiplier} \\ \hline 512 \text{ Product} \end{array}$$

- Step 1. Write the multiplicand (64).
- Step 2. Place the multiplier (8) below the multiplicand.
- Step 3. Start by multiplying the unit column of the multiplicand by the multiplier,  $8 \times 4 = 32$ . Place the 2 in the units column and the 3 over the 6 as it represents 3 tens.
- Step 4. Multiply  $8 \times 6$  (the number in the tens column) which equals 48 or 48 tens, add the 3 tens from Step 3 to the 48.  $3 + 48 = 51$ . Place the 51 in the product line. The product of  $64 \times 8 = 512$ .

Example 2: Multiply  $346 \times 72$

$$\begin{array}{r} 346 \\ \times 72 \\ \hline \end{array}$$

$$\begin{array}{r} \text{(4)} \\ \text{(3)} 1 \\ 346 \text{ Multiplicand} \\ \times 72 \text{ Multiplier} \\ \hline 692 \text{ (a) Partial Product} \\ 2422 \text{ (b) Partial Product} \\ \hline \end{array}$$

$$\begin{array}{r} 346 \\ \times 72 \\ \hline 692 \\ 2422 \\ \hline 24912 \end{array}$$

*Step 1.* Write the multiplicand (346).

*Step 2.* Place the multiplier below the multiplicand lining up the units with the units column, the tens with the tens column, etc.

*Step 3.* Always start at the right of a multiplication problem by multiplying the multiplicand by the units number of the multiplier,  $2 \times 6 = 12$ .

Place the 2 in the units column of the partial product (a). The 1 represents 1 ten and is carried over to the tens column.

*Step 4.* Multiply the 4 in the tens column by the 2 in the multiplier.  $2 \times 4 = 8$  tens. Add the 1 carried over from the units column,  $8 + 1 = 9$ .

Place the 9 in the tens column of the partial product and cross out the 1 carried over.

*Step 5.* Multiply the 3 in the hundreds column by the 2 in the multiplier.  $2 \times 3 = 6$ .

Place the 6 in the hundreds column of the partial product.

*Step 6.* Multiply the units number in the multiplicand by the tens number (7) in the multiplier.  $7 \times 6 = 42$ .

Place the 2 in a second line below the 9 in the tens column of the partial product (b). The 4 represents 4 tens and is carried over to the tens column.

*Step 7.* Multiply the tens number (4) in the multiplicand by the tens multiplier (7).  $7 \times 4 = 28$ . Add the 4 tens from step 6.  $28 + 4 = 32$ .

Place the 2 under the 6 in the partial product (b). 3 tens remain and are carried over to the hundreds column.

*Step 8.* Multiply the hundreds number (3) by the multiplier (7).  $7 \times 3 = 21$ . Add the 3 tens from step 7.  $21 + 3 = 24$ .

Place the 24 next to the 22 in the partial product (b). Add the two partial products. The product of  $72 \times 346 = 24,912$ .

Example 3: Multiply  $732 \times 208$

$$\begin{array}{r} 732 \\ 208 \\ \hline 5856 \text{ (a)} \\ 14640 \text{ (b)} \\ \hline 152256 \end{array}$$

Step 1. Set the problem up as shown.

Step 2. Start by multiplying the multiplicand by the 8 in the units column of the multiplier. The result is the partial product (a).

Step 3. Zero has no value, therefore  $0 \times 2 = 0$ ,  $0 \times 3 = 0$ ,  $0 \times 7 = 0$ . Since the multiplier of the tens column is an 0, place an 0 in the partial product (b).

Step 4. Proceed to multiply by the number in the hundreds column (2) placing the partial product (b) next to the 0 and under the 8. Notice that when there is a zero in the multiplier, you multiply by only those numbers which have value and see that the right hand figure of each partial product is placed under the figure used to find it.

Step 5. Add the partial products (a) + (b). The product of  $208 \times 732$  is 152,256.

Example 4: Multiply  $346 \times 300$

$$\begin{array}{r} 346 \\ \times 300 \\ \hline 103800 \end{array}$$

Step 1. Write the multiplicand 346.

Step 2. Write the multiplier (300) under the multiplicand, with the zeros on the right side of the tens column of the multiplicand.

Step 3. Bring the zeros down into the product line.

Step 4. Multiply as before. The product of  $300 \times 346 = 103,800$ .

To multiply a number by 10, add 0.  $45 \times 10 = 450$

To multiply a number by 100, add 00.  $64 \times 100 = 6400$

To multiply a number by 1000, add 000.  $92 \times 1000 = 92000$

Solve the Following Multiplication Problems:

1.  $\begin{array}{r} 23 \\ \times 8 \\ \hline \end{array}$

2.  $\begin{array}{r} 321 \\ \times 7 \\ \hline \end{array}$

3.  $\begin{array}{r} 38 \\ \times 12 \\ \hline \end{array}$

4.  $\begin{array}{r} 82 \\ \times 65 \\ \hline \end{array}$

5.  $\begin{array}{r} 51 \\ \times 94 \\ \hline \end{array}$

6.  $\begin{array}{r} 312 \\ \times 88 \\ \hline \end{array}$

7.  $\begin{array}{r} 515 \\ \times 25 \\ \hline \end{array}$

8.  $\begin{array}{r} 11 \\ \times 11 \\ \hline \end{array}$

9.  $\begin{array}{r} 1760 \\ \times 36 \\ \hline \end{array}$

10.  $\begin{array}{r} 5280 \\ \times 1760 \\ \hline \end{array}$

11. If a carpenter can average driving 312 nails an hour, how many nails can he drive in 32 hours?

12. It takes  $527-2 \times 4$  studs to frame a certain type house. How many studs will it take to frame a tract containing 1220 houses?
13. If a carpenter can put on 33 sq. ft. of siding an hour, how many square feet can he put on in an 8-hour day by 7 men?
14. It takes  $47-1\frac{1}{4}$ " screws for one display fixture. How many screws will it take for 52 fixtures.
15.  $538 \times 1007 =$
16.  $200 \times 4890 =$

### Division of Whole Numbers

Division is the short process of repeatedly subtracting the same number from a given number until there is nothing left or the number left is less than the divisor. Division is the reverse of multiplication.

$$\begin{array}{r} \text{Quotient} \\ \text{Divisor } \overline{) \text{ Division}} \end{array}$$

The number to be divided is called the *dividend*.

The number to divide by is called the *divisor*.

The answer is called the *quotient*.

The part of the dividend left over when the quotient is not exact is called the *remainder*.

The sign  $\div$  means division.  $10 \div 5 = 2$ . Or  $\frac{10}{5} = 2$ .

The line between also means division.

Example 1:  $854 \div 7$  ( $854 \div 7 = ?$ )

$$(a) \quad 7 \overline{) 854}$$

$$(b) \quad \begin{array}{r} 1 \\ 7 \overline{) 854} \\ \underline{7} \phantom{00} \\ 1 \phantom{00} \end{array}$$

$$(c) \quad \begin{array}{r} 1 \\ 7 \overline{) 854} \\ \underline{7} \phantom{00} \\ 15 \phantom{00} \end{array}$$

$$(d) \quad \begin{array}{r} 12 \\ 7 \overline{) 854} \\ \underline{7} \phantom{00} \\ 15 \phantom{00} \end{array}$$

Step 1. (a) Place the dividend (854) under the frame and the divisor (7) to the left of the frame.

Step 2. (b) Always start at the left of the dividend. By inspecting the problem, we find that 8 is the smallest number to the left of the dividend divisible by 7. 7 times what number is equal to or nearly equal to 8?  $1 \times 7 = 7$ . Place the 1 in the quotient above the 8 and the 7 below the 8. ( $1 \times 7 = 7$ ). Subtract the 7 from the 8.  $8 - 7 = 1$ .

Step 3. (c) Bring the next unused number in the dividend (5) down alongside the 1 as indicated, making the number 15.

Step 4. (d) Divide into 15. 7 times what number is equal to or nearly equal to 15?  $2 \times 7 = 14$ .

Place the 2 in the quotient.

$$\begin{array}{r} 12 \\ (e) \ 7 \overline{) 854} \\ \underline{7} \phantom{00} \\ 15 \phantom{0} \\ \underline{14} \phantom{0} \\ 1 \phantom{0} \end{array}$$

Step 5. (e) Multiply the 2 in the quotient by the 7 in the divisor.  $2 \times 7 = 14$ .

Place the 14 under the 15 and subtract.

$$\begin{array}{r} 12 \\ (f) \ 7 \overline{) 854} \\ \underline{7} \phantom{00} \\ 15 \phantom{0} \\ \underline{14} \phantom{0} \\ 14 \phantom{0} \end{array}$$

Step 6. (f) Bring down the remaining unused number (4) and place beside the one, making the number 14.

Step 7. Divide the 14 by the divisor (7). 7 times what number is equal to or nearly equal to 14?  $2 \times 7 = 14$ .

Place the 2 in the quotient.

$$\begin{array}{r} 122 \\ 7 \overline{) 854} \\ \underline{7} \phantom{00} \\ 15 \phantom{0} \\ \underline{14} \phantom{0} \\ 14 \phantom{0} \\ \underline{14} \phantom{0} \\ 0 \end{array}$$

Step 8. Multiply the 2 in the quotient by the 7 in the divisor.  $2 \times 7 = 14$ .

Place under the 14 and subtract.  $14 - 14 = 0$ .

$$854 \div 7 = 122.$$

$$\begin{array}{r} 122 \\ \times 7 \\ \hline 854 \end{array}$$

To check for accuracy, multiply the quotient by the divisor and if the product is the same as the dividend your division is correct.

Example 2: Divide 2178 by 17

$$\begin{array}{r} 1 \\ 17 \overline{) 2178} \\ \underline{17} \phantom{00} \\ 4 \phantom{00} \end{array}$$

Step 1. Write the dividend and the divisor as indicated.

Step 2. Examine the dividend. What is the smallest number that 17 can be divided into (working from the left)? 17 times what number is equal or nearly equal to 21?  $1 \times 17 = 17$ .

Place the 1 in the quotient line above the 1 of the dividend.

$$\begin{array}{r} 12 \\ 17 \overline{) 2178} \\ \underline{17} \\ 47 \\ \underline{34} \\ 13 \end{array}$$

*Step 3.* Multiply the divisor (17) by the 1 in the quotient ( $1 \times 17 = 17$ ), place the 17 under the 21 of the dividend and subtract.  $21 - 17 = 4$ .

*Step 4.* Bring down the next unused number of the dividend and place it by the 4, making the number 47.

*Step 5.* Divide the 47 by the divisor (17). 17 times what number is equal or nearly equal to 47?  $2 \times 17 = 34$ . Place the 2 in the quotient line and over the 7 in the dividend.

$$\begin{array}{r} 12 \\ 17 \overline{) 2178} \\ \underline{17} \\ 47 \\ \underline{34} \\ 138 \end{array}$$

*Step 6.* Multiply the 2 in the quotient by 17 in the divisor ( $2 \times 17 = 34$ ), place the answer beneath the 47 and subtract.

*Step 7.* Bring down the next unused number of the dividend and place it by the 13, making the number 138.

$$\begin{array}{r} 128 \\ 17 \overline{) 2178} \\ \underline{17} \\ 47 \\ \underline{34} \\ 138 \\ \underline{136} \\ 2R \end{array}$$

*Step 8.* Divide 138 by the divisor (17). 17 will go into 138 about 8 times. Place the 8 over the 8 in the dividend and multiply by the divisor (17).  $8 \times 17 = 136$ . Place the 136 under the 138 and subtract. When the division is not exact, the number left over is called the remainder. We have a remainder of 2.

$$2178 \div 17 = 128 R2$$

$$\begin{array}{r} 128 \\ \times 17 \\ \hline \end{array}$$

To check your work, multiply the quotient by the divisor and add the remainder.

$$\begin{array}{r} 896 \\ 128 \\ \hline 2176 \\ + 2R \\ \hline 2178 \end{array}$$

Solve the Following Division Problems:

1.  $84 \div 7 =$

2.  $96 \div 6 =$

3.  $108 \div 9 =$

4.  $169 \div 13 =$

5.  $121 \div 11 =$

6.  $132 \div 12 =$

# MATHEMATICS

## Whole Numbers

- |                               |                                |                             |
|-------------------------------|--------------------------------|-----------------------------|
| 7. $54 \overline{) 11826}$    | 8. $299 \overline{) 295711}$   | 9. $407 \overline{) 80993}$ |
| 10. $1760 \overline{) 5280}$  | 11. $4532 \overline{) 819034}$ | 12. $66 \overline{) 28248}$ |
| 13. $219 \overline{) 45333}$  | 14. $12 \overline{) 168}$      | 15. $8 \overline{) 9204}$   |
| 16. $318 \overline{) 156134}$ | 17. $357 \overline{) 2437681}$ |                             |

18. How long will it take to pour 368 yards of concrete at the rate of 43 yards per hour?
19. How many sheets of plywood will it take to cover 1728 sq. ft. if each sheet covers 32 sq. ft?
20. Seventy-five lbs. of 16d box nails contains 5325 nails. How many nails are in 1 lb?
21. How many 24 in. stakes can be cut from three 216 in. boards?
22. Five men can set 1525 sq. ft. of straight-run wall forms a day. How much can two men set?

Solve the Following Review Problems:

- |                                      |                                |
|--------------------------------------|--------------------------------|
| 1. $484 + 937 + 526 + 20001 =$       | 2. $7834 + 2106 + 429 + 906 =$ |
| 3. $5009 + 397 + 648 + 68921 + 72 =$ | 4. $732 - 584 =$               |
| 5. $5006 - 3217 =$                   | 6. $2493 - 1584 =$             |
| 7. $47 \times 316 =$                 | 8. $526 \times 438 =$          |
| 9. $9879 \times 8432 =$              |                                |
10. A pile of lumber contains 205 boards 10 ft. long, 83 boards 12 ft. long, 172 boards 8 ft. long, and 16 boards 16 ft. long.
    - a. How many boards are in the pile?
    - b. How many linear feet of lumber are in the pile?
  11. From a board 96 in. long, 3 pieces are to be cut 24 in., 28 in., and 36 in. in length. How long is the piece that remains?
  12. It takes 560 pieces of floor tile to cover a floor with an area of 35 sq. yds. How many pieces will it take to cover one yard?
  13. One thousand and ninety-two sheets of sheet rock are used in an office building. If it takes an average of 52 sheets per office, how many offices are there in the building?
  14. A carpenter makes \$310 for a 40-hour week. What is his hourly wage rate? What are his wages for a week if he is rained out 2 days.

# FRACTIONS

## Definition of Fractions

A *fraction* is a part of a whole number. The fraction is composed of two numbers. An example is the fraction one-half, which is written  $\frac{1}{2}$  *Numerator* *Denominator*.

The top number is called the *numerator* and the bottom number is called the *denominator*.

The denominator indicates the number of equal parts into which the whole figure or quantity is to be divided. For example, the fraction  $\frac{1}{2}$ , 2 is the denominator and means that the whole figure or quantity is to be divided into 2 equal parts.

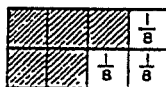
The numerator indicates the number of equal parts (divisor) of the total amount of the whole figure or quantity needed for the specific problem. For example in the fraction  $\frac{3}{4}$ , the divisor is 4 and indicates that the whole figure is to be divided into 4 equal parts. The numerator is 3 and indicates that 3 of these equal parts are needed to show the amount meant by the fraction  $\frac{3}{4}$ . (See Figure 1 below.)

A *proper* fraction is a fraction with the numerator smaller than the denominator, example  $\frac{3}{4}$ . An *improper* fraction is a fraction with the numerator equal to or larger than the denominator, example  $\frac{5}{4}$ .



The shaded area =  $\frac{3}{4}$

When working with fractions, we find the four basic operations of arithmetic involved (addition, subtraction, multiplication and division). There are, however, certain steps that must be followed when dealing with proper and improper fractions as well as mixed numbers.



The shaded area =  $\frac{5}{8}$

Fig. 1

## Reducing Fractions

Measurements involving fractions usually are easier when the fraction is given in its lowest terms. The value of a fraction is not changed when the numerator and denominator are both multiplied by the same number: Example:  $\frac{1}{2} = \frac{2}{4} = \frac{4}{8}$ , etc.

The number which can be divided evenly into both the numerator and denominator is called a *common factor*.

## Proper Fractions

To reduce a proper fraction, find a number that can be divided evenly into both the numerator and denominator.

Example: Reduce  $\frac{4}{8}$  to its lowest term.

$$\frac{4}{8} = \frac{4}{8} \div \frac{4}{4} = \frac{1}{2}$$

What number can be divided into both 4 and 8? 4 can be divided into both 4 and 8. When the numerator is one (1), the fraction cannot be reduced further. However, the numerator may be greater than 1 when there is no factor common to the numerator and denominator.

Example: Reduce  $2\frac{4}{32}$  to its lowest terms.

$$8 \mid 2\frac{4}{32} = \frac{3}{4}$$

An alternate method is to set up the reduction as shown and place the divisor (8) to the left of the vertical line. Divide both the numerator and denominator by the common factor.

The fraction  $\frac{3}{4}$  is a proper fraction reduced to its lowest terms.

Time can be saved in reducing fractions when the largest apparent common factor is used.

### Improper Fractions

To reduce an improper fraction to its lowest terms, divide the numerator by the denominator first. The result will be a whole number and a fraction.

Example: Reduce  $20/8$  to its lowest term.

$$\begin{array}{r} 2 \\ 8 \overline{) 20} \\ \underline{16} \\ 4 \\ \underline{4} \\ 0 \end{array}$$

Step 1. Divide the numerator (20) by the denominator (8). The quotient is a whole number (2) with a remainder of 4. The remainder is placed over the divisor (denominator) and the result is the proper fraction  $\frac{4}{8}$ .

$4 \mid \frac{4}{8} = \frac{1}{2}$  Step 2. Reduce  $\frac{4}{8}$  to its lowest term.

Step 3. Combine the whole number with the reduced fraction to obtain the answer.

$$2 + \frac{1}{2} = 2\frac{1}{2} \quad 20/8 = 2\frac{1}{2}$$

### Problems:

- |            |            |            |            |             |              |
|------------|------------|------------|------------|-------------|--------------|
| 1. $6/8$   | 2. $4/6$   | 3. $12/16$ | 4. $20/32$ | 5. $16/64$  | 6. $18/4$    |
| 7. $40/32$ | 8. $33/16$ | 9. $42/32$ | 10. $7/8$  | 11. $96/12$ | 12. $32/128$ |

### Addition of Fractions

Problems encountered on the job call for the adding of dimensions which may include whole numbers, fractions, and the combination of whole numbers and fractions. The combination of a whole number and a fraction is called a mixed number.

In order to add these various numbers, the denominator of each fraction must be the same number. The smallest number that can be divided by each of the denominators is called the *lowest common denominator*.

Finding the lowest common denominator (LCD) can often be done by inspection. For example, the lowest common denominator of  $\frac{1}{2}$ ,  $\frac{1}{4}$  and  $\frac{1}{8}$  would be 8, as 8 can be divided by 2, 4, and 8. The LCD may be found mathematically when it is difficult to determine it by inspection.

Example: Find the LCD of  $\frac{3}{4}$ ,  $\frac{5}{8}$ ,  $1\frac{1}{32}$ , and  $\frac{7}{12}$ .

4, 8, 32, 12

$$\begin{array}{r} 2 \overline{) 4 \ 8 \ 32 \ 12} \\ \underline{2 \ 4 \ 16 \ 6} \end{array}$$

$$\begin{array}{r} 2 \overline{) 2 \ 4 \ 16 \ 6} \\ \underline{1 \ 2 \ 8 \ 3} \end{array}$$

$$\begin{array}{r} 2 \overline{) 1 \ 2 \ 8 \ 3} \\ \underline{1 \ 1 \ 4 \ 3} \end{array}$$

$$2 \times 2 \times 2 \times 1 \times 1 \times 4 \times 3 = 96$$

Step 1. Place the denominator in a line.

Step 2. Find the smallest number which can be divided into 2 or more of the denominators. 2 can be divided into each denominator.

Divide as many of the denominators by 2 as possible.

Step 3. Repeat Step 2. Again 2 can be divided into 2 or more of the numbers.

Step 4. Repeat again. 2 can be divided into 2 or more of the numbers. When the number cannot be divided by the divisor, bring that number down as indicated.

Step 5. Now there is no divisor other than 1 that can be used that will divide 2 or more of the remaining numbers.

Multiply the divisors used by the remaining numbers.

96 is the LCD of  $\frac{3}{4}$ ,  $\frac{5}{8}$ ,  $1\frac{1}{32}$ , and  $\frac{7}{12}$ .

Rule for reducing fractions to the lowest common denominator:

1. Divide the number selected as the LCD by the denominator of each fraction.
2. Multiply both the numerator and the denominator by the quotient.

Example: The LCD of  $\frac{3}{4}$ ,  $\frac{5}{8}$ ,  $1\frac{1}{32}$ , and  $\frac{7}{12}$  is 96.

$$96 \div 4 = 24$$

Step 1. Divide the LCD by the denominator of the first fraction ( $\frac{3}{4}$ ).

$$\frac{3 \times 24}{4 \times 24} = \frac{72}{96}$$

Step 2. Multiply both the numerator and the denominator of the fraction by 24.

Step 3. Repeat Steps 1 and 2 for remaining fractions.

$$\frac{5}{8}; 96 \div 8 = 12$$

$$1\frac{1}{32}; 96 \div 32 = 3$$

$$\frac{7}{12}; 96 \div 12 = 8$$

$$\frac{5 \times 12}{8 \times 12} = \frac{60}{96}$$

$$\frac{11 \times 3}{32 \times 3} = \frac{33}{96}$$

$$\frac{7 \times 8}{12 \times 8} = \frac{56}{96}$$

Rule for adding fractions:

1. Reduce the given fraction to fractions having the lowest common denominator.
2. Add the numerators and place this sum over the LCD.
3. Reduce the result to the lowest term.

$$\frac{1}{4} = \frac{2}{8} \quad \text{Example: Add } \frac{1}{4}, \frac{1}{2}, \frac{3}{8}.$$

$$\frac{1}{2} = \frac{4}{8} \quad \text{Step 1. Place the fractions in a vertical column.}$$

$$\frac{3}{8} = \frac{3}{8} \quad \text{Step 2. Reduce the fraction to the LCD. Inspection shows that 8 is the LCD.}$$

$$2 + 4 + 3 = 9$$

$\frac{9}{8}$

$$\frac{9}{8} = 1\frac{1}{8}$$

Step 3. Add the numerators.

Step 4. Place the sum over the LCD.

Step 5. Reduce to the lowest terms.

Rule for adding whole numbers, common fractions, and mixed numbers:

1. Add the whole numbers.
2. Add the fractions and reduce to lowest terms.
3. Add the two sums and reduce to lowest terms.

Example: Add 5,  $\frac{7}{8}$ , and  $1\frac{1}{4}$ .

$$\begin{array}{r} 5 \\ 1\frac{7}{8} \\ 1\frac{1}{4} \\ \hline 5 \\ 1\frac{7}{8} \\ 1\frac{2}{8} \\ \hline 6\frac{9}{8} = 7\frac{1}{8} \end{array}$$

(b)  $6\frac{9}{8} = 7\frac{1}{8}$  (a)

$$\begin{array}{r} 6 \\ 1\frac{1}{8} \\ 7\frac{1}{8} \\ \hline 7\frac{2}{8} = 7\frac{1}{4} \end{array}$$

(c)  $7\frac{1}{4}$

Step 1. Write all numbers in a vertical column.

Step 2. Reduce fractions to LCD. LCD = 8.

Step 3. Add the numerators of the fractions and place over the LCD.

Step 4. Reduce the improper fraction to the lowest terms. (a)

Step 5. Add whole numbers. (b)

Step 6. Add results of Step 4 and Step 5. (c)

Problems:

Solve the following problems and reduce all answers to their lowest terms:

1.  $\frac{1}{4} + \frac{3}{4} =$
2.  $\frac{1}{2} + \frac{3}{8} =$
3.  $\frac{3}{4} + \frac{7}{32} =$
4.  $\frac{5}{8} + 1\frac{5}{16} + 2\frac{7}{32} =$
5.  $1\frac{1}{2} + 2\frac{1}{4} =$
6.  $3\frac{1}{8} + 2\frac{5}{16} + 4\frac{1}{4} =$
7.  $6\frac{5}{32} + 1\frac{7}{8} + 1\frac{5}{16} =$
8.  $2\frac{3}{8} + \frac{5}{64} + 3\frac{5}{16} + 1\frac{1}{2} =$

### Subtraction of Fractions

Often a situation arises on the job where the entire dimension is known and a part of another dimension is also known. In order to find a missing dimension, it is necessary to be able to subtract common fractions, mixed numbers, and whole numbers.

Rule for subtracting common fractions:

1. Reduce all fractions to their lowest common denominator.
2. Subtract the numerators and place the result over the LCD.
3. Reduce the result to the lowest terms.

Example: Subtract  $\frac{1}{8}$  from  $\frac{5}{16}$ .

$$\frac{1}{8} = \frac{2}{16}$$

Step 1. Reduce the fractions to LCD. 16 is LCD.

$$\frac{5}{16} - \frac{2}{16}$$

Step 2. Set up problem using reduced fraction with LCD.

$$5 - 2 = 3$$

Step 3. Subtract the numerators.

$$\frac{3}{16}$$

Step 4. Place result over LCD.

$$\frac{5}{16} - \frac{1}{8} = \frac{3}{16}$$

Step 5. Reduce the fraction to lowest term. In this example, the result is in its lowest term.

Rule for subtracting a fraction from a whole number:

1. Subtract 1 from the whole number and change the 1 to a fraction with the same denominator as the fraction which is to be subtracted.
2. Subtract the numerator of the original fraction from the fraction obtained by #1 and place over denominator.
3. Reduce the result to its lowest term.
4. Place the whole number next to the fraction.

$$\begin{array}{r} 3 \\ - \frac{1}{4} \\ \hline \end{array}$$

Example: Subtract  $\frac{1}{4}$  from 3.

$$\begin{array}{r} 2 \\ 3 \frac{1}{4} \\ - \frac{1}{4} \\ \hline \end{array}$$

Step 1. Place the smaller number (the common fraction  $\frac{1}{4}$ ) under the larger number (the whole number 3).

$$\begin{array}{r} 2 \\ 3 \frac{1}{4} \\ - \frac{1}{4} \\ \hline 3 \frac{3}{4} \end{array}$$

Step 2. Subtract 1 from the whole number 3 and change the 1 to a fraction with the same denominator as the fraction to be subtracted.

$$\begin{array}{r} 2 \\ 3 \frac{1}{4} \\ - \frac{1}{4} \\ \hline 2 \frac{3}{4} \end{array}$$

Step 3. Subtract the numerators, ( $4 - 1 = 3$ ) and place the result over the denominator.

Step 4. Place the whole number remaining (2) next to the fraction  $3 - \frac{1}{4} = 2\frac{3}{4}$ .

Rule for subtracting a mixed number from a whole number:

1. Subtract 1 from the whole number and change the 1 to a fraction with the same denominator as the fraction in the mixed number.
2. Subtract the fraction part of the mixed number from the fraction obtained in #1.
3. Subtract the whole numbers.
4. Combine the results of Steps 2 and 3.

Example: Subtract  $1\frac{1}{2}$  from 4.

$$\begin{array}{r} 4 \\ - 1 \frac{5}{8} \\ \hline \end{array}$$

Step 1. Place the smaller number (the mixed number  $1\frac{5}{8}$ ) under the larger number (4).

$$\begin{array}{r} 3 \\ \cancel{4} \frac{8}{8} \\ - 1 \frac{5}{8} \\ \hline \end{array}$$

Step 2. Subtract 1 from the whole number 4 and change the 1 to a fraction with the same denominator as the fraction to be subtracted.

$$\begin{array}{r} 3 \\ \cancel{4} \frac{8}{8} \\ - 1 \frac{5}{8} \\ \hline 3 \frac{3}{8} \end{array}$$

Step 3. Subtract the numerators ( $8 - 5 = 3$ ) and place the result over the denominator.

Step 4. Subtract the whole numbers ( $3 - 1 = 2$ ) and place the result by the fraction.

$$\begin{array}{r} 3 \\ \cancel{4} \frac{8}{8} \\ - 1 \frac{5}{8} \\ \hline 2 \frac{3}{8} \end{array}$$

$$4 - 1\frac{5}{8} = 2\frac{3}{8}$$

Rules for subtracting mixed numbers:

1. Change the fractions of the mixed numbers to fractions with the lowest common denominator.
2. When the subtrahend is larger than the minuend, borrow 1 from the whole number in the minuend and make an improper fraction.
3. Subtract the fractions.
4. Subtract the whole numbers.
5. Combine the whole number and the fraction.

$$\begin{array}{r} 9 \frac{1}{4} \\ 5 \frac{3}{8} \\ \hline \end{array}$$

Example: Subtract  $5\frac{3}{8}$  from  $9\frac{1}{4}$ .

$$\begin{array}{r} 9 \frac{2}{8} \\ 5 \frac{3}{8} \\ \hline \end{array}$$

Step 1. Place the subtrahend under the minuend.

$$\begin{array}{r} 8 \\ \cancel{9} \frac{10}{8} \\ 5 \frac{3}{8} \\ \hline \end{array}$$

Step 2. Change fractions to LCD. (8 is LCD).

Step 3. Subtract 1 from the 9 in the minuend and add to the fraction. ( $\frac{8}{8} + \frac{2}{8} = \frac{10}{8}$ ).

Step 4. Subtract the fraction. (a)

$$\begin{array}{r} 8 \frac{10}{8} \\ 5 \frac{3}{8} \\ \hline 3 \frac{7}{8} \end{array}$$

Step 5. Subtract the whole numbers. (b)

(b) (a)

$$\text{Answer: } 9\frac{1}{4} - 5\frac{3}{8} = 3\frac{7}{8}$$

Problems:

Solve the following problems and reduce all answers to the lowest terms:

1.  $\frac{7}{8} - \frac{1}{2} =$

5.  $2\frac{5}{32} - \frac{1}{2} =$

9.  $17\frac{1}{2} - 10\frac{3}{16} =$

2.  $1\frac{5}{10} - \frac{3}{10} =$

6.  $4\frac{9}{16} - 2\frac{1}{4} =$

10.  $12\frac{3}{8} - 8\frac{5}{10} =$

3.  $\frac{5}{8} - \frac{3}{16} =$

7.  $23\frac{1}{32} - 3\frac{15}{16} =$

11.  $3\frac{7}{10} - 2\frac{17}{32} =$

4.  $1\frac{3}{16} - \frac{1}{2} =$

8.  $6 - \frac{5}{32} =$

12.  $16 - 1\frac{1}{2} =$

13. A wall is 96 in. high, including the bottom, top and double plate. How long are the studs cut if the plates are each  $1\frac{1}{2}$  in. thick?
14. A board is  $84\frac{1}{2}$  in. long. Two pieces,  $42\frac{5}{8}$  in. and  $12\frac{7}{16}$  in., are cut from the board. How long is the remaining piece of stock?
15. What is the final width of an  $11\frac{1}{4}$  in. board if  $\frac{3}{16}$  of an inch is planed off both sides?

**RULE FOR CHANGING A MIXED NUMBER TO AN IMPROPER FRACTION**

1. Multiply the whole number by the denominator of the fraction.
2. Place the result over the denominator of the fraction.
3. Add the two fractions.

Example: Change  $2\frac{3}{4}$  to an improper fraction

$$2 \times 4 = 8$$

Step 1. Multiply the whole number (2) by the denominator (4) of the fraction.

$$\frac{8}{4}$$

Step 2. Place the result of Step 1 over the denominator.

$$\frac{8}{4} + \frac{3}{4} = 11\frac{1}{4}$$

Step 3. Combine the two fractions.

**Problems:**

Change the following mixed numbers to improper fractions.

1.  $2\frac{1}{8} =$

3.  $5\frac{5}{16} =$

5.  $1\frac{35}{64} =$

2.  $3\frac{1}{2} =$

4.  $4\frac{3}{32} =$

6.  $6\frac{1}{4} =$

**Multiplication of Fractions**

Rule for multiplying two or more fractions

1. Multiply the numerators.
2. Multiply the denominators.
3. Write product of numerator over the product of the denominator.
4. Reduce the fraction to lowest term.

Example: Multiply  $\frac{5}{16} \times \frac{2}{3}$

$$5 \times 2 = 10$$

Step 1. Multiply the numerators

$$16 \times 3 = 48$$

Step 2. Multiply the denominators.

$$\frac{10}{48}$$

Step 3. Place the product of the numerators over the product of the denominators.

$$\frac{10}{48} = \frac{5}{24}$$

Step 4. Reduce to lowest terms.

Rule for multiplying a mixed number by a fraction—

1. Change the mixed number to an improper fraction.
2. Multiply the numerators.
3. Multiply the denominators.
4. Place the product of the numerators over the product of the denominators.
5. Reduce to lowest terms.

Example: Multiply  $2\frac{1}{8}$  by  $\frac{1}{2}$ .

$$2\frac{1}{8} = \frac{17}{8}$$

Step 1. Change the mixed number to an improper fraction.

$$\frac{17}{8} \times \frac{1}{2}$$

$$17 \times 1 = 17$$

Step 2. Multiply the numerators.

$$8 \times 2 = 16$$

Step 3. Multiply the denominators.

$$\frac{17}{16}$$

Step 4. Place the product of the numerators over the product of the denominators.

$$1\frac{1}{16} = 1\frac{1}{16}$$

Step 5. Reduce to lowest terms.

### Cancellation Method in Multiplying Fractions

Earlier, it was indicated that the value of a fraction was not changed when the numerator and denominator were both multiplied or divided by the same number. The process of dividing both the numerator and denominator by the same divisor is called cancellation.

Rule for cancellation process in multiplying improper fractions—

1. Change all mixed numbers into improper fractions.
2. Place all numerators above the line and all denominators below the line.
3. Select a divisor common to both numerator and denominator and divide.
4. After there is no common divisor, proceed to multiply the remaining fraction.
5. Reduce to lowest terms if possible.

Example: Multiply  $16 \times 3\frac{1}{2} \times 4\frac{1}{4}$ .

$$3\frac{1}{2} = \frac{7}{2}$$

Step 1. Change the mixed numbers into improper fractions.

$$4\frac{1}{4} = \frac{17}{4}$$

$$\frac{16 \times 7 \times 17}{1 \times 2 \times 4}$$

Step 2. Place all numerators above the line and all denominators below the line.

$$\frac{2}{4}$$

Step 3. Select a divisor. 4 is common to both 16 and 4. Divide.

$$\frac{16 \times 7 \times 17}{1 \times 2 \times 4}$$

Step 4. 2 is common to 4 and 2. Divide.

$$\frac{2 \times 7 \times 17}{1 \times 1 \times 1} = \frac{238}{1} = 238$$

Step 5. Multiply the numerators and denominators.

Problems:

1.  $\frac{3}{4} \times \frac{1}{2} =$
2.  $\frac{1}{4} \times \frac{1}{8} =$
3.  $\frac{5}{8} \times \frac{4}{7} =$
4.  $\frac{5}{8} \times \frac{4}{7} =$
5.  $\frac{5}{16} \times 1\frac{1}{4} =$
6.  $6 \times 3\frac{1}{2} =$
7.  $12\frac{5}{8} \times 9\frac{3}{4} =$
8.  $14\frac{3}{4} \times 1\frac{1}{16} \times 32 =$
9.  $5\frac{7}{8} \times 1\frac{5}{16} \times 3\frac{1}{2} =$
10.  $2\frac{1}{4} \times 3\frac{5}{8} \times 3\frac{1}{16} =$
11.  $3\frac{5}{8} \times 3\frac{5}{8} \times 8 =$
12.  $11\frac{1}{4} \times 2\frac{1}{2} \times 7 =$
13. A board is to be ripped into five  $1\frac{3}{4}$  in. strips. Allow  $\frac{5}{8}$  in. for saw cuts. How wide a board should be used?
14. 116 Sheets of  $\frac{5}{8}$  in. plywood are to be stacked one atop the other. How high will the stack be?
15. If it takes  $\frac{7}{8}$  yards of concrete to pour a column, how much concrete will it take to pour 32 columns?

Division of Fractions

Rule for dividing fractions:

1. Invert the divisor. This means to interchange the numerator and the denominator.
2. Multiply the resulting fractions.
3. Reduce to lowest terms if possible.

Example: Divide  $\frac{1}{2}$  by  $\frac{1}{4}$ .

$$\frac{1}{2} \div \frac{1}{4} \quad \text{Step 1. Invert the divisor } (\frac{1}{4}). \quad (\frac{1}{4}) \text{ becomes } \frac{4}{1}.$$

$$\frac{1}{2} \times \frac{4}{1} = \frac{4}{2} = 2 \quad \text{Step 2. Multiply the resulting fractions. (Use cancellation.)}$$

Example: Divide  $13\frac{1}{8}$  by  $\frac{5}{8}$ .

$$13\frac{1}{8} \div \frac{5}{8} \quad \text{Step 1. Invert the divisor } \frac{5}{8}. \quad \frac{5}{8} \text{ becomes } \frac{8}{5}.$$

$$13\frac{1}{8} \times \frac{8}{5} = \frac{13}{1} \times \frac{8}{5} = \frac{104}{5} \quad \text{Step 2. Multiply the resulting fractions.}$$

$$13\frac{1}{8} \div \frac{5}{8} = 13\frac{1}{10} \quad \text{Step 3. Reduce to lowest terms.}$$

Rule for dividing mixed numbers:

1. Change the mixed numbers to improper fractions.
2. Invert the divisor.
3. Multiply the resulting fractions.

4. Reduce to lowest terms.

Example: Divide  $8\frac{5}{8}$  by  $2\frac{1}{4}$ .

$$8\frac{5}{8} = 29\frac{5}{8}$$

Step 1. Change the mixed numbers to improper fractions.

$$2\frac{1}{4} = \frac{9}{4}$$

$$29\frac{5}{8} \div \frac{9}{4} =$$

Step 2. Invert the divisor  $\frac{9}{4}$ .  $\frac{9}{4}$  becomes  $\frac{4}{9}$ .

$$\frac{29}{8} \times \frac{4}{9} = \frac{29}{18}$$

Step 3. Multiply the resulting fractions.

$$29\frac{5}{18} = 11\frac{11}{18}$$

Step 4. Reduce to lowest terms.

Problems:

1.  $\frac{1}{2} \div \frac{1}{4} =$
2.  $\frac{5}{8} \div \frac{1}{3} =$
3.  $15\frac{1}{32} \div \frac{9}{16} =$
4.  $\frac{2}{3} \div \frac{3}{4} =$
5.  $16 \div 15\frac{1}{8} =$
6.  $\frac{5}{6} \div \frac{3}{4} =$
7.  $11\frac{1}{4} \div 13\frac{1}{4} =$
8.  $7\frac{1}{4} \div 6 =$
9.  $2\frac{1}{8} \div \frac{3}{4} =$
10.  $\frac{7}{8} \div \frac{7}{16} =$
11. How many pieces of  $\frac{3}{4}$  in. plywood are in a stack  $92\frac{1}{4}$  in. high?
12. How many  $6\frac{3}{8}$  in. cripples can be cut from a 192 in.  $2 \times 4$ ?
13. How many shelves are in a bookcase if the shelves are spaced  $13\frac{3}{4}$  in. O. C. and the bookcase is  $82\frac{1}{2}$  in. high?
14. If a  $124\frac{7}{8}$  in. board were divided into 27 equal spaces, how long is each space?
15. A floor has 1728 sq. ft. If  $\frac{3}{4}$  of the floor is carpet and  $\frac{1}{4}$  of the floor is asphalt tile, how many square feet of carpet is required? How many square feet of floor tile is required?

Solve the Following Problems:

The following problems are a review of whole numbers and fractions.

$$\begin{array}{r} 1. \quad 475 \\ \times 27 \\ \hline \end{array}$$

$$\begin{array}{r} 2. \quad 7019 \\ \times 225 \\ \hline \end{array}$$

$$\begin{array}{r} 3. \quad 7477 \\ \times 5232 \\ \hline \end{array}$$

$$\begin{array}{r} 4. \quad 3021 \\ \times 96 \\ \hline \end{array}$$

$$\begin{array}{r} 5. \quad 10097 \\ \times 2016 \\ \hline \end{array}$$

$$6. \quad 2143 \times 114 \times 526 =$$

$$10. \quad \frac{3}{4} \times \frac{1}{2} =$$

$$7. \quad 48 \times 32 \times 96 =$$

$$11. \quad 15\frac{1}{8} \times \frac{1}{4} =$$

$$8. \quad 16 \times 2 \times 32 =$$

$$12. \quad 7\frac{1}{4} \times 15\frac{1}{8} \times 16 =$$

$$9. \quad 7\frac{1}{16} \times 8\frac{3}{8} =$$

$$13. \quad 3\frac{1}{2} \times 25\frac{1}{32} \times \frac{1}{16} =$$

# MATHEMATICS

## Fractions

14.  $9\frac{1}{4} \times 11\frac{1}{4} =$
15.  $8415 - 2379 =$
16.  $96354 - 9544 =$
17.  $10199 - 7991 =$
18.  $7870 - 1892 =$
19.  $12514 - 1907 =$
20.  $1\frac{5}{16} - \frac{1}{4} =$
21.  $2\frac{5}{32} - \frac{3}{4} =$
22.  $7\frac{1}{4} - 1\frac{1}{8} =$
23.  $32\frac{5}{8} - 121\frac{1}{2} =$
24.  $2\frac{9}{16} - 1\frac{3}{8} =$
25.  $441\frac{1}{16} - 8 =$
26.  $4050 \div 5 =$
27.  $5280 \div 1760 =$
28.  $37449 \div 513 =$
29.  $14105 \div 217 =$
30.  $38963 \div 829 =$
31.  $11850 \div 158 =$
32.  $\frac{3}{4} \div \frac{1}{2} =$
33.  $7\frac{1}{4} \div 1\frac{3}{4} =$
34.  $32 \div 11\frac{1}{8} =$
35.  $121\frac{3}{4} \div \frac{5}{8} =$
36.  $\frac{7}{16} \div \frac{7}{8} =$
37.  $24 \div 5\frac{1}{3} =$
38.  $33\frac{1}{3} \div 6\frac{1}{3} =$
39.  $7392 + 2481 =$
40.  $8685 + 7327 =$
41.  $5280 + 1760 =$
42.  $1002 + 625 + 739 + 484 =$
43.  $15184 + 42956 + 79521 =$
44.  $609 + 17 + 2002 + 39908 =$
45.  $78593 + 3302 + 210970 =$
46.  $1\frac{3}{16} + \frac{7}{8} =$
47.  $\frac{1}{4} + \frac{1}{2} + \frac{5}{8} + 1\frac{5}{16} =$
48.  $27\frac{7}{8} + 1\frac{3}{4} + 3 + \frac{7}{16} =$
49.  $1\frac{7}{34} + 1\frac{9}{8} + \frac{9}{14} + \frac{1}{2} =$
50.  $\frac{5}{64} + \frac{3}{32} + \frac{9}{16} + \frac{3}{8} + \frac{1}{4} + \frac{1}{2} =$
51. What is the finished thickness of a piece of material 2 in. thick if  $\frac{5}{32}$  in. is planed off each face?
52. How many pieces of lumber  $1\frac{1}{2}$  in. wide will be needed to cover a space 39 in. wide?
53. A piece of lumber  $2\frac{7}{8}$  in. wide is ripped from a board. How wide is the piece left if the original piece was  $11\frac{1}{4}$  in. and  $\frac{3}{32}$  in. is allowed for the saw cut?
54. There are 807 four-penny finish nails in a pound. How many are there in  $21\frac{3}{4}$  lbs.
55. A stack of lumber contains 984 two by fours. If  $\frac{1}{4}$  of the stack were used, how many 2 x 4's are used?
56. If  $\frac{2}{3}$  of the remaining stock of 2 x 4's in problem 55 are used, how many pieces remain in the stock? What is the total number of 2 x 4's used?

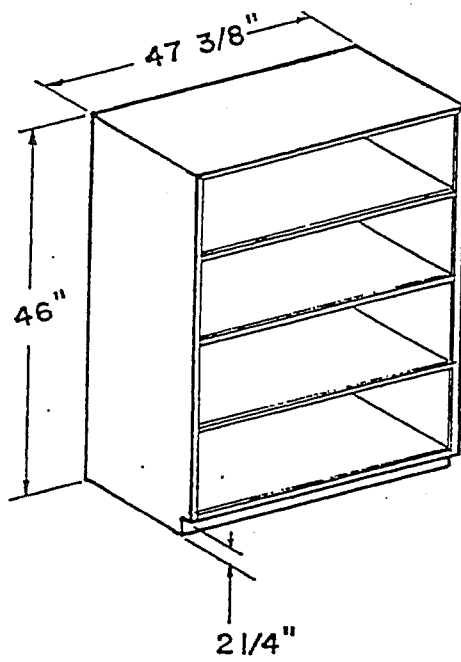


Fig. 2

57. Figure 2, is constructed of  $\frac{3}{4}$  in. plywood. If the shelves are evenly spaced, what is the distance between them?
58. What are the lengths of the shelves in Figure 2? ( $\frac{3}{8}$ " to each end of the shelves to allow for dado.)
59. How many  $14\frac{5}{16}$  in. pieces can be cut from twelve 192 in. boards?
60. If 6 equal pieces are ripped from a 1 x 12 ( $11\frac{1}{4}$  in.), how wide is each piece?

## DECIMALS

The decimal system is used in precision measurements and in our monetary system. The location of the decimal point changes the value of any number and consequently, accurate placement of the decimal point in the solution of any problem is most important.

Expanding the table on page one, we have:

Ten Millions	Millions		Hundred Thousands	Ten Thousands	Thousands		Hundreds	Tens	Units	Decimal Point	Tenths	Hundredths	Thousandths	Ten Thousandths
6	1	,	3	5	4	,	2	8	9	.	2	5	6	3

The whole numbers to the left of the decimal point are read as shown on page one. The decimal is read as follows:

.2     *Read:* Two tenths

.25    *Read:* Twenty-five hundredths

.256   *Read:* Two hundred fifty-six thousandths

.2563   *Read:* Two thousand five hundred sixty-three ten thousandths

The whole number and decimal in the above chart is read as follows:

Sixty-one million, three hundred fifty-four thousand, two hundred eighty-nine and two thousand five hundred sixty-three ten thousandths.

Fractions involving tens or multiples of tens as the denominators are classified in the decimal system. In the decimal system, the denominator is not written as such but is established by the use of the decimal point.

Examples are as follows:

$$\frac{3}{10} = .3 = \text{three tenths}$$

$$\frac{3}{100} = .03 = \text{three hundredths}$$

$$\frac{3}{1,000} = .003 = \text{three thousandths}$$

$$\frac{3}{10,000} = .0003 = \text{three ten thousandths}$$

Notice that adding zeros between the number and the decimal point changes the value of the number. Zeros added to the right of the number or to the left of the decimal point do not change the value of the number.

To change a decimal fraction to a common fraction, the figure in the decimal fraction is used as the numerator. The denominator is determined by adding as many zeros to 1 as there are figures to the right of the decimal point.

Examples:

1.  $.33 = \frac{33}{100}$  There are two figures to the right of the decimal point.

2.  $.0248 = \frac{248}{10,000}$  There are four figures to the right of the decimal point.

Problems:

Write the following as decimals or whole numbers and decimals:

1. Two hundred eighty-three and forty-five thousands.
2. One thousand eight hundred fifty-five ten thousandths.
3. Ninety-nine and forty-four one hundredths.

Write the following fractions as decimals:

4.  $\frac{75}{100} =$

5.  $\frac{42}{1000} =$

6.  $\frac{7}{10} =$

7.  $\frac{3265}{10,000} =$

Write the following decimals as fractions:

8. .25

9. .325

10. .9

11. .8653

12. .892

### Addition of Decimals

The decimal point is the only different factor to be considered in the addition of decimals when compared to the addition of whole numbers.

Rule for adding decimals:

1. Write all the given numbers in a column in such a manner that all the decimal points are under each other.
2. Add zeros to the right of the decimal point so that each number has the same number of places after the decimal point.
3. Add the column of numbers as though they were all whole numbers.
4. Place the decimal point in the answer in the column it appears with each number.

Example: Add 22.3, 37.26, 4.386, and 52.

# MATHEMATICS

## Decimals

22.3  
37.26  
4.386  
52.

*Step 1.* Write all the numbers in a vertical column with the decimal points under each other.

22.300  
37.260  
4.386  
52.000

*Step 2.* Add zeros as needed to the right of the decimal point.

*Step 3.* Add the column.

115.946

*Step 4.* Locate the decimal point in answer directly below decimal point column.

### Problems:

1. Add 3.462, 27.18, 324.2, 10.625, and 81.

4. \$ 12.65

5. \$ 148.00

2.  $.16 + 3.465 + 3.18 =$

109.83

217.41

4.15

2.88

3.  $72 + 38.4 + 6.195 + .63 =$

.22

1023.09

### Subtraction of Decimals

#### Rule for subtracting decimals:

1. Write the given numbers with the decimal points over each other.
2. Add zeros to the right of the decimal point so each number has the same number of places to the right of the decimal point.
3. Subtract as though the numbers were whole numbers.
4. Place the decimal point in the answer in the column it appears with each number.

Example: Subtract 13.25 from 21.6.

21.6  
13.25

*Step 1.* Write the numbers with the decimal points over each other.

21.60  
13.25

*Step 2.* Add zeros as needed.

*Step 3.* Subtract.

8.35

*Step 4.* Locate the decimal point under the column of decimal points.

### Problems:

1. Subtract 6.32 from 8.46

4. \$10215.18

5. \$ 295.63

2.  $26.38 - 14.59 =$

— 248.75

— 38.94

3.  $13.625 - 9.5 =$

### Multiplication of Decimals

Rules for multiplying decimals:

1. Use the same process of multiplication as used with whole numbers.
2. Count the number of decimal places to the right of the decimal point in both the multiplicand and the multiplier.
3. To locate the decimal point in the product, count from the right the number obtained in step 2.

Example: Multiply 3.45 by 2.3.

$$\begin{array}{r} 3.45 \\ 2.3 \\ \hline \end{array}$$

Step 1. Multiply as for whole numbers.

$$\begin{array}{r} 1035 \\ 690 \\ \hline \end{array}$$

Step 2. Count decimal places in the multiplier and multiplicand.

$$7935$$

Step 3. Count 3 places from right of product and locate the decimal point.

$$\begin{array}{r} 3.45 \text{ (2 decimal places)} \\ 2.3 \text{ (1 decimal place)} \\ \hline \end{array}$$

$$7.935 \text{ (3 decimal places)}$$

Problems:

1.  $45.82 \times .75 =$

4.  $14. \times 25 \times 18 =$

2.  $50.375 \times .25 =$

5.  $2.875 \times .5 \times 5.25 =$

3.  $9.625 \times 40 =$

### Division of Decimals

Rule for dividing decimals:

1. Use the same process of division as used with whole numbers. Zeros may be added to the right of the decimal point in the dividend without changing the value of the number.
2. Move the decimal point in the dividend to the right as many places as there are places to the right of the decimal point in the divisor.
3. Locate the decimal point in the quotient directly over the decimal point in the dividend. (from #2)
4. Add as many zeros to the right of the decimal point in the dividend as are needed to give the number of places required in the quotient.

Example: Divide 1.475 by 1.25.

$$1.25 \overline{) 1.475}$$

Step 1. Set up the problem the same as for whole numbers.

$$\begin{array}{r} 1.25 \overline{) 1.475} \\ \nearrow \quad \nearrow \end{array}$$

Step 2. Move the decimal point in the dividend 2 places to the right as there are two places to the right in the divisor.

$$\begin{array}{r} 1.18 \\ 125 \overline{) 147.50} \\ \underline{125} \end{array}$$

Step 3. Divide.

$$\begin{array}{r} 225 \\ 125 \overline{) 147.50} \\ \underline{125} \phantom{00} \\ 2250 \\ \underline{2250} \phantom{00} \\ 0000 \\ \underline{0000} \end{array}$$

Step 4. Place decimal point in the quotient above the decimal point in the dividend. (from Step #2)

Example 2: Divide 34.4 by 1.375.

$$1.375 \overline{) 34.4}$$

Step 1. Set up the problem.

$$1.375 \overline{) 34.400}$$

Step 2. Add zeros to the dividend so there are as many places to the right of the decimal point as there are to the right of decimal point in the divisor.

$$\begin{array}{r} 25.01 \\ 1375 \overline{) 34400.00} \\ \underline{2750} \phantom{00} \\ 6900 \phantom{00} \\ \underline{6875} \phantom{00} \\ 2500 \phantom{00} \\ \underline{1375} \phantom{00} \\ 1125 \phantom{00} \end{array}$$

Step 3. Divide. More zeros may be added to obtain as many places in the quotient as needed for the answer.

Step 4. Place the decimal point in the quotient over the decimal point in the dividend. (from Step #2)

Problems:

1.  $11.25 \div 1.5 =$

4.  $121.375 \div 9 =$

2.  $16.625 \div 2.75 =$

5.  $7.25 \div 12 =$

3.  $32 \div .5 =$

To change a common fraction to a decimal fraction, divide the numerator by the denominator.

Example: Change  $\frac{1}{4}$  to a decimal fraction.

$$4 \overline{) 1.}$$

Step 1. Divide numerator (1) by the denominator (4).

$$\begin{array}{r} 25 \\ 4 \overline{) 1.00} \\ \underline{8} \\ 20 \\ \underline{20} \end{array}$$

Step 2. Add zeros as needed to permit division process.

$$4 \overline{) 1.00} \quad .25$$

Step 3. Locate decimal point. (Directly above decimal point in the dividend)

Problems:

Convert the following common fractions to decimal fractions:

1.  $\frac{3}{4}$

2.  $\frac{7}{8}$

3.  $\frac{5}{16}$

4.  $2\frac{5}{32}$

5.  $\frac{7}{32}$

Shortcuts in multiplication and division of decimals:

1. When multiplying by 10, 100, 1000, etc., move the decimal point in the multiplicand to the right the same number of places as there are zeros in the multiplier.

Example:  $356.251 \times 100 = 35625.1$ .

2. When dividing by 10, 100, 1000, etc., move the decimal point in the dividend to the left the same number of places as there are zeros in the divisor.

Example:  $356.251 \div 100 = 3.56251$ .

3. When multiplying by 50, multiply by 100 and divide by 2 ( $50 = 100 \div 2$ ).
4. When dividing by 50, multiply by 2 and divide by 100 (move decimal 2 places to the left).
5. When multiplying by 25 multiply by 100 and divide by 4 ( $25 = 100 \div 4$ ).
6. When dividing by 25, multiply by 4 and divide by 100 (move decimal point 2 places to the left).
7. When multiplying by  $12\frac{1}{2}$ , multiply by 100 and divide by 8 ( $12\frac{1}{2} = 100 \div 8$ ).
8. When dividing by  $12\frac{1}{2}$ , multiply by 8 and divide by 100 (move decimal 2 places to the left).

PERCENTAGE

Percentage is a term we encounter daily in discount buying, payroll deductions, sales tax, income taxes, interest and in determining material and costs for jobs. The term "percent" means the number of hundredths of an original quantity. A fractional part of a whole number can be expressed as common fractions ( $\frac{3}{4}$ ), as a decimal fraction (0.75) and as a percent (75%). The sign used to designate percent is %.

A percent figure always relates to a fixed quantity. For example: 75% of a hundred is 75, and 75% of sixty would be 45.

To use percent in determining a percentage, the percent is usually changed to a decimal fraction by moving the decimal point two places to the left and dropping the percent sign (%).

Example: 75% becomes 0.75 or  $\frac{75}{100}$  and 6% becomes 0.06 or  $\frac{6}{100}$ .

By reversing this process, a decimal fraction can be changed to a percent.

Example: Change .45 to a percent.

.45. = 45%      Move the decimal two places to the right and add the percent sign.

To change a common fraction to a percent, the common fraction is first converted to a decimal fraction and then to a percent.

Example: Change  $\frac{5}{8}$  to a percent.

Step 1. Divide the numerator (5) by the denominator (8).

$$\begin{array}{r} .625 \\ 8 \overline{) 5.000} \\ \underline{48} \phantom{00} \\ 20 \phantom{00} \\ \underline{16} \phantom{00} \\ 40 \phantom{00} \\ \underline{40} \phantom{00} \\ 0 \end{array}$$

.625 = 62.5%  
or 62½%

Step 2. Convert the decimal fraction (.625) to a percent by moving the decimal two places to the right and adding the percent sign (%).

Whenever percents are used, the percent is taken of some quantity called the *base*. The percent taken of the base is called the *rate* and is expressed as a decimal fraction. The result of multiplying the *base* by the *rate* is called the *percentage*.

Example 1: A set of wood chisels has a list price of \$42.00. If a carpenter receives a discount of 25%, what is the purchase price?

\$42.00 Base Price  
× .25 Rate of Discount

Step 1. Change the percent (25%) to a decimal (.25) and multiply the base (\$42.00) by this rate.

\$10.50 Percentage

\$42.00 Base Price  
— 10.50 Percentage

Step 2. Subtract the percentage from the base price to arrive at the difference.

\$31.50 Difference

# MATHEMATICS

## Percentage

Example 2: What is the amount of subflooring to be ordered if it is estimated that 2450 board feet are needed and 15% is allowed for waste?

2450 Base  
.15 Rate

Step 1. Change the percent to a decimal and multiply the base (2450) by this rate.

367.50 Percentage of Waste

2450 Base  
+ 367.50 Waste

Step 2. Add the base and percentage of waste to arrive at the amount of order.

2817.50 Board Feet

## REVIEW PROBLEMS

Solve the following problems:

1. A crew of four men worked 8 days on one project. How much did each man earn at the rate of \$7.12 per hour for an eight-hour day? How much did the whole crew earn?
2. One lot of lumber contained 2182 board feet. What is the value of this lumber if 1000 board feet cost \$470?
3. A contractor paid \$33.75 for cabinet hinges for each of 16 houses. How many hinges were used if each hinge cost  $62\frac{1}{2}$  cents? What was the total cost of the hinges for the 16 houses?
4. A contractor paid bills amounting to \$43.52, \$143.85, \$7,302.48, \$9.69, \$2,842.19, and \$752.00. He had a bank balance of \$16,400.03 to start. How much money remained in the bank after the bills were paid?
5. If nails cost \$11.85 per 100-pound keg, how much would 539 pounds cost? (The 39 pounds were bought at the same rate.)
6. Concrete for a slab floor cost \$322.50. At \$18.75 per cubic yard, how many cubic yards of concrete were used?
7.  $3.25 + 12.182 + 8.7 =$
8.  $12.92 + 9.435 + 6.247 =$
9.  $127.3 + 47.65 + 83.747 + 71.05 =$
10.  $63.2 + 84.721 + 9.08 + 425.3 =$
11.  $5.18 + 62.32 + 91.875 + 40.006 =$
12.  $54.7 + 83.25 + 491.1 + 62.065 =$
13.  $48.51 - 32.625 =$
14.  $14.325 - 9.537 =$
15.  $47.5 - 35.625 =$
16.  $102.31 - 84.6 =$
17.  $2.732 - 1.928 =$
18.  $73.47 - 51.624 =$
19.  $4.5 \times 8.8 =$
20.  $5.35 \times 3.16 =$
21.  $15.2 \times 31.4 =$
22.  $72.1 \times 32.33 =$
23.  $6.48 \times 7.28 =$
24.  $38.7 \times 6.128 =$
25.  $46.5 \div 12.5 =$
26.  $27.95 \div 4.3 =$

# MATHEMATICS

# Review of Problems

27.  $1.376 \div 3.2 =$
29.  $3.2208 \div 44 =$
31. Find 9% of 845
33. Find 12.5% of 264
35. Find 16.67% of 250
37. Convert  $\frac{3}{10}$  to decimal
39. Convert  $\frac{9}{32}$  to decimal
41.  $549 + 727 + 983 =$
43.  $6425 + 805 + 974 =$
45.  $6461 + 5461 + 1923 =$
48. 
$$\begin{array}{r} 10405 \\ - 7546 \\ \hline \end{array}$$
49. 
$$\begin{array}{r} 6127 \\ - 3249 \\ \hline \end{array}$$
52. 
$$\begin{array}{r} 839 \\ \times 724 \\ \hline \end{array}$$
53. 
$$\begin{array}{r} 3984 \\ \times 223 \\ \hline \end{array}$$
56.  $48 \overline{) 816}$
57.  $129 \overline{) 18576}$
28.  $8.22 \div 6.85 =$
30.  $1585.78 \div 32.9 =$
32. Find 4.125% of 1875
34. Find 23% of 742
36. Convert  $\frac{5}{8}$  to decimal
38. Convert  $\frac{3}{4}$  to decimal
40. Convert  $\frac{7}{8}$  to decimal
42.  $204 + 7438 + 364 =$
44.  $6661 + 814 + 338 =$
46. 
$$\begin{array}{r} 7643 \\ - 951 \\ \hline \end{array}$$
47. 
$$\begin{array}{r} 9763 \\ - 8652 \\ \hline \end{array}$$
50. 
$$\begin{array}{r} 7456 \\ - 3218 \\ \hline \end{array}$$
51. 
$$\begin{array}{r} 308 \\ \times 48 \\ \hline \end{array}$$
54. 
$$\begin{array}{r} 3027 \\ \times 869 \\ \hline \end{array}$$
55. 
$$\begin{array}{r} 72568 \\ \times 5512 \\ \hline \end{array}$$
58.  $90666 \div 433 =$
60.  $1478555 \div 1495 =$
62.  $1\frac{5}{8} + 7\frac{3}{4} + 1\frac{5}{32} =$
64.  $12\frac{1}{2} \div \frac{5}{8} =$
66.  $\frac{7}{16} \div 3\frac{1}{3} =$
68.  $\frac{1}{8} \times \frac{3}{16} \times \frac{7}{8} =$
70.  $\frac{7}{16} \times \frac{5}{8} \times \frac{5}{32} =$
72.  $\frac{5}{32} - \frac{5}{64} =$
74.  $\frac{1}{2} - 1\frac{3}{4} =$
76.  $51\frac{5}{16} \times 3\frac{1}{2} =$
78.  $3\frac{1}{10} - 1\frac{3}{20} =$
80.  $52.634 + 5.215 + 25.24 =$
82.  $.165 = \text{-----} \%$
84.  $.625 = \text{-----} \%$
86. 14% of 72 =
88.  $33.3 - 2.5 =$
61.  $\frac{7}{8} + 1\frac{3}{4} + 1\frac{10}{48} =$
63.  $12\frac{1}{3} + 3\frac{1}{4} + 7\frac{9}{10} =$
65.  $\frac{3}{16} \div 1\frac{1}{8} =$
67.  $\frac{1}{6} \times \frac{2}{3} \times \frac{3}{4} =$
69.  $7\frac{1}{4} \times \frac{5}{18} \times \frac{1}{3} =$
71.  $1\frac{6}{30} - \frac{3}{8} =$
73.  $1\frac{1}{20} - 1\frac{1}{10} =$
75.  $8\frac{1}{4} \times 7\frac{1}{8} =$
77.  $9\frac{1}{32} - 7\frac{1}{64} =$
79.  $12.54 + 5.412 =$
81.  $1.125 + 4.625 + 2.25 =$
83.  $.123 = \text{-----} \%$
85. 23% of 590 =

## MATHEMATICS

## Review of Problems

89.  $1.275 - .75 =$

90.  $99.15 - 33.05 =$

91.  $175.40 \times 3.16 =$

92.  $67.43 \times 1.27 =$

93.  $.304 \times 27 =$

Convert to Fraction or Decimal:

94.  $.0625 =$

95.  $.09375 =$

96.  $.8125 =$

97.  $\frac{7}{32} =$

98.  $\frac{3}{16} =$

99.  $1\frac{9}{32} =$

100.  $1\frac{1}{16} =$

## MATHEMATICS

### Measurements

To become proficient at the trade, one of the first things the student must do is to learn to measure accurately. He should also be able to convert measurements from one unit to another and to add, subtract, multiply and divide them.

*Direct* measurements are those measurements taken directly from objects with the various types of measuring tools and instruments. These measurements are expressed in terms of inches, feet, yards or miles in this country while the metric system, using the meter as a base, is used in other countries.

When it is impossible or impractical to take a direct measurement, the measurement is calculated by some mathematical procedure. The result is called *indirect* or computed measurement.

### LINEAR MEASUREMENT

Linear measure is the measurement of length. In job situations we are faced with problems involving linear measurement many times each day in building layout and construction. Certain building materials, such as molding, are sold by the lineal or running foot.

#### *Symbols*

inch = "

foot = '

#### *Linear Measure*

12 inches (in.) = 1 foot (ft.)

3 feet (ft.) = 1 yard (yd.) = 36 inches

The common measuring tools used for linear measurement are the rule, steel tape and steel square. The smallest unit of measure is the inch which is divided into parts which may be considered either common or decimal fractions.

Figure 3 indicates the subdivision of the inch and the measured distance from the starting point as indicated by "0". The line length of the inch subdivision will assist you in reading the distance measured. The inch markers are the longest with the half, quarter, eighth, sixteenth inch markers progressively shorter. The reading of a given distance becomes a matter of adding to or subtracting from the nearest subdivision which you recognize.

For example:

$\frac{5}{16}$  is  $\frac{1}{16}$  more than the quarter inch division;

$\frac{13}{16}$  is  $\frac{1}{16}$  less than the seven-eighths inch division.

The most common divisions on the carpenter's measuring tools represent halves, quarters, eights, sixteenths and thirty-seconds.

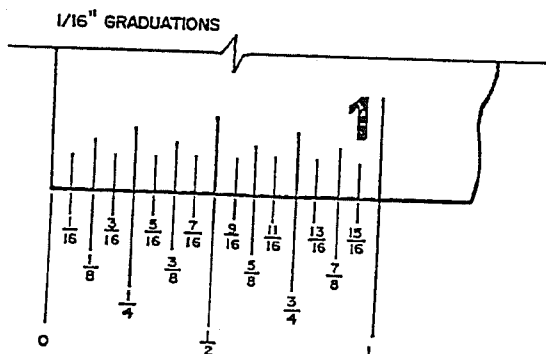


Fig. 3

Figure 4 shows a steel tape that is divided into eighths.

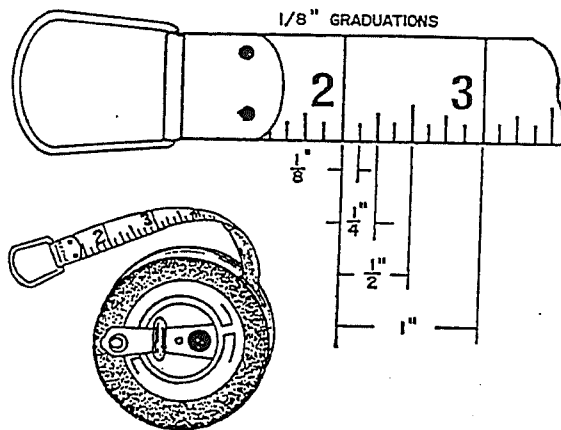


Fig. 4

The scale or divisions of measuring tools differ, depending upon the degree of accuracy required. The standard folding rule may be graduated in  $\frac{1}{16}$  inch division on both edges, Figure 5, or may have one edge graduated in  $\frac{1}{8}$  inch parts, and the other edge graduated in  $\frac{1}{16}$  inch parts.

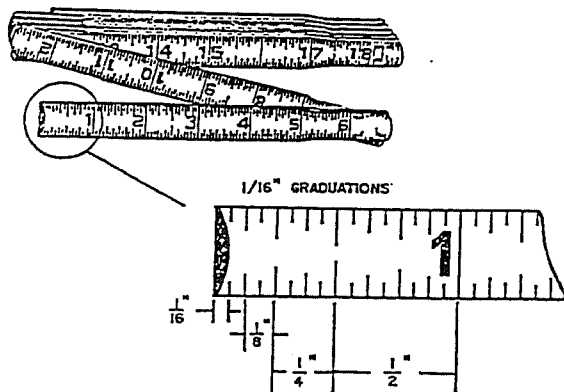


Fig. 5

Other measuring tools use scales or divisions that divide the inch into even smaller parts, such as  $\frac{1}{32}$  and  $\frac{1}{64}$  inch in Figure 6.

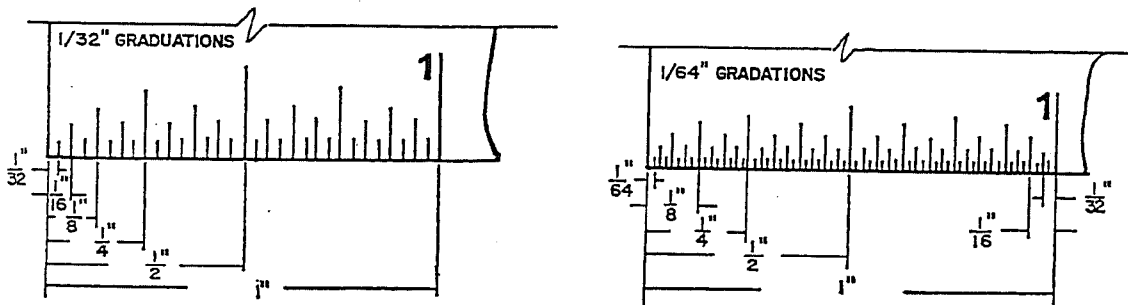


Fig. 6

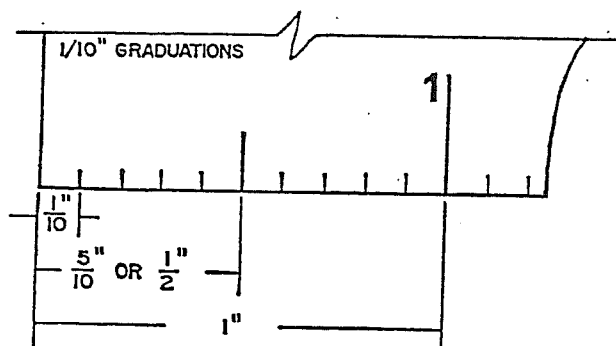


Fig. 7

Measuring tools are also graduated into tenths in order to read the measurements in decimal fractions. The engineer's rule is so constructed, Figure 7.

The steel square has one side of the tongue divided into twelfths in order for the carpenter to reduce a problem to  $\frac{1}{12}$  inch size, Fig. 8; thus, allowing direct reduction of feet and inches.

For example, 8 feet 7 inches can be represented as  $8\frac{7}{12}$  inches on the twelfth scale.

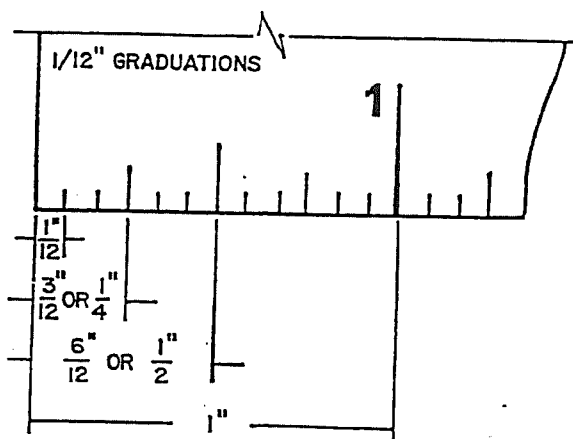


Fig. 8

The carpenter's measuring tools, as with all measuring tools, involves the use of common and mixed fractions in the computation of linear measurement. To adequately work with measurements, it is necessary for one to be able to add, subtract, divide, and multiply fractions and decimals, along with the ability to convert fractions to decimals and from decimals to fractions.

Measurement may be taken directly from the rule to give a desired length. The difference between two lengths may be measured by laying out the two lengths and measuring the difference (direct measurement) or by subtracting the shorter of the two lengths from the longer (mathematically computed measurement).

Measurements involving feet, inches and fractions of an inch are read as follows:

Examples:  $5' 7\frac{3}{4}"$  is read five feet, seven and three-quarters of an inch.

$12' 0\frac{3}{8}"$  is read 12 feet and three eighths of an inch.

Reading direct and indirect measurements, what is the distance between the following letters in Fig. 9?

- |           |                |                |
|-----------|----------------|----------------|
| 1. A to B | 5. AB minus BC | 9. AH minus BG |
| 2. A to C | 6. CD plus EF  | 10. D to H     |
| 3. A to D | 7. C to F      | 11. C to E     |
| 4. A to H | 8. B to F      | 12. DE plus EF |

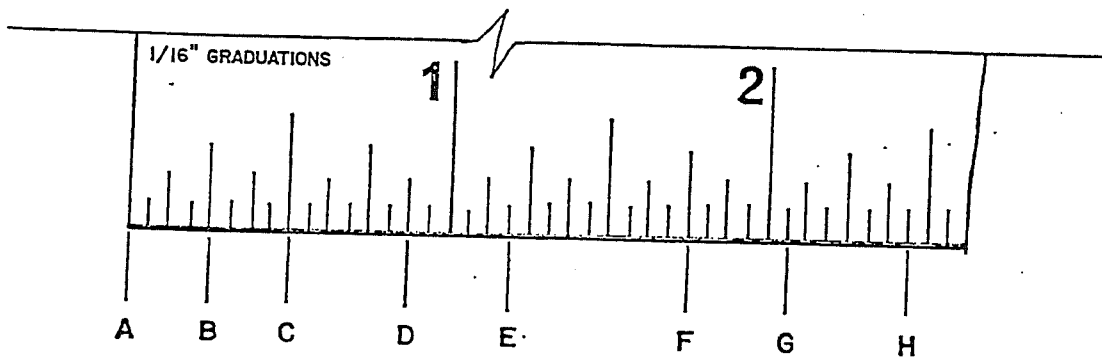


Fig. 9

13. Divide a line 8 inches long into lengths of  $2\frac{1}{4}$ ",  $3\frac{1}{2}$ ",  $1\frac{7}{16}$ ". How long is the remaining part?
14. A doorway is installed in the center of a 33' 5" wall. What is the measurement to the center of the door opening?

A measurement of length that is expressed in one unit may be expressed in another unit. For example, a board 87" long may be expressed in feet and inches by dividing the length of the board (87") by the number of inches in a foot (12);  $87" \div 12" = 7' 3"$ .

To convert to larger units a measurement that is expressed in smaller units, divide the given measurement by the number of smaller units contained in one of the larger units.

Divide the number of inches by 12 to obtain the number of feet.

Divide the number of feet by 3 to obtain the number of yards.

Divide the number of inches by 36 to obtain the number of yards.

To convert to smaller units a measurement that is expressed in larger units, multiply the given measurement by the number of smaller units contained in one of the larger units.

Multiply the number of feet by 12 to obtain the number of inches.

Multiply the number of yards by 3 to obtain the number of feet.

When a length is given in terms of two units and it is desirable to convert to the smaller units, express the larger unit in terms of the smaller unit and add the result to the number of smaller units.

Example: Convert 12' 6" to inches.

$$\begin{array}{r} 12 \times 12 = 144 \\ + 6 \\ \hline 150 \text{ inches} \end{array}$$

Problems:

Convert to feet:

1. 144"

3. 21 yds.

5. 120"

2. 96"

4. 84"

6. 48 yds.

Convert to inches:

7. 12'

10. 8' 3 $\frac{3}{4}$ "

13. 212'  $\frac{1}{2}$ "

8. 14' 7"

11. 25 yds.

14. 16' 7 $\frac{1}{4}$ "

9. 17 yds. 2' 7"

12. 6' 5 $\frac{5}{8}$ "

Common and Decimal Fractions

When multiplying and dividing compound numbers, it is necessary to convert inches into fractional or decimal parts of a foot. For example: 8 inches may be written as  $\frac{8}{12}$  or  $= \frac{2}{3}$  of a foot. Eight inches may also be expressed as a decimal part of a foot by converting the common fraction to a decimal fraction. For example, express 8 inches as a decimal fraction:  $\frac{8}{12} = \frac{2}{3} = 2 \div 3 = .667$  feet.

To convert a decimal fraction to a common fraction, multiply the decimal fraction by a denominator representing the desired degree of accuracy and place the result over this denominator.

Example 1: Convert .8125 to the nearest 16th.

$$\begin{array}{r} .8125 \\ \times 16 \\ \hline 48750 \\ 8125 \\ \hline 13.0000 = 1\frac{3}{4} \end{array}$$

Example 2: Convert .667 feet to inches.

$$\begin{array}{r} .667 \\ \times 12 \\ \hline 1334 \\ 667 \\ \hline 8.004 = \frac{8}{12} \text{ feet or 8 inches} \end{array}$$

Example 3: Convert .375 to the nearest eight.

$$\begin{array}{r} .375 \\ \times 8 \\ \hline 3.000 = \frac{3}{8} \end{array}$$

Problems:

1. Convert 9" to a decimal part of a foot.
2. Convert 8" to a decimal part of a foot.
3. Convert .375' to a common fraction.
4. Convert .1875" to a common fraction.
5. Convert 6.75 feet to inches.
6. Convert 12.875' to inches.
7. Convert 18' 7" to feet and decimal parts of a foot.
8. Convert 168" to feet and decimal parts of a foot.
9. Convert .650 yards to feet and inches.
10. Convert .5 in. to a decimal part of a foot.

## MATHEMATICS

### Compound Numbers

The ability to add, subtract, divide and multiply compound numbers of two or more denominations is necessary not only in working with measurements but in calculating time, weight, volume, etc.

Although this text will deal only with those compound numbers involving linear measurement, these same principles will apply when working with areas, volumes, angular measure, etc., involving different denominations or more than one unit.

#### Addition

In the addition of compound numbers, arrange the separate units in the proper columns, add the columns and simplify the sum if necessary.

Example 1: Add  $6' 4'' + 8' 6'' + 14'$ .

$$\begin{array}{r} 6' 4'' \\ 8' 6'' \\ 14' \\ \hline \end{array}$$

*Step 1.* Arrange the feet and inches in separate columns and in the proper order to be added.

$$28' 10''$$

*Step 2.* Add the columns (inches to inches, and feet to feet).  
Answer  $28' 10''$ .

Example 2: Add  $7' 9'' + 23' 6'' + 103' 11''$ .

$$\begin{array}{r} 7' 9'' \\ 23' 6'' \\ 103' 11'' \\ \hline \end{array}$$

*Step 1.* Arrange the columns as described above.

*Step 2.* Add the inches (a).

$$133' 26''$$

(b) (a)

*Step 3.* Add the feet (b).

$$\begin{array}{r} 26'' \div 12 = 2' 2'' \\ (c) \end{array}$$

*Step 4.* Convert the inches to feet (if 12" or over) by dividing by 12 (c).

$$\begin{array}{r} 133' \\ + 2' 2'' \\ \hline \end{array}$$

*Step 5.* Add the results to the sum of the feet (d).

$$135' 2'' (d)$$

#### Subtraction

To subtract compound numbers, arrange the units in the proper columns and subtract each column, borrowing as necessary. When borrowing, borrow the entire quantity of smaller units contained in one larger unit.

Example 1: Subtract  $8' 5''$  from  $12' 10''$

$$\begin{array}{r} 12' 10'' \\ - 8' 5'' \\ \hline \end{array}$$

*Step 1.* Arrange the units in columns.

$$4' 5''$$

*Step 2.* Subtract the columns.

# MATHEMATICS

## Compound Numbers

Example 2:  $23' 3'' - 9' 7''$

$$\begin{array}{r} 22' 15'' \\ 22' 3'' \\ - 9' 7'' \\ \hline \end{array}$$

$$\begin{array}{r} 22' 15'' \\ - 9' 7'' \\ \hline 13' 8'' \end{array}$$

Step 1. Arrange the units in columns.

Step 2. Borrow 1 unit from the 23' in order to complete the subtraction process, reducing the 23' to 22'. When dealing with feet and inches, one 1-foot unit contains 12".

Step 3. Add the unit (12") to the existing inch units (3") making a total of 15" and subtract.

Step 4. Subtract the feet column.

(a)  $\begin{array}{r} 13' 8'' \\ + 9' 7'' \\ \hline \end{array}$

$$23' 3'' - 9' 7'' = 13' 8''.$$

To check your answer, add the subtrahend and the difference (a). If the answer is the minuend, the answer is correct.

$$\begin{array}{r} 22' 15'' \\ 15'' = 1' 3'' \\ \hline \end{array}$$

$$\begin{array}{r} 22' \\ + 1' 3'' \\ \hline 23' 3'' \end{array}$$

### Problems:

1.  $8' 5'' + 9' 7'' + 23' 8\frac{1}{2}'' =$

5.  $72' 10'' - 17' 9'' =$

2.  $127' 6\frac{1}{2}'' + 254' 3'' =$

6.  $24' 5'' - 18' 7'' =$

3.  $48' 11'' + 6' 5\frac{1}{8}'' + 1' 4'' =$

7.  $96' 2'' - 88' 10'' =$

4.  $35' 5'' + 16' 0'' + 9\frac{1}{4}'' =$

8.  $105.625' - 25.375' =$

### Multiplication

Multiplication of compound numbers is used to determine area, volume and total length. When multiplying a compound number by a whole number, multiply each unit of the compound number by the whole number and simplify the answer.

Example: Eight wall panels, each 7' 8" long, are placed end to end; what is the overall length?

# MATHEMATICS

## Compound Numbers

$$\begin{array}{r} 7' \ 8'' \\ \times 8 \\ \hline \end{array}$$

*Step 1.* Arrange the problem in the proper manner.

$$56' \ 64''$$

*Step 2.* Multiply each unit by the multiplier (8).

$$64'' \div 12 = 5' \ 4''$$

*Step 3.* Convert the inches to feet and inches.

$$\begin{array}{r} 56' \\ + 5' \ 4'' \\ \hline \end{array}$$

*Step 4.* Add the results to the feet in Step 2.

$$61' \ 4''$$

To multiply one compound number by another compound is a more difficult problem in that the units must be reduced to the smallest units of the compound member or converted to a fraction, common or decimal, of the largest unit.

*Example 1:* Multiply  $5' \ 3'' \times 4' \ 6''$ .

$$5 \times 12 = 60'' + 3'' = 63''$$

$$4 \times 12 = 48'' + 6'' = 54''$$

*Step 1.* Convert the feet and inches to inches by multiplying the feet by 12 and adding the inches.

$$\begin{array}{r} 63'' \\ \times 54'' \\ \hline \end{array}$$

*Step 2.* Set up the problem for multiplication of whole numbers.

$$3402 \text{ sq. in.}$$

*Step 3.* Multiply (inches multiplied by inches produce square inches).

$$3420 \div 144 = 23.625 \text{ sq. ft.}$$

*Step 4.* Convert to feet by dividing by 144 (144 sq. in. = 1 sq. ft.)

*Example 2:* Multiply  $5' \ 3'' \times 4' \ 6''$ .

$$5\frac{3}{12} \times 4\frac{6}{12} =$$

$$5\frac{1}{4} \times 4\frac{1}{2} =$$

*Step 1.* Set the problem up as mixed numbers.

$$2\frac{1}{4} \times \frac{9}{2} = 18\frac{9}{8}$$

*Step 2.* Convert the mixed numbers to improper fractions and multiply.

$$18\frac{9}{8} = 23.625 \text{ sq. ft.}$$

*Step 3.* Reduce the improper fraction.

*Example 3:* Multiply  $5' \ 3'' \times 4' \ 6''$ .

$$\frac{3}{12} = \frac{1}{4} = .25$$

$$\frac{6}{12} = \frac{1}{2} = .50$$

*Step 1.* Convert the inches to decimal fractions of a foot.

$$\begin{array}{r} 5.25' \\ \times 4.50' \\ \hline \end{array}$$

*Step 2.* Set up the problem as for the multiplication of whole numbers and multiply.

$$26250$$

$$2100$$

$$23.6250 \text{ sq. ft.}$$

It is obvious that all three methods will result in the same answer; however, less difficulty is generally encountered if decimal fractions are used.

Division

In the division of compound numbers, generally, the compound number is the dividend and the whole number is the divisor. It is usually less difficult to work with decimal fractions but the compound number may be solved without conversion, as follows.

Example 1: Divide 11' 1" by 7.

$$\begin{array}{r} 1' 7'' \\ 7 \overline{) 11' 1''} \\ \underline{7} \phantom{00} \\ 4' = 48'' \\ + 1'' \\ \hline 49'' \end{array}$$

Step 1. Set up the division problem.

Step 2. Divide each unit by 7.

Step 3. Convert the indivisible feet to inches and add the inches from the inch column.

Step 4. Divide the total number of inches by the divisor.  
 $11' 1'' \div 7 = 1' 7''$ .

Example 2:  $11' 1'' \div 7$ .

$$\frac{1}{12} = .0833$$

$$\begin{array}{r} 11.0833 \\ 7 \overline{) 11.0833} \\ \underline{7} \phantom{00} \\ 40 \\ \underline{35} \\ 58 \\ \underline{56} \\ 23 \\ \underline{21} \\ 23 \\ \underline{21} \\ 2 \end{array}$$

Step 1. Convert the inches to decimal parts of a foot.

Step 2. Set up the division problem.

Step 3. Divide.

Step 4. Convert the decimal to inches.

$$\begin{array}{r} .5833 \\ \times 12 \\ \hline \end{array}$$

$$\begin{array}{r} 11666 \\ 5833 \\ \hline \end{array}$$

$$6.9996 = 7''$$

$$11' 1'' \div 7 = 11.0833 \div 7 = 1' 7''$$

# MATHEMATICS

## Compound Numbers

In those instances where the dividend and divisor are both compound numbers, it is usually more practical to convert both numbers to the smallest unit contained in the compound number.

Example: How many 3' 2" boards can be cut from a board 12' 8" long?

$$12' 8" = 152"$$

Step 1. Convert both numbers to inches.

$$3' 2" = 38"$$

Step 2. Set up the division problem.

$$\begin{array}{r} 4 \\ 38 \overline{) 152} \\ \underline{152} \\ 0 \end{array}$$

Step 3. Divide.

Four 3' 2" boards can be cut from a 12' 8" board.

### Problems:

1.  $12' 5" \times 9 =$
2.  $18' 3" \times 4 =$
3.  $112' 7\frac{1}{2}" \times 6 =$
4.  $5' 4" \times 3' 2" =$
5.  $20' 6" \times 10' 4" =$
6.  $6' 3" \times 2' 5" =$
7.  $84' 6" \div 6 =$
8.  $8' 2" \div 4 =$
9.  $16' 8" \div 16 =$
10.  $90' 4" \div 1' 4" =$
11.  $124' \div 1' 6" =$
12.  $44' 3" \div 1' 5" =$

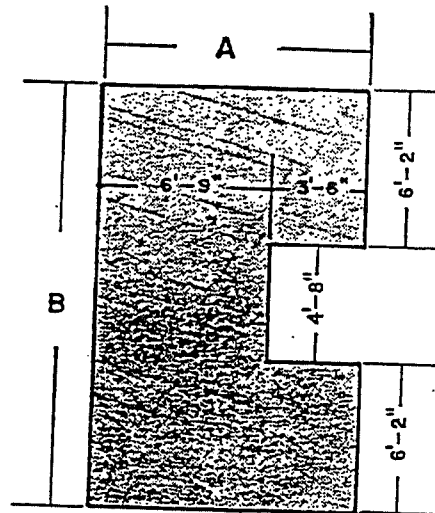


Fig. 10

13. The following questions are based on Fig. 11.

What is the length of side A? \_\_\_\_\_

What is the length of side B? \_\_\_\_\_

What is the sum of  $A + B$ ? \_\_\_\_\_

How much longer is side B than side A? \_\_\_\_\_

## MATHEMATICS

14. How many 1' 4" pieces can be cut from a board 16' 5" long? Disregarding saw cuts, what size is the piece of scrap?
15. If it takes a row of  $14\frac{1}{2}'' \times 9''$  floor tile to cover the length of one wall, how long is the wall?
16. What is the length of the board shown in Fig. 11? -----

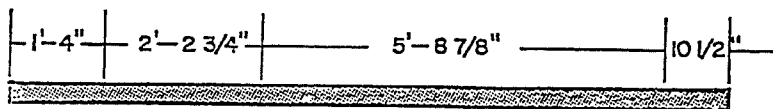


Fig. 11

17. A board 18' 6" long is divided into 16 equal pieces, how long are the pieces?
18. A stack of  $\frac{3}{4}''$  plywood 7'  $2\frac{1}{4}''$  high contains how many sheets?
19. The following questions are based on Fig. 12.

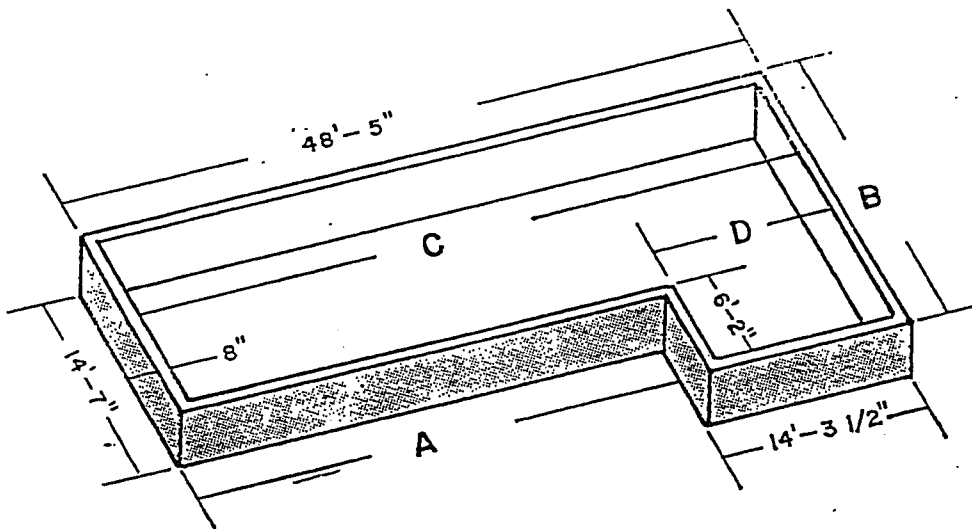


Fig. 12

- What is the length of side A?
- What is the length of side B?
- What is the dimension C?
- What is the dimension D?
20. A storage closet 7' 10" high has six equally spaced  $\frac{3}{4}''$  shelves, what is the on-center spacing of the shelves?

RATIO AND PROPORTION

Ratio is the relation of one quantity to another. It is the comparison of two like quantities. A ratio is found by dividing the first term by the second and may be expressed in the form of a fraction. If the first term is smaller than the second, the ratio is similar to a proper fraction and the answer will be less than 1. If the first term is larger than the second, the ratio is similar to an improper fraction and the answer will be larger than 1.

The ratio of 10 to 5 is 2, and may be expressed as  $\frac{10}{5}$ . The symbol for a ratio is the colon (:).

Example: 10:5 expresses the ratio of 10 to 5

Rule—To find the first term of a ratio, multiply the ratio by the second term.

Example: The second term is 5 and the ratio is 2. What is the first term?

$$\frac{?}{5} = 2 \quad 2 \times 5 = 10. \quad 10:5 = 2$$

Rule—To find the second term of a ratio, divide the first term by the ratio.

Example: The first term is 10 and the ratio is 2. What is the second term?

$$\frac{10}{?} = 2. \quad 10 \div 2 = 5. \quad 10:5 = 2$$

*Proportion* is the expression of the equality of two ratios and is used in the solution of a number of problems in the construction field.

Example:  $4:2 :: 8:4$  or  $\frac{4}{2} = \frac{8}{4}$

In ratio, the quantities were called the first and second terms. In proportion, new terminology is used. "Means" and "extremes" are applied to parts of the proportion. The inner numbers are called "means" and the outer numbers are called "extremes."

-Example:  $2 :: 8$  means  
4: :4 extremes

Rule—The product of the means always equals the product of the extremes.

Example:  $4:2 :: 8:4$

(Extremes)  $4 \times 4 = 16$

(Means)  $2 \times 8 = 16$

Rule—The product of the extremes divided by one mean gives the other mean as the quotient.

Example:  $4:2 :: ? : 4$

The product of the extremes is 16. This product divided by the known mean (2) is 8.

$$\frac{4 \times 4}{2} = 8$$

## MATHEMATICS

### Ratio and Proportion

Rule—The product of the means divided by one extreme gives the other extreme as the quotient.

Example:  $4:2 :: 8:P$

The product of the means is 16. This product divided by the known extreme (4) is 4.

$$\frac{2 \times 8}{4} = 4$$

#### Problems:

1. What is the ratio of 12 to 3?
2. What is the ratio of 4 to 16?
3. If the first term is 12 and the ratio is 4, what is the second term?
4. If the second term is 15 and the ratio is 5, what is the first term?
5.  $6:8 :: P:12$ .
6.  $12:5 :: 60:P$
7.  $5\frac{1}{2}:P :: 2\frac{1}{3}:7$ .
8.  $\frac{P}{2.2} : \frac{33}{66}$

POWER AND ROOTS

Solutions of problems to follow involve an understanding of powers and roots and the ability to extract roots mathematically.

A *power* is the product of a factor multiplied by itself a definite number of times. For example:  $4 \times 4 \times 4 = 64$ . The product, 64, is the power and the 4 which is the factor, is called the base.

When the base is used only two times as a factor, the product is called a *second power* or a *square*.

Example:  $2 \times 2 = 4$ . Four is the square of two.

When the base is used three times as a factor, the product is called a *third power* or a *cube*.

Example:  $3 \times 3 \times 3 = 27$ . Twenty-seven is the cube of three.

To indicate the number of times a base is to be used as a factor to obtain a power, a small number is placed above and to the right of the base. This small number is called an *exponent*. Thus,  $4^3$  means  $4 \times 4 \times 4$ . The 3 is the exponent and indicates that 4 is to be multiplied by itself 3 times. The use of the exponent thus gives us an abbreviated method of indicating how many times a number is to be multiplied by itself.

Example:  $2^4 = 2$  to the fourth power or  $2 \times 2 \times 2 \times 2 = 16$ .

$2^5 = 2$  to the fifth power or  $2 \times 2 \times 2 \times 2 \times 2 = 32$ .

Fractions and decimals as well as whole numbers are involved. For example:  $(\frac{3}{4})^2$  means that we want to square the fraction  $(\frac{3}{4})$  and is written  $\frac{3}{4} \times \frac{3}{4}$  or  $\frac{3 \times 3}{4 \times 4}$  which equals  $\frac{9}{16}$ .

In fractions, the power is always less than the base fraction.

Problems:

1.  $6^2 =$

2.  $12^2 =$

3.  $7^3 =$

4.  $15^4 =$

5.  $(\frac{2}{3})^2 =$

6.  $(\frac{3}{4})^3 =$

A *root* of a number is one of the equal factors that, when multiplied together, will equal the given number. For example: two equal factors of 9 are 3 and 3 ( $3 \times 3 = 9$ ). 3 is therefore a root of 9. Finding one of two equal factors of a given number is called extracting the *square root*. The *cube root* of a given number is the factor which, when multiplied by itself 3 times, will equal the given number. The symbol used to indicate the root of a number is called the radical sign and is written  $\sqrt{\quad}$ .

For example:  $\sqrt{2}$  means the square root of 2.  $\sqrt[3]{8}$  would mean the cube root of 8. In this case, the small 3, called the *index*, indicates the root to be found. Note that the small figure is omitted when the square root is desired. The radical sign by itself indicates that the square root is to be found.

Most problems which will be encountered will involve the extraction of the square root of numbers. The procedure for finding the square root of different kinds of numbers will be explained with examples.

Example 1. Find the square root of 144

$$\sqrt{144}$$

Step 1. Place the 144 under the radical sign.

$$\sqrt{1\ 44}$$

Step 2. Bracket the number in groups of two from the right side. The last group may only have one number.

$$\begin{array}{r} 1 \\ \sqrt{1\ 44} \\ 1 \\ \hline 0 \end{array}$$

Step 3. Inspect the group at the left. What number squared will equal or nearly equal this group? This number squared must not be larger than the group. In this example:  $1 \times 1 = 1$ . Place the 1 above the group and  $1^2$  or 1 below the group and subtract.

$$\begin{array}{r} 1 \\ \sqrt{1\ 44} \\ 1 \\ \hline 0\ 44 \end{array}$$

Step 4. Bring down the next group to the right of the first group.

$$\begin{array}{r} 1 \\ \sqrt{1\ 44} \\ 1 \\ \hline 0\ 44 \end{array}$$

Step 5. Multiply the number in the root by 2 and place to the left of the 44.

$$2 \times 1 = 2$$

$$\begin{array}{r} 1\ 2 \\ \sqrt{1\ 44} \\ 1 \\ \hline 0\ 44 \\ 44 \end{array}$$

$$22$$

Step 6. Use this number 2 as a trial divisor and divide into the 4 of the 44. 2 will go into 4 just 2 times. Place the 2 next to the 2 in the trial divisor space and also above the group in the root line. Multiply the 22 by 2. 12 is the square root of 144. ( $12 \times 12 = 144$ )

- Example 2. Find the square root of 1296

$$\sqrt{1296}$$

Step 1. Place the 1296 under the radical sign.

$$\sqrt{12\ 96}$$

Step 2. Bracket the number in groups of two from the right.

$$\begin{array}{r} 3 \\ \sqrt{12\ 96} \\ 9 \\ \hline 3 \end{array}$$

$$3 \times 3 = 9$$

Step 3. Inspect the group at the left. What number squared will equal or be slightly less than 12?  $3^2 = 9$ . Place the 3 in the root line and the  $3^2$  below the 12 and subtract.

$$\begin{array}{r} 3 \\ \sqrt{12\ 96} \\ 9 \\ \hline 3\ 96 \end{array}$$

Step 4. Bring down the next group and place to the right of the remainder of the first group. This will give the number 396.

$$\begin{array}{r} 3 \\ \sqrt{12 \ 96} \\ 9 \\ \hline 6 \ 3 \ 96 \end{array}$$

Step 5. Multiply the number in the root by 2 and place to the left of the 396.  $2 \times 3 = 6$

$$\begin{array}{r} 3 \ 6 \\ \sqrt{12 \ 96} \\ 9 \ 96 \\ \hline 66 \ 3 \ 96 \end{array}$$

Step 6. Use 6 as a trial divisor and divide into the 39 of the 396. 6 will go into 39 just 6 times. Place the 6 next to the 6 of the trial divisor and also above the group in the root line. Multiply the 66 by the 6.

36 is the square root of 1296. ( $36 \times 36 = 1296$ )

Example 3. Find the square root of 119025

$$\sqrt{119025}$$

Step 1. Place the 119025 under the radical sign.

$$\sqrt{11 \ 90 \ 25}$$

Step 2. Bracket the number in groups of 2 from the right.

$$\begin{array}{r} 3 \\ \sqrt{11 \ 90 \ 25} \\ 9 \\ \hline 2 \end{array}$$

Step 3. Inspect the group at the left. What number squared will equal or nearly equal this group?  $3^2 = 9$ . Place the 3 in the root line and  $3^2$  (9) below the group and subtract.

$$\begin{array}{r} 3 \\ \sqrt{11 \ 90 \ 25} \\ 9 \\ \hline 2 \ 90 \end{array}$$

Step 4. Bring down the next group and place to the right of the remainder of the first group. This will give the number 290.

$$\begin{array}{r} 3 \\ \sqrt{11 \ 90 \ 25} \\ 9 \\ \hline 6 \ 2 \ 90 \end{array}$$

Step 5. Multiply the number in the root by 2 and place to the left of the 290.

$$\begin{array}{r} 3 \ 4 \\ \sqrt{11 \ 90 \ 25} \\ 9 \ 90 \\ \hline 64 \ 2 \ 56 \\ 34 \end{array}$$

Step 6. Use 6 as a trial divisor and divide into the 29 of the 290. 6 will go into 29 only 4 times. Place the 4 next to the 6 in the trial divisor and also next to the 3 in the root line. Multiply the 64 by 4 and subtract from the 290.

$$\begin{array}{r} 3 \ 4 \\ \sqrt{11 \ 90 \ 25} \\ 9 \ 90 \\ \hline 64 \ 2 \ 56 \\ 34 \ 25 \end{array}$$

Step 7. Bring down the next group and place to the right of the remainder of the second group. This will give the number 3425.

$$\begin{array}{r} \phantom{0}3 \phantom{0}4 \\ \sqrt{11 \overline{90} \overline{25}} \\ 64 \phantom{0} \overline{9} \\ \phantom{0}2 \phantom{0}90 \\ 68 \phantom{0} \overline{2} \phantom{0}56 \\ \phantom{0} \phantom{0}34 \phantom{0}25 \end{array}$$

Step 8. Multiply the number in the root by 2 and place to the left of the 3425.  $2 \times 34 = 68$

$$\begin{array}{r} \phantom{0}3 \phantom{0}4 \phantom{0}5 \\ \sqrt{11 \overline{90} \overline{25}} \\ 64 \phantom{0} \overline{9} \\ \phantom{0}2 \phantom{0}90 \\ 685 \phantom{0} \overline{2} \phantom{0}56 \\ \phantom{0} \phantom{0}34 \phantom{0}25 \\ \phantom{0} \phantom{0}34 \phantom{0}25 \end{array}$$

Step 9. Use 68 as a trial divisor and divide into the 342 of the 3425. 68 will go into 342 just 5 times. Place the 5 next to the 68 in the trial divisor and also next to the 4 in the root line. Multiply the 685 by 5.

345 is the square root of 119,025. ( $345 \times 345 = 119,025$ )

Example 4. Find the square root of 18.8356

Whenever a decimal point appears in a series of numbers, the numbers are bracketed in pairs both to the right and to the left of the decimal point.

$$\sqrt{18.8356}$$

Step 1. Place the 18.8356 under the radical sign.

$$\sqrt{18.\overline{83} \overline{56}}$$

Step 2. Bracket the number in groups of 2 from the decimal point right and left.

$$\begin{array}{r} \phantom{0}4 \\ \sqrt{18.\overline{83} \overline{56}} \\ \phantom{0}16 \\ \phantom{0} \phantom{0}2 \end{array}$$

Step 3. Inspect the group at the left. What number squared will equal or nearly equal this group?  $4^2 = 16$   
Place the 4 in the root line above the group and the  $4^2$  (16) below the group and subtract.

$$\begin{array}{r} \phantom{0}4 \\ \sqrt{18.\overline{83} \overline{56}} \\ \phantom{0}16 \\ \phantom{0} \phantom{0}2 \phantom{0}83 \end{array}$$

Step 4. Bring down the next group and place to the right of the remainder from the first group.

$$\begin{array}{r} \phantom{0}4 \\ \sqrt{18.\overline{83} \overline{56}} \\ \phantom{0}16 \\ \phantom{0} \phantom{0}2 \phantom{0}83 \end{array}$$

Step 5. Multiply the number in the root by 2 and place to the left of the 283.  $2 \times 4 = 8$

$$\begin{array}{r} \phantom{0}4 \phantom{0}3 \\ \sqrt{18.\overline{83} \overline{56}} \\ 83 \phantom{0} \overline{16} \\ \phantom{0} \phantom{0}2 \phantom{0}83 \\ \phantom{0} \phantom{0}2 \phantom{0}49 \\ \phantom{0} \phantom{0} \phantom{0}34 \end{array}$$

Step 6. Use 8 as a trial divisor and divide into 28 of the 283. 3 will go into 28 just 3 times. Place the 3 next to the 8 in the trial divisor and next to the 4 in the root. Multiply the 83 by 3 and subtract from the 283.

$$\begin{array}{r} 4 \quad 3 \\ \sqrt{18.83 \ 56} \\ 16 \\ \hline 2 \ 83 \\ 2 \ 49 \\ \hline 34 \ 56 \end{array}$$

Step 7. Bring down the next group and place to the right of the remainder of the second group. This will give the number 3456.

$$\begin{array}{r} 4 \quad 3 \\ \sqrt{18.83 \ 56} \\ 16 \\ \hline 2 \ 83 \\ 2 \ 49 \\ \hline 34 \ 56 \end{array}$$

Step 8. Multiply the number in the root by 2 and place to the left of the 3456.  $2 \times 43 = 86$

$$\begin{array}{r} 4 \quad 3 \quad 4 \\ \sqrt{18.83 \ 56} \\ 16 \\ \hline 2 \ 83 \\ 2 \ 49 \\ \hline 34 \ 56 \\ 34 \ 56 \end{array}$$

Step 9. Use 86 as a trial divisor and divide into 345 of the 3456. 86 will go into the 345 just 4 times. Place the 4 next to the 86 of the trial divisor and next to the 43 in the root line. Multiply the 864 by 4.

$$\begin{array}{r} 4. \ 3 \ 4 \\ \sqrt{18.83 \ 56} \end{array}$$

Step 10. Place the decimal point in the root line above the decimal point in the original number which is under the radical. 4.34 is the square root of 18.8356.  $(4.34 \times 4.34) = 18.8356$

Example 5. Find the square root of 5 to two decimal places

$$\sqrt{5}$$

Step 1. Place the 5 under the radical sign.

$$\sqrt{5.00 \ 00}$$

Step 2. Add the decimal point and 4 zeros to the right of the decimal point. Whenever it is necessary to add zeros to obtain the number of places in the answer, there must always be an even number of digits to the right of the decimal point. This allows the bracketing of the numbers in groups of 2.

$$\sqrt{5.00 \ 00}$$

Step 3. Bracket the numbers in groups of 2 to the right and left of the decimal point.

$$\begin{array}{r} 2 \\ \sqrt{5.00 \ 00} \\ 4 \\ \hline 1 \end{array}$$

Step 4. Inspect the group at the left. What number squared will equal or nearly equal this group?  $2^2 = 4$  Place the 2 in the root line and  $2^2$  (4) below the 5 and subtract.

$$\begin{array}{r} 2 \\ \sqrt{5.00 \ 00} \\ 4 \\ \hline 1.00 \end{array}$$

Step 5. Bring down the next group and place to the right of the remainder from the first group.

$$\begin{array}{r} 2 \\ \sqrt{5.00\ 00} \\ 4 \overline{) 4} \ 00 \\ \underline{1} \ 00 \end{array}$$

Step 6. Multiply the number in the root by 2 and place to the left of the 100.

$$\begin{array}{r} 2 \quad 2 \\ \sqrt{5.00\ 00} \\ 4 \overline{) 1} \ 00 \\ \underline{84} \\ 16 \end{array}$$

Step 7. Use 4 as a trial divisor and divide into the 10 of the 100. 4 will go into 10 just 2 times. Place the 2 next to the 4 in the trial divisor and also next to the 2 in the root line. Multiply the 42 by 2 and subtract.

$$\begin{array}{r} 2 \quad 2 \\ \sqrt{5.00\ 00} \\ 4 \overline{) 1} \ 00 \\ \underline{84} \\ 16 \ 00 \end{array}$$

Step 8. Bring down the next group and place to the right of the remainder of the second group. This will give the number 1600.

$$\begin{array}{r} 2 \quad 2 \\ \sqrt{5.00\ 00} \\ 4 \overline{) 1} \ 00 \\ \underline{84} \\ 16 \ 00 \end{array}$$

Step 9. Multiply the number in the root by 2 and place to the left of the 1600.  $2 \times 22 = 44$

$$\begin{array}{r} 2 \quad 2 \quad 3 \\ \sqrt{5.00\ 00} \\ 4 \overline{) 1} \ 00 \\ \underline{84} \\ 16 \ 00 \\ \underline{13} \ 29 \\ 2 \ 71 \end{array}$$

Step 10. Use 44 as a trial divisor and divide into the 160 of the 1600. 44 will go into 160 just 3 times. Place the 3 next to the 44 in the trial divisor and next to the 22 in the root line. Multiply the 443 by 3. Subtract. If the remainder is less than the divisor, the largest number has been used.

$$\begin{array}{r} 2. \ 2 \ 3 \\ \sqrt{5.00\ 00} \end{array}$$

Step 11. Place the decimal point in the root line above the decimal point in the original number which is under the radical. 2.23 is the closest square root of 5 when calculated to two decimal places.

Problems — Find the square roots of the following numbers:

1. 625

4. 60516

7. 2 (3 decimal places)

2. 256

5. 10.5625

8. 1.6 (2 decimal places)

3. 2116

6. 3. (2 places)

9. 25.375 (2 decimal places)

# MATHEMATICS

## Review of Problems

Add the Following Quantities:

$$\begin{array}{r} 1. \quad 15'' \\ 21'' \\ 17'' \\ 73'' \\ 54'' \\ \hline \end{array}$$

$$\begin{array}{r} 2. \quad 340' \\ 18' \\ 117' \\ 75' \\ 237' \\ \hline \end{array}$$

$$\begin{array}{r} 3. \quad 1247 \text{ yds.} \\ 1760 \text{ yds.} \\ 16 \text{ yds.} \\ 181 \text{ yds.} \\ \hline \end{array}$$

$$4. \quad \frac{1}{4}'' + \frac{3}{4}'' + \frac{5}{8}'' =$$

$$5. \quad 1\frac{3}{16}'' + \frac{7}{8}'' + 2\frac{5}{32}'' + \frac{3}{4}'' =$$

$$6. \quad \frac{1}{2} + \frac{5}{6} + \frac{5}{8} + \frac{3}{4} =$$

$$\begin{array}{r} 7. \quad 17.565 \\ 41.021 \\ 214.922 \\ 48.625 \\ \hline \end{array}$$

$$\begin{array}{r} 8. \quad 215.7 \\ 344.375 \\ 7.250 \\ 14.875 \\ \hline \end{array}$$

$$\begin{array}{r} 9. \quad 33 \text{ ft. } 8 \text{ in.} \\ 12 \text{ ft. } 6 \text{ in.} \\ 6 \text{ ft. } 3 \text{ in.} \\ 96 \text{ ft. } 1 \text{ in.} \\ \hline \end{array}$$

$$\begin{array}{r} 10. \quad 8' 5\frac{1}{4}'' \\ 23' 7\frac{3}{8}'' \\ 44' 9\frac{15}{16}'' \\ 231' 8\frac{1}{2}'' \\ \hline \end{array}$$

$$\begin{array}{r} 11. \quad 36' 7\frac{3}{4}'' \\ 4' 2'' \\ 21' 9\frac{15}{16}'' \\ 1' 4\frac{3}{8}'' \\ \hline \end{array}$$

$$\begin{array}{r} 12. \quad 5 \text{ yds. } 2 \text{ ft. } 4 \text{ in.} \\ 9 \text{ yds. } 1 \text{ ft. } 9 \text{ in.} \\ 14 \text{ yds. } 10 \text{ in.} \\ \hline \end{array}$$

13. A carpenter works for several contractors during the year, what are his total earnings if his W-2 forms are as follows: \$1540.25, \$2317.41, \$4702, \$3146.18, and \$215.96? \_\_\_\_\_

14. Lengths of 2' 6 $\frac{1}{2}$ ", 3' 4" and 6' 1 $\frac{3}{4}$ " are cut from a board. If a piece of scrap 3' 11 $\frac{3}{8}$ " is left, and allowing  $\frac{1}{8}$ " for each saw cut, how long was the board? \_\_\_\_\_

Subtract the Following Quantities:

$$\begin{array}{r} 15. \quad 257 \\ 188 \\ \hline \end{array}$$

$$\begin{array}{r} 16. \quad 12342 \\ 9603 \\ \hline \end{array}$$

$$17. \quad \frac{7}{8} - \frac{1}{2} =$$

$$18. \quad 2\frac{5}{22} - \frac{1}{4} =$$

$$\begin{array}{r} 19. \quad 7' 5'' \\ - 3' 3'' \\ \hline \end{array}$$

$$\begin{array}{r} 20. \quad 24' 3'' \\ - 18' 10'' \\ \hline \end{array}$$

$$\begin{array}{r} 21. \quad 96' 2\frac{7}{8}'' \\ 14' 9\frac{5}{16}'' \\ \hline \end{array}$$

$$\begin{array}{r} 22. \quad \$9.57 \\ - 8.44 \\ \hline \end{array}$$

$$\begin{array}{r} 23. \quad 144.625' \\ - 37.875' \\ \hline \end{array}$$

# MATHEMATICS

## Review of Problems

24. Seven and one-fourth inch is ripped from a  $11\frac{1}{4}$ " board. The saw cut allowance is  $\frac{1}{16}$ ", how wide is the remaining piece?
25. A wall is 8' 0" high. The bottom, top and double plates are each  $1\frac{1}{2}$ " thick. How long are the studs?

Multiply the Following Quantities:

$$\begin{array}{r} 26. \quad 5280 \\ \times 1760 \\ \hline \end{array}$$

$$\begin{array}{r} 27. \quad 18421 \\ \times 544 \\ \hline \end{array}$$

$$28. \quad \frac{3}{4} \times \frac{1}{2} =$$

$$29. \quad \frac{5}{8} \times 1\frac{5}{16} =$$

$$\begin{array}{r} 30. \quad 35.22 \\ 18.41 \\ \hline \end{array}$$

$$\begin{array}{r} 31. \quad 242.750 \\ 56.625 \\ \hline \end{array}$$

$$32. \quad 36\frac{1}{4} \times 14\frac{3}{8} =$$

$$\begin{array}{r} 33. \quad 112' 6'' \\ \times 8 \\ \hline \end{array}$$

$$\begin{array}{r} 34. \quad 8' 8\frac{3}{4}'' \\ \times 4 \\ \hline \end{array}$$

$$35. \quad \frac{1}{8} \times \frac{3}{16} \times \frac{7}{8} =$$

$$36. \quad 10' 5'' \times 6' 3'' =$$

37. What is the height of a stack of  $\frac{3}{4}$ " plywood containing 84 sheets? \_\_\_\_\_

38. A pound of 8d smooth box nails contains 145 nails. How many nails are in  $78\frac{3}{4}$  lbs? \_\_\_\_\_

39. If a butcher block-type table top is made of forty-two  $\frac{3}{4}$ " boards glued together, how wide is the top? \_\_\_\_\_

Divide the Following Quantities:

$$40. \quad 1\frac{1}{8} =$$

$$41. \quad 144 \div 12 =$$

$$42. \quad 175.8 \div 3 =$$

$$43. \quad 297 \overline{) 25288}$$

$$44. \quad 5203 \overline{) 634,766}$$

$$45. \quad 25.5 \overline{) 603.075}$$

$$46. \quad 16.282 \overline{) 233.158}$$

$$47. \quad \frac{3}{4} \div \frac{3}{8} =$$

$$48. \quad 2\frac{1}{2} - \frac{5}{16} =$$

$$49. \quad 123\frac{3}{4} \div 18\frac{1}{2} =$$

$$50. \quad 16' - 8'' \div 6 =$$

51. How many  $8\frac{1}{2}$ " pieces can be cut from a  $11' 5\frac{1}{2}$ " board, if  $1\frac{1}{2}$ " is allowed for waste?

52. How many joists spaced 16" on center are required for a building 120' long? (Add 1 joist for starter.) \_\_\_\_\_

## MATHEMATICS

## Review of Problems

53. A floor to ceiling bookcase requires 6 shelves equally spaced within the case. If the case is 94" inside and the shelves are  $\frac{3}{4}$ " thick, what is the distance between shelves? -----

### Convert to Fractions:

54. .9375 =                      55. .6875 =                      56. .375 =  
57. .250 =                      58. .0625 =

### Convert to Decimals:

59.  $\frac{7}{8}$  =                      60.  $\frac{3}{16}$  =                      61.  $\frac{1}{8}$  =  
62.  $3\frac{1}{32}$  =                      63.  $\frac{5}{16}$  =

### Solve the Following Problems:

64. 25% of 1648 =                      65. 23% of 590 =                      66. 5:P :: 45:63 =  
67. 17:10 :: 85:P =                      68.  $9^2$  =                      69.  $13^2$  =  
70.  $\sqrt{441}$                       71.  $\sqrt{202.25}$                       72.  $\sqrt{1552.36}$