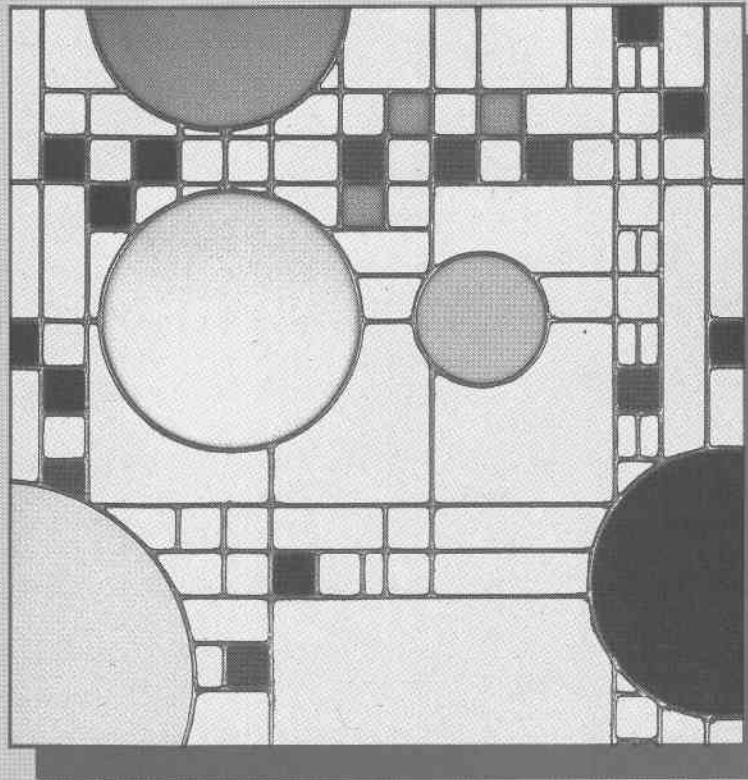


2

Measurement and Geometry



After completing this chapter, you should

Section 9.1 Measurement and the United States System

- know what the word measurement means
- be familiar with United States system of measurement
- be able to convert from one unit of measure in the United States system to another unit of measure

Section 9.2 The Metric System of Measurement

- be more familiar with some of the advantages of the base ten number system
- know the prefixes of the metric measures
- be familiar with the metric system of measurement
- be able to convert from one unit of measure in the metric system to another unit of measure

Section 9.3 Simplification of Denominate Numbers

- be able to convert an unsimplified unit of measure to a simplified unit of measure
- be able to add and subtract denominate numbers
- be able to multiply and divide a denominate number by a whole number

Section 9.4 Perimeter and Circumference of Geometric Figures

- know what a polygon is
- know what perimeter is and how to find it
- know what the circumference, diameter, and radius of a circle is and how to find each one
- know the meaning of the symbol π and its approximating value
- know what a formula is and four versions of the circumference formula of a circle

Section 9.5 Area and Volume of Geometric Figures and Objects

- know the meaning and notation for area
- know the area formulas for some common geometric figures
- be able to find the areas of some common geometric figures
- know the meaning and notation for volume
- know the volume formulas for some common geometric objects
- be able to find the volume of some common geometric objects

9.1 Measurement and the United States System

Section
Overview

- MEASUREMENT
- THE UNITED STATES SYSTEM OF MEASUREMENT
- CONVERSIONS IN THE UNITED STATES SYSTEM

MEASUREMENT

There are two major systems of measurement in use today. They are the *United States system* and the *metric system*. Before we describe these systems, let's gain a clear understanding of the concept of measurement.

Measurement

Measurement is comparison to some standard.

Standard Unit of Measure

The concept of measurement is based on the idea of direct comparison. This means that measurement is the result of the comparison of two quantities. The quantity that is used for comparison is called the **standard unit of measure**.

Over the years, standards have changed. Quite some time in the past, the standard unit of measure was determined by a king. For example,

1 inch was the distance between the tip of the thumb and the knuckle of the king.
1 inch was also the length of 16 barley grains placed end to end.

Today, standard units of measure rarely change. Standard units of measure are the responsibility of the Bureau of Standards in Washington D.C.

Some desirable properties of a standard are the following:

1. *Accessibility*. We should have access to the standard so we can make comparisons.
2. *Invariance*. We should be confident that the standard is not subject to change.
3. *Reproducibility*. We should be able to reproduce the standard so that measurements are convenient and accessible to many people.

THE UNITED STATES SYSTEM OF MEASUREMENT

Some of the common units (along with their abbreviations) for the United States system of measurement are listed in the following table.

UNIT CONVERSION TABLE

Length	1 foot (ft) = 12 inches (in.)
	1 yard (yd) = 3 feet (ft)
	1 mile (mi) = 5,280 feet
Weight	1 pound (lb) = 16 ounces (oz)
	1 ton (T) = 2,000 pounds
Liquid Volume	1 tablespoon (tbsp) = 3 teaspoons (tsp)
	1 fluid ounce (fl oz) = 2 tablespoons
	1 cup (c) = 8 fluid ounces
	1 pint (pt) = 2 cups
	1 quart (qt) = 2 pints
	1 gallon (gal) = 4 quarts
Time	1 minute (min) = 60 seconds (sec)
	1 hour (hr) = 60 minutes
	1 day (da) = 24 hours
	1 week (wk) = 7 days

☐ CONVERSIONS IN THE UNITED STATES SYSTEM

It is often convenient or necessary to convert from one unit of measure to another. For example, it may be convenient to convert a measurement of length that is given in feet to one that is given in inches. Such conversions can be made using *unit fractions*.

Unit Fraction

A **unit fraction** is a fraction with a value of 1.

Unit fractions are formed by using two equal measurements. One measurement is placed in the numerator of the fraction, and the other in the denominator. **Placement depends on the desired conversion.**

Placement of Units

Place the unit being converted *to* in the **numerator**.
Place the unit being converted *from* in the **denominator**.

For example,

Equal Measurements	Unit Fraction
1 ft = 12 in.	$\frac{1 \text{ ft}}{12 \text{ in.}}$ or $\frac{12 \text{ in.}}{1 \text{ ft}}$
1 pt = 16 fl oz	$\frac{1 \text{ pt}}{16 \text{ fl oz}}$ or $\frac{16 \text{ fl oz}}{1 \text{ pt}}$
1 wk = 7 da	$\frac{7 \text{ da}}{1 \text{ wk}}$ or $\frac{1 \text{ wk}}{7 \text{ da}}$

☆ SAMPLE SET A

Make the following conversions. If a fraction occurs, convert it to a decimal rounded to two decimal places.

1. Convert 11 yards to feet.

Looking in the unit conversion table under *length*, we see that $1 \text{ yd} = 3 \text{ ft}$. There are two corresponding unit fractions, $\frac{1 \text{ yd}}{3 \text{ ft}}$ and $\frac{3 \text{ ft}}{1 \text{ yd}}$. Which one should we use? Look to see which unit we wish to convert to. Choose the unit fraction with this unit in the *numerator*. We will choose $\frac{3 \text{ ft}}{1 \text{ yd}}$ since this unit fraction has feet in the numerator. Now, multiply 11 yd by the unit fraction. Notice that since the unit fraction has the value of 1, multiplying by it does not change the value of 11 yd.

$$\begin{aligned} 11 \text{ yd} &= \frac{11 \text{ yd}}{1} \cdot \frac{3 \text{ ft}}{1 \text{ yd}} \\ &= \frac{11 \cancel{\text{ yd}}}{1} \cdot \frac{3 \text{ ft}}{1 \cancel{\text{ yd}}} \\ &= \frac{11 \cdot 3 \text{ ft}}{1} \\ &= 33 \text{ ft} \end{aligned}$$

Divide out common units. (Units can be added, subtracted, multiplied, and divided, just as numbers can.)

Thus, $11 \text{ yd} = 33 \text{ ft}$.

Continued

2. Convert 36 fl oz to pints.

Looking in the unit conversion table under *liquid volume*, we see that 1 pt = 16 fl oz. Since we are to convert to pints, we will construct a unit fraction with pints in the numerator.

$$\begin{aligned} 36 \text{ fl oz} &= \frac{36 \text{ fl oz}}{1} \cdot \frac{1 \text{ pt}}{16 \text{ fl oz}} \\ &= \frac{36 \cancel{\text{ fl oz}}}{1} \cdot \frac{1 \text{ pt}}{16 \cancel{\text{ fl oz}}} \\ &= \frac{36 \cdot 1 \text{ pt}}{16} \end{aligned}$$

Divide out common units.

$$= \frac{36 \text{ pt}}{16}$$

Reduce.

$$= \frac{9}{4} \text{ pt}$$

Convert to decimals: $\frac{9}{4} = 2.25$.

Thus, 36 fl oz = 2.25 pt.

3. Convert 2,016 hr to weeks.

Looking in the unit conversion table under *time*, we see that 1 wk = 7 da and that 1 da = 24 hr. To convert from hours to weeks, we must first convert from hours to days and then from days to weeks. We need two unit fractions.

The unit fraction needed for converting from hours to days is $\frac{1 \text{ da}}{24 \text{ hr}}$. The unit fraction needed for

converting from days to weeks is $\frac{1 \text{ wk}}{7 \text{ da}}$.

$$2,016 \text{ hr} = \frac{2,016 \text{ hr}}{1} \cdot \frac{1 \text{ da}}{24 \text{ hr}} \cdot \frac{1 \text{ wk}}{7 \text{ da}}$$

Divide out common units.

$$= \frac{2,016 \cancel{\text{ hr}}}{1} \cdot \frac{1 \cancel{\text{ da}}}{24 \cancel{\text{ hr}}} \cdot \frac{1 \text{ wk}}{7 \cancel{\text{ da}}}$$

$$= \frac{2,016 \cdot 1 \text{ wk}}{24 \cdot 7}$$

Reduce.

$$= 12 \text{ wk}$$

Thus, 2,016 hr = 12 wk.

★ PRACTICE SET A

Make the following conversions. If a fraction occurs, convert it to a decimal rounded to two decimal places.

1. Convert 18 ft to yards.
2. Convert 2 mi to feet.
3. Convert 26 ft to yards.
4. Convert 9 qt to pints
5. Convert 52 min to hours.
6. Convert 412 hr to weeks.

Section 9.1 EXERCISES

For problems 1–30, make each conversion using unit fractions. If fractions occur, convert them to decimals rounded to two decimal places.

1. 14 yd to feet
2. 3 mi to yards
3. 8 mi to inches
4. 2 mi to inches
5. 18 in. to feet
6. 84 in. to yards
7. 5 in. to yards
8. 106 ft to miles
9. 62 in. to miles
10. 0.4 in. to yards
11. 3 qt to pints
12. 5 lb to ounces
13. 6 T to ounces
14. 4 oz to pounds