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Learning Outcomes

- Make unit conversions in the metric system
- Use mixed units of measurement in the metric system

Make Unit Conversions in the Metric System

In the metric system, units are related by powers of 10 . The root words of their names reflect this relation. For example, the basic unit for measuring length is a meter. One kilometer is 1000 meters; the prefix *kilo-* means thousand. One centimeter is $\frac{1}{100}$ of a meter, because the prefix *centi-* means one one-hundredth (just like one cent is $\frac{1}{100}$ of one dollar).

The equivalencies of measurements in the metric system are shown in the reference table below. The common abbreviations for each measurement are given in parentheses.

Metric Measurements		
Length	Mass	Volume/Capacity
1 kilometer (km) = 1000 m	1 kilogram (kg) = 1000 g	1 kiloliter (kL) = 1000 L
1 hectometer (hm) = 100 m	1 hectogram (hg) = 100 g	1 hectoliter (hL) = 100 L
1 dekameter (dam) = 10 m	1 dekagram (dag) = 10 g	1 dekaliter (daL) = 10 L
1 meter (m) = 1 m	1 gram (g) = 1 g	1 liter (L) = 1 L
1 decimeter (dm) = 0.1 m	1 decigram (dg) = 0.1 g	1 deciliter (dL) = 0.1 L

$1 \text{ centimeter (cm)}$ $= 0.01 \text{ m}$	1 centigram (cg) $= 0.01 \text{ g}$	$1 \text{ centiliter (cL)}$ $= 0.01 \text{ L}$
$1 \text{ millimeter (mm)}$ $= 0.001 \text{ m}$	1 milligram (mg) $= 0.001 \text{ g}$	$1 \text{ milliliter (mL)}$ $= 0.001 \text{ L}$
1 meter $= 100 \text{ centimeters}$	1 gram $= 100 \text{ centigrams}$	1 liter $= 100 \text{ centiliters}$
1 meter $= 1000 \text{ millimeters}$	1 gram $= 1000 \text{ milligrams}$	1 liter $= 1000 \text{ milliliters}$

To make conversions in the metric system, we will use the same technique we did in the U.S. system. Using the identity property of multiplication, we will multiply by a conversion factor of one to get to the correct units.

Have you ever run a 5 km or 10 km race? The lengths of those races are measured in kilometers. The metric system is commonly used in the United States when talking about the length of a race.

example

Nick ran a 10 km -kilometer race. How many meters did he run?

(credit: William Warby, Flickr)

Solution

We will convert kilometers to meters using the Identity Property of Multiplication and the equivalencies in the reference table from earlier.

	10 kilometers
Multiply the measurement to be converted by 1 .	$10 \text{ km} \cdot 1$
Write 1 as a fraction relating kilometers and meters.	$10 \text{ km} \cdot \frac{1000 \text{ m}}{1 \text{ km}}$

Simplify.	$\frac{10\text{ km}}{1\text{ km}} \cdot 1000\text{ m}$
Multiply.	$10,000\text{ m}$
	Nick ran $10,000$ meters.

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example

Eleanor's newborn baby weighed 3200 grams. How many kilograms did the baby

weigh?

Show Solution

Solution

We will convert grams to kilograms.

	3200 grams
Multiply the measurement to be converted by 1 .	$3200 \text{ g} \cdot 1$
Write 1 as a fraction relating kilograms and grams.	$3200 \text{ g} \cdot \frac{1 \text{ kg}}{1000 \text{ g}}$
Simplify.	$3200 \text{ g} \cdot \frac{1 \text{ kg}}{1000 \text{ g}}$
Multiply.	$\frac{3200 \text{ kilograms}}{1000}$
Divide.	3.2 kilograms
	The baby weighed 3.2 kilograms.

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Since the metric system is based on multiples of ten, conversions involve multiplying by multiples of ten. [Previously, we learned how to simplify these calculations by just moving the decimal.](#)

To multiply by $10, 100, \text{ or } 1000$, we move the decimal to the right $1, 2, \text{ or } 3$ places, respectively. To multiply by $0.1, 0.01, \text{ or } 0.001$ we move the decimal to the left $1, 2, \text{ or } 3$ places respectively.

We can apply this pattern when we make measurement conversions in the metric system.

In the previous example, we changed 3200 grams to kilograms by multiplying by $\frac{1}{1000}$ or 0.001 . This is the same as moving the decimal 3 places to the left.

example

1. Convert 350 liters to kiloliters 2. Convert 4.1 liters to milliliters.

Show Solution

Solution

1. We will convert liters to kiloliters. In the reference table, we see that $1 \text{ kiloliter} = 1000 \text{ liters}$.

	350 L
Multiply by 1 , writing 1 as a fraction relating liters to kiloliters.	$350 \text{ L} \cdot \frac{1 \text{ kL}}{1000 \text{ L}}$
Simplify.	$350 \text{ L} \cdot \frac{1 \text{ kL}}{1000}$
Move the decimal 3 units to the left.	
	0.35 kL

2. We will convert liters to milliliters. In the reference table, we see that $1 \text{ liter} = 1000 \text{ milliliters}$.

	4.1 L
Multiply by 1 , writing 1 as a fraction relating milliliters to liters.	$4.1 \text{ L} \cdot \frac{1000 \text{ mL}}{1 \text{ L}}$
Simplify.	$4.1 \text{ L} \cdot \frac{1000 \text{ mL}}{1}$
Move the decimal 3 units to the right.	
	4100 mL

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Use Mixed Units of Measurement in the Metric System

Performing arithmetic operations on measurements with mixed units of measures in the metric system requires the same care we used in the U.S. system. But it may be easier because of the relation of the units to the powers of 10 . We still must make sure to add or subtract like units.

example

Ryland is 1.6 meters tall. His younger brother is 85 centimeters tall. How much taller is Ryland than his younger brother?

Show Solution

Solution

We will subtract the lengths in meters. Convert 85 centimeters to meters by moving the decimal 2 places to the left; 85 cm is the same as 0.85 m.

Now that both measurements are in meters, subtract to find out how much taller Ryland is than his brother.

$$\begin{array}{r} 1.60 \text{ m} \\ - 0.85 \text{ m} \\ \hline 0.75 \text{ m} \end{array}$$

Ryland is 0.75 meters taller than his brother.

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example

Dena's recipe for lentil soup calls for 150 milliliters of olive oil. Dena wants to triple the recipe. How many liters of olive oil will she need?

Show Solution

Solution

We will find the amount of olive oil in milliliters then convert to liters.

	Triple 150 mL
Translate to algebra.	$3 \cdot 150$ mL
Multiply.	450 mL
Convert to liters.	$450 \text{ mL} \cdot \frac{0.001 \text{ L}}{1 \text{ mL}}$
Simplify.	0.45 L
	Dena needs 0.45 liter of olive oil.

try it



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