The Metric System

1. Understand the Basic Units of Length used in Health Care Careers

The metric system is the most commonly used system of measurement in the Health Care career field. A **meter** is the basic unit of length in the metric system and 1 meter (abbreviated 1 m) is approximately 3 inches longer than 1 yard. Both larger and smaller units of measure are expressed using a prefix on the word *meter*. Below are diagrams of meter sticks whose lengths are scaled with markings of unit measures that are less than 1 meter. The abbreviations for the prefix on the word *meter* are shown in the parenthesis.

1 meter = 10 **decimeters** (dm)

<table>
<thead>
<tr>
<th>dm</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>2.5</th>
<th>3</th>
<th>3.5</th>
<th>4</th>
<th>4.5</th>
<th>5</th>
<th>5.5</th>
<th>6</th>
<th>6.5</th>
<th>7</th>
<th>7.5</th>
<th>8</th>
<th>8.5</th>
<th>9</th>
<th>9.5</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 dm</td>
<td>0.5</td>
<td>1</td>
<td>1.5</td>
<td>2</td>
<td>2.5</td>
<td>3</td>
<td>3.5</td>
<td>4</td>
<td>4.5</td>
<td>5</td>
<td>5.5</td>
<td>6</td>
<td>6.5</td>
<td>7</td>
<td>7.5</td>
<td>8</td>
<td>8.5</td>
<td>9</td>
<td>9.5</td>
</tr>
</tbody>
</table>

1 meter = 100 **centimeters** (cm)

| cm | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 |
|----|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 0 cm | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 |

1 meter = 1,000 **millimeters** (mm)

| mm | 0 | 50 | 100 | 150 | 200 | 250 | 300 | 350 | 400 | 450 | 500 | 550 | 600 | 650 | 700 | 750 | 800 | 850 | 900 | 950 | 1000 |
|----|---|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0 mm | 50 | 100 | 150 | 200 | 250 | 300 | 350 | 400 | 450 | 500 | 550 | 600 | 650 | 700 | 750 | 800 | 850 | 900 | 950 | 1000 |

Use the above meter sticks and previous content to answer the following questions.

1) Write down the abbreviations for *meters*, *decimeters*, *centimeters*, and *millimeters*.

2) How does the abbreviation for miles differ from the abbreviation for meters?

3) Order the following lengths of measure from smallest to largest.
   - 1 dm, 1 mm, 1 m, 1 cm

4) Order the following lengths of measure from largest to smallest.
   - 450 mm, 40 cm, \( \frac{1}{2} \) m, 6 dm, 1 yd

5) A length of 3 dm is equal to a length of how many millimeters?

6) A length of 70 cm is equal to a length of how many decimeters?

7) A length of \( \frac{1}{4} \) m is equal to a length of how many millimeters?

8) A length of \( \frac{1}{5} \) m is equal to a length of how many decimeters?
Many of the things we use on a daily basis can help us estimate lengths of other objects. For example, the length of a dollar bill is 6.14 inches and its width is 2.61 inches. In metric units its length is approximately 16 cm and its width approximately 7 cm. A mechanical pencil is slightly smaller than the length of a dollar bill, and therefore its length can be approximated as 15 cm.

Here are some other items that we may use on a daily basis that can help us estimate metric lengths.

The diameter of a quarter is about 25 mm. A dime is about 1 mm thick.

A USB plug is about 1 cm wide. The diameter of a DVD is about 14 cm.

Using an incorrect metric prefix to represent measurements of quantities such as length, mass (weight), or drug dosages, can result in dangerous errors. In order to determine if a given or calculated quantity makes sense, we need to develop good estimation skills. Let’s now begin developing our estimation skills by doing problems that require us to write in an appropriate metric unit.

Fill in the blank with the appropriate metric unit. Choose m, dm, cm, or mm.

9) The width of the palm of your hand is 10 ____.

10) The height of a soda can is 12 ____.
11) The length of a key is 50 ____.
12) The diameter of a nickel is about 2 ____.
13) The length of your index finger is about 7 ____. 
14) The average length of an adult female femur bone is about 45 ____.
15) A cellular phone is approximately 120 ____ in length.
16) A plastic fork is approximately 16 ____ in length.
17) Your teacher is about 1.7 ____ tall.
18) A CD-ROM disk has a thickness of 1.2 ____.

2. Converting between Metric Units using Powers of 10

Looking at the meter stick diagrams below, we notice that the prefix **deci** is used to represent unit lengths that are \( \frac{1}{10} \) of a meter and therefore \( 10 \text{ dm} = 1 \text{ m} \). Similarly, we see that **centi** is used to represent unit lengths that are \( \frac{1}{100} \) of a meter. Therefore, \( 100 \text{ cm} = 1 \text{ m} \). Finally, we see that **milli** is used to represent unit lengths that are \( \frac{1}{1,000} \) of a meter and therefore \( 1,000 \text{ mm} = 1 \text{ m} \).

You may have noticed that one-half of a meter, or 0.5 m, is equal to 5 dm. The diagrams below show us that 5 dm is equal to 50 cm, and that 50 cm is equal to 500 mm. Summarizing this, we get the relationship 0.5 m = 5 dm = 50 cm = 500 mm. Do you see a pattern?
Let’s now complete a table to demonstrate the pattern. Fill in the blank cells.

<table>
<thead>
<tr>
<th>Equivalent Lengths</th>
<th>0.5 m</th>
<th>5 dm</th>
<th>50 cm</th>
<th>500 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.7 m</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>m</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>m</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

When moving across each row to the right, we see that the numbers are multiplied by a factor of 10. When moving across each row to the left, the numbers are divided by a factor of 10. Remember that multiplying a number by 10 moves the decimal point to the right one place value. Dividing a number by 10 moves the decimal point to the left one place value.

Now let’s apply what we have learned to the following questions.

Convert each measure to the indicated unit.

19) 25 cm to mm
20) 35 dm to mm
21) 0.2 m to cm
22) 0.7 cm to mm
23) 7.6 dm to cm
24) 278 mm to cm
25) 3.2 dm to m
26) 5 mm to dm
27) 1.5 m to cm
28) 17.5 dm to m
29) 1,578 mm to m
30) 349 cm to m

3. Understand Units of Length Greater Than 1 Meter

Up to this point we have mainly dealt with lengths that measure less than 1 meter. What about lengths that are more than 1 meter? In this case we again use a prefix on the word meter to represent measures of length that are greater than 1 meter.

The prefix *deka* is used to represent a length that is 10 meters. 1 dekameter = 10 meters
The prefix *hecto* is used to represent a length that is 100 meters. 1 hectometer = 100 meters
The prefix *kilo* is used to represent a length that is 1,000 meters. 1 kilometer = 1,000 meters

Again you may notice that there is a pattern involving powers of 10. Notice that the prefix *deka* is used to represent unit lengths that are 10 times that of a meter. Therefore, 1 dekameter = 10 m.
Next, we see that *hecto* is used to represent unit lengths that are 100 times that of a meter.
Therefore, 1 hectometer = 100 m. Finally, we see that *kilo* is used to represent unit lengths that are 1,000 times that of a meter and therefore 1 kilometer = 1,000 m.
Let’s again complete a table to demonstrate the pattern. Fill in the blank cells. The abbreviations for the prefix on the word meter are shown in the parenthesis.

<table>
<thead>
<tr>
<th>Equivalent Lengths</th>
<th>kilometers (km)</th>
<th>hectometers (hm)</th>
<th>dekameters (dam)</th>
<th>meters (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 km</td>
<td></td>
<td></td>
<td></td>
<td>m</td>
</tr>
<tr>
<td>km</td>
<td>hm</td>
<td>86.5 dam</td>
<td>4,675 m</td>
<td></td>
</tr>
<tr>
<td>km</td>
<td>10.09 hm</td>
<td>dam</td>
<td>m</td>
<td></td>
</tr>
</tbody>
</table>

Again we can see that when moving across each row to the right, the numbers are multiplied by a factor of 10. When moving across each row to the left, the numbers are divided by a factor of 10. Remember that multiplying a number by 10 moves the decimal point to the right one place value. Dividing a number by 10 moves the decimal point to the left one place value.

Let’s now continue to develop our estimation skills by doing problems that require us to write in an appropriate metric unit.

Fill in the blank with the appropriate metric unit. Choose m, dam, hm, or km.

31) The length of a car is about 5 ____.

32) The height the Empire State Building is about 45 ____.

33) The radius of the earth is approximately 6,000 ____.

34) The distance from New York to Los Angeles is about 4,000 ____.

35) The height of the Statue of Liberty is about 1 ____.

36) The traveled length across the Golden Gate Bridge is about 2 ____.

37) A Boeing 747 Jumbo Jet is approximately 6.4 ____ in length.

38) The length of a NFL football field is approximately 9.1 ____ in length.
The following diagram organizes the unit measures covered in this section in order from largest to smallest. Notice how the powers of ten are used to move from one unit measure to the next. Each arrow represents the movement of the decimal point one time. Use this diagram to answer the following questions.

Convert each measure to the indicated unit by moving the decimal point appropriately. Write down the number of times you moved the decimal point and the direction you moved it.

39) 3.8 hm to dm  
40) 2,385 mm to hm  
41) 0.7 cm to m  
42) 0.91 dam to dm  
43) 80.04 cm to hm  
44) 31.08 m to hm  
45) 19 hm to m  
46) 31 dam to cm  
47) 3,498 dm to km  
48) 0.164 km to cm  
49) 0.028 dam to dm  
50) 1,578 mm to dm

Review Exercises

Evaluate the expression.
51) \( \frac{2}{3} - \frac{5}{6} + 8 \)
52) \(-3 + \frac{8(3/2)^3}{9} \)

Simplify the expression as much as possible.
53) \(-16 - 12x - 5 + 3x \)
54) \(8 - 5(2x - 3) + 6x \)
55) \(-2|3 - 8| + 7 \)
56) \(6 - |5 + 12| + 11 \)

Fill in the blank with the appropriate metric unit.
57) The length of a paper clip is approximately 3.2 ____.
58) The diameter of a nickel is approximately 21____.

Answer True or False.
59) Dividing a number by 1,000 is the same as multiplying by \(\frac{1}{1,000}\).
60) 220 cm is 20 cm more than 2 dm.
Conversions with Lengths, Weight (Mass), and Volume

1. Learn How to Perform Conversions using One Conversion Factor

A conversion factor is a fraction or ratio involving two equivalent quantities that are expressed in different units. For example, if you wish to convert inches to centimeters, you will need to use a conversion factor to perform the calculation. Recall that \( 2.54 \text{ cm} = 1 \text{ in.} \).

This gives us the conversion factor \( \frac{2.54 \text{ cm}}{1 \text{ in.}} \) which is equivalent to \( \frac{1 \text{ in.}}{2.54 \text{ cm}} \). Next, we will need to develop a sense of how to choose the appropriate conversion factor or factors, for a given conversion calculation.

Example 1: How many centimeters are in 10 inches?

In this example we are being asked to convert 10 in. to cm. We begin the conversion calculation by first writing the given quantity as a ratio using a 1 to represent the denominator.

\[
\frac{10 \text{ in.}}{1}
\]

Next, we will multiply are given quantity using the appropriate conversion factor to get the desired result in centimeters.

\[
\frac{10 \text{ in.}}{1} \times \frac{2.54 \text{ cm}}{1 \text{ in.}}
\]

Notice that the denominator of our conversion factor contains units of inches. This allows us to divide out the units of inches leaving the desired units of centimeters. Here is what our completed conversion calculation will look like.

\[
\frac{10 \text{ in.}}{1} = \frac{25.4 \text{ cm}}{1}
\]

Based on our conversion calculation, we can now answer the question by stating there are 25.4 centimeters in 10 inches.

When performing conversion calculations it is always important to show how you reached your solution. This will allow someone else to easily verify that your calculation is correct by checking your work.

Note: In Example 1 above, the conversion factor was written for converting inches to centimeters. In the next example we will convert from centimeters to inches. Notice how the conversion factor differs in Example 2.
Example 2: How many inches are in 35 centimeters?

In this example we are being asked to convert 35 cm to inches. Again, we begin the conversion calculation by first writing the given quantity as a ratio using a 1 to represent the denominator.

\[
\frac{35 \text{ cm}}{1}
\]

Next, we will multiply our given quantity using the appropriate conversion factor to get the desired result in inches.

\[
\frac{35 \text{ cm}}{1} \times \frac{1 \text{ in.}}{2.54 \text{ cm}}
\]

In this example, notice that the denominator of our conversion factor contains units of centimeters. This allows us to divide out the units of centimeters leaving the desired units of inches. Here is what our completed conversion calculation will look like. We will round our final answer to the nearest one-thousandth.

\[
\frac{35 \text{ cm}}{1} \times \frac{1 \text{ in.}}{2.54 \text{ cm}} = 13.780 \text{ in.}
\]

Based on our conversion calculation, we can now answer the question by stating there are approximately 13.780 inches in 35 centimeters.

Perform the following conversion calculations using one conversion factor.

1) How many seconds are in 17 minutes?

2) How many feet are in 40 yards?

3) Convert 10 cm to inches.

4) Convert 25 inches to centimeters.

5) Convert 2 liters to quarts.

6) Convert 5,000 pounds to tons.

7) If one tablet contains 150 mg of ibuprofen, how much ibuprofen is in \(3\frac{1}{2}\) tablets?

8) Given that 1 kilogram = 2.2 pounds, how many kilograms does a 175 lb adult male weigh?
Many conversion calculations require the use of more than one conversion factor to obtain the desired result. In these cases, we let the dimensions guide us through the calculations, telling us where to put the numeric values. This approach will be demonstrated in Example 3 and Example 4. We will be using the following equivalent relationships to perform these types of conversion calculations.

\[
12 \text{ in.} = 1 \text{ ft} \quad 3 \text{ ft} = 1 \text{ yd} \quad 5,280 \text{ ft} = 1 \text{ mile} \quad 2.54 \text{ cm} = 1 \text{ in.}
\]

Other equivalent relationships can be found on the conversion handout sheet found at the end of this sections material.

**Example 3: How many miles are in 500,000 inches?**

As always, we begin the conversion calculation by first writing the given quantity as a ratio using a 1 to represent the denominator.

\[
\left( \frac{500,000 \text{ in.}}{1} \right)
\]

Our first conversion factor will convert inches to feet by placing units of inches in the denominator and feet in the numerator.

\[
\left( \frac{500,000 \text{ in.}}{1} \right) \left( \frac{1 \text{ ft}}{12 \text{ in.}} \right)
\]

Our second conversion factor will now convert feet to miles by placing feet in the denominator and miles in the numerator.

\[
\left( \frac{500,000 \text{ in.}}{1} \right) \left( \frac{1 \text{ ft}}{12 \text{ in.}} \right) \left( \frac{1 \text{ mi}}{5,280 \text{ ft}} \right)
\]

Notice that the denominators of our conversion factors divide out the units in the preceding numerators. This leaves us with the desired units of miles. Here is what our completed conversion calculation will look like. We will round our final answer to the nearest one-thousandth.

\[
\left( \frac{500,000 \text{ in.}}{1} \right) \left( \frac{1 \text{ ft}}{12 \text{ in.}} \right) \left( \frac{1 \text{ mi}}{5,280 \text{ ft}} \right) = 7.891 \text{ mi}
\]

Based on our conversion calculation, we can now answer the question by stating there are approximately 7.891 miles in 500,000 inches.
Example 4: How many yards are in 4,500 centimeters?

Again, we first write the given quantity as a ratio using a 1 to represent the denominator.

\[
\frac{4,500 \text{ cm}}{1}
\]

Our first conversion factor will convert centimeters to inches by placing units of centimeters in the denominator and inches in the numerator.

\[
\frac{4,500 \text{ cm}}{1} \times \frac{1 \text{ in.}}{2.54 \text{ cm}}
\]

Our second conversion factor will now convert inches to feet by placing inches in the denominator and feet in the numerator.

\[
\frac{4,500 \text{ cm}}{1} \times \frac{1 \text{ in.}}{2.54 \text{ cm}} \times \frac{1 \text{ ft}}{12 \text{ in.}}
\]

Our third conversion factor will now convert feet to yards by placing feet in the denominator and yards in the numerator.

\[
\frac{4,500 \text{ cm}}{1} \times \frac{1 \text{ in.}}{2.54 \text{ cm}} \times \frac{1 \text{ ft}}{12 \text{ in.}} \times \frac{1 \text{ yd}}{3 \text{ ft}}
\]

Again we see that the denominators of our conversion factors divide out the units in the preceding numerators. Doing so leaves us with the desired units of yards. Here is what our completed conversion calculation will look like. We will round our final answer to the nearest one-thousandth.

\[
\frac{4,500 \text{ cm}}{1} \times \frac{1 \text{ in.}}{2.54 \text{ cm}} \times \frac{1 \text{ ft}}{12 \text{ in.}} \times \frac{1 \text{ yd}}{3 \text{ ft}} = 49.213 \text{ yd}
\]

Based on our conversion calculation, we can now answer the question by stating there are approximately 49.213 yards in 4,500 centimeters.

Perform the following conversion calculations using multiple conversion factors.

9) How many meters are in 1 mile?

10) How many seconds are in 1 year?

11) Convert 3 pounds to grams.

12) Convert 2 liters to ounces.
3. Solve Applied Problems using Conversion Calculations

Conversion calculations can be used to solve many of the applied problems seen within the Health Care career field. Probably the most important types of conversion calculations are applied problems that involve dosage calculations. With these types of problems, a given solution strength ratio or dosage strength ratio is used as a conversion factor. The following examples represent common dosage calculations using this approach.

Example 5: Suppose you found that 100 mL of a solution contains 1 gram of lidocaine. How many mg of lidocaine are in $\frac{1}{2}$ mL of the solution?

We begin the conversion calculation by first writing the given quantity as a ratio using a 1 to represent the denominator.

$$\left(\frac{2.5 \text{ mL}}{1}\right)$$

Next, we multiply our given quantity by the solution strength ratio. This conversion factor will convert milliliters to grams by placing units of milliliters in the denominator and grams in the numerator. This allows us to divide out the units of mL leaving us with grams of lidocaine.

Now we must convert the grams of lidocaine to mg. To accomplish this, we add a second conversion factor that will convert grams to milligrams.

Once again the denominators of our conversion factors divide out the units in the preceding numerators. Doing so leaves us with the desired units of milligrams of lidocaine. Here is what our completed conversion calculation will look like. We will round our final answer to the nearest one-thousandth.

$$\left(\frac{2.5 \text{ mL}}{1}\right)\left(\frac{1 \text{ g}}{100 \text{ mL}}\right)\left(\frac{1,000 \text{ mg}}{1 \text{ g}}\right) = 25.000 \text{ mg of lidocaine}$$

Based on our conversion calculation, we can now answer the question by stating there are 25,000 mg of lidocaine in 2.5 mL of solution.
Example 6: Suppose you found that 1,000 mL of a solution contains 1 g of epinephrine. How many mg of epinephrine are in 2 tbsp of solution? Assume 1 tbsp = 15 mL.

Notice that we are given a volume measured by tablespoons. Because our solution strength ratio involves volume by milliliters, we must begin our conversion calculation by first converting tablespoons to milliliters.

We start by first representing the given quantity as a ratio using a 1 to represent the denominator.

\[
\frac{2 \text{ tbsp}}{1}
\]

Our first conversion factor will convert tablespoons to millimeters. Notice that by placing units of tablespoons in the denominator and milliliters in the numerator, we can divide out the units of tablespoons leaving us with milliliters of epinephrine.

\[
\frac{2 \text{ tbsp}}{1 \text{ tbsp}} \cdot \frac{15 \text{ mL}}{1 \text{ tbsp}}
\]

Next, we use our solution strength ratio as the second conversion factor to convert milliliters to grams. Notice that milliliters are placed in the denominator and grams in the numerator. This allows us to divide out the units of milliliters leaving us with grams of epinephrine. At this point, the calculation will give us the grams of epinephrine in 2 tbsp of solution.

\[
\frac{2 \text{ tbsp}}{1 \text{ tbsp}} \cdot \frac{15 \text{ mL}}{1 \text{ tbsp}} \cdot \frac{1 \text{ g}}{1,000 \text{ mL}}
\]

Because we are asked to calculate the dosage of epinephrine in mg, we need to add an additional conversion factor that will convert grams to milligrams. Doing this leaves us with the desired units of milligrams of epinephrine.

\[
\frac{2 \text{ tbsp}}{1 \text{ tbsp}} \cdot \frac{15 \text{ mL}}{1 \text{ tbsp}} \cdot \frac{1 \text{ g}}{1,000 \text{ mL}} \cdot \frac{1,000 \text{ mg}}{1 \text{ g}}
\]

Here is what our completed conversion calculation will look like. We will round our final answer to the nearest one-thousandth.

\[
\frac{2 \text{ tbsp}}{1 \text{ tbsp}} \cdot \frac{15 \text{ mL}}{1 \text{ tbsp}} \cdot \frac{1 \text{ g}}{1,000 \text{ mL}} \cdot \frac{1,000 \text{ mg}}{1 \text{ g}} = 30.000 \text{ mg epinephrine}
\]

Based on our conversion calculation, we can now answer the question by stating there are approximately 30.000 mg of epinephrine in 2 tbsp of solution.
Solve the applied problems.

13) The solution strength label of a solution indicates that 100 mL contains 10 grams of magnesium sulfate. How many mL of solution will contain 350 mg of magnesium sulfate?

14) The solution strength label of a solution indicates that 2,000 mL contains 1 gram of epinephrine. How many mL of solution will contain 0.25 mg of epinephrine?

15) Suppose you found that 5 mL of a solution contains 0.25 grams of Amoxicillin. How many mg of Amoxicillin are in 2 tbsp of solution? Assume 1 tbsp = 15 mL.

16) Suppose you found that 5 mL of a solution contains 0.1 grams of Motrin®. How many mg of Motrin® are in 2 tsp of solution? Assume 1 tsp = 5 mL.

Review Exercises

Evaluate the expression.

17) \( \frac{3}{4} \cdot \frac{6}{7} \cdot \frac{10}{4} \)

18) \( 3 + \frac{6}{5} \div \frac{3}{20} \)

Simplify the expression as much as possible.

19) \( \frac{4y^3}{x^2} \cdot \frac{x}{3} \div \frac{y}{4} \)

20) \( \frac{5b^2}{a^3} \div \frac{15b^3}{7} \cdot \frac{b}{21a} \)

Fill in the blank with the appropriate metric unit.

21) The width of a dollar bill is approximately 6.6 ____.

22) The diameter of a quarter is approximately 24 ____.

Fill in the blanks with the appropriate metric prefix.

23) _____ means \( \frac{1}{1,000} \).

24) _____ means \( \frac{1}{100} \).
## Equivalent Measurement Table

<table>
<thead>
<tr>
<th>LENGTH</th>
<th>FLUID VOLUME</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 inches = 1 foot</td>
<td>1,000 mL = 1 L</td>
</tr>
<tr>
<td>3 feet = 1 yard</td>
<td>1,000,000 μL = 1 L</td>
</tr>
<tr>
<td>5,280 feet = 1 mile</td>
<td>1.06 quarts ≈ 1 L</td>
</tr>
<tr>
<td>2.54 centimeter = 1 inch</td>
<td>1 gallon ≈ 3.79 L</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AREA</th>
</tr>
</thead>
<tbody>
<tr>
<td>144 in² = 1 ft²</td>
</tr>
<tr>
<td>9 ft² = 1 yd²</td>
</tr>
<tr>
<td>6.4516 cm² = 1 in²</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VOLUME</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,728 in³ = 1 ft³</td>
</tr>
<tr>
<td>27 ft³ = 1 yd³</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FLUID VOLUME</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 cup = 8 fluid ounces</td>
</tr>
<tr>
<td>2 cups = 1 pint</td>
</tr>
<tr>
<td>2 pints = 1 quart</td>
</tr>
<tr>
<td>4 quarts = 1 gallon</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 pound = 16 ounces</td>
</tr>
<tr>
<td>1 Ton = 2,000 pounds</td>
</tr>
<tr>
<td>28.3 grams ≈ 1 ounce</td>
</tr>
<tr>
<td>2.20 pounds ≈ 1 kilogram</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FLUID VOLUME</th>
</tr>
</thead>
<tbody>
<tr>
<td>16.39 milliliter = 1 in³</td>
</tr>
<tr>
<td>1 milliliter = 1 cc (1 cm³)</td>
</tr>
<tr>
<td>1 teaspoon ≈ 5 milliliters</td>
</tr>
<tr>
<td>1 tablespoon ≈ 15 milliliters</td>
</tr>
<tr>
<td>1 fluid ounce ≈ 29.6 milliliters</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TEMPERATURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C° = \frac{5(F° - 32)}{9}$</td>
</tr>
<tr>
<td>$F° = \frac{9}{5}C° + 32$</td>
</tr>
</tbody>
</table>
Conversions of Rates

**Objective 1** Convert a Rate to an equivalent Rate of different Dimensions

In some cases we may want to know the equivalent rate in feet per second of 65 miles per hour. In cases like this we can use conversions factors to perform this calculation.

The entire calculation is done in one single problem. We can first use conversion factors to convert the numerator to the desired dimension, and then use additional conversion factors to convert the denominator to the desired dimension. This process is demonstrated in the following examples.

**Example 1:** Convert 65 miles per hour to feet per second.

\[
\left( \frac{65 \text{ mi}}{1 \text{ hr}} \right) \left( \frac{ft}{\text{mi}} \right) \left( \frac{hr}{\text{min}} \right) \left( \frac{\text{min}}{sec} \right)
\]
Example 2: Convert 1,000 cm per second to miles per hour.

\[
\left( \frac{1,000 \text{ cm}}{1 \text{ sec}} \right) \left( \frac{1 \text{ in}}{1 \text{ cm}} \right) \left( \frac{1 \text{ ft}}{1 \text{ in}} \right) \left( \frac{1 \text{ mi}}{1 \text{ ft}} \right) \left( \frac{1 \text{ sec}}{1 \text{ min}} \right) \left( \frac{1 \text{ min}}{1 \text{ hr}} \right)
\]

Example 3: Convert 65 miles per hour to kilometers per hour.

Example 4: Convert 100 kilometers per hour to centimeters per second.