Chapter 1
Basic Math

Topics

1.0.0  Parts of a Whole Number
2.0.0  Decimals
3.0.0  Fractions
4.0.0  Conversions – Fractions and Decimals
5.0.0  Ratios and Proportions
6.0.0  Percentages
7.0.0  Conversions – Percentages and Decimals
8.0.0  Square Roots
9.0.0  Metric System
10.0.0  Using Measuring Tools
11.0.0  Construction Geometry

To hear audio, click on the box.

Overview

Addition, subtraction, multiplication, and division; these are all basic math skills that Builders use every day. A sound understanding of these basics prepares you for the more complex math skills you’re likely to use on construction projects, including fractions, ratios, proportions, percentages, square roots, and the metric system. They will also prepare you for measurements and calculations using geometric shapes.

Measuring components for a construction project and figuring the materials needed to complete a project are both tasks that are accomplished using math. Figuring materials needed is a task that people in all construction trades perform, whether it’s a mason calculating amounts of block and mortar, or a plumber figuring amounts of pipe and fittings.

Safety can be impacted by calculations you make for your project. Concrete form design relies on math to determine what load the form can carry without failing. Form failure can cause both loss of material and injury. Careful calculations help ensure the best results for all of your projects.
Objectives

When you have completed this chapter, you will be able to do the following:

1. Identify whole numbers.
2. Understand how to work with decimals.
3. Understand how to work with fractions.
4. Understand how to convert fractions to decimals and decimals to fractions.
5. Understand how to work with ratios and proportions.
6. Understand how to work with percentages.
7. Understand how to convert percentages to decimals and decimals to percentages.
8. Understand how to calculate square roots.
9. Understand the metric system.
10. Understand how to use measuring tools, including a standard ruler, a metric ruler, and an architect's scale.
11. Understand construction geometry.

Prerequisites

None

This course map shows all of the chapters in Builder Basic. The suggested training order begins at the bottom and proceeds up. Skill levels increase as you advance on the course map.
Features of this Manual

This manual has several features which make it easy to use online.

- Figure and table numbers in the text are italicized. The figure or table is either next to or below the text that refers to it.

- The first time a glossary term appears in the text, it is bold and italicized. When your cursor crosses over that word or phrase, a popup box displays with the appropriate definition.

- Audio and video clips are included in the text, with an italicized instruction telling you where to click to activate it.

- Review questions that apply to a section are listed under the Test Your Knowledge banner at the end of the section. Select the answer you choose. If the answer is correct, you will be taken to the next section heading. If the answer is incorrect, you will be taken to the area in the chapter where the information is for review. When you have completed your review, select anywhere in that area to return to the review question. Try to answer the question again.

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1.0.0 PARTS of a WHOLE NUMBER

Whole numbers are made up of digits, which can be any numerical symbol from 0 to 9. Each digit of a whole number represents a place value, as shown in Figure 1-1. The number in this example is read as one million two hundred thirty-four thousand five hundred sixty-seven.

![Figure 1-1 – Place values in whole numbers.](image)

Every digit has a value that depends on its place, or location, in the whole number. In Figure 1-1, the place value of the 1 is one million; the place value of the 5 is five hundred.

Numbers can be positive or negative. **Positive numbers** are larger than zero and don’t usually have a positive sign (+) before them. **Negative numbers** are smaller than zero and always have a negative sign (-) before them. Zero is not positive or negative; it never has a positive or negative sign before it. Any whole number that doesn’t have a negative sign in front of it is a positive number.

Test your Knowledge (Select the Correct Response)
1. What number is the same as the words one thousand three hundred eighty-six?
   A. 1,068
   B. 1,368
   C. 1,386
   D. 3,186

2.0.0 DECIMALS

Decimals are numbers in the base 10 system, using any numerical symbol from 0 to 9. The place values in decimal numbers are similar to the place values in whole numbers, except that decimal numbers appear to the right of a decimal point and do not use comma separators. Place values in decimal numbers are shown in Figure 1-2.

![Figure 1-2 – Place values in decimal numbers.](image)
Like whole numbers, decimal numbers have values that depend on their place in the number. In the example above, the place value of the 1 is one tenth, the place value of the 3 is three thousandths.

Operations with decimals are very similar to operations with whole numbers. The only difference is that you have to keep track of the decimal point.

2.1.0 Adding Decimals

12.34
+5.678

When you add numbers containing decimals, make sure to keep the decimal points lined up. For example, if you add 12.34 to 5.678, they should look like this when you add them:

Be sure to add each column of numbers, starting with the numbers that are farthest right. In this case, the first number has no digit in the thousandths position, so it can be treated as a zero:

12.340
+5.678
8

As you move left adding the columns, make sure to carry any numbers greater than 10. When you add 4 and 7 in the hundredths column, the sum is 11. Record a 1 in the hundredths column and carry a 1 to the tenths column as shown below:

1
12.340
+5.678
18

When you add the tenths column, you have to add 3 and 6, and the 1 you carried from the sum in the hundredths column. This will give you a sum of 10, so record the 0 in the tenths column and carry a 1 to the units column as shown below:

1
12.340
+5.678
18.018

Add the remaining numbers as you would any whole number. Remember to place the decimal point between the units column and the tenths column, as shown below:

12.340
+5.678
18.018
Test your Knowledge (Select the Correct Response)

2. What is the sum of 54.32 and 1.786?

A. 72.18  
B. 56.106  
C. 64.143  
D. 54.498

2.2.0 Subtracting Decimals

Subtracting decimals is very similar to adding decimals. You need to line up the decimal points as in addition. Subtracting 5.678 from 12.34 looks like this:

12.37
-1.248

Since there are only 2 decimal points after the whole number in 12.34, we need to add a zero at the end so we can subtract the three decimal points in 5.678.

12.370
-1.248

You subtract columns the same way as you add them, starting with the farthest right column. In this case, you can’t subtract 8 from 0, so you need to borrow from the hundredths column to be able to subtract from 10, as shown below:

6
12.3710
-1.248

2

You now have 6 to subtract 4 from, since you borrowed 1 from 7. The rest of the numbers subtract normally, as shown below:

6
12.3710
-1.248

11.122

Test your Knowledge (Select the Correct Response)

3. What is the difference between 65.43 and 2.897?

A. 36.46  
B. 98.993  
C. 62.533  
D. 65.14
2.3.0 Multiplying Decimals

Multiplying numbers with decimals is a two step process. First, multiply the numbers as if they were whole numbers. Then place the decimal point in the correct location. The example below shows the product of 1.2 and 3.4, before the decimal is placed.

\[
\begin{array}{c}
1.2 \\
\times 3.4 \\
\end{array}
\]

\[
\begin{array}{c}
408 \\
\end{array}
\]

To get the correct location for the decimal point, count the number of decimal places in each number and add the number of decimal places. In this case, each number has one decimal place, so the product will have two decimal places. The product of the equation is 4.08.

Test your Knowledge (Select the Correct Response)

4. What is the product of 21.34 and 5.964?

A. 127.271  
B. 1272.71  
C. 127.422  
D. 1274.22

2.4.0 Dividing Decimals

Dividing numbers with decimals is a four step process.

1. Convert the divisor to a whole number. A divisor of .2 becomes 2.

2. Convert the dividend by the same number of decimal places as the divisor. In this case, 2.34 becomes 23.4.

3. Divide the two numbers as shown below.

\[
\begin{array}{c}
2 \overline{)23.4} \\
2 \\
3 \\
2 \\
14 \\
14 \\
0 \\
\end{array}
\]

4. Place the decimal according to the number of decimal places in the dividend.
Test your Knowledge (Select the Correct Response)

5. What is the result of dividing 246.81 by 12.3?
   A. 0.0498
   B. 4.983
   C. 2.007
   D. 20.07

3.0.0 FRACTIONS

A fraction is a part of a whole. Fractions are usually written as two numbers separated by a slash, such as 1/2. The slash means the same thing as the division sign (÷), so 1/2 = 1 ÷ 2. Figure 1-3 shows a whole triangle shaded blue and a triangle with one half (1/2) shaded blue.

The bottom number of a fraction is called the denominator and tells how many parts the whole is being divided into. The top number of a fraction is called the numerator and tells how many of the parts are being used. In the example of 1/2, 2 is the denominator and 1 is the numerator. The denominator and numerator are also known as the terms of the fraction.

Equivalent fractions are different fractions which mean the same amount. For example, 1/2 is an equivalent fraction to 2/4, 10/20, and 25/50.

3.1.0 Reducing Fractions to their Lowest Terms

Fractions shown with different numbers can have the same value. Fractions are easier to work with when they are at the lowest terms possible. For example, it is easier to work with the fraction 1/2 than it is to work with the equivalent fraction 17/34. To reduce a fraction to its lowest terms, there are two steps.

1. Determine what the largest number is that will divide evenly into both the numerator and the denominator. If the only number that will divide evenly into both numbers is 1, the fraction is at its lowest terms.

2. Divide both the numerator and denominator by the number you determined in Step 1. For the fraction 8/32, the largest number that evenly divides both the numerator 8 and the denominator 32 is 8. Reducing the fraction to its lowest terms looks like this:

   \[ \frac{8}{32} \div \frac{8}{8} = \frac{1}{4} \]
3.2.0 Comparing Fractions and Finding the Lowest Common Denominator

Comparing fractions is simple if the two fractions have the same denominator. In this case, the fraction with the larger numerator is larger than the fraction with the smaller numerator.

Most fractions that you need to compare won’t have the same denominator. You need to convert them to the same denominator to compare them. The simplest way to convert fractions to the same denominator is to multiply their denominators to get a common denominator, and then convert each fraction to the resulting denominator. For example, if you are comparing 3/4 to 5/7, you would convert and compare them as shown below.

1. Find the common denominator.
   \[4 \times 7 = 28\]
2. Convert each fraction to the common denominator.
   \[
   \frac{3}{4} \times \frac{7}{7} = \frac{21}{28} \\
   \frac{5}{7} \times \frac{4}{4} = \frac{20}{28}
   \]
3. Compare the fractions. You find that 3/4 is larger than 5/7.

Just as you can find the lowest terms for single fractions, you can find the lowest common denominator for multiple fractions.

1. Reduce both fractions to their lowest terms.
2. Determine the lowest common multiple for the denominators. You may find that one denominator is a multiple of the other. For example, if you are comparing 1/4 and 3/8, the denominator 8 is a multiple of the denominator 4.
3. Convert the fractions to equivalent fractions with the common denominator.
   \[
   \frac{1}{4} \times \frac{2}{2} = \frac{2}{8} \\
   \frac{3}{8} \times \frac{1}{1} = \frac{3}{8}
   \]
4. Compare the fractions. You find that 1/4 is smaller than 3/8.

3.3.0 Adding Fractions

Sometimes you calculate a number in which the numerator is larger than the denominator. This is called an improper fraction. You can convert an improper fraction to a whole number and a fraction, which is known as a mixed number. Start by adding the fractions as you would normally. To add 5/7 to 3/4:

1. Find the common denominator.
   \[7 \times 4 = 28\]
2. Convert each fraction to the common denominator.
   \[
   \frac{5}{7} \times \frac{4}{4} = \frac{20}{28}
   \]
\[
\frac{3}{4} \times \frac{7}{7} = \frac{21}{28}
\]

3. Add the numerators of the fractions, and place the sum over the common denominator. Do NOT add the denominators.

\[
\frac{20}{28} + \frac{21}{28} = \frac{41}{28}
\]

4. Convert the improper fraction to a mixed number.

\[
41 \div 28 = 1 \text{ with a remainder of } 13 \text{ or } 1 \frac{13}{28}
\]

The remainder becomes the numerator for the fraction portion of the mixed number. The resulting mixed number is \(1 \frac{13}{28}\).

**Test your Knowledge (Select the Correct Response)**

6. \(\frac{12}{24} + \frac{6}{16} = \)
   
   A. 18/24  
   B. 1 1/8  
   C. 7/8  
   D. 18/40

### 3.4.0 Subtracting Fractions

When you need to subtract measurements that include fractions on construction projects, it is very similar to adding fractions. If the denominators of the fractions are the same, subtract the numerators, place the result over the denominator, and reduce the resulting fraction to its lowest terms. If the denominators are not the same, follow these steps.

1. Write out the equation.

\[
\frac{3}{4} - \frac{1}{8} = x
\]

2. Determine the common denominator for the fractions you need to subtract. For the fractions 3/4 and 1/8, the common denominator is

\[
4 \times 8 = 32
\]

3. Convert the fractions to equivalent fractions with the common denominator.

\[
\frac{3}{4} \times \frac{8}{8} = \frac{24}{32} \\
\frac{1}{8} \times \frac{4}{4} = \frac{4}{32}
\]

4. Subtract the numerators of the fractions, and place the result over the common denominator. Do NOT subtract the denominators.

\[
\frac{24}{32} - \frac{4}{32} = \frac{20}{32}
\]

5. Reduce the resulting fraction to its lowest terms.

\[
\frac{20}{32} \div \frac{4}{4} = \frac{5}{8}
\]

Sometimes you need to subtract a fraction from a whole number. To do this you need to convert the whole number to an equivalent fraction, and then make your subtraction. In this example we’ll subtract \(\frac{5}{8}\) from 1.
1. Write out the equation.
   \[ 1 - \frac{5}{8} = x \]

2. Convert the whole number to an equivalent fraction.
   \[ 1 \times \frac{8}{8} = \frac{8}{8} \]

3. Subtract the numerators of the fractions, and place the result over the common denominator. Do NOT subtract the denominators.
   \[ \frac{8}{8} - \frac{5}{8} = \frac{3}{8} \]

4. Reduce the resulting fraction to its lowest terms. In this case the result is already in its lowest terms.

**Test your Knowledge (Select the Correct Response)**

7. \( \frac{5}{8} - \frac{3}{16} = \)

   A. \( \frac{2}{12} \)
   B. \( \frac{1}{6} \)
   C. \( \frac{7}{16} \)
   D. \( \frac{3}{8} \)

*3.5.0 Multiplying Fractions*

Multiplying fractions is fairly simple, since you don’t need to worry about finding a common denominator. When you read or hear that you need to find a part of a number, such as \( \frac{3}{8} \) of \( \frac{5}{6} \), it means you need to multiply the numbers using the steps below.

1. Write out the equation.
   \[ \frac{3}{8} \times \frac{5}{6} = x \]

2. Multiply the numerators.
   \[ 3 \times 5 = 15 \]

3. Multiply the denominators.
   \[ 8 \times 6 = 48 \]

4. Reduce the resulting fraction to its lowest terms.
   \[ \frac{15}{48} \div \frac{3}{3} = \frac{5}{16} \]

In this case, 3 is the largest number that can be evenly divided into both the numerator and the denominator. You may find it easier to work with the fractions if you reduce them to their lowest terms before you multiply them.

**Test your Knowledge (Select the Correct Response)**

8. \( \frac{2}{8} \times \frac{10}{16} = \)

   A. \( \frac{20}{16} \)
   B. \( 1 \ 1/4 \)
   C. \( \frac{5}{32} \)
   D. \( 1 \ 2/8 \)
3.6.0 Dividing Fractions

Dividing fractions is very similar to multiplying fractions, except that you invert or flip the fraction by which you are dividing. Use the following steps to divide $\frac{7}{8}$ by $\frac{1}{4}$.

1. Write out the equation.
   
   \[ \frac{7}{8} \div \frac{1}{4} = x \]

2. Invert the fraction you are dividing by.
   
   \[ \frac{1}{4} \text{ becomes } \frac{4}{1} \]

3. Convert the division sign (÷) to a multiplication sign (x) and write the new equation.
   
   \[ \frac{7}{8} \div \frac{1}{4} \text{ becomes } \frac{7}{8} \times \frac{4}{1} \]

4. Multiply the numerators.
   
   \[ 7 \times 4 = 28 \]

5. Multiply the denominators.
   
   \[ 8 \times 1 = 8 \]

6. Reduce the resulting fraction to its lowest terms.
   
   \[ \frac{28}{8} \div \frac{4}{4} = \frac{7}{2} \]

7. Convert the improper fraction to a mixed number.
   
   \[ 3 \frac{1}{2} \]

Test your Knowledge (Select the Correct Response)

9. \[ \frac{3}{8} \div \frac{3}{6} = \]
   
   A. \[ \frac{3}{4} \]
   B. \[ \frac{9}{48} \]
   C. \[ \frac{3}{16} \]
   D. \[ \frac{6}{8} \]

4.0.0 CONVERSIONS – FRACTIONS and DECIMALS

There will be times when you need to convert numbers so that all of the numbers you are working with are in the same format. The most common conversions you will work with are from fractions to decimals and from decimals to fractions.

4.1.0 Converting Fractions to Decimals

To convert a number from a fraction to a decimal, divide the numerator by the denominator. The fraction $\frac{5}{8}$ can be converted as shown.

\[
\begin{array}{c}
5.000 \\
8 \underline{-4.8} \\
-4.8 \\
-4.8 \\
\hline
-0.20 \\
-0.16 \\
-0.16 \\
-0.16 \\
\hline
-0.040 \\
-0.040 \\
-0.040 \\
-0.040 \\
\hline
0
\end{array}
\]

\[ \frac{5}{8} = 0.625 \]
4.2.0 Converting Decimals to Fractions

There are three steps to convert a decimal to a fraction. The decimal .125 can be converted to a fraction as follows:

1. Place the number to the right of the decimal point in the numerator.
   
   \( \frac{125}{1} \)

2. Count the number of decimal places in the number. Place this number of zeros following a 1 in the denominator.
   
   \( \frac{125}{1000} \)

3. Reduce the fraction to its lowest terms.
   
   \( \frac{125}{1000} \div \frac{125}{125} = \frac{1}{8} \)

4.3.0 Converting Inches to Decimal Equivalents in Feet

Sometimes you will need to convert measurements in inches to decimal equivalents in feet. You can calculate what the decimal equivalent in feet would be for 6 inches with the following steps.

1. Show the measurement as a fraction of a foot. Use 12 as the denominator, since there are 12 inches in a foot.
   
   \( \frac{6}{12} \)

2. Reduce the fraction to its lowest terms.
   
   \( \frac{6}{12} \div \frac{6}{6} = \frac{1}{2} \)

3. Convert the fraction to a decimal. Divide the numerator by the denominator.

   \[
   \begin{array}{c|c}
   \text{2} & \text{1.0} \\ \\
   \text{-1.0} & \\ \\
   \hline
   
   \text{0} \\
   \end{array}
   \]

   The result is that 6 inches converts to .5 foot.

Test your Knowledge (Select the Correct Response)

10. Is 14 inches = 1.17 feet?

   A. Yes
   B. No

5.0.0 RATIOS and PROPORTIONS

5.1.0 Ratios

A ratio is a comparison of two numbers, which can be expressed in three ways. A comparison of the numbers 1 and 2 can be expressed as follows:

1:2
One place where ratios come into play for Builders is Rule 42 for concrete mixes. This rule specifies a ratio of 1:2:4 for cement, sand, and aggregates.

Ratios can be used to calculate the quantities of materials needed for a project. If your specifications call for a 1:2:4 concrete mix with 2-inch coarse aggregates, you use Rule 42 to figure the material amounts.

1. Add 1:2:4, which gives you 7.
2. Divide 42 by 7 to figure the prime number.
   \[ 42 \text{ cu ft} \div 7 = 6 \text{ cu ft} \]
3. Compute your material requirements by multiplying the prime number by the ratio as follows:
   - \( 1 \times 6 = 6 \text{ cu ft of cement} \)
   - \( 2 \times 6 = 12 \text{ cu ft of sand} \)
   - \( 4 \times 6 = 24 \text{ cu ft of coarse aggregates} \)

### 5.2.0 Proportions

A proportion is an equation showing a ratio on each side. The equation shows that the two ratios are equal, as shown below:

\[ 1:2 = 2:4 \]

You will usually work with proportions to figure an unknown number on one side of the equation. If you have a ratio of 1:2 and need to figure the equivalent ratio of \( n:8 \), there are three steps.

1. Write out the proportion.
   \[ 2:4 = n:8 \]
   OR
   \[ \frac{2}{4} = \frac{n}{8} \]
2. Use the cross product.
   \[ 4 \times n = 2 \times 8 \]
   \[ 4n = 16 \]
3. Solve the proportion.
   \[ n = \frac{16}{4} \]
   \[ n = 4 \]

The solved proportion is \( 2:4 = 4:8 \).
6.0.0 PERCENTAGES

A percentage is a number expressed as a fraction of 100. You will usually see percentages with the percent sign, as in 35%.

You can calculate the percentage of a material that has been used in two steps.

1. Divide the used amount by the initial amount.
2. Multiply the result by 100.

If you had an initial supply of 300 sheets of plywood and you have used 80 of them, you calculate the percent used as follows:

\[
\frac{80}{300} = .27
\]

\[
.27 \times 100 = 27\%
\]

If you need to know what percent you have remaining, you subtract the percent used from 100, as follows:

\[
100 - 27 = 73\%
\]

If you have not calculated the percent used, you can still calculate the percent remaining with two steps.

1. Calculate the amount remaining.
   \[
   300 - 80 = 220
   \]
2. Calculate the percent remaining.
   \[
   \frac{220}{300} = .73
   \]
   \[
   .73 \times 100 = 73\%
   \]

Test your Knowledge (Select the Correct Response)
11. If you started with 400 concrete masonry units, and you have used 175 of them, what percent have you used?

   A. 2.286%
   B. 22.86%
   C. .4375%
   D. 43.75%

7.0.0 CONVERSIONS – PERCENTAGES and DECIMALS

7.1.0 Converting Percentages to Decimals

Convert a percentage to a decimal by dividing the percent by 100. If you need the decimal equivalent of 37%, perform the following calculation:

\[
37/100 = .37
\]

7.2.0 Converting Decimals to Percentages

Convert a decimal to a percentage by multiplying the decimal by 100. If you need the
percentage equivalent of .74, perform the following calculation:

\[ .74 \times 100 = 74\% \]

### 8.0.0 SQUARE ROOTS

The square root of a number is a value that, multiplied by itself, gives the original number. In other words, if you have a value \( x \), the square root \( r \) is a number such that \( r^2 = x \). A simple example is the square root of 9, which is 3.

There is a table in Appendix I of NAVEDTRA 14139 Mathematics, Basic Math, and Algebra called Squares, Cubes, Square Roots, Cube Roots, Logarithms, and Reciprocals of Numbers that you can use to look up a square root. If that resource or a calculator with a square root function is not available, there are several methods of calculating a square root. The simplest of these methods is called the Babylonian Method, which is repeated until you get as close to the square root as you need to. In this example we will calculate the square root of 8.

1. Estimate a number that you think is close to the square root. The closest squares to 8 are 2 (\( 2^2 = 4 \)) and 3 (\( 3^2 = 9 \)). For this example, use 3 as the estimate.

2. Divide the number you are trying to calculate the square root of by your estimate.
   \[ \frac{8}{3} = 2.67 \]

3. Add that number to your estimate.
   \[ 3 + 2.67 = 5.67 \]

4. Divide the sum by 2.
   \[ \frac{5.67}{2} = 2.835 \]

5. Test your result by multiplying the number by itself. If the result is accurate enough, great! Stop here.

6. If the number is not accurate enough, use the result as your new estimate. In our example, when 2.835 is squared, the result is 8.037225. Using a second round brings us to a possible square root of 2.828, with a result of 7.997584.

7. Repeat these steps until you have as accurate a result as you need.

**Test your Knowledge (Select the Correct Response)**

**12.** What is the square root of 10?

A. 4.0025  
B. 3.1275  
C. 3.1623  
D. 2.9876

### 9.0.0 METRIC SYSTEM

The metric system is a decimal-based system of units. We will focus on units of weight, length, volume, and temperature.
9.1.0 Units of Weight

The standard metric unit of mass is the gram. Table 1-1 shows units of mass, their equivalents in grams, and the abbreviations for the units of mass.

Table 1-1 – Metric Units of Mass.

<table>
<thead>
<tr>
<th>Unit of Mass</th>
<th>Equivalent in Grams</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 milligram</td>
<td>0.001 gram</td>
<td>mg</td>
</tr>
<tr>
<td>1 centigram</td>
<td>0.01 gram</td>
<td>cg</td>
</tr>
<tr>
<td>1 decigram</td>
<td>0.1 gram</td>
<td>dg</td>
</tr>
<tr>
<td>1 gram</td>
<td>1 gram</td>
<td>g</td>
</tr>
<tr>
<td>1 kilogram</td>
<td>1000 grams</td>
<td>kg</td>
</tr>
</tbody>
</table>

Rough equivalent masses of objects you might be familiar with are:

1 gram paper clip
1 kilogram liter of water

9.2.0 Units of Length

The standard metric unit of length is the meter. Table 1-2 shows units of length, their equivalents in meters, and the abbreviations for the units of length.

Table 1-2 – Metric Units of Length.

<table>
<thead>
<tr>
<th>Unit of Length</th>
<th>Equivalent in Meters</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 millimeter</td>
<td>0.001 meter</td>
<td>mm</td>
</tr>
<tr>
<td>1 centimeter</td>
<td>0.01 meter</td>
<td>cm</td>
</tr>
<tr>
<td>1 decimeter</td>
<td>0.1 meter</td>
<td>dm</td>
</tr>
<tr>
<td>1 meter</td>
<td>1 meter</td>
<td>m</td>
</tr>
<tr>
<td>1 kilometer</td>
<td>1000 meters</td>
<td>km</td>
</tr>
</tbody>
</table>

Rough equivalent lengths of objects you might be familiar with are:

1 meter a little longer than 1 yard
1 centimeter nearly the diameter of a dime
1 millimeter about the thickness of a dime

9.3.0 Units of Volume

The standard metric unit of volume is the liter. Table 1-3 shows units of volume, their equivalents in liters, and the abbreviations for units of volume.
Table 1-3 – Metric Units of Volume.

<table>
<thead>
<tr>
<th>Unit of Volume</th>
<th>Equivalent in Liters</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 milliliter</td>
<td>0.001 liter</td>
<td>ml</td>
</tr>
<tr>
<td>1 centiliter</td>
<td>0.01 liter</td>
<td>cl</td>
</tr>
<tr>
<td>1 deciliter</td>
<td>0.1 liter</td>
<td>dl</td>
</tr>
<tr>
<td>1 liter</td>
<td>1 liter</td>
<td>l</td>
</tr>
<tr>
<td>1 kiloliter</td>
<td>1000 liters</td>
<td>kl</td>
</tr>
</tbody>
</table>

Rough equivalent volumes of objects you might be familiar with are:

- 1 liter         a little more than a quart
- 5 millimeters   about one teaspoon

9.4.0 Units of Temperature

The standard metric unit of temperature is the degree Celsius. The boiling point of water at sea level is 100°Celsius, or 100°C. The freezing point of water at sea level is 0°Celsius, or 0°C. A day with a temperature of 30°C is considered hot.

9.5.0 Metric Conversion

There will be times when you need to convert to metric equivalents of measurements. *Table 1-4* shows conversions for some of the most common measurements.
### Table 1-4 – Conversion to Metric Equivalents.

<table>
<thead>
<tr>
<th>English Symbol</th>
<th>When You Know</th>
<th>Multiply By</th>
<th>To Find</th>
<th>Metric Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>LENGTH</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>in</td>
<td>inches</td>
<td>25.4</td>
<td>millimeters</td>
<td>mm</td>
</tr>
<tr>
<td>ft</td>
<td>feet</td>
<td>0.305</td>
<td>meters</td>
<td>m</td>
</tr>
<tr>
<td>yd</td>
<td>yards</td>
<td>0.914</td>
<td>meters</td>
<td>m</td>
</tr>
<tr>
<td>mi</td>
<td>miles</td>
<td>1.61</td>
<td>kilometers</td>
<td>km</td>
</tr>
<tr>
<td>AREA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>in²</td>
<td>square inches</td>
<td>645.2</td>
<td>square millimeters</td>
<td>mm²</td>
</tr>
<tr>
<td>ft²</td>
<td>square feet</td>
<td>0.0903</td>
<td>square meters</td>
<td>m²</td>
</tr>
<tr>
<td>yd²</td>
<td>square yards</td>
<td>0.836</td>
<td>square meters</td>
<td>m²</td>
</tr>
<tr>
<td>ac</td>
<td>acres</td>
<td>0.405</td>
<td>hectares</td>
<td>ha</td>
</tr>
<tr>
<td>mi²</td>
<td>square miles</td>
<td>2.59</td>
<td>square kilometers</td>
<td>km²</td>
</tr>
<tr>
<td>VOLUME</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>fl oz</td>
<td>fluid ounces</td>
<td>29.57</td>
<td>milliliters</td>
<td>mL</td>
</tr>
<tr>
<td>gal</td>
<td>gallons</td>
<td>3.785</td>
<td>liters</td>
<td>L</td>
</tr>
<tr>
<td>ft³</td>
<td>cubic feet</td>
<td>0.028</td>
<td>cubic meters</td>
<td>m³</td>
</tr>
<tr>
<td>yd³</td>
<td>cubic yards</td>
<td>0.765</td>
<td>cubic meters</td>
<td>m³</td>
</tr>
<tr>
<td>MASS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>oz</td>
<td>ounces</td>
<td>28.35</td>
<td>grams</td>
<td>g</td>
</tr>
<tr>
<td>lb</td>
<td>pounds</td>
<td>0.454</td>
<td>kilograms</td>
<td>kg</td>
</tr>
<tr>
<td>T</td>
<td>short tons</td>
<td>0.907</td>
<td>Megagrams</td>
<td>Mg (or “t”)</td>
</tr>
<tr>
<td></td>
<td>(2000 lb)</td>
<td></td>
<td>(“metric ton”)</td>
<td></td>
</tr>
<tr>
<td>TEMP</td>
<td>°F</td>
<td></td>
<td>Celsius</td>
<td>°C</td>
</tr>
<tr>
<td></td>
<td>Fahrenheit</td>
<td>(F-32) x 5/9</td>
<td>Or (F-32)/1.8</td>
<td></td>
</tr>
</tbody>
</table>

**Test your Knowledge (Select the Correct Response)**

13. What is the equivalent in meters of 2 yards?

A. 1828 m  
B. 182.8 m  
C. 18.28 m  
D. 1.828 m
10.0.0 USING MEASURING TOOLS

Measuring tools are a key part of a Builder's toolkit. You will most likely use a **standard (English) ruler**, an **architect's scale**, and a **metric ruler**, as shown in **Figure 1-4**. There are conversions between standard and metric measurements, but you will have better results if you measure with the appropriate ruler, such as a standard ruler when you are working in the United States.

![Figure 1-4 – Types of measurement tools.](image)

10.1.0 Using a Standard Ruler

A standard ruler is divided into inches and feet. Inches are divided into fractions of an inch, including halves, fourths, eighths, and sixteenths, as represented in **Figure 1-5**. There are some rulers that are further divided into thirty-seconds and sixty-fourths of an inch.

![Figure 1-5 – Inch divided into 16ths.](image)

An English or metric ruler is read from left to right. The arrow in **Figure 1-6** is at 2 and 5/16 inches.
10.2.0 Using the Architect’s Scale

An architect’s scale is used to read all plans except site plans. It measures interior and exterior dimensions for structures and buildings, including rooms, walls, doors, and windows. Table 1-5 shows scales that are generally grouped in pairs using the same dual-numbered index line.

Table 1-5 – Common Architect Scale Groupings.

<table>
<thead>
<tr>
<th>Scale One</th>
<th></th>
<th></th>
<th>Scale Two</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Abbreviation</td>
<td>Ratio Equivalent</td>
<td>Description</td>
<td>Abbreviation</td>
<td>Ratio Equivalent</td>
</tr>
<tr>
<td>Three inches to the foot</td>
<td>3” = 1’ 0”</td>
<td>1:4</td>
<td>One and one half inches to the foot</td>
<td>1 1/2” = 1’ 0”</td>
<td>1:8</td>
</tr>
<tr>
<td>One inch to the foot</td>
<td>1” = 1’ 0”</td>
<td>1:12</td>
<td>One half inch to the foot</td>
<td>1/2” = 1’ 0”</td>
<td>1:24</td>
</tr>
<tr>
<td>Three quarters inch to the foot</td>
<td>3/4” = 1’ 0”</td>
<td>1:16</td>
<td>Three eighths inch to the foot</td>
<td>3/8” = 1’ 0”</td>
<td>1:32</td>
</tr>
<tr>
<td>One quarter inch to the foot</td>
<td>1/4” = 1’ 0”</td>
<td>1:48</td>
<td>One eighth inch to the foot</td>
<td>1/8” = 1’ 0”</td>
<td>1:96</td>
</tr>
<tr>
<td>Three sixteenths inch to the foot</td>
<td>3/16” = 1’ 0”</td>
<td>1:64</td>
<td>Three thirty-seconds inch to the foot</td>
<td>3/32” = 1’ 0”</td>
<td>1:128</td>
</tr>
</tbody>
</table>

Numbers on architect scales can be read from left to right or right to left, depending on which scale you are using. Unlike standard rulers, the 0 point on an architect’s scale is not at the end of the measuring line. Any numbers below 0 represent fractions of one foot.

Determine what scale you need to use from the drawing you are working with. Find the matching scale on one of the ends of the architect’s scale you are using. If the scale you need is shown on the left of the architect’s scale, measure and read from left to right. If the scale you need is shown on the right of the architect’s scale, measure and read from right to left. Figure 1-7 shows measurement on the 1/8” = 1’ 0” scale, Figure 1-8 shows measurement on the 1/4” = 1’ 0” scale.
This diagram shows a reading of 21’ 4” on the one eighth inch to the foot scale, reading from left to right. Notice that the numbers for this scale are the top set, reading 0, 4, 8, 12, etc. The feet are measured to the right of the zero on the scale; the inches are measured to the left of the zero on the scale. The numbers in the bottom set, reading 46, 44, 42, 40, etc. are for the one quarter inch to the foot scale.

This diagram shows a reading of 6’ 2” on the one fourth inch to the foot scale, reading from right to left. Notice that the numbers for this scale are the bottom set, reading 0, 2, 4, 6, etc. The feet are measured to the left of the zero on the scale; the inches are measured to the right of the zero on the scale. The numbers in the top set, reading 56, 60, 64, 72, etc. are for the one eighth inch to the foot scale.

10.3.0 Using a Metric Ruler

A metric ruler is divided into millimeters and centimeters, which makes it fairly easy to read, as shown in Figure 1-9.

Centimeters are shown as larger lines with numbers; millimeters are shown as smaller lines. One millimeter is 1/10th of a centimeter.
11.0.0 CONSTRUCTION GEOMETRY

Measurements of shapes are a basic part of construction you will use every day. You should be familiar with measuring basic shapes like circles, triangles, squares, and rectangles.

11.1.0 Angles

Two straight lines that meet at a common point form an angle. The point where the lines meet to form the angle is called a vertex. Angles are measured with a tool called a protractor, using degrees. There are many different types of angles, as shown in Figure 1-10.

11.1.1 Acute angle

An acute angle measures between 0 and 90 degrees. Common acute angles measure 30, 45, and 60 degrees as shown in Figure 1-10.

![Figure 1-10 – Acute angles.](image)

11.1.2 Right Angle

A right angle measures 90 degrees. The two lines that form a right angle are perpendicular to each other as shown in Figure 1-11. This is the angle that is used most in construction. It is indicated in drawings by the symbol \( \perp \).

![Figure 1-11 – Right angle.](image)

11.1.3 Obtuse Angle

An obtuse angle measures between 90 and 180 degrees. Common obtuse angles are 120, 135, and 150 degrees as shown in Figure 1-12.

![Figure 1-12 – Obtuse angles.](image)
11.1.4 Straight Angle
A straight angle measures 180 degrees, a flat line, as shown in Figure 1-13.

![Figure 1-13 – Straight angle.](image)

11.1.5 Adjacent Angles
Adjacent angles are right next to each other; they share a vertex and one side as shown in Figure 1-14.

![Figure 1-14 – Adjacent angles.](image)

11.1.6 Opposite Angles
Opposite angles are formed by two straight lines that cross; they are always equal as shown in Figure 1-15.

![Figure 1-15 – Opposite angles.](image)
11.2.0 Shapes
Your work in construction involves common geometric shapes. These shapes include rectangles, squares, triangles, and circles.

11.2.1 Rectangle
A rectangle is a four sided shape with all four angles being right angles. All four angles in a rectangle add up to 360° as shown in Figure 1-16. A rectangle has two pairs of parallel sides, which makes a rectangle a parallelogram. In a rectangle, the longer sides define the length of the rectangle; the shorter sides define the width.

11.2.2 Square
A square is a special rectangle with four right angles and equal length parallel sides as shown in Figure 1-17. Each angle in a square is 90°, totaling 360° for all four angles.

11.2.3 Triangle
A triangle is a basic shape in geometry, with three sides or edges, also known as line segments. A triangle is a polygon with three corners, or vertices. The three angles of a triangle always add up to 180° as shown in Figure 1-18.

Types of triangles are classified by the relative lengths of their sides.

Right Triangle – A right triangle has one 90°, or right, angle as shown in Figure 1-19. The longest side of the right triangle is opposite the right angle, and is called the hypotenuse. The other two sides of the right triangle are called the legs.
**Equilateral Triangle** – An equilateral triangle has all three sides of an equal length; this makes it equilinear. It is also equiangular, which means that all three of its internal angles are the same, 60° as shown in Figure 1-20.

![Figure 1-20 – Equilateral triangle.](image)

**Isosceles Triangle** – An isosceles triangle has two sides of equal length as shown in Figure 1-21. An isosceles triangle also has two angles equal to each other; the angles opposite the equal sides.

![Figure 1-21 – Isosceles triangle.](image)

**Scalene Triangle** – A scalene triangle has three sides of different lengths as shown in Figure 1-22. The angles inside a scalene triangle are also all different.

![Figure 1-22 – Scalene triangle.](image)

**11.2.4 Circle**

A circle is a simple closed curve where every point on the curved line is the same distance from the center. A circle always measures 360° as shown in Figure 1-23. There are three measurements you can make of a circle, as shown in Figure 1-24. The **circumference** of a circle is the outside perimeter of the circle. The **diameter** of a circle is a line straight through the circle from one point on the outside to a point directly opposite on the outside. The **radius** of a circle is the distance from the center of the circle to a fixed point on the outside of the circle. The radius is half of the diameter of the circle.

![Figure 1-23 – Circle.](image)
11.3.0 Area of Shapes

Area is a measurement of the two-dimensional size of a surface. Calculations for the area of shapes differ according to the type of shape.

11.3.1 Rectangle

The area (A) of a rectangle is the product of its length (L) and its width (W). This is expressed as

\[ A = L \times W \]

If you need to paint a wall that is 12 feet long and 8 feet high, you calculate the area of the wall based on a rectangle with a length of 12 feet and a width of 8 feet.

\[ A = 12 \text{ feet} \times 8 \text{ feet} = 96 \text{ feet}^2 \]

11.3.2 Square

The area of a square is the product of the length (L) of its sides.

\[ A = L^2 \]

If you need to tile a counter that is 3 feet square, you calculate the area of the counter based on a 3 foot square.

\[ A = 3^2 \text{ feet} = 9 \text{ feet}^2 \]
11.3.3 Circle
The area enclosed by a circle is the radius of the circle squared multiplied by π. The radius is one half of the diameter of the circle.

\[ A = R^2 \times \pi \]

If you need sealer to cover a circular driveway 16 feet in diameter, you calculate the area of the driveway based on a radius of 8 feet.

\[ A = 8^2 \text{ feet} \times 3.14 = 64 \text{ feet} \times 3.14 = 201 \text{ square feet} \]

11.3.4 Triangle
The area of a triangle is the base times the height times 0.5.

\[ A = B \times H \times 0.5 \]

If you need siding to cover a triangular shape 4 feet wide and 3 feet high, you calculate the area of the triangular shape based on a triangle with a base of 4 feet and a height of 3 feet.

\[ A = 4\text{feet} \times 3 \text{feet} \times 0.5 = 6 \text{feet}^2 \]

Test your Knowledge (Select the Correct Response)
14. What is the area of a triangle with a base of 5 feet and a height of 8 feet?

A. 40 square feet
B. 20 square feet
C. 32 square feet
D. 36 square feet

11.4.0 Volume of Shapes
The volume of any solid, liquid or gas is how much three-dimensional space it occupies. Volumes of straight edged and circular shapes are calculated using arithmetic formulae based on length, width, and height. Volume is measured in cubic units, as shown in Table 1-6.
Table 1-6 – Cubic Measurements.

<table>
<thead>
<tr>
<th>Cubic Measure</th>
<th>Full Expression</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cubic inch</td>
<td>1 inch x 1 inch x 1 inch</td>
<td>inch³</td>
</tr>
<tr>
<td>Cubic foot</td>
<td>1 foot x 1 foot x 1 foot</td>
<td>foot³</td>
</tr>
<tr>
<td>Cubic yard</td>
<td>1 yard x 1 yard x 1 yard</td>
<td>yard³</td>
</tr>
<tr>
<td>Cubic centimeter</td>
<td>1 centimeter x 1 centimeter x 1 centimeter</td>
<td>centimeter³</td>
</tr>
<tr>
<td>Cubic meter</td>
<td>1 meter x 1 meter x 1 meter</td>
<td>meter³</td>
</tr>
</tbody>
</table>

11.4.1 Rectangular Shape

The volume of a rectangular shape is the length times the width times the depth.

\[ V = L \times W \times D \]

If you need to figure how many cubic yards of concrete to order for a slab 15 feet long and 5 feet wide and 4 inches thick, you calculate the volume of the slab based on a length of 15 feet, a width of 10 feet, and a depth of 4 inches. This will take several steps.

1. Convert inches to feet.
   
   \[ 4 \text{ inches} \div 12 \text{ inches/foot} = .33 \text{ feet} \]

2. Figure the volume.
   
   \[ V = 15 \text{ feet} \times 10 \text{ feet} \times .33 \text{ feet} = 49.5 \text{ cubic feet} \]

3. Convert cubic feet to cubic yards.
   
   \[ 49.5 \text{ cubic feet} \div 27 \text{ cubic feet / cubic yard} = 1.83 \text{ cubic yards} \]

Figure 1-29 – Volume of a rectangular shape.
11.4.2 Cube

The volume of a cube, which is based on a square, is similar to the volume of a rectangle; it is the length times the width times the depth. The only difference is that all three measurements are the same in a cube.

If you need to figure how many cubic yards of concrete to order for a support member measuring 6 feet cubed, you calculate the volume of the support member based on the length, width, and depth each being 6 feet.

1. Figure the volume.
\[ V = 6 \text{ feet} \times 6 \text{ feet} \times 6 \text{ feet} = 216 \text{ cubic feet} \]

2. Convert cubic feet to cubic yards.
\[ 216 \text{ cubic feet} \div 27 \text{ cubic feet / cubic yard} = 8 \text{ cubic yard} \]
11.4.3 Cylinder

The volume of a cylinder, which is based on a circle, is \( \pi \) times the radius\(^2\) times the height of the cylinder. Another way to think of this is the area of the circle times the height of the cylinder.

If you need to figure how many cubic yards of concrete to order for a column 2 feet in diameter and 12 feet high, you calculate the volume of the column as follows:

1. Figure the area of the circle.
   \[ A = \pi \times 1 \text{ foot} = 3.14 \text{ square feet} \]
2. Figure the volume of the cylinder.
   \[ V = 3.14 \text{ square feet} \times 12 \text{ feet} = 37.68 \text{ cubic feet} \]
3. Convert cubic feet to cubic yards.
   \[ 37.69 \text{ cubic feet} \div 27 \text{ cubic feet} / \text{cubic yard} = 1.395 \text{ cubic yards} \]

11.4.4 Triangular Shape

The volume of a triangular shape is 0.5 times the base times the height times the depth. Another way to think of this is the area of the triangle times the height of the structure.

If you need to figure how many cubic yards of concrete to order for a triangular shape with a base of 2 feet, a height of 2 feet, and 16 feet long, you calculate the volume of the triangular shape as follows:

1. Figure the area of the triangle.
   \[ A = 0.5 \times 2 \text{ feet} \times 2 \text{ feet} = 2 \text{ sq feet} \]
2. Figure the volume of the triangular shape.
   \[ V = 2 \text{ square feet} \times 16 \text{ feet} = 32 \text{ cubic feet} \]
3. Convert cubic feet to cubic yards.
   \[ 32 \text{ cubic feet} \div 27 \text{ cubic feet} / \text{cubic yard} = 1.19 \text{ cubic yard} \]

Figure 1-32 – Volume of a triangular shape.
Test your Knowledge (Select the Correct Response)

15. What is the volume of a column 3 feet in diameter and 10 feet tall?

A. 28.26 square feet
B. 28.26 cubic feet
C. 10.47 square feet
D. 10.47 cubic feet

Summary

Use of math is an integral part of each day on a construction project. You need solid math skills on the job, whether you’re cutting wood, applying paint to a wall, or installing plumbing. Basic mathematical operations like addition, subtraction, multiplication, and division are critical skills for any construction crewmember. The ability to measure, mark, and use materials and supplies efficiently makes you a valuable part of your construction crew.
Review Questions (Select the Correct Response)

Based on this description of a number:

Digit in the units place: 3
Digit in the tens place: 5
Digit in the hundreds place: 8
Digit in the thousands place: 2

1. How should the number be written?
   A. 2,853
   B. 3,582
   C. 20,853
   D. 28,053

2. Based on the number 14,607 the numeral 4 is in what place?
   A. Tens
   B. Thousands
   C. Units
   D. Hundreds

3. What is the sum of 23.45 and 687.1?
   A. 92.16
   B. 921.6
   C. 71.055
   D. 710.55

4. What is the difference between 34.56 and 7.982?
   A. 26.578
   B. 54.74
   C. 45.26
   D. 4.526

5. What is the product of 43.12 and 4.695?
   A. 20.2448
   B. 202.448
   C. 2024.48
   D. 20244.8

6. What is the result of dividing 186.42 by 32.1?
   A. 5807
   B. 58.07
   C. 5.807
   D. .5807
For questions 7 and 8, is the fraction on the right the lowest term for the fraction on the left?

7. \( \frac{6}{16} = \frac{2}{8} \)
   A. True
   B. False

8. \( \frac{6}{8} = \frac{3}{4} \)
   A. True
   B. False

For questions 9 and 10, identify the lowest common denominator for each set of fractions.

9. \( \frac{2}{6} \) and \( \frac{3}{4} \)
   A. 12
   B. 10
   C. 8
   D. 6

10. \( \frac{1}{4} \) and \( \frac{3}{16} \)
    A. 12
    B. 14
    C. 16
    D. 18

For questions 11 and 12, add the following fractions. Identify the correct sum in its lowest terms.

11. \( \frac{2}{16} + \frac{1}{4} = \)
    A. \( \frac{6}{16} \)
    B. \( \frac{4}{16} \)
    C. \( \frac{3}{8} \)
    D. \( \frac{1}{8} \)

12. \( \frac{9}{12} + \frac{2}{8} = \)
    A. \( \frac{11}{20} \)
    B. \( \frac{1}{1} \)
    C. \( \frac{4}{4} \)
    D. \( \frac{3}{4} \)
For questions 13 and 14, subtract the following fractions. Identify the correct difference in its lowest terms.

13. \( \frac{4}{9} - \frac{1}{3} = \)
   
   A. \( \frac{3}{6} \)
   
   B. \( \frac{1}{9} \)
   
   C. \( \frac{1}{2} \)
   
   D. \( \frac{3}{9} \)

14. \( \frac{6}{8} - \frac{1}{4} = \)
   
   A. \( \frac{5}{4} \)
   
   B. \( 1 \frac{1}{4} \)
   
   C. \( \frac{2}{4} \)
   
   D. \( \frac{1}{2} \)

For questions 15 and 16, multiply the following fractions. Identify the correct product in its lowest terms.

15. \( \frac{3}{4} \times \frac{5}{8} = \)
   
   A. \( 1 \frac{5}{8} \)
   
   B. \( 1 \frac{7}{8} \)
   
   C. \( 3 \frac{3}{4} \)
   
   D. \( \frac{15}{32} \)

16. \( \frac{8}{16} \times \frac{32}{64} = \)
   
   A. \( \frac{1}{4} \)
   
   B. \( \frac{256}{64} \)
   
   C. \( 4 \)
   
   D. \( \frac{256}{16} \)

For questions 17 and 18, divide the following fractions. Identify the correct quotient in its lowest terms.

17. \( \frac{5}{8} \div \frac{1}{2} = \)
   
   A. \( \frac{10}{8} \)
   
   B. \( \frac{5}{8} \)
   
   C. \( \frac{8}{10} \)
   
   D. \( 1 \frac{1}{4} \)

18. On a scale drawing, if \( \frac{1}{4} \) of an inch represents a distance of 1 foot, what length does a line on the drawing measuring 8 1/2 inches long represent?
   
   A. \( 34 \) feet
   
   B. \( 36 \) feet
   
   C. \( 38 \) feet
   
   D. \( 40 \) feet
19. Is \( \frac{7}{8} = 0.875 \)?
   A. True
   B. False

20. Is \( 0.67 = \frac{2}{5} \)?
   A. True
   B. False

For questions 21 and 22, is the measurement in inches the same as the measurement in feet?

21. 9 inches = .95 feet
   A. True
   B. False

22. 10 inches = .83 feet
   A. True
   B. False

23. If you have 50 Builders (BUs) and 10 Engineering Aids (EAs), what is the ratio of EAs to BUs in simplest terms?
   A. 50:10
   B. 10:50
   C. 5:1
   D. 1:5

24. If you have a ratio of 1:9 Equipment Operators (EOs) to Builders (BUs), when you have 3 EOs, how many BUs do you have?
   A. 27
   B. 18
   C. 12
   D. 9

25. What percent of 8 is 6?
   A. 25%
   B. 33%
   C. 50%
   D. 75%
26. What is 33% of 120?
   A. 39.6
   B. 40.0
   C. 41.2
   D. 42.3

For questions 27 and 28, is the decimal on the left the same as the percentage on the right?

27. 0.62 = 62%
   A. True
   B. False

28. 1.47 = 14.7%
   A. True
   B. False

For questions 29 and 30, is the percentage on the left the same as the decimal on the right?

29. 12.5% = 1.25
   A. True
   B. False

30. 72% = 0.72
   A. True
   B. False

31. What is the square root of 8?
   A. 2.835
   B. 2.828
   C. 2.913
   D. 2.924

32. What is the equivalent in liters of 3 gallons?
   A. 1.1355 liters
   B. 11.355 liters
   C. 113.55 liters
   D. 1135.5 liters
33. What mark is the arrow at?
   A. 42 cm  
   B. 4.2 cm  
   C. 4.2 mm  
   D. 420 mm

34. What mark is A at?
   A. 1/4 inch  
   B. 1/2 inch  
   C. 1/16 inch  
   D. 1/8 inch

35. What mark is B at?
   A. 1/16 inch  
   B. 5/16 inch  
   C. 15/16 inch  
   D. 1 5/16 inch

36. How many degrees are in a right angle?
   A. 30º  
   B. 45º  
   C. 90º  
   D. 115º
37. What is the term for a straight line through a circle that runs from one point on the outside of the circle to another point directly on the outside of the circle?
   A. Circumference
   B. Radius
   C. Area
   D. Diameter

38. The area of a rectangle that is 8 feet long and 4 feet wide is
   A. 12 sq ft
   B. 22 sq ft
   C. 32 sq ft
   D. 36 sq ft

39. The area of a 16 centimeter square is
   A. 256 sq cm
   B. 265 sq cm
   C. 276 sq cm
   D. 278 sq cm

40. The area of a circle with a 14-foot diameter is
   A. 15.44 sq ft
   B. 153.86 sq ft
   C. 43.96 sq ft
   D. 196 sq ft

41. The area of a triangle with a base of 4 feet and a height of 6 feet is
   A. 36 sq ft
   B. 32 sq ft
   C. 24 sq ft
   D. 12 sq ft

42. If a concrete block measures 17 feet square and is 6 inches thick, its volume is
   A. 144.5 cu yd
   B. 5.35 cu yd
   C. 102 cu yd
   D. 3.77 cu yd

43. The volume of a 3 centimeter cube is
   A. 6 cu cm
   B. 9 cu cm
   C. 12 cu cm
   D. 27 cu cm
44. The volume of a cylinder that is 6 centimeters in diameter and 60 centimeters high is
   A. 1130.4 cu cm
   B. 1810.6 cu cm
   C. 1695.6 cu cm
   D. 6728.4 cu cm

45. The volume of a triangular shape that has a 6 inch base, a 2 inch height, and a 4 inch length is
   A. 12 sq in
   B. 24 cu in
   C. 48 sq in
   D. 36 cu in
Trade Terms Introduced in this Chapter

**Angle**
The figure formed by two rays (lines) sharing a common endpoint.

**Architect’s scale**
An architect’s scale is a specialized ruler. It is used in making or measuring from reduced scale drawings, such as blueprints and floor plans. It is marked with a range of calibrated scales (ratios).

**Circumference**
The distance around a closed curve. Circumference is a kind of perimeter.

**Common denominator**
An integer that is a multiple of the denominators of two or more fractions.

**Denominator**
The name for the bottom part of a fraction. It indicates how many equal parts make up a whole.

**Diameter**
Any straight line segment that passes through the center of the circle and whose endpoints are on the circle.

**Digit**
A symbol used in numerals to represent numbers in positional numeral systems.

**Improper fraction**
The absolute value of the numerator is greater than or equal to the absolute value of the denominator.

**Lowest common denominator**
The least common multiple of the denominators of a set of fractions. The smallest positive integer that is a multiple of the denominators.

**Metric ruler**
A ruler used for measuring with the metric system, generally divided into centimeters and millimeters.

**Mixed number**
The sum of a whole number and a proper fraction, such as 1 2/3.

**Negative number**
A number that is less than zero, such as −2.

**Numerator**
The name for the top part of a fraction. It indicates how many parts of a whole you are working with.

**Place value**
A numeral system in which each position is related to the next by a constant multiplier, such as 10.

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**Positive number**
A number that is greater than 0, such as 2.
**Protractor**  
A circular or semicircular tool for measuring an angle or a circle. The units of measurement used are generally degrees.

**Radius**  
Any line segment from the center of a circle to its perimeter.

**Standard (English) ruler**  
A ruler used for measuring with the English system, generally divided into inches, 1/2 inches, 1/4 inches, 1/8 inches, and 1/16 inches. Some standard rulers are further divided into 1/32 inches and 1/64 inches.

**Vertex**  
The point where two rays (line segments) begin or meet.
Additional Resources and References

This chapter is intended to present thorough resources for task training. The following reference works are suggested for further study. This is optional material for continued education rather than for task training.


http://en.wikipedia.org/wiki/Percentage

Operations with Decimals: http://cstl.syr.edu/fipse/Decunit/opdec/opdec.htm

U.S. Metric Association: http://lamar.colostate.edu/~hillger/

CliffsNotes.com. *How do you convert a fraction to a decimal or change a decimal to a fraction?* 5 Jun 2008 http://www.cliffsnotes.com/WileyCDA/Section/id-305405,articleId-7841.html


http://www.math.com/school/subject1/lessons/S1U1L9DP.html

The Math League http://www.mathleague.com/

Online Conversion: http://www.onlineconversion.com

Science Made Simple, Inc.:
http://www.scientcemadesimple.com/metric_conversion_chart.html
CSFE Nonresident Training Course – User Update

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