12.1 CUSTOMARY TO WHOM?
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Metric Measurement.........................................................781

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From the temperature outside, to the size of a room, a person’s weight, to the distance between two cities, people use measurement every day to describe all sorts of things. In the United States, the main measurement system used is the customary measurement system. Most other countries use a different measurement system.

However, before any measurement system came along, the lengths of objects was sometimes determined by comparing them to “typical” measures of body parts. For example:

- A *w* was the distance from the elbow to the tip of the middle finger.
- A *span* was the distance between the thumb and the pinky finger when the fingers were stretched out as far as they could go.
- A *digit* was the width of a finger.
- A *fathom* was the distance between the tips of the middle fingers when a person stretched his or her arms as wide as they could go!
- And finally, a *thumb* was the basis of what is now known as the inch.

That’s a lot of measurement types! What problems do you think might have come about using these measures?
Problem 1  Examples of Customary Units of Measure

**Standard units of measure** are units that are used by everyone in a certain area, and they don’t change from person to person. Standard units of measure are used for length, weight, and capacity.

Here are some standard units in the customary system that are often used to measure lengths, weights, and capacities.

<table>
<thead>
<tr>
<th>Unit of Measure</th>
<th>Abbreviation</th>
<th>Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Length</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>inch</td>
<td>in.</td>
<td>1 in. = length of a small paper clip</td>
</tr>
<tr>
<td>foot</td>
<td>ft</td>
<td>1 ft = length of a man’s foot</td>
</tr>
<tr>
<td>yard</td>
<td>yd</td>
<td>1 yd = length across a doorway</td>
</tr>
<tr>
<td>mile</td>
<td>mi</td>
<td>1 mi = length of 14 football fields</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ounce</td>
<td>oz</td>
<td>1 oz = weight of one slice of cheese</td>
</tr>
<tr>
<td>pound</td>
<td>lb</td>
<td>1 lb = weight of one can of canned food</td>
</tr>
<tr>
<td>ton</td>
<td>t</td>
<td>1 t = weight of a small car</td>
</tr>
<tr>
<td><strong>Capacity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>fluid ounce</td>
<td>fl oz</td>
<td>1 fl oz = a sip from a drink</td>
</tr>
<tr>
<td>cup</td>
<td>c</td>
<td>1 c = amount in a large scoop of ice cream</td>
</tr>
<tr>
<td>pint</td>
<td>pt</td>
<td>1 pt = amount in a school lunch milk container</td>
</tr>
<tr>
<td>quart</td>
<td>qt</td>
<td>1 qt = amount in a container of automobile oil</td>
</tr>
<tr>
<td>gallon</td>
<td>gal</td>
<td>1 gal = amount in a large can of paint</td>
</tr>
</tbody>
</table>

When using abbreviations, customary units of measure do not use periods, except for abbreviating "inch" (in.).
1. Name some objects that are:
   a. about one inch.  b. about one ton.
   c. about one mile.  d. about one gallon.
   e. about one ounce.

Problem 2 Which Unit of Measure Would You Use?

1. Choose the appropriate customary unit of measure you would use when measuring each. Explain your reasoning.
   a. the height of a building
   b. the length of your pencil
   c. the weight of your math book
   d. the weight of an 18-wheel truck
   e. the amount of tomato juice in a juice can
   f. the amount of water that fills a bathtub

I first thought about the units of measure that were definitely NOT appropriate.
2. What helped you decide which unit of measure to choose?

3. How do you know when to use a unit of length, weight, or capacity?

4. Describe a situation in which you would use:
   a. a unit of length.
   b. a unit of weight.
   c. a unit of capacity.
Problem 3  Time to Estimate!

A measurement has two parts: a number and a unit of measure.

1. Circle the most appropriate measurement for each.
   a. The weight of a dog is
      • 15 pounds.  • 18 ounces.
      • 1 ton.  • fluid ounces.
   b. The amount of milk in a cereal bowl is
      • 2 ounces.  • 1 cup.
      • 4 quarts.  • 3 gallons.
   c. The height of your classroom is
      • 90 inches.  • 1 mile.
      • 2 yards.  • 12 feet.
   d. The length of your bed is
      • 24 inches.  • 6 feet.
      • 7 yards.  • 200 inches.
   e. What helped you to decide which measurement to choose?

2. The smallest unit of length in the customary system is the inch, but the inch is too big to measure many objects. You can use fractional parts of inches to measure lengths that are smaller than an inch. Determine the fraction of an inch between 0 and 1 that each mark represents on the rulers shown.
   a. 
      ![Ruler a]
   b. 
      ![Ruler b]
   c. 
      ![Ruler c]
Problem 4  Ready, Set, Measure!

1. For each object in the table, choose an appropriate unit of measure. Then estimate
the length and determine the actual length. Record your information.

<table>
<thead>
<tr>
<th>Unit of Measure</th>
<th>Estimate</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desk Width</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher Desk Height</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doorway Width</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locker Height</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Window Width</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. How did you decide which unit to use?

b. Compare your estimates to the actual measurements. Did everyone have the same
estimates? Did everyone in the class have the same measurements? How do you
explain the differences?
Problem 5  Making Changes

You can use more than one measurement to describe the same length, weight, or capacity. For example, you may say that a student is 5 feet tall, or you may say that the student is 60 inches tall. You might say that a football field is 100 yards long or 300 feet long. In each case, the lengths are the same—you just say them in different ways.

There are many situations in which you need to convert measurements to different units. To convert a measurement means to change it to an equivalent measurement in different units.

1. Name a situation in which converting one measurement to another would be necessary or useful.

The table shows some common measurement conversions.

<table>
<thead>
<tr>
<th>Length</th>
<th>Weight</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 in. = 1 ft</td>
<td>16 oz = 1 lb</td>
<td>8 fl oz = 1 c</td>
</tr>
<tr>
<td>36 in. = 1 yd</td>
<td>2000 lb = 1 t</td>
<td>2 c = 1 pt</td>
</tr>
<tr>
<td>3 ft = 1 yd</td>
<td>4 c = 1 qt</td>
<td></td>
</tr>
<tr>
<td>5280 ft = 1 mi</td>
<td>2 pt = 1 qt</td>
<td>4 qt = 1 gal</td>
</tr>
</tbody>
</table>
This model shows that 3 gallons is equivalent to 12 quarts. Each gallon is shaded differently. Notice that each gallon is divided into four equal parts since there are 4 quarts in every gallon.

You can convert gallons into quarts by multiplying.

\[
(3 \text{ gal}) \times \left(\frac{4 \text{ qt}}{1 \text{ gal}}\right) = 12 \text{ qt}
\]

2. First, complete each model. Then, multiply to determine each measurement conversion. Show your work.
   a. How many feet are in 5 yards?

\[
\frac{5 \text{ yd}}{1 \text{ yd}} = \text{? ft}
\]
b. How many ounces are in 2 pounds?

\[ \frac{? \text{ oz}}{1 \text{ lb}} \]

\[ 2 \text{ lb} \]

\[ ? \text{ oz} \]

\[ \frac{? \text{ oz}}{1 \text{ lb}} \]

---

c. How many quarts are in 12 cups?

\[ \frac{12 \text{ c}}{1 \text{ qt}} \]

\[ \frac{? \text{ c}}{1 \text{ qt}} \]

\[ 12 \text{ c} \]

\[ \frac{? \text{ c}}{1 \text{ qt}} \]

---

d. How many gallons are in 16 quarts?

\[ \frac{16 \text{ qt}}{1 \text{ gal}} \]

\[ \frac{? \text{ qt}}{1 \text{ gal}} \]

\[ 16 \text{ qt} \]

\[ \frac{? \text{ qt}}{1 \text{ gal}} \]
3. How many pounds are in 2 tons? 3 tons? \( \frac{1}{2} \) ton? \( \frac{1}{4} \) ton? Show your work.

4. How many miles are in 31,680 feet? 52,800 feet? 6483.84 feet? Multiply each value by \( \frac{\text{1 mi}}{\text{5280 ft}} \) to determine each conversion.

5. A giraffe is 18 feet tall. How tall is the giraffe in inches? Explain how you determined your answer.

6. A giraffe is 174 inches tall. How tall is the giraffe in feet? Show your work.

7. Does it make more sense to measure a giraffe in feet or inches? Why?
8. The length of the school playground is 45 feet. How many yards long is the playground? Explain how you calculated your answer.


Problem 6  Convert across Customary Units of Measure

Convert each measurement.

1. 32 cups = _______ gallons
2. 324 inches = _______ yards
3. 73,920 feet = _______ miles
4. 128,000 ounces = _______ tons
5. 7 gallons = _______ cups
6. 18 miles = _______ feet

Use >, =, or < to complete each statement.

7. 6 c _______ 2 qt
8. 4\(\frac{1}{2}\) lb _______ 72 oz
9. 74 in. _______ 2 yd
10. 2640 ft _______ \(\frac{1}{2}\) mi

Hmm . . .

32 cups is the same as 16 pints is the same as 8 quarts . . .
1. Compare these two conversions. How are they similar? How are they different?

2. When you convert a measurement with smaller units to a measurement with larger units, does the number of units increase or decrease?

3. Explain how you convert a measurement with smaller units to a measurement with larger units.

4. When you convert a measurement with larger units to a measurement with smaller units, does the number of units increase or decrease?

5. Explain how you convert a measurement with larger units to a measurement with smaller units.

Be prepared to share your solutions and methods.
Previously, you learned about the customary system of measurement. Four hundred years ago, scientists proposed a measurement system based on decimals. They called this measurement system the metric system. Today, the metric system is the most widely used measurement system in the world. Because the metric system is based on powers of 10, it can be simpler to convert measurements within the metric system than within the customary system.

What do you think “powers of 10” means? If converting measurements within the metric system is simpler, why do you think some countries use the customary measurement system?
Problem 1  Metric Units

In the metric system:

- the standard unit of length is the **meter (m)**. Meters are used to measure distance.
- the standard unit of mass is the **gram (g)**. Grams are used to measure the amount of matter in an object.
- the standard unit of capacity is the **liter (L)**. Liters are used to measure the amount a container holds.

The table displays six prefixes that are used to indicate size in the metric system. A prefix is a group of letters attached to the beginning of a word which changes the meaning of the word.

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Meaning</th>
<th>Prefix</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>kilo-</td>
<td>which means 1000</td>
<td>deci-</td>
<td>which means (\frac{1}{10}) or 0.1</td>
</tr>
<tr>
<td>hecto-</td>
<td>which means 100</td>
<td>centi-</td>
<td>which means (\frac{1}{100}) or 0.01</td>
</tr>
<tr>
<td>deka-</td>
<td>which means 10</td>
<td>milli-</td>
<td>which means (\frac{1}{1000}) or 0.001</td>
</tr>
</tbody>
</table>

By putting each prefix together with a standard unit of length (meter), mass (gram), or capacity (liter), you can write all the units of measure in the metric system.
The table displays some units in the metric system that are used to measure length, mass, and capacity.

<table>
<thead>
<tr>
<th>Unit of Measure</th>
<th>Abbreviation</th>
<th>Relationship to Standard Unit</th>
<th>Estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Length</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>kilometer</td>
<td>km</td>
<td>$1 \text{ km} = 1000 \text{ meters}$</td>
<td>$1 \text{ km} \approx \text{ length of 11 football fields}$</td>
</tr>
<tr>
<td>meter</td>
<td>m</td>
<td>$1 \text{ meter}$</td>
<td>$1 \text{ m} \approx \text{ length of } 6 \frac{1}{2} \text{ dollar bills in a row}$</td>
</tr>
<tr>
<td>centimeter</td>
<td>cm</td>
<td>$\frac{1}{100} \text{ of a meter, or 0.01 meter}$</td>
<td>$1 \text{ cm} \approx \text{ width of a computer keyboard key}$</td>
</tr>
<tr>
<td>millimeter</td>
<td>mm</td>
<td>$\frac{1}{1000} \text{ of a meter, or 0.001 meter}$</td>
<td>$1 \text{ mm} \approx \text{ thickness of a CD}$</td>
</tr>
<tr>
<td><strong>Mass</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>kilogram</td>
<td>kg</td>
<td>$1 \text{ kg} = 1000 \text{ grams}$</td>
<td>$1 \text{ kg} \approx \text{ mass of a dictionary}$</td>
</tr>
<tr>
<td>gram</td>
<td>g</td>
<td>$1 \text{ gram}$</td>
<td>$1 \text{ g} \approx \text{ mass of a dollar bill}$</td>
</tr>
<tr>
<td>milligram</td>
<td>mg</td>
<td>$\frac{1}{1000} \text{ of a gram, or 0.001 gram}$</td>
<td>$1 \text{ mg} \approx \text{ mass of a strand of hair}$</td>
</tr>
<tr>
<td><strong>Capacity</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>kiloliter</td>
<td>kL</td>
<td>$1 \text{ kL} = 1000 \text{ liters}$</td>
<td>$1 \text{ kL} \approx \text{ amount of water in two full bathtubs}$</td>
</tr>
<tr>
<td>liter</td>
<td>L</td>
<td>$1 \text{ liter}$</td>
<td>$1 \text{ L} \approx \text{ amount of liquid in a bottle of water}$</td>
</tr>
<tr>
<td>milliliter</td>
<td>mL</td>
<td>$\frac{1}{1000} \text{ of a liter, or 0.001 liter}$</td>
<td>$1 \text{ mL} \approx \text{ amount of water in two drops of rain}$</td>
</tr>
</tbody>
</table>
1. Name an object that is:
   a. about one centimeter.
   b. about one meter.
   c. about one kiloliter.
   d. about one kilogram.
   e. about one gram.

2. Choose the appropriate metric unit of measure to use when measuring each. Explain your reasoning.
   a. your height
   b. the distance from New York to California
   c. the mass of a puppy
   d. the length of your pencil
   e. a bottle of soda
   f. the amount of water to fill a swimming pool
3. What helped you to decide which metric unit of measure to choose for each situation?

Problem 2  Time to Estimate!

1. Circle the most appropriate measurement for each.

   a. The mass of an elephant is
      • 500 grams.
      • 7000 kilograms.
      • 15 kilograms.
      • 1000 milligrams.

   b. The amount of gas in a car’s tank is
      • 50 milliliters.
      • 55 liters.
      • 2 kiloliters.
      • 12 kiloliters.

   c. The length of your classroom is
      • 1000 millimeters.
      • 7 meters.
      • 1 kilometer.
      • 300 centimeters.

   d. The height of a basketball hoop is
      • 3 meters.
      • 500 millimeters.
      • 70 centimeters.
      • 1 kilometer.

   e. What helped you to decide the best approximate measure?
1. Complete the table by recording a customary and metric measurement for each length.

<table>
<thead>
<tr>
<th></th>
<th>Customary Measurement</th>
<th>Metric Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head Circumference</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wrist Circumference</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foot Length</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arm Span</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knee to Ankle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smile</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. Which units of length did you use most often? Why do you think these units were used most frequently?

b. Aaron said that his height was 4 kilometers. Do you think he is correct? Why or why not?
c. Determine the mean foot length for your classmates using customary and then metric measurements. Explain your calculations.

d. Determine the median for wrist circumference. Explain your calculations.

Problem 4  Moving Across Metric Units of Measure

Just as in the customary system, you can use more than one measurement to describe the same length, mass, or capacity in the metric system. You might say that a room is 3 meters long, or you might say that the same room is 300 centimeters long. Either way, the lengths are the same—they are just said in different ways. As with the customary system, there are many times in which you need to convert one measurement to another with different units.

Before, you looked at common prefixes and their meanings. Since you know that “kilo” means 1000, you say that:

- A kilometer is 1000 meters.
- A kilogram is 1000 grams.
- A kiloliter is 1000 liters.

Since you know that “centi” means $\frac{1}{100}$, you can say that a centimeter is $\frac{1}{100}$ of a meter, or 0.01 meter. You also know that “milli” means $\frac{1}{1000}$, so a millimeter is $\frac{1}{1000}$ of a meter, or 0.001 meter.
The metric system is based on powers of 10, just like the base-ten number system.

<table>
<thead>
<tr>
<th>Place Value</th>
<th>Metric System</th>
</tr>
</thead>
<tbody>
<tr>
<td>thousands (1000)</td>
<td>km (1000)</td>
</tr>
<tr>
<td>hundreds (100)</td>
<td>hm (100)</td>
</tr>
<tr>
<td>tens (10)</td>
<td>dm (10)</td>
</tr>
<tr>
<td>ones (1)</td>
<td>m (1)</td>
</tr>
<tr>
<td>decimal point</td>
<td>dm (0.1)</td>
</tr>
<tr>
<td>tenths (0.1)</td>
<td>cm (0.1)</td>
</tr>
<tr>
<td>hundredths (0.01)</td>
<td>mm (0.001)</td>
</tr>
<tr>
<td>thousandths (0.001)</td>
<td></td>
</tr>
</tbody>
</table>

2 . 0

The number shown in the place-value chart is 2, 2.0, or 2 ones. You can also say that this number means 20 tenths. Since there are 10 tenths in one whole, you can convert ones into tenths by multiplying:

\[
\frac{2 \text{ ones}}{10 \text{ tenths}} = 20 \text{ tenths}
\]

You can also convert tenths into ones by multiplying:

\[
\frac{20 \text{ tenths}}{10 \text{ tenths}} = \frac{20 \text{ ones}}{1 \text{ one}} = 2 \text{ ones}
\]

The measure shown in the metric system chart is 2 meters, or 2.0 m. You can also say that this measure is 20 decimeters, or 20 dm. A decimeter is \(\frac{1}{10}\), or 0.1, of a meter, so there are 10 decimeters in one meter. You can convert meters to decimeters by multiplying:

\[
\frac{2 \text{ m}}{10 \text{ dm}} = 20 \text{ dm}
\]

You can also convert decimeters to meters by multiplying:

\[
\frac{20 \text{ dm}}{10 \text{ dm}} = \frac{20 \text{ m}}{10} = 2 \text{ m}
\]
1. Use the metric system chart to determine each measurement conversion. The first conversion is done for you.

<table>
<thead>
<tr>
<th>km (1000)</th>
<th>hm (100)</th>
<th>dam (10)</th>
<th>m (1)</th>
<th>dm (0.1)</th>
<th>cm (0.01)</th>
<th>mm (0.001)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td></td>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td></td>
<td></td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td></td>
<td></td>
<td>5</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e.</td>
<td>4</td>
<td>5</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3 cm = 0.03 m
4 m = ________ mm
55 mm = ________ cm
1004 m = ________ km
45.3 m = ________ mm

2. Describe the strategies you used to determine the measurement conversions.

3. Write fraction and decimal statements to answer each question.
   a. What part of a liter is a milliliter?
   b. What part of a gram is a milligram?
   c. What part of a kilometer is a meter?
4. A giraffe is 6 meters tall. How many centimeters tall is the giraffe? How many millimeters tall is the giraffe? Which unit of measure would be the best to use to measure the height of a giraffe?

5. If you place seven 15-centimeter pens end to end, will the total length of the pens be greater than, less than, or equal to one meter? Explain your answer.

6. You have two bottles, with each bottle holding 575 milliliters of water. Will the amount of water in the two bottles fill a one-liter bottle? If so, is there any extra water? If not, how much more water would you need to fill the bottle?

7. The Empire State Building is 0.380 kilometer tall. How many meters tall is it? How many centimeters tall is it?
1. When you convert a measurement with smaller units to a measurement with larger units, does the number of units increase or decrease?

2. Explain how you convert a measurement with smaller units to a measurement with larger units.

3. When you convert a measurement with larger units to a measurement with smaller units, does the number of units increase or decrease?

4. Explain how you convert a measurement with larger units to a measurement with smaller units.
5. Name one advantage of the metric system over the customary system.

6. What are the two parts of every measurement?

7. Explain how to convert measurements in the metric system.

Be prepared to share your solutions and methods.
Learning Goals

In this lesson, you will:

- Select appropriate types of measurement between customary and metric measurement systems.
- Select appropriate units for each type of measurement.
- Convert from one unit to another in different systems.

Have you ever traveled to a different country? If you have, you probably have noticed that gasoline is sold in liters. You may have also noticed that the distances between locations is written in kilometers. In fact, the speed limit signs may have also shown kilometers per hour.

Although these show examples of the metric system, there are some things that are displayed in both metric and customary measurement systems. For example, most car speedometer displays have both miles per hour and kilometers per hour.

Can you think of other instruments or signs that show both measurement systems? Why do you think that most car speedometers display speed in both customary and metric measurement systems?
**Problem 1 Estimating Conversions**

A few estimates are given to help you convert among metric and customary measures.

- One meter is about the same length as one yard (one yard is a little shorter than one meter).
- One inch is about 2.5 centimeters.
- One kilometer is a little more than half of a mile.
- One foot is about 30 centimeters.
- One liter is about the same as one quart. (One quart is a little less than one liter.)
- One kilogram is a little more than 2 pounds.
- Multiply a temperature in degrees Celsius by 2 and then add 30 to estimate the temperature in degrees Fahrenheit.

1. Estimate each measurement conversion.
   a. If the speed limit is 100 kilometers per hour, what is the approximate speed limit in miles per hour?
   
   b. A gas station sign reads, “$2.20 \text{ per liter}.” About how much is the gas per gallon?
   
   c. The distance to Toronto is 548 km. About how many miles is that distance?
   
   d. You order 5 kilograms of food pellets for your guinea pig. About how many pounds are you ordering?
   
   e. If the temperature is 20°C, what is the approximate temperature in degrees Fahrenheit?

2. Describe the strategies you used to estimate each measurement conversion in Question 1, parts (a) through (e).
Problem 2  Getting a Room Makeover

In Problem 1, you converted metric measurements to customary measurements. Now, you will use the common conversions shown in the table to convert between customary and metric measurements.

<table>
<thead>
<tr>
<th>Length</th>
<th>Mass</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 in. = 2.54 cm</td>
<td>1 oz = 28.35 g</td>
<td>1 pt = 0.47 L</td>
</tr>
<tr>
<td>1 cm = 0.39 in.</td>
<td>1 g = 0.035 oz</td>
<td>1 L = 2.11 pt</td>
</tr>
<tr>
<td>1 ft = 30.48 cm</td>
<td>1 lb = 0.45 kg</td>
<td>1 qt = 0.95 L</td>
</tr>
<tr>
<td>1 m = 3.28 ft</td>
<td>1 kg = 2.2 lb</td>
<td>1 L = 1.06 qt</td>
</tr>
<tr>
<td>1 mi = 1.61 km</td>
<td></td>
<td>1 gal = 3.79 L</td>
</tr>
<tr>
<td>1 km = 0.62 mi</td>
<td></td>
<td>1 L = 0.26 g</td>
</tr>
<tr>
<td>1 m = 39.37 in.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 in. = 0.0254 m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 m = 1.09 yd</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To convert between systems, you can scale up or scale down using ratios. Two methods are shown to determine how many kilograms are in 2.5 pounds.

1 lb = 0.45 kg

Use the information from the chart.

2.5 lb = 1.125 kg

Multiply to calculate the number of kilograms in 2.5 pounds.

1 lb = 0.45 kg

Write a ratio using the information from the chart.

2.5 lb = 1.125 kg

Scale up to calculate the number of kilograms in 2.5 pounds.
1. You want to redecorate your bedroom. To redecorate, you need to measure the room for new carpeting, paint, and a border on the walls. You realize that you have only a meter stick, not a ruler or yardstick. You measure the room, but you need to know the dimensions in inches and feet in order to purchase the materials. You record the following measurements:

- The length of the room is 5 meters.
- The width of the room is 4 meters.
- The height of the room is 2.5 meters.

a. What is the length of the room in inches? In feet?

b. What is the width of the room in inches? In feet?

c. What is the height of the room in inches? In feet?

d. There are 39.37 inches in a meter. Explain to a classmate how many feet are in a meter.
A marathon is a long-distance foot race with an official distance of 42.195 kilometers (26 miles and 385 yards) that is usually run as a road race. More than 500 marathons occur throughout the world each year. Larger marathons can have tens of thousands of runners. Most of these marathon runners are not professional marathoners, but run to raise funds for various charities.

2. To train for a marathon, runners build up their endurance by running shorter distances. Complete the table shown by writing the unknown measurements.

<table>
<thead>
<tr>
<th>Race</th>
<th>Kilometers</th>
<th>Miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short Distance</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Medium Distance</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Medium Distance</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Half Marathon</td>
<td></td>
<td>13.1</td>
</tr>
<tr>
<td>Ultramarathon</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Ironman Triathlon Swim</td>
<td>2.4</td>
<td></td>
</tr>
<tr>
<td>Ironman Triathlon Bike</td>
<td>112</td>
<td></td>
</tr>
</tbody>
</table>
1. Keisha took a 5-mile walk at the park on Saturday. How many kilometers did Keisha walk? Show your work.

2. Mr. Johnson pumped 12 gallons of gas into his car. How many liters of gas would that be? Show your work.

3. What is your height in centimeters? Show your work.

4. Use $>$, $<$, or $=$ to make each statement correct.
   a. $2 \text{ in.} \underline{\quad} 4 \text{ cm}$
   b. $2 \text{ kg} \underline{\quad} 4.4 \text{ lb}$
   c. $3 \text{ qt} \underline{\quad} 3 \text{ L}$
   d. $6 \text{ km} \underline{\quad} 3 \text{ mi}$

5. The school cafeteria has eight very large cans of tomato sauce for making pizza. Each can contains 2 gallons of sauce. Is there more or less than 50 L of sauce in these 8 cans? Explain your reasoning.
6. Tyrone, the quarterback for the Tigers Football team, can throw a football 40 meters. Jason, the quarterback for the Spartans, can throw a football 45 yards. Who can throw farther? How do you know?

7. Molly says that she is 1.5 meters tall. Shawna is 5 feet tall. Molly says that she is taller, but Shawna disagrees. Who is correct? Explain your reasoning.

8. Larry weighs 110 pounds, Casey weighs 98 pounds, Shaun weighs 42 kg, and Jamal weighs 52 kg. Place the boys in order from the lowest weight to the highest weight using pounds and kilograms.
9. Karen has a gold bracelet that weighs 24 grams. She wants to sell the bracelet, but she needs a minimum of one ounce of gold in order to sell it. Can Karen sell her bracelet? Why or why not?

Be prepared to share your solutions and methods.
In this lesson, you will use some of the facts you learned about the customary and metric systems of measurement. A measurement must include a number and a unit of measure to be recorded. One of the first decisions you must make is what unit is appropriate for your measurement. You must then decide which measurement tool you will use.

Do you remember the measurement tools you have used? Besides the simple comparisons you learned previously, what other tools are helpful to make conversions between the two measurement systems?
Problem 1  Scavenger Hunt

For this activity, you are going on a scavenger hunt with your group in search of objects. You will try to find objects in your classroom that match certain customary or metric lengths. Then you will measure those objects to see how close you got. Here’s a list of what you’ll need and the rules of the scavenger hunt.

What You’ll Need

- You will need a ruler, yardstick, and meter stick.

Rules

- The first column of the table shows measurements in both customary and metric units. Find an object that you think has a measurement that is close to each estimated measurement.
- Next, measure that object and record the measurement in the table.
- Then, calculate the difference between the estimated measurement and actual measurement.
- After you have calculated each difference, add up all the differences for both customary and metric measurements.
- The group with the smallest difference in each category will be the scavenger hunt winner!
### Scavenger Hunt

#### Metric Measurements

<table>
<thead>
<tr>
<th>Estimated Measurement</th>
<th>Object</th>
<th>Actual Measurement</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 cm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 cm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 cm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 m</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 m</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 m</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Customary Measurements

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Object</th>
<th>Actual Measurement</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 in.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 in.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 ft</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 ft</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 yd</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 yd</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sum of the differences of your metric measurements

__________

Sum of the differences of your customary measurements

__________
1. For which estimated lengths was it most difficult to find objects? Why do you think that was?

2. Which objects had the closest measurements to your estimates?

3. Did you find an object in your classroom larger than 10 yards? Why or why not?

4. Did you find an object in your classroom larger than 10 meters? Why or why not?

**Problem 2  Area, Perimeter, and Volume**

You have learned that the area of a figure is the number of square units needed to cover that figure. You also know that the perimeter of a figure is the distance around its sides. Finally, you have also learned that the volume of a solid is the amount of space it takes up.

Analyze each figure and the measurements given for each.
Using the figures and what you know, select the appropriate measurements.

1. Which is the best measurement to describe the area of Figure A?
   a. 60 cm
   b. 60 cm²
   c. 60 cm³

2. Which is the best measurement to describe the perimeter of Figure B?
   a. 44 in.
   b. 44 in.²
   c. 44 in.³

3. Which is the best measurement for the volume of Figure C?
   a. 282.7 cm
   b. 282.7 cm²
   c. 282.7 cm³

4. Which is the best measurement for the volume of Figure D?
   a. 70 cm
   b. 70 cm²
   c. 70 cm³

5. When is a figure measured in linear units, square units, or cubic units?

6. Draw a figure that has an area of 10 square feet. Label its dimensions.

7. Draw a figure that has a perimeter of 30 centimeters. Label its dimensions.
8. Draw a rectangular prism that has a volume of 36 cubic inches. Label its dimensions.

**Problem 3  Making Choices**

In this activity, you will complete a table to select the most appropriate customary unit and metric unit to measure a given object. You might want to use these pictures to help you decide which units to choose.

- 1 meter (or 1 m) = about a yardstick plus the length of a piece of chalk
- 1 centimeter (or 1 cm) = the width of some part of your smallest finger or fingernail
- 1 kilogram (or 1 kg) = about the mass of 2.2 pounds of butter
- 1 gram (or 1 g) = about the mass of a large thumbtack
- A nickel = about 5 grams (or 5 g)
- 1 km = a little more than \( \frac{1}{2} \) a mile
1. Complete the table by determining the most appropriate metric and customary units, or an object with the given unit of measure.

<table>
<thead>
<tr>
<th>Metric Unit</th>
<th>Customary Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tree Height</td>
<td>mg</td>
</tr>
<tr>
<td></td>
<td>oz</td>
</tr>
<tr>
<td>Bedroom Length</td>
<td>L</td>
</tr>
<tr>
<td></td>
<td>gal</td>
</tr>
<tr>
<td>Math Book Width</td>
<td></td>
</tr>
<tr>
<td>Adult Weight</td>
<td></td>
</tr>
<tr>
<td>Liquid Volume of Mug</td>
<td></td>
</tr>
</tbody>
</table>

b. In the blank spaces, add three other items that you can measure to the chart. Give the metric and customary units for each of the items.
Problem 4  Let It Snow

1. Let’s assume that it snowed yesterday in Chicago, Detroit, Pittsburgh, and New York. Each city had a different amount of snow accumulation. Using these clues, figure out how much it snowed in each city. Remember your conversion chart? One inch is equal to 2.54 centimeters. If necessary, round your answers to the nearest inch or the nearest hundredth of a centimeter.

- Chicago had a total accumulation of 27.94 centimeters.
- New York had 5 fewer inches than Chicago.
- Pittsburgh and New York had a total accumulation of 48.26 centimeters.
- Detroit and Chicago had a total accumulation of 19 inches.

a. How many centimeters did it snow in each city?

b. How many inches did it snow in each city?

c. Explain the strategies that you used to help you solve this problem.

I can estimate to see if my answers are reasonable.
2. Determine the most appropriate unit for each situation.
   
   a. The longest of the great whales is the California blue whale. This whale can have a length of over 30 meters. How can this length be stated using the most appropriate customary unit of measure?

   b. The length of the largest dinosaur from the Jurassic period was the diplodocus, which was about 88 feet long. How can this length be stated in the appropriate metric units?

   c. The bullet train in Japan can travel as fast as 200 kilometers per hour. How would you state this speed in the appropriate customary unit?

**Talk the Talk**

Think about what you have learned in the past few lessons. Use your tables or pictures to help you answer these questions.

1. How are the metric system and the customary system different?
2. How are the metric system and the customary system alike?

3. A classmate has been absent for a few weeks. Write a letter to that classmate explaining what you have learned about the metric and customary measurement systems. Use some objects as examples and give the length of one object, the mass of a second object, and the capacity of a third object. Be sure to label each object with appropriate measurements.

4. State some reasons why the United States should continue using the customary measurement system.

5. State some reasons why the United States should replace the customary measurement system with the metric measurement system.

Be prepared to share your solutions and methods.
Customary Units of Measure

Standard units of measure are used for length, weight, and capacity. Length measures distance. Weight measures how heavy or how light an object is. Capacity measures the amount of a liquid substance. A measurement has two parts: a number and a unit of measure.

Example

Look at the list shown.

- 5 oz
- 4 t
- 6 ft
- 3 c

From the list shown, the most appropriate measure for the weight of an elephant is 4 tons because an ounce is too small a unit of measure to represent an animal this size, feet measure distance or height, and cups measure capacity.

New information travels between the neurons of your brain at 260 miles per hour! Hmmm... how many kilometers per hour is that?
Converting Customary Units of Measure

More than one unit of measure can be used to describe the same length, weight, or capacity.

Here are some common measurement conversions:

<table>
<thead>
<tr>
<th>Length</th>
<th>Weight</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 in. = 1 ft</td>
<td>16 oz = 1 lb</td>
<td>8 fl oz = 1 c</td>
</tr>
<tr>
<td>36 in. = 1 yd</td>
<td>2000 lb = 1 t</td>
<td>2 c = 1 pt</td>
</tr>
<tr>
<td>3 ft = 1 yd</td>
<td></td>
<td>4 c = 1 qt</td>
</tr>
<tr>
<td>5280 ft = 1 mi</td>
<td></td>
<td>2 pt = 1 qt</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 qt = 1 gal</td>
</tr>
</tbody>
</table>

Example

You can use models to show measurement conversions, or multiplication to calculate conversions.

How many cups are in 6 quarts?

\[
6 \text{ qt} = 4 \text{ c} \times 6 = 24 \text{ c}
\]

For example, there are 24 cups in 6 quarts.
Metric Units of Measure

The metric system of measurement is based on powers of ten. The table shows the six prefixes used to indicate size in the metric system. By putting each prefix together with a standard unit of length (meter), mass (gram), or capacity (liter), you can write all the units of measure in the metric system.

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Meaning</th>
<th>Prefix</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>kilo-</td>
<td>which means 1000</td>
<td>deci-</td>
<td>which means $\frac{1}{10}$, or 0.1</td>
</tr>
<tr>
<td>hecto-</td>
<td>which means 100</td>
<td>centi-</td>
<td>which means $\frac{1}{100}$, or 0.01</td>
</tr>
<tr>
<td>deka-</td>
<td>which means 10</td>
<td>milli-</td>
<td>which means $\frac{1}{1000}$, or 0.001</td>
</tr>
</tbody>
</table>

Example

Look at the list shown.

- 75 kL
- 90 m
- 100 cm
- 120 mg

For example, the most appropriate measure for the length of a soccer field is 90 meters because kiloliters measure capacity, milligrams measure mass, and centimeters are too small a unit of measure.
Converting Metric Units of Measure

More than one unit of measure can be used to describe the same length, mass, or capacity in the metric system. The metric system is based on powers of ten, just like the base-ten number system.

Example

You can use a metric system chart to determine the metric measurement conversion.

<table>
<thead>
<tr>
<th>km (1000)</th>
<th>hm (100)</th>
<th>dam (10)</th>
<th>m (1)</th>
<th>dm (0.1)</th>
<th>cm (0.01)</th>
<th>mm (0.001)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Converting between the Customary and Metric Systems

To convert measurements between the customary and metric systems, write a proportion.

Example

To determine how many centimeters are equivalent to 24 inches, follow the steps shown.

\[
\frac{24 \text{ in.}}{x \text{ cm}} = \frac{1 \text{ in.}}{2.54 \text{ cm}}
\]

\[
(24)(2.54) = (x)(1)
\]

\[
60.96 = x
\]

24 in. = 60.96 cm

60.96 centimeters are equivalent to 24 inches.
Choosing Appropriate Measures

When converting from one measurement system to another, it is important to choose a measure that is comparable in both systems.

Example

The average height of a male giraffe is 18 feet. You can convert this measurement to a metric unit of measure. First, you must choose the appropriate unit of measure as shown.

\[
\frac{18 \text{ ft}}{x \text{ m}} = \frac{3.28 \text{ ft}}{1 \text{ m}}
\]

\[(18)(1) = (x)(3.28)\]

\[
\frac{18}{3.28} = \frac{3.28x}{3.28}
\]

\[5.49 \approx x\]

\[18 \text{ ft} \approx 5.49 \text{ m}\]

The average height of a male giraffe is about 5.49 meters.