4.5 Metric Measurement

Previously, we used U. S. units to measure length, weight, and volume. We will now look at a different system of measures known as the **metric system**.

The metric system was first adopted by France in 1799 and is now the basic system of measure used in most of the world. It bases all measures on powers of 10.

The metric system uses the following basic units for length, volume, and weight.

**Meter:** The basic unit of **length** is the **meter**; the symbol for a meter is **m**. (A meter is about 3 inches longer than a yard. Michael Jordan is about 2 meters tall.)

**Liter:** The basic unit of **volume** is the **liter**; the symbol for a liter is **L**. (Slightly less than 4 liters are equivalent to 1 gallon. It takes about 50 liters of gasoline to fill a Mini Cooper’s gas tank.)

**Gram:** The basic unit of **weight** is the **gram**; the symbol for a gram is **g**. (Slightly more than 28 grams make an ounce, and about 453 grams make a pound. The average weight of a healthy newborn baby is about 3,000 grams.)

In the metric system, a **prefix** can be attached to the basic unit to produce a new unit. The new unit is smaller or larger than the basic unit by a power of 10.

The table shows some of the more common prefixes and their meanings:

<table>
<thead>
<tr>
<th>Prefix</th>
<th>KILO</th>
<th>HECTO</th>
<th>DEKA</th>
<th>BASIC UNIT</th>
<th>DECI</th>
<th>CENTI</th>
<th>MILLI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meaning</td>
<td>Thousand</td>
<td>Hundred</td>
<td>Ten</td>
<td>(m,L,g)</td>
<td>Tenth</td>
<td>Hundredth</td>
<td>Thousandth</td>
</tr>
<tr>
<td></td>
<td>1,000</td>
<td>100</td>
<td>10</td>
<td>1</td>
<td>0.1</td>
<td>0.01</td>
<td>0.001</td>
</tr>
</tbody>
</table>

For example, a centimeter (cm) is smaller than a meter because one centimeter is equal to one hundredth of a meter. A kilogram (kg) is larger than a gram because one kilogram is equal to one thousand grams.

When we convert from feet to inches, we multiply by 12; when we convert from inches to feet, we divide by 12. Metric system conversions can be completed more easily because the metric system, like our numbering system, is based on powers of 10. Conversions between metric system units will require us either to multiply or to divide by 10 or by 100 or by 1000, etc.

As an example of a simple metric system conversion that we will encounter, multiply the number 456.392 by 10: the answer is 4563.92, a shift of the decimal point one place to the right. As
another example, multiply the same original number 456.392 by 100: the answer is 45639.2, a shift of the decimal point two places to the right. In short, multiplying by a power of 10 shifts the decimal point to the right.

On the other hand, dividing by a power of ten shifts the decimal point to the left. As an example, divide the number 456.392 by 10: the answer is 45.6392, a shift of the decimal point one place to the left. As another example, divide the same original number 456.392 by 100: the answer is 4.56392, a shift of the decimal point two places to the left.

Since metric system conversions involve multiplying or dividing by powers of 10, a quick way to make a metric-to-metric conversion is to move the decimal point. If you can remember the order of the prefixes, you can shift the decimal the correct number of places, either right or left.

Use the saying “King Henry’s daughter makes delicious chocolate milk” to help you keep the prefix order straight.

<table>
<thead>
<tr>
<th>KILO k-</th>
<th>HECTO h-</th>
<th>DEKA da-</th>
<th>BASIC UNIT meter liter gram</th>
<th>DECI d-</th>
<th>CENTI c-</th>
<th>MILLI m-</th>
</tr>
</thead>
<tbody>
<tr>
<td>King</td>
<td>Henry’s Daughter Makes Likes Gives</td>
<td>Delicious</td>
<td>Chocolate</td>
<td>Milk</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Here are some lesser known alternative sayings to help you memorize the prefix order. Pick your favorite.

Klingons hate Dr. McCoy’s deadly cold medicine.
Kmart has district managers distributing cash machines.
Kansas hockey divisions meet during cold months.

**STEPS TO CONVERT USING THE PREFIXES IN THE TABLE ABOVE:**

1. Locate the prefix *originally given*.

2. Count how many positions and in what direction you need to move to get to the prefix you *want*.

3. Move the decimal point in the original value by that same number of places and in the same direction.

**Example 1:** Convert 3 kilometers (km) to meters (m).
Locate the *given* unit (**km**) in the prefix table. To get to the unit you **want** (**m**), move three places to the right. So, move the decimal point in 3 = 3.000 by three places to the right.

\[ 3 \text{ km} = 3.000 \text{ km} = 3000 \text{ m} \]

**Answer:** \(3 \text{ km} = 3000 \text{ m}\)

**Practice 1:** Convert 3.52 kilograms (kg) to grams (g).  
**Answer:** 3520 g  
**Watch It:** [http://youtu.be/7Q_TZb5bq4](http://youtu.be/7Q_TZb5bq4)

**Example 2:** Convert 88 centigrams (cg) to grams (g).  
Locate the *given* unit (**cg**) in the prefix table. To get to the unit we **want** (**g**), move two places to the left. So move the decimal point in 88 = 88. by two places to the left.

\[ 88 \text{ cg} = 88. \text{ cg} = 0.88 \text{ g} \]

**Answer:** \(88 \text{ cg} = 0.88 \text{ g}\).

**Practice 2:** Convert 5.6 centimeters (cm) to meters (m).  
**Answer:** 0.056 m  
**Watch It:** [http://youtu.be/KldH2ydr64E](http://youtu.be/KldH2ydr64E)

**Example 3:** Convert 41 liters (L) to kiloliters (kL).  
Locate the *given* unit (**L**) in the prefix table. To get to the unit we **want** (**kL**), move three places to the left. So move the decimal point in 41 = 41. by three places to the left. Notice we need to insert a 0 as a placeholder to the left of the digit 4 so we can move the decimal point by three places.

\[ 41 \text{ L} = 0.041 \text{ L} = 0.041 \text{ kL} \]

**Answer:** \(41 \text{ L} = 0.041 \text{ kL}\)

**Practice 3:** Convert 2 meters (m) to kilometers (km).  
**Answer:** 0.002 km  
**Watch It:** [http://youtu.be/1EJWTCmNGZA](http://youtu.be/1EJWTCmNGZA)
Example 4: Convert 423 milligrams (mg) to grams (g).

Locate the given unit (mg) in the prefix table. To get to the unit we want (g), move three places to the left. So move the decimal point in 423 = 423. by three places to the left.

\[423 \text{ mg} = 4.23 \text{ g} = 0.423 \text{ g}\]

Answer: \(423 \text{ mg} = 0.423 \text{ g}\)

Practice 4: Convert 713.2 milliliters (mL) to liters (L). \(\text{Answer: } 0.7132 \text{ L}\)

Watch It: http://youtu.be/3BrISQYPF8

Example 5: Convert 2.57 liters (L) to milliliters (mL).

Locate the given unit (L) in the prefix table. To get to the unit we want (mL), move three places to the right. So move the decimal point in 2.57 by three places to the right. Notice we need to insert a 0 as a placeholder to the right of the digit 7 so we can move the decimal point by three places.

\[2.57 \text{ L} = 2.570 \text{ L} = 2570 \text{ mL}\]

Answer: \(2.57 \text{ L} = 2570 \text{ mL}\).

Practice 5: Convert 52.9 grams (g) to milligrams (mg). \(\text{Answer: } 52,900 \text{ mg}\)

Watch It: http://youtu.be/IYoLCXc2Xtg

Example 6: Convert 59 dekagrams (dag) to decigrams (dg).

Locate the given unit (dag) in the prefix table. To get to the unit we want (dg), move two places to the right. So move the decimal point in 59 = 59. by two places to the right.

\[59 \text{ dag} = 59.00 \text{ dag} = 5900 \text{ dg}\]

Answer: \(59 \text{ dag} = 5900 \text{ dg}\)

Practice 6: Convert 5000 centimeters (cm) to kilometers (km). \(\text{Answer: } 0.05 \text{ km}\)

Watch It: http://youtu.be/csB3bcbLNZI

Because the metric system and our decimal numbering system are both based on powers of 10, we were able to convert within the metric system by moving decimal points as above. We can also convert units by using conversion factors as we did in a previous section.
Let’s write the information in the prefix table using conversion factors instead. The conversion factors below are shown using meters (the metric unit for length). Notice that “meter” could be replaced with “liter” (the metric unit for volume) or “gram” (the metric unit for weight).

1 kilometer (km) = 1000 meters (m)
1 hectometer (hm) = 100 meters (m)
1 dekameter (dam) = 10 meters (m)
10 decimeters (dm) = 1 meter (m)
100 centimeters (cm) = 1 meter (m)
1000 millimeter (mm) = 1 meter (m)

If we write a conversion factor as a fraction, its value is 1. For example, we can write the conversion factor relating meters and centimeters as both:

\[
\frac{1 \text{ m}}{100 \text{ cm}} = 1 \quad \text{and} \quad \frac{100 \text{ cm}}{1 \text{ m}} = 1
\]

**Example 7:** Convert 3 kilometers (km) to meters (m).

The **given** unit is kilometers and the **wanted** unit is meters. Write the conversion factor

\[
1 \text{ kilometer (km)} = 1000 \text{ meters (m)} \quad \text{as} \quad \frac{1000 \text{ m}}{1 \text{ km}}.
\]

Multiply:

\[
\frac{3 \text{ km}}{1} \times \frac{1000 \text{ m}}{1 \text{ km}} = 3 \times 1000 \text{ m} = 3000 \text{ m}
\]

**Answer:** 3 km = 3000 m.

**Practice 7:** Convert 3.52 kilograms (kg) to grams (g). **Answer:** 3520 g

**Watch It:** [http://youtu.be/RKY8ptSCYy8](http://youtu.be/RKY8ptSCYy8)

**Example 8:** Convert 88 centigrams (cg) to grams (g).
The given unit is centimeters and the wanted unit is meters. Write the conversion factor

\[
\frac{100 \text{ centigrams (cg)}}{1 \text{ gram (g)}} = \frac{1 \text{ g}}{100 \text{ cg}}.
\]

Multiply:

\[
\frac{88 \text{ cg}}{1} \times \frac{1 \text{ g}}{100 \text{ cg}} = \frac{88}{100} \text{ g} = 0.88 \text{ g}
\]

Answer: 88 cg = 0.88 g.

Practice 8: Convert 5.6 centimeters (cm) to meters (m). Answer: 0.056 m

Watch It: [http://youtu.be/mIonX-JCmaA](http://youtu.be/mIonX-JCmaA)

Example 9: Convert 567 milliliters (mL) to kiloliters (kL).

The given unit is milliliters and the wanted unit is kiloliters. We will use two conversion factors: one to convert from milliliters to liters and another to convert from liters to kiloliters.

Multiply:

\[
\frac{567 \text{ mL}}{1} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{1 \text{ kL}}{1000 \text{ L}} = \frac{567}{1,000,000} \text{ kL} = 0.000567 \text{ kL}
\]

Answer: 567 mL = 0.000567 kL.

Practice 9: Convert 5000 centimeters (cm) to kilometers (km). Answer: 0.05 km

Watch It: [http://youtu.be/UB-hS3B87h4](http://youtu.be/UB-hS3B87h4)

Watch All: [http://youtu.be/skFS1BueLVo](http://youtu.be/skFS1BueLVo)
4.5 Metric Measurement Exercises

1. Convert 6804 m to km.
2. Convert 4.2 kg to g.
3. Convert 1970 mg to g.
4. Convert 18,000 L to hL.
5. Convert 450 mm to m.
6. Convert 73.9 cm to m.
7. Convert 357 ml to L.
8. Convert 43.89 hm to m.
9. Convert 345 g to mg.
10. Convert 8.75 m to cm.
11. Convert 8 daL to L.
12. Convert 7.5 cg to kg.
13. Convert 14 dm to m.
15. Convert 553 dL to hL.
16. Convert 2.8 g to dag.
17. Convert 65 cm to dm.
18. Convert 0.078 km to cm.
19. Convert 50 mg to hg.
20. Convert 0.35 L to dL.
4.5 Metric Measurement Exercises Answers

1. 6.804 km
2. 4.200 g
3. 1.970 g or 1.97 g
4. 180 hL
5. 0.450 m or 0.45 m
6. 0.739 m
7. 0.357 L
8. 4,389 m
9. 345,000 mg
10. 875 cm
11. 80 L
12. 0.000075 kg
13. 1.4 m
14. 60,000 cg
15. 0.553 hL
16. 0.28 dag
17. 6.5 dm
18. 7,800 cm
19. 0.0005 hg
20. 3.5 dL