

6-5

Measurement: Changing Metric Units

MAIN IDEA

Change metric units of length, capacity, and mass.

New Vocabulary

metric system

meter

liter

gram

kilogram

Math Online

glencoe.com

- Extra Examples
- Personal Tutor
- Self-Check Quiz

MINI Lab

The lengths of two objects are shown below.

Object	Length (millimeters)	Length (centimeters)
paper clip	45	4.5
CD case	144	14.4

1. Select three other objects. Find and record the width of all five objects to the nearest millimeter and tenth of a centimeter.
2. Compare the measurements of the objects, and write a rule that describes how to convert from millimeters to centimeters.
3. Measure the length of your classroom in meters. Make a conjecture about how to convert this measure to centimeters. Explain.

The **metric system** is a decimal system of measures. The prefixes commonly used in this system are kilo-, centi-, and milli-

Prefix	Meaning In Words	Meaning In Numbers
kilo-	thousands	1,000
centi-	hundredths	0.01
milli-	thousandths	0.001

In the metric system, the base unit of *length* is the **meter** (m). Using the prefixes, the names of other units of length are formed. Notice that the prefixes tell you how the units relate to the meter.

Unit	Symbol	Relationship to Meter	
kilometer	km	1 km = 1,000 m	1 m = 0.001 km
meter	m	1 m = 1 m	
centimeter	cm	1 cm = 0.01 m	1 m = 100 cm
millimeter	mm	1 mm = 0.001 m	1 m = 1,000 mm

The **liter** (L) is the base unit of *capacity*, the amount of dry or liquid material an object can hold. The **gram** (g) measures *mass*, the amount of matter in an object. The prefixes can also be applied to these units. Whereas the meter and liter are the base units of length and capacity, the base unit of mass is the **kilogram** (kg).

To change a metric measure of length, mass, or capacity from one unit to another, you can use the relationship between the two units and multiplication by a power of 10.

EXAMPLES Convert Units in the Metric System

Study Tip

Metric Conversions
When converting from a larger unit to a smaller unit, the power of ten being multiplied will be greater than 1.
When converting from a smaller unit to a larger unit, the power of ten will be less than 1.

1 Convert 4.5 liters to milliliters.

You need to convert liters to milliliters. Use the relationship

$$1 \text{ L} = 1,000 \text{ mL}$$

$$1 \text{ L} = 1,000 \text{ mL}$$

Write the relationship.

$$4.5 \times 1 \text{ L} = 4.5 \times 1,000 \text{ mL}$$

Multiply each side by 4.5 since you have 4.5 L.

$$4.5 \text{ L} = 4,500 \text{ mL}$$

To multiply 4.5 by 1,000, move the decimal point 3 places to the right.

2 Convert 500 millimeters to meters.

You need to convert millimeters to meters. Use the relationship

$$1 \text{ mm} = 0.001 \text{ m}$$

$$1 \text{ mm} = 0.001 \text{ m}$$

Write the relationship.

$$500 \times 1 \text{ mm} = 500 \times 0.001 \text{ m}$$

Multiply each side by 500 since you have 500 mm.

$$500 \text{ mm} = 0.5 \text{ m}$$

To multiply 500 by 0.001, move the decimal point 3 places to the left.

CHECK Your Progress

Complete.

a. $25.4 \text{ g} = \square \text{ kg}$

b. $158 \text{ mm} = \square \text{ m}$



Real-World Link

The maximum weight of a grizzly bear is 521.64 kilograms.

Source: North American Bear Center

Real-World EXAMPLE

3 BEARS The California Grizzly Bear was designated the official state animal in 1953. Use the information at the left to find the maximum weight of a grizzly bear in grams.

You are converting kilograms to grams. Since the maximum weight of a grizzly bear is 521.64 kilograms, use the relationship $1 \text{ kg} = 1,000 \text{ g}$.

$$1 \text{ kg} = 1,000 \text{ g}$$

Write the relationship.

$$521.64 \times 1 \text{ kg} = 521.64 \times 1,000 \text{ g}$$

Multiply each side by 521.64 since you have 521.64 kg.

$$521.64 \text{ kg} = 521,640 \text{ g}$$

To multiply 521.64 by 1,000, move the decimal point 3 places to the right.

So, the maximum weight of a grizzly bear is 521,640 grams.

CHECK Your Progress

c. **FOOD** A bottle contains 1.75 liters of juice. How many milliliters is this?

To convert measures between customary units and metric units, use the relationships below.

Customary and Metric Relationships			Key Concept
Type of Measure	Customary	→	Metric
Length	1 inch (in.)	≈	2.54 centimeters (cm)
	1 foot (ft)	≈	0.30 meter (m)
	1 yard (yd)	≈	0.91 meter (m)
	1 mile (mi)	≈	1.61 kilometers (km)
Weight/Mass	1 pound (lb)	≈	453.6 grams (g)
	1 pound (lb)	≈	0.4536 kilogram (kg)
	1 ton (T)	≈	907.2 kilograms (kg)
Capacity	1 cup (c)	≈	236.59 milliliters (mL)
	1 pint (pt)	≈	473.18 milliliters (mL)
	1 quart (qt)	≈	946.35 milliliters (mL)
	1 gallon (gal)	≈	3.79 liters (L)

EXAMPLES Convert Between Measurement Systems

Study Tip

Alternative Method
When converting 17.22 inches to centimeters, you can use the relationship $1 \text{ in.} \approx 2.54 \text{ cm}$ or the unit ratio $\frac{2.54 \text{ cm}}{1 \text{ in.}}$.

- 4** Convert 17.22 inches to centimeters. Round to the nearest hundredth if necessary.

Use the relationship $1 \text{ inch} \approx 2.54 \text{ centimeters}$.

$$1 \text{ inch} \approx 2.54 \text{ cm} \quad \text{Write the relationship.}$$

$$17.22 \times 1 \text{ in.} \approx 17.22 \times 2.54 \text{ cm} \quad \text{Multiply each side by 17.22 since you have 17.22 in.}$$

$$17.22 \text{ in.} \approx 43.7388 \text{ cm} \quad \text{Simplify.}$$

So, 17.22 inches is approximately 43.74 centimeters.

- 5** Convert 828.5 milliliters to cups. Round to the nearest hundredth if necessary.

Since $1 \text{ cup} \approx 236.59 \text{ milliliters}$, multiply by $\frac{1 \text{ c}}{236.59 \text{ mL}}$.

$$\begin{aligned} 828.5 \text{ mL} &\approx 828.5 \text{ mL} \cdot \frac{1 \text{ c}}{236.59 \text{ mL}} && \text{Multiply by } \frac{1 \text{ c}}{236.59 \text{ mL}}. \\ &\approx \frac{828.5 \text{ c}}{236.59} \text{ or } 3.5 \text{ c} && \text{Simplify.} \end{aligned}$$

So, 828.5 milliliters is approximately 3.5 cups.

CHECK Your Progress

Complete. Round to the nearest hundredth if necessary.

d. $7.44 \text{ c} \approx \square \text{ mL}$ e. $22.09 \text{ lb} \approx \square \text{ kg}$ f. $35.85 \text{ L} \approx \square \text{ gal}$



Real-World EXAMPLE

Convert with Rates

- 6 LIGHT** The speed of light is about 186,000 miles per second. Find the approximate speed of light in kilometers per second.

Since 1 mile \approx 1.61 kilometers, multiply by $\frac{1.61 \text{ km}}{1 \text{ mi}}$.

$$\begin{aligned} \frac{186,000 \text{ mi}}{\text{s}} &\approx \frac{186,000 \cancel{\text{mi}}}{1 \text{ s}} \times \frac{1.61 \text{ km}}{1 \cancel{\text{mi}}} && \text{Multiply by } \frac{1.61 \text{ km}}{1 \text{ mi}}. \\ &\approx \frac{299,460 \text{ km}}{1 \text{ s}} && \text{Simplify.} \end{aligned}$$

So, the speed of light is approximately 299,460 kilometers per second.



CHECK Your Progress

- g. **RUNNING** Chuck runs at a speed of 3 meters per second. About how many feet per second does Chuck run?



Real-World Link

Before the seventeenth century, people thought light was transmitted instantly. Now, we know that light is too fast for the delay to be noticeable.

Source: University of California, Riverside



CHECK Your Understanding

Examples 1, 2, 4, 5
(pp. 305–306)

Complete. Round to the nearest hundredth if necessary.

- 3.7 m = cm
- 550 m = km
- 1,460 mg = g
- 2.34 kL = L
- 9.36 yd \approx m
- 11.07 pt \approx mL
- 58.14 kg \approx lb
- 38.44 cm \approx in.

Examples 3, 6
(pp. 305, 307)

- SPORTS** About how many feet does a team of athletes run in a 1,600-meter relay race?



Practice and Problem Solving

HOMework HELP

For Exercises	See Examples
10–23	1, 2, 4, 5
24–27	3, 6

Complete. Round to the nearest hundredth if necessary.

- 720 cm = m
- 983 mm = m
- 3.2 m = cm
- 0.03 g = mg
- 997 g = kg
- 82.1 g = kg
- 9.1 L = mL
- 130.5 kL = L
- 3.75 c \approx mL
- 41.8 in. \approx cm
- 156.25 lb \approx kg
- 9.5 gal \approx L
- 680.4 g \approx lb
- 4.725 m \approx ft

- WATERFALLS** At 979 meters tall, Angel Falls in Venezuela is the highest waterfall in the world. How many kilometers tall is the waterfall?
- FOOD** An 18-ounce jar contains 510 grams of grape jelly. How many kilograms of grape jelly does the jar contain?

43. **WRITING IN MATH** Explain why it makes sense to multiply by a power of 10 that is greater than 1 when changing from a larger unit to a smaller unit.

TEST PRACTICE

44. The table shows the mass of four wireless telephones. Find the approximate total mass of the telephones in kilograms.

Telephone Owner	Mass (g)
Elena	100.4
Kevin	70.8
Marissa	95.6
Corey	120.4

- A 0.39 kilogram
 B 3.9 kilograms
 C 39.0 kilograms
 D 390.0 kilograms

45. Which relationship between the given units of measure is correct?

- F One gram is $\frac{1}{100}$ of a centigram.
 G One meter is $\frac{1}{100}$ of a centimeter.
 H One gram is $\frac{1}{1,000}$ of a kilogram.
 J One milliliter is $\frac{1}{100}$ of a liter.

Spiral Review

46. **MEASUREMENT** A certain car weighs 3,200 pounds. What is the weight of the car in tons? (Lesson 6-4)
47. **MEASUREMENT** The table shows the number of inches per foot. Graph the data. Then find the slope of the line. Explain what slope represents. (Lesson 6-3)

Feet (x)	1	2	3	4
Inches (y)	12	24	36	48

Add or subtract. Write in simplest form. (Lesson 5-3)

48. $3\frac{4}{7} + 1\frac{1}{7}$ 49. $8\frac{3}{5} - 2\frac{2}{5}$ 50. $9\frac{1}{6} + 4\frac{3}{8}$ 51. $11\frac{7}{10} - 5\frac{3}{4}$

52. **BASKETBALL** Jared made thirty-seven percent of his free-throw attempts during basketball practice. Write this percent as a decimal. (Lesson 4-7)

▶ GET READY for the Next Lesson

PREREQUISITE SKILL Solve each equation. (Lesson 3-3)

53. $5 \cdot 4 = x \cdot 2$ 54. $9 \cdot 24 = 27 \cdot x$ 55. $x \cdot 15 = 12 \cdot 4$ 56. $8\frac{1}{2} \cdot x = 11 \cdot 17$