

9.4 LINEAR MEASUREMENT

Objective **A** Defining and Converting U.S. System Units of Length

In the United States, two systems of measurement are commonly used. They are the **United States (U.S.), or English, measurement system** and the **metric system**. The U.S. measurement system is familiar to most Americans. Units such as feet, miles, ounces, and gallons are used. However, the metric system is also commonly used in fields such as medicine, sports, international marketing, and certain physical sciences. We are accustomed to buying 2-liter bottles of soft drinks, watching televised coverage of the 100-meter dash at the Olympic Games, or taking a 200-milligram dose of pain reliever.

The U.S. system of measurement uses the **inch, foot, yard, and mile** to measure length. The following is a summary of equivalencies between units of length:

U.S. Units of Length

$$\begin{aligned} 12 \text{ inches (in.)} &= 1 \text{ foot (ft)} \\ 3 \text{ feet} &= 1 \text{ yard (yd)} \\ 36 \text{ inches} &= 1 \text{ yard} \\ 5280 \text{ feet} &= 1 \text{ mile (mi)} \end{aligned}$$

To convert from one unit of length to another, we will use **unit fractions**. We define a unit fraction to be a fraction that is equivalent to 1. Examples of unit fractions are as follows:

Unit Fractions

$$\begin{aligned} \frac{12 \text{ in.}}{1 \text{ ft}} &= 1 \text{ or } \frac{1 \text{ ft}}{12 \text{ in.}} = 1 \text{ (since } 12 \text{ in.} = 1 \text{ ft)} \\ \frac{3 \text{ ft}}{1 \text{ yd}} &= 1 \text{ or } \frac{1 \text{ yd}}{3 \text{ ft}} = 1 \text{ (since } 3 \text{ ft} = 1 \text{ yd)} \\ \frac{5280 \text{ ft}}{1 \text{ mi}} &= 1 \text{ or } \frac{1 \text{ mi}}{5280 \text{ ft}} = 1 \text{ (since } 5280 \text{ ft} = 1 \text{ mi)} \end{aligned}$$

Remember that multiplying a number by 1 does not change the value of the number.

EXAMPLE 1 Convert 8 feet to inches.

Solution: We multiply 8 feet by a unit fraction that uses the equality 12 inches = 1 foot. The unit fraction should be in the form $\frac{\text{units to convert to}}{\text{original units}}$ or in this case $\frac{12 \text{ inches}}{1 \text{ foot}}$. We do this so that like units will divide out to 1, as shown.

$$\begin{aligned} 8 \text{ ft} &= \frac{8 \text{ ft}}{1} \cdot 1 && \text{Multiply by 1 in the form of } \frac{12 \text{ in.}}{1 \text{ ft}} \\ &= \frac{8 \cancel{\text{ ft}}}{1} \cdot \frac{12 \text{ in.}}{1 \cancel{\text{ ft}}} \\ &= 8 \cdot 12 \text{ in.} \\ &= 96 \text{ in.} && \text{Multiply.} \end{aligned}$$

Continued on next page

Objectives

- A** Define U.S. Units of Length and Convert from One Unit to Another.
- B** Use Mixed Units of Length.
- C** Perform Arithmetic Operations on U.S. Units of Length.
- D** Define Metric Units of Length and Convert from One Unit to Another.
- E** Perform Arithmetic Operations on Metric Units of Length.

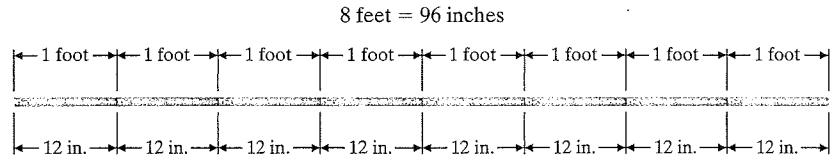
PRACTICE PROBLEM 1

Convert 6 feet to inches.

Answer

1. 72 in.

Thus, 8 ft = 96 in., as shown in the diagram:



Work Practice Problem 1

PRACTICE PROBLEM 2

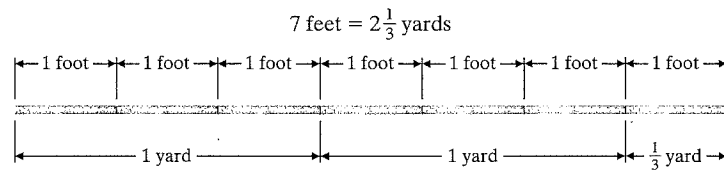
Convert 8 yards to feet.

EXAMPLE 4 Convert 7 feet to yards.

Solution: We multiply by a unit fraction that compares 1 yard to 3 feet.

$$\begin{aligned} 7 \text{ ft} &= \frac{7 \text{ ft}}{1} \cdot 1 \\ &= \frac{7 \cancel{\text{ft}}}{1} \cdot \frac{1 \text{ yd}}{3 \cancel{\text{ft}}} \quad \leftarrow \begin{array}{l} \text{Units to convert to} \\ \text{Original units} \end{array} \\ &= \frac{7}{3} \text{ yd} \\ &= 2\frac{1}{3} \text{ yd} \quad \text{Divide.} \end{aligned}$$

Thus, 7 ft = $2\frac{1}{3}$ yd, as shown in the diagram.



Work Practice Problem 2

Helpful Hint

When converting from one unit to another, select a unit fraction with the properties below:

$\frac{\text{units you are converting to}}{\text{original units}}$

By using this unit fraction, the original units will divide out, as wanted.

PRACTICE PROBLEM 3

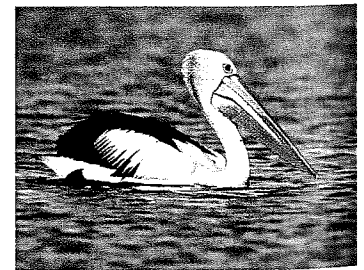
Suppose the bill in the photo measures 18 inches. Convert 18 inches to feet, using decimals.

EXAMPLE 5 Finding Length of Pelican's Bill

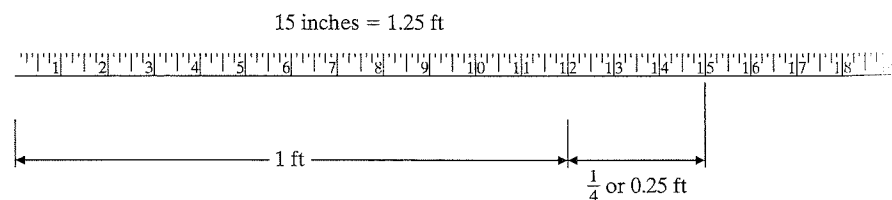
The Australian pelican has the longest bill, measuring from 13 to 18.5 inches long. The pelican in the photo has a 15-inch bill. Convert 15 inches to feet, using decimals in your final answer.

Solution:

$$\begin{aligned} 15 \text{ in.} &= \frac{15 \cancel{\text{in.}}}{1} \cdot \frac{1 \text{ ft}}{12 \cancel{\text{in.}}} \quad \leftarrow \begin{array}{l} \text{Units to convert to} \\ \text{Original units} \end{array} \\ &= \frac{15}{12} \text{ ft} \\ &= \frac{5}{4} \text{ ft} \quad \text{Simplify } \frac{15}{12}. \\ &= 1.25 \text{ ft} \quad \text{Divide.} \end{aligned}$$



Thus, 15 in. = 1.25 ft, as shown in the diagram.



Answers

2. 24 ft 3. 1.5 ft

Work Practice Problem 3

Objective B Using Mixed U.S. System Units of Length

Sometimes it is more meaningful to express a measurement of length with mixed units such as 1 ft and 5 in. We usually condense this and write 1 ft 5 in.

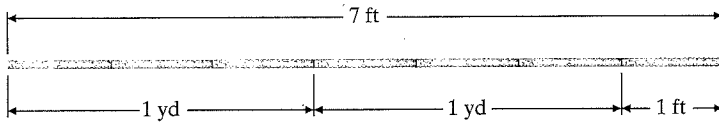
In Example 2, we found that 7 feet was the same as $2\frac{1}{3}$ yards. The measurement can also be written as a mixture of yards and feet. That is,

$$7 \text{ ft} = \underline{\quad} \text{ yd } \underline{\quad} \text{ ft}$$

Because 3 ft = 1 yd, we divide 3 into 7 to see how many whole yards are in 7 feet. The quotient is the number of yards, and the remainder is the number of feet.

$$\begin{array}{r} 2 \text{ yd } 1 \text{ ft} \\ 3 \overline{)7} \\ \underline{-6} \\ 1 \end{array}$$

Thus, 7 ft = 2 yd 1 ft, as seen in the diagram:



EXAMPLE 4 Convert: 134 in. = ft in.

Solution: Because 12 in. = 1 ft, we divide 12 into 134. The quotient is the number of feet. The remainder is the number of inches. To see why we divide 12 into 134, notice that

$$134 \text{ in.} = \frac{134 \cancel{\text{ in.}}}{1} \cdot \frac{1 \text{ ft}}{12 \cancel{\text{ in.}}} = \frac{134}{12} \text{ ft}$$

$$\begin{array}{r} 11 \text{ ft } 2 \text{ in.} \\ 12 \overline{)134} \\ \underline{-12} \\ 14 \\ \underline{-12} \\ 2 \end{array}$$

Thus, 134 in. = 11 ft 2 in.

Work Practice Problem 4

EXAMPLE 5 Convert 3 feet 7 inches to inches.

Solution: First, we convert 3 feet to inches. Then we add 7 inches.

$$3 \text{ ft} = \frac{3 \cancel{\text{ ft}}}{1} \cdot \frac{12 \text{ in.}}{1 \cancel{\text{ ft}}} = 36 \text{ in.}$$

Then

$$3 \text{ ft } 7 \text{ in.} = \underline{36 \text{ in.}} + 7 \text{ in.} = 43 \text{ in.}$$

Work Practice Problem 5

PRACTICE PROBLEM 4

Convert:
68 in. = ft in.

PRACTICE PROBLEM 5

Convert 5 yards 2 feet to feet.

Answers

4. 5 ft 8 in. 5. 17 ft

Objective **C** Performing Operations on U.S. System Units of Length

Finding sums or differences of measurements often involves converting units, as shown in the next example. Just remember that, as usual, only like units can be added or subtracted.

PRACTICE PROBLEM 6

Add 4 ft 8 in. to 8 ft 11 in.

EXAMPLE 6 Add 3 ft 2 in. and 5 ft 11 in.

Solution: To add, we line up the similar units.

$$\begin{array}{r} 3 \text{ ft } 2 \text{ in.} \\ + 5 \text{ ft } 11 \text{ in.} \\ \hline 8 \text{ ft } 13 \text{ in.} \end{array}$$

Since 13 inches is the same as 1 ft 1 in., we have

$$\begin{array}{r} 8 \text{ ft } 13 \text{ in.} = 8 \text{ ft} + \overbrace{1 \text{ ft } 1 \text{ in.}} \\ = 9 \text{ ft } 1 \text{ in.} \end{array}$$

Work Practice Problem 6

✓ Concept Check How could you estimate the following sum?

$$\begin{array}{r} 7 \text{ yd } 4 \text{ in.} \\ + 3 \text{ yd } 27 \text{ in.} \\ \hline \end{array}$$

PRACTICE PROBLEM 7

Multiply 4 ft 7 in. by 4.

EXAMPLE 7 Multiply 8 ft 9 in. by 3.

Solution: By the distributive property, we multiply 8 ft by 3 and 9 in. by 3.

$$\begin{array}{r} 8 \text{ ft } 9 \text{ in.} \\ \times \quad 3 \\ \hline 24 \text{ ft } 27 \text{ in.} \end{array}$$

Since 27 in. is the same as 2 ft 3 in., we simplify the product as

$$\begin{array}{r} 24 \text{ ft } 27 \text{ in.} = 24 \text{ ft} + \overbrace{2 \text{ ft } 3 \text{ in.}} \\ = 26 \text{ ft } 3 \text{ in.} \end{array}$$

We divide in a similar manner as above.

Work Practice Problem 7

PRACTICE PROBLEM 8

A carpenter cuts 1 ft 9 in. from a board of length 5 ft 8 in. Find the remaining length of the board.

EXAMPLE 8 Finding the Length of a Piece of Rope

A rope of length 6 yd 1 ft has 2 yd 2 ft cut from one end. Find the length of the remaining rope.

Solution: Subtract 2 yd 2 ft from 6 yd 1 ft.

$$\begin{array}{r} \text{beginning length} \rightarrow 6 \text{ yd } 1 \text{ ft} \\ - \text{amount cut} \rightarrow \underline{2 \text{ yd } 2 \text{ ft}} \\ \hline \text{remaining length} \end{array}$$

We cannot subtract 2 ft from 1 ft, so we borrow 1 yd from the 6 yd. One yard is converted to 3 ft and combined with the 1 ft already there.

Answers

6. 13 ft 7 in. 7. 18 ft 4 in.
8. 3 ft 11 in.

✓ Concept Check Answer

round each to the nearest yard:
 $7 \text{ yd} + 4 \text{ yd} = 11 \text{ yd}$

$$\begin{array}{r}
 \text{Borrow 1 yd} = 3 \text{ ft} \\
 5 \text{ yd} + \begin{array}{l} \text{1 yd} \\ \text{3 ft} \end{array} \\
 \hline
 6 \text{ yd } 1 \text{ ft} \\
 - 2 \text{ yd } 2 \text{ ft} \\
 \hline
 3 \text{ yd } 2 \text{ ft}
 \end{array}
 =
 \begin{array}{r}
 5 \text{ yd } 4 \text{ ft} \\
 - 2 \text{ yd } 2 \text{ ft} \\
 \hline
 3 \text{ yd } 2 \text{ ft}
 \end{array}$$

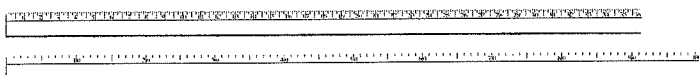
The remaining rope is 3 yd 2 ft long.

Work Practice Problem 8

Objective D Defining and Converting Metric System Units of Length

The basic unit of length in the metric system is the **meter**. A meter is slightly longer than a yard. It is approximately 39.37 inches long. Recall that a yard is 36 inches long.

$$1 \text{ yard} = 36 \text{ inches}$$

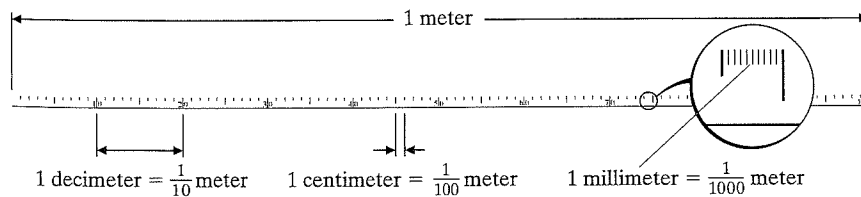


$$1 \text{ meter} \approx 39.37 \text{ inches}$$

All units of length in the metric system are based on the meter. The following is a summary of the prefixes used in the metric system. Also shown are equivalencies between units of length. Like the decimal system, the metric system uses powers of 10 to define units.

Metric Unit of Length
1 kilometer (km) = 1000 meters (m)
1 hectometer (hm) = 100 m
1 dekameter (dam) = 10 m
1 meter (m) = 1 m
1 decimeter (dm) = $\frac{1}{10}$ m or 0.1 m
1 centimeter (cm) = $\frac{1}{100}$ m or 0.01 m
1 millimeter (mm) = $\frac{1}{1000}$ m or 0.001 m

The figure below will help you with decimeters, centimeters, and millimeters.



Helpful Hint

Study the figure above for other equivalencies between metric units of length.

$$\begin{array}{ll}
 10 \text{ decimeters} = 1 \text{ meter} & 10 \text{ millimeters} = 1 \text{ centimeter} \\
 100 \text{ centimeters} = 1 \text{ meter} & 10 \text{ centimeters} = 1 \text{ decimeter} \\
 1000 \text{ millimeters} = 1 \text{ meter} &
 \end{array}$$

These same prefixes are used in the metric system for mass and capacity. The most commonly used measurements of length in the metric system are the **meter**, **millimeter**, **centimeter**, and **kilometer**.

✓ Concept Check Is this statement reasonable? “The screen of a home television set has a 30-meter diagonal.” Why or why not?

Being comfortable with the metric units of length means gaining a “feeling” for metric lengths, just as you have a “feeling” for the length of an inch, a foot, and a mile. To help you accomplish this, study the following examples:

A millimeter is about the thickness of a large paper clip.

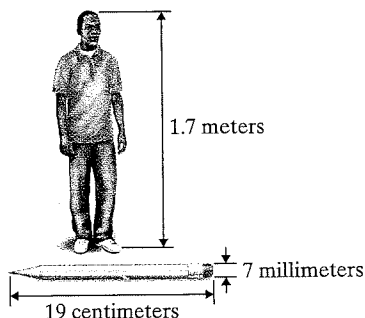
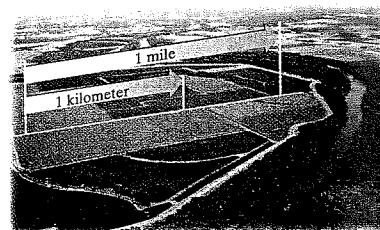
A centimeter is about the width of a large paper clip.

A meter is slightly longer than a yard.

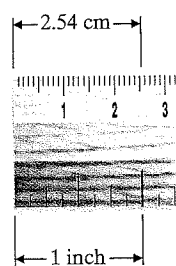
A kilometer is about two-thirds of a mile.

The width of this book is approximately 21.5 centimeters.

The distance between New York and Philadelphia is about 160 kilometers.



$2\frac{1}{2}$ centimeters is about 1 inch.



As with the U.S. system of measurement, unit fractions may be used to convert from one unit of length to another. For example, let's convert 1200 meters to kilometers. To do so, we will multiply by 1 in the form of the unit fraction

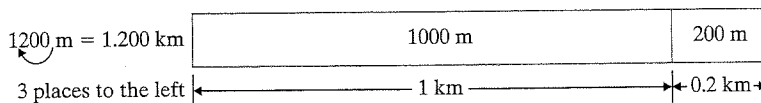
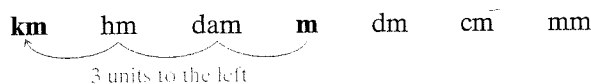
$$\frac{1 \text{ km}}{1000 \text{ m}} \leftarrow \begin{array}{l} \text{Units to convert to} \\ \text{Original units} \end{array}$$

$$1200 \text{ m} = \frac{1200 \text{ m}}{1} \cdot 1 = \frac{1200 \cancel{\text{m}}}{1} \cdot \frac{1 \text{ km}}{1000 \cancel{\text{m}}} = \frac{1200 \text{ km}}{1000} = 1.2 \text{ km}$$

Unit fraction

The metric system does, however, have a distinct advantage over the U.S. system of measurement: The ease of converting from one unit of length to another. Since all units of length are powers of 10 of the meter, converting from one unit of length to another is as simple as moving the decimal point. Listing units of length in order from largest to smallest helps to keep track of how many places to move the decimal point when converting.

Let's again convert 1200 meters to kilometers. This time, to convert from meters to kilometers, we move along the chart shown 3 units to the left, from meters to kilometers. This means that we move the decimal point 3 places to the left.



Thus, $1200 \text{ m} = 1.2 \text{ km}$ as shown in the diagram.

✓ Concept Check Answer
no; answers may vary

EXAMPLE 9 Convert 2.3 m to centimeters.

Solution: First we will convert by using a unit fraction.

$$2.3 \text{ m} = \frac{2.3 \cancel{\text{m}}}{1} \cdot \frac{100 \text{ cm}}{1 \cancel{\text{m}}} = 230 \text{ cm}$$

Unit fraction

Now we will convert by listing the units of length in order from left to right and moving from meters to centimeters.

km hm dam m dm cm mm

2 units to the right

$$2.30 \text{ m} = 230. \text{ cm}$$

2 places to the right

With either method, we get 230 cm.

Work Practice Problem 9

EXAMPLE 10 Convert 450,000 mm to meters.

Solution: We list the units of length in order from left to right and move from millimeters to meters.

km hm dam m dm cm mm

3 units to the left

Thus, move the decimal point 3 places to the left.

$$450,000 \text{ mm} = 450.000 \text{ m} \text{ or } 450 \text{ m}$$

Work Practice Problem 10

✓ **Concept Check** What is wrong with the following conversion of 150 cm to meters?

$$150.00 \text{ cm} = 15,000 \text{ m}$$

Objective 1 Performing Operations on Metric System Units of Length

To add, subtract, multiply, or divide with metric measurements of length, we write all numbers using the same unit of length and then add, subtract, multiply, or divide as with decimals.

EXAMPLE 11 Subtract 430 m from 1.3 km.

Solution: First we convert both measurements to kilometers or both to meters.

$$430 \text{ m} = 0.43 \text{ km} \quad \text{or} \quad 1.3 \text{ km} = 1300 \text{ m}$$

$$\begin{array}{r} 1.30 \text{ km} \\ - 0.43 \text{ km} \\ \hline 0.87 \text{ km} \end{array} \quad \begin{array}{r} 1300 \text{ m} \\ - 430 \text{ m} \\ \hline 870 \text{ m} \end{array}$$

The difference is 0.87 km or 870 m.

Work Practice Problem 11

PRACTICE PROBLEM 9

Convert 2.5 m to millimeters.

PRACTICE PROBLEM 10

Convert 3500 m to kilometers.

PRACTICE PROBLEM 11

Subtract 640 m from 2.1 km.

Answers

9. 2500 mm 10. 3.5 km

11. 1.46 km or 1460 m

✓ Concept Check Answer

decimal point should be moved two places to the left: 1.5 m

PRACTICE PROBLEM 12

Multiply 18.3 hm by 5.

PRACTICE PROBLEM 13

Doris Blackwell is knitting a scarf that is currently 0.8 meter long. If she knits an additional 45 centimeters, how long will the scarf be?

EXAMPLE 1 Multiply 5.7 mm by 4.

Solution: Here we simply multiply the two numbers. Note that the unit of measurement remains the same.

$$\begin{array}{r} 5.7 \text{ mm} \\ \times 4 \\ \hline 22.8 \text{ mm} \end{array}$$

Work Practice Problem 12

EXAMPLE 1 Finding a Person's Height

Fritz Martinson was 1.2 meters tall on his last birthday. Since then, he has grown 14 centimeters. Find his current height in meters.

Solution:

$$\begin{array}{r} \text{original height} \rightarrow 1.20 \text{ m} \\ + \text{height grown} \rightarrow + 0.14 \text{ m} \quad (\text{Since } 14 \text{ cm} = 0.14 \text{ m}) \\ \hline \text{current height} \quad \quad \quad 1.34 \text{ m} \end{array}$$

Fritz is now 1.34 meters tall.

Work Practice Problem 13**Answers**

12. 91.5 hm 13. 125 cm or 1.25 m

Vocabulary and Readiness Check

Use the choices below to fill in each blank. Some choices may be used more than once.

inches yard unit fraction
feet meter

1. The basic unit of length in the metric system is the _____.
2. The expression $\frac{1 \text{ foot}}{12 \text{ inches}}$ is an example of a _____.
3. A meter is slightly longer than a _____.
4. One foot equals 12 _____.
5. One yard equals 3 _____.
6. One yard equals 36 _____.
7. One mile equals 5280 _____.

9.4 EXERCISE SET

FOR EXTRA HELP



Student Solutions Manual



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Objective **A** Convert each measurement as indicated. See Examples 1 through 3.

1. 60 in. to feet
2. 84 in. to feet
3. 12 yd to feet
4. 18 yd to feet
5. 42,240 ft to miles
6. 36,960 ft to miles
7. $8\frac{1}{2}$ ft to inches
8. $12\frac{1}{2}$ ft to inches
9. 10 ft to yards
10. 25 ft to yards
11. 6.4 mi to feet
12. 3.8 mi to feet
13. 162 in. to yd (Write answer as a decimal.)
14. 7216 yd to mi (Write answer as a decimal.)
15. 3 in. to ft (Write answer as a decimal.)
16. 129 in. to ft (Write answer as a decimal.)

Objective **B** Convert each measurement as indicated. See Examples 4 and 5.

17. 40 ft = _____ yd _____ ft
18. 100 ft = _____ yd _____ ft
19. 85 in. = _____ ft _____ in.
20. 59 in. = _____ ft _____ in.
21. 10,000 ft = _____ mi _____ ft
22. 25,000 ft = _____ mi _____ ft
23. 5 ft 2 in. = _____ in.
24. 4 ft 11 in. = _____ in.
25. 8 yd 2 ft = _____ ft
26. 4 yd 1 ft = _____ ft
27. 2 yd 1 ft = _____ in.
28. 1 yd 2 ft = _____ in.

Objective **C** Perform each indicated operation. Simplify the result if possible. See Examples 6 through 8.

29. $3 \text{ ft } 10 \text{ in.} + 7 \text{ ft } 4 \text{ in.}$

30. $12 \text{ ft } 7 \text{ in.} + 9 \text{ ft } 11 \text{ in.}$

31. $12 \text{ yd } 2 \text{ ft} + 9 \text{ yd } 2 \text{ ft}$

32. $16 \text{ yd } 2 \text{ ft} + 8 \text{ yd } 2 \text{ ft}$

33. $22 \text{ ft } 8 \text{ in.} - 16 \text{ ft } 3 \text{ in.}$

34. $15 \text{ ft } 5 \text{ in.} - 8 \text{ ft } 2 \text{ in.}$

35. $18 \text{ ft } 3 \text{ in.} - 10 \text{ ft } 9 \text{ in.}$

36. $14 \text{ ft } 8 \text{ in.} - 3 \text{ ft } 11 \text{ in.}$

37. $28 \text{ ft } 8 \text{ in.} \div 2$

38. $34 \text{ ft } 6 \text{ in.} \div 2$

39. $16 \text{ yd } 2 \text{ ft} \times 5$

40. $15 \text{ yd } 1 \text{ ft} \times 8$

Objective **D** Convert as indicated. See Examples 9 and 10.

41. 60 m to centimeters

42. 46 m to centimeters

43. 40 mm to centimeters

44. 14 mm to centimeters

45. 500 m to kilometers

46. 400 m to kilometers

47. 1700 mm to meters

48. 6400 mm to meters

49. 1500 cm to meters

50. 6400 cm to meters

51. 0.42 km to centimeters

52. 0.95 km to centimeters

53. 7 km to meters

54. 5 km to meters

55. 8.3 cm to millimeters

56. 4.6 cm to millimeters

57. 20.1 mm to decimeters

58. 140.2 mm to decimeters

59. 0.04 m to millimeters

60. 0.2 m to millimeters

Objective **E** Perform each indicated operation. See Examples 11 through 13.

61. $8.6 \text{ m} + 0.34 \text{ m}$

62. $14.1 \text{ cm} + 3.96 \text{ cm}$

63. $2.9 \text{ m} + 40 \text{ mm}$

64. $30 \text{ cm} + 8.9 \text{ m}$

65. $24.8 \text{ mm} - 1.19 \text{ cm}$

66. $45.3 \text{ m} - 2.16 \text{ dam}$

67. $15 \text{ km} - 2360 \text{ m}$

68. $14 \text{ cm} - 15 \text{ mm}$

69. $18.3 \text{ m} \times 3$

70. $14.1 \text{ m} \times 4$

71. $6.2 \text{ km} \div 4$

72. $9.6 \text{ m} \div 5$

Objectives **A** **C** **D** **E** **Mixed Practice** Solve. Remember to insert units when writing your answers. For Exercises 73 through 82, complete the charts. See Examples 1 through 13.

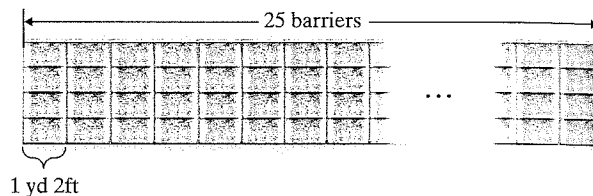
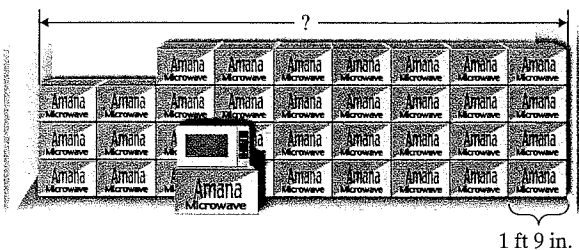
	Yards	Feet	Inches
73. Chrysler Building in New York City		1046	
74. 4-story building			792
75. Python length		35	
76. Ostrich height			108

Complete the chart.

	Meters	Millimeters	Kilometers	Centimeters
77. Length of elephant	5			
78. Height of grizzly bear	3			
79. Tennis ball diameter				6.5
80. Golf ball diameter				4.6
81. Distance from London to Paris			342	
82. Distance from Houston to Dallas			396	

83. The National Zoo maintains a small patch of bamboo, which it grows as a food supply for its pandas. Two weeks ago, the bamboo was 6 ft 10 in. tall. Since then, the bamboo has grown 3 ft 8 in. How tall is the bamboo now?
84. While exploring in the Marianas Trench, a submarine probe was lowered to a point 1 mile 1400 feet below the ocean's surface. Later it was lowered an additional 1 mile 4000 feet below this point. How far is the probe below the surface of the Pacific?
85. At its deepest point, the Grand Canyon of the Colorado River in Arizona is about 6000 ft. The Grand Canyon of the Yellowstone River, which is in Yellowstone National Park in Wyoming, is at most 900 feet deep. How much deeper is the Grand Canyon of the Colorado River than the Grand Canyon of the Yellowstone River? (Source: National Park Service)
86. The Grand Canyon of the Gunnison River, in Colorado, is often called the Black Canyon of the Gunnison because it is so steep that light rarely penetrates the depth of the canyon. The Black Canyon of the Gunnison is only 1150 ft wide at its narrowest point. At its narrowest, the Grand Canyon of the Yellowstone is $\frac{1}{2}$ mile wide. Find the difference in width between the Grand Canyon of the Yellowstone and the Black Canyon of the Gunnison. (Note: Notice that the dimensions are different.) (Source: National Park Service)
87. The tallest man in the world is recorded as Robert Pershing Wadlow of Alton, Illinois. Born in 1918, he measured 8 ft 11 in. at his tallest. The shortest man in the world is Gul Mohammed of India, who measures 22.5 in. How many times taller than Gul is Robert? Round to one decimal place. (Source: Guinness World Records)
88. A 3.4-m rope is attached to a 5.8-m rope. However, when the ropes are tied, 8 cm of length is lost to form the knot. What is the length of the tied ropes?

89. The ice on a pond is 5.33 cm thick. For safe skating, the owner of the pond insists that it must be 80 mm thick. How much thicker must the ice be before skating is allowed?
90. The sediment on the bottom of the Towamencin Creek is normally 14 cm thick, but the recent flood washed away 22 mm of sediment. How thick is it now?
91. The Amana Corporation stacks up its microwave ovens in a distribution warehouse. Each stack is 1 ft 9 in. wide. How far from the wall would 9 of these stacks extend?
92. The highway commission is installing concrete sound barriers along a highway. Each barrier is 1 yd 2 ft long. Find the total length of 25 barriers placed end to end.



93. A logging firm needs to cut a 67-m-long redwood log into 20 equal pieces before loading it onto a truck for shipment. How long will each piece be?
94. An 18.3-m-tall flagpole is mounted on a 65-cm-high pedestal. How far is the top of the flagpole from the ground?
95. The world's longest Coca-Cola truck is in Sweden and is 79 feet long. How many yards long are 4 of these trucks? (*Source: Coca-Cola Today*)
96. The world's largest Coca-Cola sign is in Arica, Chile. It is in the shape of a rectangle whose length is $133\frac{1}{3}$ yards and whose width is 131 feet. Find the area of the sign in square feet. (*Source: Coca-Cola Today*) (*Hint: Recall that area of a rectangle is the product: length times width.*)

Review

Write each decimal as a fraction and each fraction as a decimal. See Section 5.1.

97. 0.21 98. 0.86 99. $\frac{13}{100}$ 100. $\frac{47}{100}$ 101. $\frac{1}{4}$ 102. $\frac{3}{20}$

Concept Extensions

Determine whether the measurement in each statement is reasonable.

103. The width of a twin-size bed is 20 meters.
104. A window measures 1 meter by 0.5 meter.
105. A drinking glass is made of glass 2 millimeters thick.
106. A paper clip is 4 kilometers long.
107. The distance across the Colorado River is 50 kilometers.
108. A model's hair is 30 centimeters long.

Estimate each sum or difference. See the first Concept Check in this section.

109.
$$\begin{array}{r} 5 \text{ yd } 2 \text{ in.} \\ + 7 \text{ yd } 30 \text{ in.} \\ \hline \end{array}$$

110.
$$\begin{array}{r} 45 \text{ ft } 1 \text{ in.} \\ - 10 \text{ ft } 11 \text{ in.} \\ \hline \end{array}$$

111. Using a unit other than the foot, write a length that is equivalent to 4 feet. (*Hint:* There are many possibilities.)

112. Using a unit other than the meter, write a length that is equivalent to 7 meters. (*Hint:* There are many possibilities.)

113. To convert from meters to centimeters, the decimal point is moved two places to the right. Explain how this relates to the fact that the prefix

centi means $\frac{1}{100}$.

114. Explain why conversions in the metric system are easier to make than conversions in the U.S. system of measurement.

115. An advertisement sign outside Fenway Park in Boston measures 18.3 m by 18.3 m. What is the area of this sign?

Objectives

- A** Define U.S. Units of Weight and Convert from One Unit to Another.
- B** Perform Arithmetic Operations on Units of Weight.
- C** Define Metric Units of Mass and Convert from One Unit to Another.
- D** Perform Arithmetic Operations on Units of Mass.

9.5 WEIGHT AND MASS

Objective **A** Defining and Converting U.S. System Units of Weight

Whenever we talk about how heavy an object is, we are concerned with the object's **weight**. We discuss weight when we refer to a 12-ounce box of Rice Krispies, a 15-pound tabby cat, or a barge hauling 24 tons of garbage.



12 ounces



15 pounds



24 tons of garbage

The most common units of weight in the U.S. measurement system are the **ounce**, the **pound**, and the **ton**. The following is a summary of equivalencies between units of weight:

U.S. Units of Weight

$$16 \text{ ounces (oz)} = 1 \text{ pound (lb)}$$

$$2000 \text{ pounds} = 1 \text{ ton}$$

Unit Fractions

$$\frac{16 \text{ oz}}{1 \text{ lb}} = \frac{1 \text{ lb}}{16 \text{ oz}} = 1$$

$$\frac{2000 \text{ lb}}{1 \text{ ton}} = \frac{1 \text{ ton}}{2000 \text{ lb}} = 1$$

✓ Concept Check If you were describing the weight of a fully-loaded semi-trailer, which type of unit would you use: ounce, pound, or ton? Why?

Unit fractions that equal 1 are used to convert between units of weight in the U.S. system. When converting using unit fractions, recall that the numerator of a unit fraction should contain the units we are converting to and the denominator should contain the original units.

PRACTICE PROBLEM 1

Convert 6500 pounds to tons.

Answer

1. $3\frac{1}{4}$ tons

✓ Concept Check Answer

ton

658



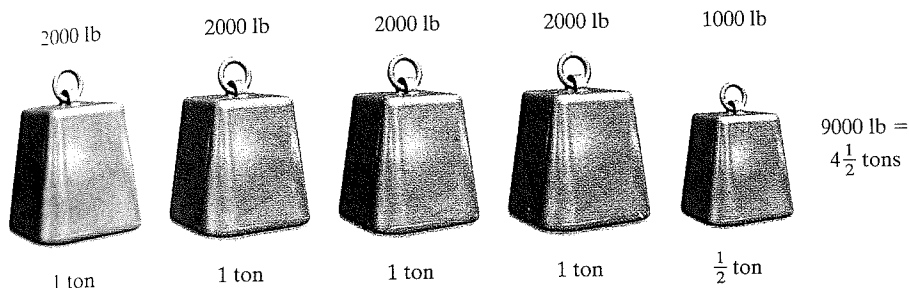
Convert 9000 pounds to tons.

Solution: We multiply 9000 lb by a unit fraction that uses the equality

$$2000 \text{ pounds} = 1 \text{ ton.}$$

Remember, the unit fraction should be $\frac{\text{units to convert to}}{\text{original units}}$ or $\frac{1 \text{ ton}}{2000 \text{ lb}}$.

$$9000 \text{ lb} = \frac{9000 \text{ lb}}{1} \cdot 1 = \frac{9000 \cancel{\text{lb}}}{1} \cdot \frac{1 \text{ ton}}{2000 \cancel{\text{lb}}} = \frac{9000 \text{ tons}}{2000} = \frac{9}{2} \text{ tons or } 4\frac{1}{2} \text{ tons}$$

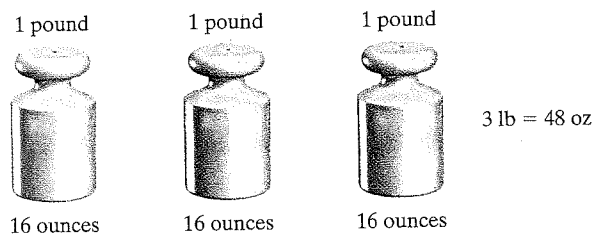


Work Practice Problem 1

Convert 3 pounds to ounces.

Solution: We multiply by the unit fraction $\frac{16 \text{ oz}}{1 \text{ lb}}$ to convert from pounds to ounces.

$$3 \text{ lb} = \frac{3 \text{ lb}}{1} \cdot 1 = \frac{3 \cancel{\text{lb}}}{1} \cdot \frac{16 \text{ oz}}{1 \cancel{\text{lb}}} = 3 \cdot 16 \text{ oz} = 48 \text{ oz}$$



Work Practice Problem 2

As with length, it is sometimes useful to simplify a measurement of weight by writing it in terms of mixed units.

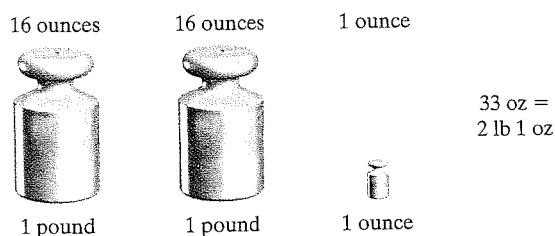
Convert: 33 ounces = ____ lb ____ oz

Solution: Because 16 oz = 1 lb, divide 16 into 33 to see how many pounds are in 33 ounces. The quotient is the number of pounds, and the remainder is the number of ounces. To see why we divide 16 into 33, notice that

$$33 \text{ oz} = 33 \cancel{\text{ oz}} \cdot \frac{1 \text{ lb}}{16 \cancel{\text{ oz}}} = \frac{33}{16} \text{ lb}$$

$$\begin{array}{r} 2 \text{ lb } 1 \text{ oz} \\ 16 \overline{)33} \\ \underline{-32} \\ 1 \end{array}$$

Thus, 33 ounces is the same as 2 lb 1 oz.



Work Practice Problem 3

PRACTICE PROBLEM 2

Convert 72 ounces to pounds.

PRACTICE PROBLEM 3

Convert:
47 ounces = ____ lb ____ oz

Answers

2. $4\frac{1}{2}$ lb 3. 2 lb 15 oz

Objective B Performing Operations on U.S. System Units of Weight

Performing arithmetic operations on units of weight works the same way as performing arithmetic operations on units of length.

PRACTICE PROBLEM 4

Subtract 5 tons 1200 lb from 8 tons 100 lb.

EXAMPLE 3 Subtract 3 tons 1350 lb from 8 tons 1000 lb.

Solution: To subtract, we line up similar units.

$$\begin{array}{r} 8 \text{ tons } 1000 \text{ lb} \\ - 3 \text{ tons } 1350 \text{ lb} \\ \hline \end{array}$$

Since we cannot subtract 1350 lb from 1000 lb, we borrow 1 ton from the 8 tons. To do so, we write 1 ton as 2000 lb and combine it with the 1000 lb.

$$\begin{array}{r} 7 \text{ tons } + \overbrace{1 \text{ ton}}^{2000 \text{ lb}} \\ \phantom{7 \text{ tons } +} 8 \text{ tons } 1000 \text{ lb} \\ - 3 \text{ tons } 1350 \text{ lb} \\ \hline 4 \text{ tons } 1650 \text{ lb} \end{array} = \begin{array}{r} 7 \text{ tons } 3000 \text{ lb} \\ - 3 \text{ tons } 1350 \text{ lb} \\ \hline 4 \text{ tons } 1650 \text{ lb} \end{array}$$

To check, see that the sum of 4 tons 1650 lb and 3 tons 1350 lb is 8 tons 1000 lb.

Work Practice Problem 4

PRACTICE PROBLEM 5

Divide 5 lb 8 oz by 4.

EXAMPLE 4 Divide 9 lb 6 oz by 2.

Solution: We divide each of the units by 2.

$$\begin{array}{r} 4 \text{ lb } 11 \text{ oz} \\ 2 \overline{) 9 \text{ lb } 6 \text{ oz}} \\ \underline{-8} \\ 1 \text{ lb } = \frac{16 \text{ oz}}{22 \text{ oz}} \end{array} \quad \text{Divide 2 into 22 oz to get 11 oz.}$$

To check, multiply 4 pounds 11 ounces by 2. The result is 9 pounds 6 ounces.

Work Practice Problem 5

PRACTICE PROBLEM 6

A 5-lb 14-oz batch of cookies is packed into a 6-oz container before it is mailed. Find the total weight.

EXAMPLE 5 Finding the Weight of a Child

Bryan weighed 8 lb 8 oz at birth. By the time he was 1 year old, he had gained 11 lb 14 oz. Find his weight at age 1 year.

Solution:

$$\begin{array}{r} \text{birth weight} \rightarrow 8 \text{ lb } 8 \text{ oz} \\ + \text{weight gained} \rightarrow + 11 \text{ lb } 14 \text{ oz} \\ \hline \text{total weight} \rightarrow 19 \text{ lb } 22 \text{ oz} \end{array}$$

Since 22 oz equals 1 lb 6 oz,

$$\begin{array}{r} 19 \text{ lb } 22 \text{ oz} = 19 \text{ lb } + 1 \text{ lb } 6 \text{ oz} \\ = 20 \text{ lb } 6 \text{ oz} \end{array}$$

Bryan weighed 20 lb 6 oz on his first birthday.

Work Practice Problem 6

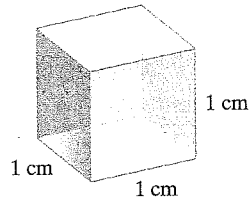
Answers

4. 2 tons 900 lb 5. 1 lb 6 oz
6. 6 lb 4 oz

Objective **C** Defining and Converting Metric System Units of Mass

In scientific and technical areas, a careful distinction is made between **weight** and **mass**. **Weight** is really a measure of the pull of gravity. The farther from Earth an object gets, the less it weighs. However, **mass** is a measure of the amount of substance in the object and does not change. Astronauts orbiting Earth weigh much less than they weigh on Earth, but they have the same mass in orbit as they do on Earth. Here on Earth weight and mass are the same, so either term may be used.

The basic unit of mass in the metric system is the **gram**. It is defined as the mass of water contained in a cube 1 centimeter (cm) on each side.

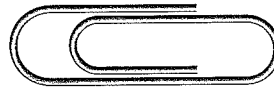


The following examples may help you get a feeling for metric masses:

A tablet contains 200 milligrams of ibuprofen.



A large paper clip weighs approximately 1 gram.



A box of crackers weighs 453 grams.



A kilogram is slightly over 2 pounds. An adult woman may weigh 60 kilograms.

The prefixes for units of mass in the metric system are the same as for units of length, as shown in the following table:

Metric Unit of Mass
1 kilogram (kg) = 1000 grams (g)
1 hectogram (hg) = 100 g
1 dekagram (dag) = 10 g
1 gram (g) = 1 g
1 decigram (dg) = 1/10 g or 0.1 g
1 centigram (cg) = 1/100 g or 0.01 g
1 milligram (mg) = 1/1000 g or 0.001 g



✓ **Concept Check** True or false? A decigram is larger than a dekagram. Explain.

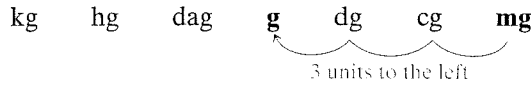
The **milligram**, the **gram**, and the **kilogram** are the three most commonly used units of mass in the metric system.

As with lengths, all units of mass are powers of 10 of the gram, so converting from one unit of mass to another involves moving only the decimal point. To convert

✓ **Concept Check Answer**
false

from one unit of mass to another in the metric system, list the units of mass in order from largest to smallest.

Let's convert 4300 milligrams to grams. To convert from milligrams to grams, we move along the list 3 units to the left.



This means that we move the decimal point 3 places to the left to convert from milligrams to grams.

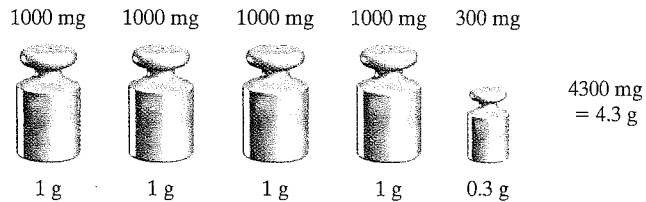
$$4300 \text{ mg} = 4.3 \text{ g}$$

Don't forget, the same conversion can be done with unit fractions.

$$\begin{aligned} 4300 \text{ mg} &= \frac{4300 \text{ mg}}{1} \cdot 1 = \frac{4300 \cancel{\text{mg}}}{1} \cdot \frac{0.001 \text{ g}}{1 \cancel{\text{mg}}} \\ &= 4300 \cdot 0.001 \text{ g} \\ &= 4.3 \text{ g} \end{aligned}$$

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

To see that this is reasonable, study the diagram:



Thus, 4300 mg = 4.3 g

PRACTICE PROBLEM 7

Convert 3.41 g to milligrams.

EXAMPLE 7

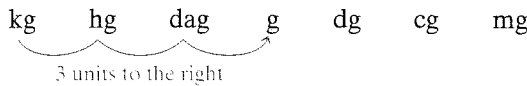
Convert 3.2 kg to grams.

Solution: First we convert by using a unit fraction.

$$3.2 \text{ kg} = 3.2 \text{ kg} \cdot 1 = 3.2 \text{ kg} \cdot \frac{1000 \text{ g}}{1 \text{ kg}} = 3200 \text{ g}$$

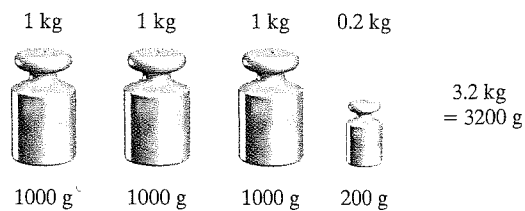
Unit fraction

Now let's list the units of mass in order from left to right and move from kilograms to grams.



$$3.200 \text{ kg} = 3200. \text{ g}$$

3 places to the right



Answer

7. 3410 mg

Work Practice Problem 7

EXAMPLE 8 Convert 2.35 cg to grams.

Solution: We list the units of mass in a chart and move from centigrams to grams.

kg hg dag g dg cg mg

└───┬───┘
2 units to the left

$$\begin{array}{r} 02.35 \text{ cg} = 0.0235 \text{ g} \\ \text{2 places to the left} \end{array}$$

Work Practice Problem 8

Objective D Performing Operations on Metric System Units of Mass

Arithmetic operations can be performed with metric units of mass just as we performed operations with metric units of length. We convert each number to the same unit of mass and add, subtract, multiply, or divide as with decimals.

EXAMPLE 9 Subtract 5.4 dg from 1.6 g.

Solution: We convert both numbers to decigrams or to grams before subtracting.

$$\begin{array}{r} 5.4 \text{ dg} = 0.54 \text{ g} \\ 1.60 \text{ g} \\ - 0.54 \text{ g} \\ \hline 1.06 \text{ g} \end{array} \quad \text{or} \quad \begin{array}{r} 1.6 \text{ g} = 16 \text{ dg} \\ 16.0 \text{ dg} \\ - 5.4 \text{ dg} \\ \hline 10.6 \text{ dg} \end{array}$$

The difference is 1.06 g or 10.6 dg.

Work Practice Problem 9

EXAMPLE 10 Calculating Allowable Weight in an Elevator

An elevator has a weight limit of 1400 kg. A sign posted in the elevator indicates that the maximum capacity of the elevator is 17 persons. What is the average allowable weight for each passenger, rounded to the nearest kilogram?

Solution: To solve, notice that the total weight of 1400 kilograms $\div 17 =$ average weight

$$\begin{array}{r} 82.3 \text{ kg} \approx 82 \text{ kg} \\ 17 \overline{) 1400.0 \text{ kg}} \\ \underline{-136} \\ 40 \\ \underline{-34} \\ 60 \\ \underline{-51} \\ 9 \end{array}$$

Each passenger can weigh an average of 82 kg. (Recall that a kilogram is slightly over 2 pounds, so 82 kilograms is over 164 pounds.)

Work Practice Problem 10

PRACTICE PROBLEM 8

Convert 56.2 cg to grams.

PRACTICE PROBLEM 9

Subtract 3.1 dg from 2.5 g.

PRACTICE PROBLEM 10

Twenty-four bags of cement weigh a total of 550 kg. Find the average weight of 1 bag, rounded to the nearest kilogram.

Answers

8. 0.562 g 9. 2.19 g or 21.9 dg
10. 23 kg

Vocabulary and Readiness Check

Use the choices below to fill in each blank.

mass weight gram

- _____ is a measure of the amount of substance in an object. This measure does not change.
- _____ is the measure of the pull of gravity.
- The basic unit of mass in the metric system is the _____.

Fill in these blanks with the correct number. Choices for these blanks are not shown in the list of terms above.

- One pound equals _____ ounces.
- One ton equals _____ pounds.

9.5 EXERCISE SET

FOR EXTRA HELP



Student Solutions Manual



PH Math/Tutor Center



CD/Video for Review

MathXL[®]

MyMathLab[®]

Objective **A** Convert as indicated. See Examples 1 through 3.

- 2 pounds to ounces
- 5 pounds to ounces
- 5 tons to pounds
- 7 tons to pounds
- 18,000 pounds to tons
- 28,000 pounds to tons
- 60 ounces to pounds
- 90 ounces to pounds
- 3500 pounds to tons
- 11,000 pounds to tons
- 12.75 pounds to ounces
- 9.5 pounds to ounces
- 4.9 tons to pounds
- 8.3 tons to pounds
- $4\frac{3}{4}$ pounds to ounces
- $9\frac{1}{8}$ pounds to ounces
- 2950 pounds to the nearest tenth of a ton
- 51 ounces to the nearest tenth of a pound
- $\frac{4}{5}$ oz to pounds
- $\frac{1}{4}$ oz to pounds
- $5\frac{3}{4}$ lb to ounces
- $2\frac{1}{4}$ lb to ounces
- 10 lb 1 oz to ounces
- 7 lb 6 oz to ounces
- 89 oz to _____ lb _____ oz
- 100 oz = _____ lb _____ oz

Objective **B** Perform each indicated operation. See Examples 4 through 6.

27. $34 \text{ lb } 12 \text{ oz} + 18 \text{ lb } 14 \text{ oz}$

28. $6 \text{ lb } 10 \text{ oz} + 10 \text{ lb } 8 \text{ oz}$

29. $3 \text{ tons } 1820 \text{ lb} + 4 \text{ tons } 930 \text{ lb}$

30. $1 \text{ ton } 1140 \text{ lb} + 5 \text{ tons } 1200 \text{ lb}$

31. $5 \text{ tons } 1050 \text{ lb} - 2 \text{ tons } 875 \text{ lb}$

32. $4 \text{ tons } 850 \text{ lb} - 1 \text{ ton } 260 \text{ lb}$

33. $12 \text{ lb } 4 \text{ oz} - 3 \text{ lb } 9 \text{ oz}$

34. $45 \text{ lb } 6 \text{ oz} - 26 \text{ lb } 10 \text{ oz}$

35. $5 \text{ lb } 3 \text{ oz} \times 6$

36. $2 \text{ lb } 5 \text{ oz} \times 5$

37. $6 \text{ tons } 1500 \text{ lb} \div 5$

38. $5 \text{ tons } 400 \text{ lb} \div 4$

Objective **C** Convert as indicated. See Examples 7 and 8.

39. 500 g to kilograms

40. 820 g to kilograms

41. 4 g to milligrams

42. 9 g to milligrams

43. 25 kg to grams

44. 18 kg to grams

45. 48 mg to grams

46. 112 mg to grams

47. 6.3 g to kilograms

48. 4.9 g to kilograms

49. 15.14 g to milligrams

50. 16.23 g to milligrams

51. 6.25 kg to grams

52. 3.16 kg to grams

53. 35 hg to centigrams

54. 4.26 cg to dekagrams

Objective **D** Perform each indicated operation. See Examples 9 and 10.

55. $3.8 \text{ mg} + 9.7 \text{ mg}$

56. $41.6 \text{ g} + 9.8 \text{ g}$

57. $205 \text{ mg} + 5.61 \text{ g}$

58. $2.1 \text{ g} + 153 \text{ mg}$

59. $9 \text{ g} - 7150 \text{ mg}$

60. $4 \text{ kg} - 2410 \text{ g}$

61. $1.61 \text{ kg} - 250 \text{ g}$

62. $6.13 \text{ g} - 418 \text{ mg}$



63. $5.2 \text{ kg} \times 2.6$

64. $4.8 \text{ kg} \times 9.3$

65. $17 \text{ kg} \div 8$

66. $8.25 \text{ g} \div 6$


Objectives **A B C D Mixed Practice** Solve. Remember to insert units when writing your answers. For Exercises 67 through 74, complete the chart. See Examples 1 through 10.

	Object	Tons	Pounds	Ounces
67.	Statue of Liberty—weight of copper sheeting	100		
68.	Statue of Liberty—weight of steel	125		
69.	 A 12-inch cube of osmium (heaviest metal)		1,345	
70.	 A 12-inch cube of lithium (lightest metal)		32	

	Object	Grams	Kilograms	Milligrams	Centigrams
71.	Capsule of Amoxicillin (antibiotic)			500	
72.	Tablet of Topamax (epilepsy and migraine uses)			25	
73.	A six-year-old boy		21		
74.	A golf ball	45			

75. A can of 7-Up weighs 336 grams. Find the weight in kilograms of 24 cans.

76. Guy Green normally weighs 73 kg, but he lost 2800 grams after being sick with the flu. Find Guy's new weight.

 77. Sudafed is a decongestant that comes in two strengths. Regular strength contains 60 mg of medication. Extra strength contains 0.09 g of medication. How much extra medication is in the extra-strength tablet?

78. A small can of Planters sunflower seeds weighs 177 g. If each can contains 6 servings, find the weight of one serving.

79. Doris Johnson has two open containers of Uncle Ben's rice. If she combines 1 lb 10 oz from one container with 3 lb 14 oz from the other container, how much total rice does she have?

80. Dru Mizel maintains the records of the amount of coal delivered to his department in the steel mill. In January, 3 tons 1500 lb were delivered. In February, 2 tons 1200 lb were delivered. Find the total amount delivered in these two months.

81. Carla Hamtini was amazed when she grew a 28 lb 10 oz zucchini in her garden, but later she learned that the heaviest zucchini ever grown weighed 64 lb 8 oz in Llanharry, Wales, by B. Lavery in 1990. How far below the record weight was Carla's zucchini? (Source: Guinness World Records)

82. The heaviest baby born in good health weighed an incredible 22 lb 8 oz. He was born in Italy in September, 1955. How much heavier is this than a 7 lb 12 oz baby? (Source: Guinness World Records)

83. The smallest baby born in good health weighed only 8.6 ounces, less than a can of soda. She was born in Chicago in December, 2004. How much lighter was she than an average baby, who weighs about 7 lb 8 ounces?
84. A large bottle of Hire's Root Beer weighs 1900 grams. If a carton contains 6 large bottles of root beer, find the weight in kilograms of 5 cartons.
85. Three milligrams of preservatives are added to a 0.5-kg box of dried fruit. How many milligrams of preservatives are in 3 cartons of dried fruit if each carton contains 16 boxes?
86. One box of Swiss Miss Cocoa Mix weighs 0.385 kg, but 39 grams of this weight is the packaging. Find the actual weight of the cocoa in 8 boxes.
87. A carton of 12 boxes of Quaker Oats Oatmeal weighs 6.432 kg. Each box includes 26 grams of packaging material. What is the actual weight of the oatmeal in the carton?
88. The supermarket prepares hamburger in 85-gram market packages. When Leo Gonzalas gets home, he divides the package in half before refrigerating the meat. How much will each package weigh?
89. The Shop 'n Bag supermarket chain ships hamburger meat by placing 10 packages of hamburger in a box, with each package weighing 3 lb 4 oz. How much will 4 boxes of hamburger weigh?
90. The Quaker Oats Company ships its 1-lb 2-oz boxes of oatmeal in cartons containing 12 boxes of oatmeal. How much will 3 such cartons weigh?
91. A carton of Del Monte Pineapple weighs 55 lb 4 oz, but 2 lb 8 oz of this weight is due to packaging. Subtract the weight of the packaging to find the actual weight of the pineapple in 4 cartons.
92. The Hormel Corporation ships cartons of canned ham weighing 43 lb 2 oz each. Of this weight, 3 lb 4 oz is due to packaging. Find the actual weight of the ham found in 3 cartons.

Review

Write each fraction as a decimal. See Section 5.5.

93. $\frac{4}{25}$

94. $\frac{3}{5}$

95. $\frac{7}{8}$

96. $\frac{3}{16}$

Concept Extensions

Determine whether the measurement in each statement is reasonable.

97. The doctor prescribed a pill containing 2 kg of medication.
98. A full-grown cat weighs approximately 15 g.
99. A bag of flour weighs 4.5 kg.
100. A staple weighs 15 mg.
101. A professor weighs less than 150 g.
102. A car weighs 2000 mg.

103. Use a unit other than centigram and write a mass that is equivalent to 25 centigrams. (*Hint:* There are many possibilities.)

104. Use a unit other than pound and write a weight that is equivalent to 4000 pounds. (*Hint:* There are many possibilities.)

True or False? See the Concept Check in this section.

105. A kilogram is larger than a gram.

106. A decigram is larger than a milligram.

107. Why is the decimal point moved to the right when grams are converted to milligrams?

108. To change 8 pounds to ounces, multiply by 16. Why is this the correct procedure?



STUDY SKILLS BUILDER

How Are Your Homework Assignments Going?

Remember that it is important to keep up with homework. Why? Many concepts in mathematics build on each other. Often, your understanding of a day's lecture depends on an understanding of the previous day's material.

To complete a homework assignment, remember these 4 things:

- Attempt all of it.
- Check it.
- Correct it.
- If needed, ask questions about it.

Take a moment and review your completed homework assignments. Answer the exercises below based on this review.

1. Approximate the fraction of your homework you have attempted.
2. Approximate the fraction of your homework you have checked (if possible).
3. If you are able to check your homework, have you corrected it when errors have been found?
4. When working homework, if you do not understand a concept, what do you personally do?

9.6 CAPACITY

Objective **A** Defining and Converting U.S. System Units of Capacity

Units of **capacity** are generally used to measure liquids. The number of gallons of gasoline needed to fill a gas tank in a car, the number of cups of water needed in a bread recipe, and the number of quarts of milk sold each day at a supermarket are all examples of using units of capacity. The following summary shows equivalencies between units of capacity:

U.S. Units of Capacity

- 8 fluid ounces (fl oz) = 1 cup (c)
- 2 cups = 1 pint (pt)
- 2 pints = 1 quart (qt)
- 4 quarts = 1 gallon (gal)

Just as with units of length and weight, we can form unit fractions to convert between different units of capacity. For instance,

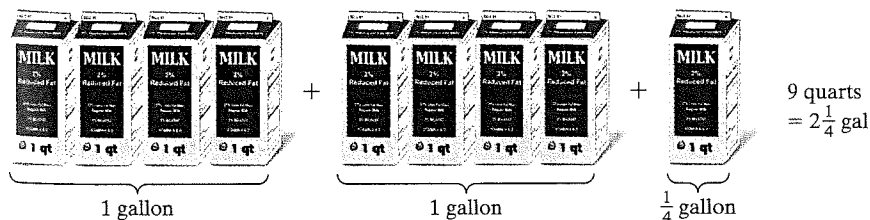
$$\frac{2 \text{ c}}{1 \text{ pt}} = \frac{1 \text{ pt}}{2 \text{ c}} = 1 \quad \text{and} \quad \frac{2 \text{ pt}}{1 \text{ qt}} = \frac{1 \text{ qt}}{2 \text{ pt}} = 1$$

EXAMPLE 1 Convert 9 quarts to gallons.

Solution: We multiply by the unit fraction $\frac{1 \text{ gal}}{4 \text{ qt}}$.

$$\begin{aligned} 9 \text{ qt} &= \frac{9 \text{ qt}}{1} \cdot 1 \\ &= \frac{9 \text{ qt}}{1} \cdot \frac{1 \text{ gal}}{4 \text{ qt}} \\ &= \frac{9 \text{ gal}}{4} \\ &= 2\frac{1}{4} \text{ gal} \end{aligned}$$

Thus, 9 quarts is the same as $2\frac{1}{4}$ gallons, as shown in the diagram:



Work Practice Problem 1

Objectives

- A** Define U.S. Units of Capacity and Convert from One Unit to Another.
- B** Perform Arithmetic Operations on U.S. Units of Capacity.
- C** Define Metric Units of Capacity and Convert from One Unit to Another.
- D** Perform Arithmetic Operations on Metric Units of Capacity.

PRACTICE PROBLEM 1

Convert 43 pints to quarts.

Answer

1. $21\frac{1}{2}$ qt

PRACTICE PROBLEM 2

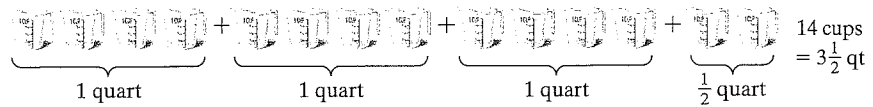
Convert 26 quarts to cups.

EXAMPLE 2 Convert 14 cups to quarts.**Solution:** Our equivalency table contains no direct conversion from cups to quarts. However, from this table we know that

$$1 \text{ qt} = 2 \text{ pt} = \frac{2 \text{ pt}}{1} \cdot 1 = \frac{2 \text{ pt}}{1} \cdot \frac{2 \text{ c}}{1 \text{ pt}} = 4 \text{ c}$$

so $1 \text{ qt} = 4 \text{ c}$. Now we have the unit fraction $\frac{1 \text{ qt}}{4 \text{ c}}$. Thus,

$$14 \text{ c} = \frac{14 \text{ c}}{1} \cdot 1 = \frac{14 \text{ c}}{1} \cdot \frac{1 \text{ qt}}{4 \text{ c}} = \frac{14 \text{ qt}}{4} = \frac{7}{2} \text{ qt} \text{ or } 3\frac{1}{2} \text{ qt}$$

**Work Practice Problem 2**

✓ **Concept Check** If 50 cups are converted to quarts, will the equivalent number of quarts be less than or greater than 50? Explain.

Objective **B** **Performing Operations on U.S. System Units of Capacity**

As is true of units of length and weight, units of capacity can be added, subtracted, multiplied, and divided.

PRACTICE PROBLEM 3

Subtract 2 qt from 1 gal 1 qt.

EXAMPLE 3 Subtract 3 qt from 4 gal 2 qt.**Solution:** To subtract, we line up similar units.

$$\begin{array}{r} 4 \text{ gal } 2 \text{ qt} \\ - \quad 3 \text{ qt} \\ \hline \end{array}$$

We cannot subtract 3 qt from 2 qt. We need to borrow 1 gallon from the 4 gallons, convert it to 4 quarts, and then combine it with the 2 quarts.

$$\begin{array}{r} 3 \text{ gal} + \overbrace{(1 \text{ gal})}^{4 \text{ qt}} \\ \hline 4 \text{ gal } 2 \text{ qt} \\ - \quad 3 \text{ qt} \\ \hline 3 \text{ gal } 3 \text{ qt} \end{array} = \begin{array}{r} 3 \text{ gal } 6 \text{ qt} \\ - \quad 3 \text{ qt} \\ \hline 3 \text{ gal } 3 \text{ qt} \end{array}$$

Answers

2. 104 c 3. 3 qt

✓ **Concept Check Answer**
less than 50

Work Practice Problem 3

EXAMPLE 3 Finding the Amount of Water in an Aquarium

An aquarium contains 6 gal 3 qt of water. If 2 gal 2 qt of water is added, what is the total amount of water in the aquarium?

$$\begin{array}{rcl} \text{Solution:} & \text{beginning water} & \rightarrow 6 \text{ gal } 3 \text{ qt} \\ & + \text{ water added} & \rightarrow + 2 \text{ gal } 2 \text{ qt} \\ & \hline & \text{total water} & \rightarrow 8 \text{ gal } 5 \text{ qt} \end{array}$$

Since 5 qt = 1 gal 1 qt, we have

$$\begin{aligned} & \overbrace{8 \text{ gal}} + \overbrace{5 \text{ qt}} \\ &= 8 \text{ gal} + 1 \text{ gal } 1 \text{ qt} \\ &= 9 \text{ gal } 1 \text{ qt} \end{aligned}$$

The total amount of water is 9 gal 1 qt.

Work Practice Problem 4**Objective 4** Defining and Converting Metric System Units of Capacity

Thus far, we know that the basic unit of length in the metric system is the meter and that the basic unit of mass in the metric system is the gram. What is the basic unit of capacity? The **liter**. By definition, a **liter** is the capacity or volume of a cube measuring 10 centimeters on each side.

The following examples may help you get a feeling for metric capacities:

One liter of liquid is slightly more than one quart.

Many soft drinks are packaged in 2-liter bottles.

The metric system was designed to be a consistent system. Once again, the prefixes for metric units of capacity are the same as for metric units of length and mass, as summarized in the following table:

Metric Unit of Capacity
1 kiloliter (kl) = 1000 liters (L)
1 hectoliter (hl) = 100 L
1 dekaliter (dal) = 10 L
1 liter (L) = 1 L
1 deciliter (dl) = 1/10 L or 0.1 L
1 centiliter (cl) = 1/100 L or 0.01 L
1 milliliter (ml) = 1/1000 L or 0.001 L

The **milliliter** and the **liter** are the two most commonly used metric units of capacity.

Converting from one unit of capacity to another involves multiplying by powers of 10 or moving the decimal point to the left or to the right. Listing units of capacity in order from largest to smallest helps to keep track of how many places to move the decimal point when converting.

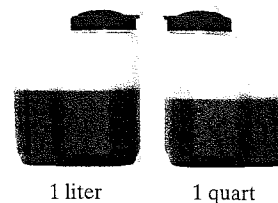
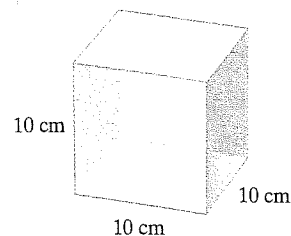
Let's convert 2.6 liters to milliliters. To convert from liters to milliliters, we move along the chart 3 units to the right.

kl hl dal **L** dl cl ml

3 units to the right

PRACTICE PROBLEM 4

A large oil drum contains 15 gal 3 qt of oil. How much will be in the drum if an additional 4 gal 3 qt of oil is poured into it?



Answer

4. 20 gal 2 qt

This means that we move the decimal point 3 places to the right to convert from liters to milliliters.

$$2.600 \text{ L} = 2600. \text{ ml}$$

This same conversion can be done with unit fractions.

$$\begin{aligned} 2.6 \text{ L} &= \frac{2.6 \text{ L}}{1} \cdot 1 \\ &= \frac{2.6 \cancel{\text{L}}}{1} \cdot \frac{1000 \text{ ml}}{1 \cancel{\text{L}}} \\ &= 2.6 \cdot 1000 \text{ ml} \\ &= 2600 \text{ ml} \end{aligned}$$

To multiply by 1000, move the decimal point 3 places to the right.

To visualize the result, study the diagram below:



Thus, $2.6 \text{ L} = 2600 \text{ ml}$.

PRACTICE PROBLEM 5

Convert 2100 ml to liters.

EXAMPLE 5 Convert 3210 ml to liters.

Solution: Let's use the unit fraction method first.

$$3210 \text{ ml} = \frac{3210 \text{ ml}}{1} \cdot 1 = 3210 \cancel{\text{ml}} \cdot \frac{1 \text{ L}}{1000 \cancel{\text{ml}}} = 3.21 \text{ L}$$

Unit fraction

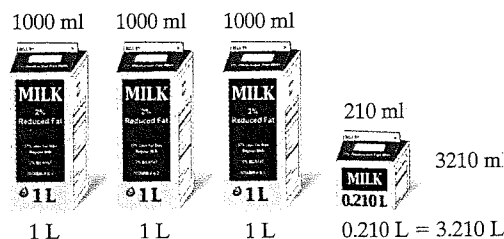
Now let's list the unit measures in order from left to right and move from milliliters to liters.

kl hl dal L dl cl ml

3 units to the left

$3210 \text{ ml} = 3.210 \text{ L}$, the same results as before and shown below in the diagram.

3 places to the left



Work Practice Problem 5

Answer
5. 2.1 L

Vocabulary and Readiness Check

Use the choices below to fill in each blank. Some choices may be used more than once.

cups pints liter
quarts fluid ounces capacity

- Units of _____ are generally used to measure liquids.
- The basic unit of capacity in the metric system is the _____.
- One cup equals 8 _____.
- One quart equals 2 _____.
- One pint equals 2 _____.
- One quart equals 4 _____.
- One gallon equals 4 _____.

9.6 EXERCISE SET

FOR EXTRA HELP



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Objective **A** Convert each measurement as indicated. See Examples 1 and 2.

- 32 fluid ounces to cups
- 16 quarts to gallons
- 8 quarts to pints
- 9 pints to quarts
- 14 quarts to gallons
- 11 cups to pints
- 80 fluid ounces to pints
- 18 pints to gallons
- 2 quarts to cups
- 3 pints to fluid ounces
- 120 fluid ounces to quarts
- 20 cups to gallons
- 42 cups to quarts
- 7 quarts to cups
- $4\frac{1}{2}$ pints to cups
- $6\frac{1}{2}$ gallons to quarts
- 5 gal 3 qt to quarts
- 4 gal 1 qt to quarts
- $\frac{1}{2}$ cup to pint
- $\frac{1}{2}$ pint to quarts
- 58 qt = _____ gal _____ qt
- 70 qt = _____ gal _____ qt
- 39 pt = _____ gal _____ qt _____ pt
- 29 pt = _____ gal _____ qt _____ pt
- $2\frac{3}{4}$ gallons to pints
- $3\frac{1}{4}$ quarts to cups

Objective **B** Perform each indicated operation. See Examples 3 and 4.

- 5 gal 3 qt + 7 gal 3 qt
- 2 gal 2 qt + 9 gal 3 qt
- 1 c 5 fl oz + 2 c 7 fl oz

30. $2\text{ c } 3\text{ fl oz} + 2\text{ c } 6\text{ fl oz}$

31. $3\text{ gal} - 1\text{ gal } 3\text{ qt}$

32. $2\text{ pt} - 1\text{ pt } 1\text{ c}$

33. $3\text{ gal } 1\text{ qt} - 1\text{ qt } 1\text{ pt}$

34. $3\text{ qt } 1\text{ c} - 1\text{ c } 4\text{ fl oz}$

35. $8\text{ gal } 2\text{ qt} \times 2$

36. $6\text{ gal } 1\text{ pt} \times 2$

37. $9\text{ gal } 2\text{ qt} \div 2$

38. $5\text{ gal } 6\text{ fl oz} \div 2$

Objective **C** Convert as indicated. See Examples 5 and 6.

39. 5 L to milliliters

40. 8 L to milliliters

41. 0.16 L to kiloliters

42. 0.127 L to kiloliters

43. 5600 ml to liters

44. 1500 ml to liters

45. 3.2 L to centiliters

46. 1.7 L to centiliters

47. 410 L to kiloliters

48. 250 L to kiloliters

49. 64 ml to liters

50. 39 ml to liters

51. 0.16 kl to liters

52. 0.48 kl to liters

53. 3.6 L to milliliters

54. 1.9 L to milliliters

Objective **D** Perform each indicated operation. See Examples 7 and 8.

55. $3.4\text{ L} + 15.9\text{ L}$

56. $18.5\text{ L} + 4.6\text{ L}$

57. $2700\text{ ml} + 1.8\text{ L}$

58. $4.6\text{ L} + 1600\text{ ml}$

59. $8.6\text{ L} - 190\text{ ml}$

60. $4.8\text{ L} - 283\text{ ml}$

61. $17,500\text{ ml} - 0.9\text{ L}$

62. $6850\text{ ml} - 0.3\text{ L}$

63. $480\text{ ml} \times 8$

64. $290\text{ ml} \times 6$

65. $81.2\text{ L} \div 0.5$

66. $5.4\text{ L} \div 3.6$

Objectives **A B C D** **Mixed Practice** Solve. Remember to insert units when writing your answers. For Exercises 67 through 70, complete the chart.

	Capacity	Cups	Gallons	Quarts	Pints
67.	An average-size bath of water		21		
68.	A dairy cow's daily milk yield				38
69.	Your kidneys filter about this amount of blood every minute	4			
70.	The amount of water needed in a punch recipe	2			

71. Mike Schaferkotter drank 410 ml of Mountain Dew from a 2-liter bottle. How much Mountain Dew remains in the bottle?

72. The Werners' Volvo has a 54.5-L gas tank. Only 3.8 liters of gasoline still remain in the tank. How much is needed to fill it?

73. Margie Phitts added 354 ml of Prestone dry gas to the 18.6 L of gasoline in her car's tank. Find the total amount of gasoline in the tank.

74. Chris Peckaitis wishes to share a 2-L bottle of Coca Cola equally with 7 of his friends. How much will each person get?

75. A garden tool engine requires a 30 to 1 gas to oil mixture. This means that $\frac{1}{30}$ of a gallon of oil should be mixed with 1 gallon of gas. Convert $\frac{1}{30}$ gallon to ounces. Round to the nearest tenth.
76. Henning's Supermarket sells homemade soup in 1 qt 1 pt containers. How much soup is contained in three such containers?
77. Can 5 pt 1 c of fruit punch and 2 pt 1 c of ginger ale be poured into a 1-gal container without it overflowing?
78. Three cups of prepared Jell-O are poured into 6 dessert dishes. How many fluid ounces of Jell-O are in each dish?
79. Stanley Fisher paid \$14 to fill his car with 44.3 liters of gasoline. Find the price per liter of gasoline to the nearest thousandth of a dollar.
80. A student carelessly misread the scale on a cylinder in the chemistry lab and added 40 cl of water to a mixture instead of 40 ml. Find the excess amount of water.

Review

Write each fraction in simplest form. See Section 4.2.

81. $\frac{20}{25}$

82. $\frac{75}{100}$

83. $\frac{27}{45}$

84. $\frac{56}{60}$

85. $\frac{72}{80}$

86. $\frac{18}{20}$

Concept Extensions

Determine whether the measurement in each statement is reasonable.

87. Clair took a dose of 2 L of cough medicine to cure her cough.
88. John drank 250 ml of milk for lunch.
89. Jeannie likes to relax in a tub filled with 3000 ml of hot water.
90. Sarah pumped 20 L of gasoline into her car yesterday.

Solve. See the Concept Checks in this section.

91. If 70 pints are converted to gallons, will the equivalent number of gallons be less than or greater than 70? Explain why.
92. If 30 gallons are converted to quarts, will the equivalent number of quarts be less than or greater than 30? Explain why.
93. Explain how to estimate the following operation: Add 986 ml to 6.9 L.
94. Find the number of fluid ounces in 1 gallon.
95. Explain how to borrow in order to subtract 1 gal 2 qt from 3 gal 1 qt.

A cubic centimeter (cc) is the amount of space that a volume of 1 ml occupies. Because of this, we will say that 1 cc = 1 ml.

A common syringe is one with a capacity of 3 cc. Use the diagram and give the measurement indicated by each arrow.

96. A

97. B

98. C

99. D

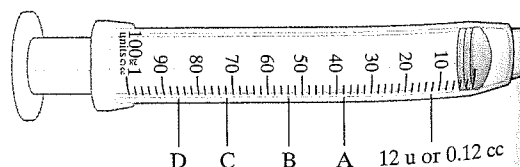
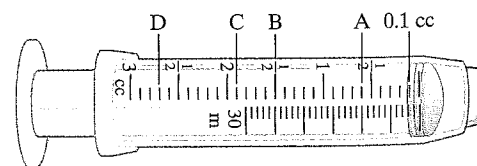
In order to measure small dosages, such as for insulin, u-100 syringes are used. For these syringes, 1 cc has been divided into 100 equal units (u). Use the diagram and give the measurement indicated by each arrow in units (u) and then cubic centimeters. Use 100 u = 1 cc and round to the nearest hundredth.

100. A

101. B

102. C

103. D



9.7 TEMPERATURE AND CONVERSIONS BETWEEN THE U.S. AND METRIC SYSTEMS

Objective A Converting Between the U.S. and Metric Systems

The metric system probably had its beginnings in France in the 1600s, but it was the Metric Act of 1866 that made the use of this system legal (but not mandatory) in the United States. Other laws have followed that allow for a slow, but deliberate, transfer to the modernized metric system. In April, 2001, for example, the U.S. Stock Exchanges completed their change to decimal trading instead of fractions. By the end of 2009, all products sold in Europe (with some exceptions) will be required to have only metric units on their labels. (Source: U.S. Metric Association and National Institute of Standards and Technology)

You may be surprised at the number of everyday items we use that are already manufactured in metric units. We easily recognize 1L and 2L soda bottles, but what about the following?

- Pencil leads (0.5 mm or 0.7 mm)
- Camera film (35 mm)
- Sporting events (5 km or 10 km races)
- Medicines (500 mg capsules)
- Labels on retail goods (dual-labeled since 1994)

Since the United States has not completely converted to the metric system, we need to practice converting from one system to the other. Below is a table of mostly approximate conversions.

Length:		Capacity:		Weight (mass):	
metric	U.S. System	metric	U.S. System	metric	U.S. System
1 m	≈ 1.09 yd	1 L	≈ 1.06 qt	1 kg	≈ 2.20 lb
1 m	≈ 3.28 ft	1 L	≈ 0.26 gal	1 g	≈ 0.04 oz
1 km	≈ 0.62 mi	3.79 L	≈ 1 gal	0.45 kg	≈ 1 lb
2.54 cm	= 1 in.	0.95 L	≈ 1 qt	28.35 g	≈ 1 oz
0.30 m	≈ 1 ft	29.57 ml	≈ 1 fl oz		
1.61 km	≈ 1 mi				

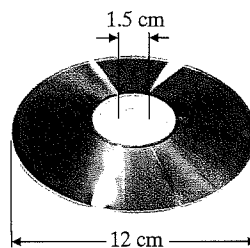
There are many ways to perform these metric to U.S. conversions. We will do so by using unit fractions.

EXAMPLE 1 Compact Discs

Standard-sized compact discs are 12 centimeters in diameter. Convert this length to inches. Round the result to two decimal places. (Source: usByte.com)

Solution: From our length conversion table, we know that 2.54 cm = 1 in. This fact gives us two unit fractions: $\frac{2.54 \text{ cm}}{1 \text{ in.}}$ and $\frac{1 \text{ in.}}{2.54 \text{ cm}}$. We use the unit fraction with cm in the denominator so that these units divide out.

$$\begin{aligned}
 12 \text{ cm} &= \frac{12 \text{ cm}}{1} \cdot 1 = \frac{12 \cancel{\text{cm}}}{1} \cdot \frac{1 \text{ in.}}{2.54 \cancel{\text{cm}}} \quad \leftarrow \begin{array}{l} \text{Unit fraction} \\ \text{Units to convert to} \\ \text{Original units} \end{array} \\
 &= \frac{12 \text{ in.}}{2.54} \\
 &\approx 4.72 \text{ in.} \quad \text{Divide.}
 \end{aligned}$$



Continued on next page

Objective

- A** Convert Between the U.S. and Metric Systems.
- B** Convert Temperatures from Degrees Celsius to Degrees Fahrenheit.
- C** Convert Temperatures from Degrees Fahrenheit to Degrees Celsius.

1 yard

1 meter

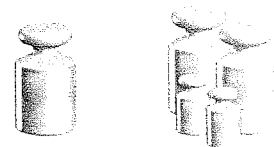


1 quart

1 liter

1 pound

1 kilogram



PRACTICE PROBLEM 1

The center hole of a standard-sized compact disc is 1.5 centimeters in diameter. Convert this length to inches. Round the result to 2 decimal places.

Answer

1. 0.59 in.

Thus, the diameter of a standard compact disc is exactly 12 cm or approximately 4.72 inches. For a dimension this size, you can use a ruler to check. Another method is to approximate. Our result, 4.72 in., is close to 5 inches. Since 1 in. is about 2.5 cm, then 5 in. is about $5(2.5 \text{ cm}) = 12.5 \text{ cm}$, which is close to 12 cm.

Work Practice Problem 1

PRACTICE PROBLEM 2

A full-grown human heart weighs about 8 ounces. Convert this weight to grams. If necessary, round your result to the nearest tenth of a gram.

EXAMPLE 1 Liver

The liver is your largest internal organ. It weighs about 3.5 pounds in a grown man. Convert this weight to kilograms. Round to the nearest tenth. (Source: *Some Body!* by Dr. Pete Rowan)

$$\text{Solution: } 3.5 \text{ lb} \approx \frac{3.5 \cancel{\text{ lb}}}{1} \cdot \frac{\overbrace{0.45 \text{ kg}}^{\text{Unit fraction}}}{\cancel{1 \text{ lb}}} = 3.5(0.45 \text{ kg}) \approx 1.6 \text{ kg}$$

Thus 3.5 pounds are approximately 1.6 kilograms. From the table of conversions, we know that $1 \text{ kg} \approx 2.2 \text{ lb}$. So that $0.5 \text{ kg} \approx 1.1 \text{ lb}$ and after adding, we have $1.5 \text{ kg} \approx 3.3 \text{ lb}$. Our result is reasonable.

Work Practice Problem 2

PRACTICE PROBLEM 3

Convert 237 ml to fluid ounces. Round to the nearest whole fluid ounce.

EXAMPLE 2 Postage Stamp

Australia converted to the metric system in 1973. In that year, four postage stamps were issued to publicize this conversion. One such stamp is shown. Let's check the mathematics on the stamp by converting 7 fluid ounces to milliliters. Round to the nearest hundred.



$$\text{Solution: } 7 \text{ fl oz} \approx \frac{7 \cancel{\text{ fl oz}}}{1} \cdot \frac{\overbrace{29.57 \text{ ml}}^{\text{Unit fraction}}}{\cancel{1 \text{ fl oz}}} = 7(29.57 \text{ ml}) = 206.99 \text{ ml}$$

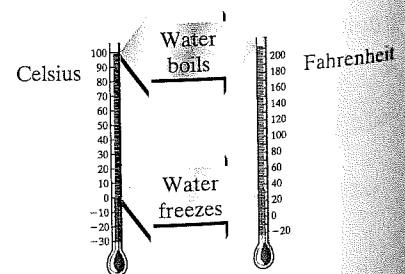
Rounded to the nearest hundred, $7 \text{ fl oz} \approx 200 \text{ ml}$.

Work Practice Problem 3

Now that we have practiced converting between two measurement systems, let's practice converting between two temperature scales.

Temperature When Gabriel Fahrenheit and Anders Celsius independently established units for temperature scales, each based his unit on the heat of water the moment it boils compared to the moment it freezes. One degree Celsius is $\frac{1}{100}$ of the difference in heat. One degree Fahrenheit is $\frac{1}{180}$ of the difference in heat. Celsius arbitrarily labeled the temperature at the freezing point at 0°C , making the boiling point 100°C ; Fahrenheit labeled the freezing point 32°F , making the boiling point 212°F . Water boils at 212°F or 100°C .

By comparing the two scales in the figure, we see that a 20°C day is as warm as a 68°F day. Similarly, a sweltering 104°F day in the Mojave desert corresponds to a 40°C day.



Answers

2. 226.8 g 3. 8 fl oz

✓ **Concept Check** Which of the following statements is correct? Explain.

- 6°C is below the freezing point of water.
- 6°F is below the freezing point of water.

Objective B Converting Degrees Celsius to Degrees Fahrenheit

To convert from Celsius temperatures to Fahrenheit temperatures, see the box below. In this box, we use the symbol F to represent degrees Fahrenheit and the symbol C to represent degrees Celsius.

Converting Celsius to Fahrenheit

$$F = \frac{9}{5}C + 32 \quad \text{or} \quad F = 1.8C + 32$$

(To convert to Fahrenheit temperature, multiply the Celsius temperature by $\frac{9}{5}$ or 1.8, and then add 32.)

EXAMPLE 3 Convert 15°C to degrees Fahrenheit.

Solution:

$$\begin{aligned} F &= \frac{9}{5}C + 32 \\ &= \frac{9}{5} \cdot 15 + 32 && \text{Replace } C \text{ with } 15. \\ &= 27 + 32 && \text{Simplify.} \\ &= 59 && \text{Add.} \end{aligned}$$

Thus, 15°C is equivalent to 59°F .

Work Practice Problem 4

EXAMPLE 4 Convert 29°C to degrees Fahrenheit.

Solution:

$$\begin{aligned} F &= 1.8C + 32 \\ &= 1.8 \cdot 29 + 32 && \text{Replace } C \text{ with } 29. \\ &= 52.2 + 32 && \text{Multiply } 1.8 \text{ by } 29. \\ &= 84.2 && \text{Add.} \end{aligned}$$

Therefore, 29°C is the same as 84.2°F .

Work Practice Problem 5

Objective C Converting Degrees Fahrenheit to Degrees Celsius

To convert from Fahrenheit temperatures to Celsius temperatures, see the box below. The symbol C represents degrees Celsius and the symbol F represents degrees Fahrenheit.

Converting Fahrenheit to Celsius

$$C = \frac{5}{9}(F - 32)$$

(To convert to Celsius temperature, subtract 32 from the Fahrenheit temperature, and then multiply by $\frac{5}{9}$.)

PRACTICE PROBLEM 4

Convert 60°C to degrees Fahrenheit.

PRACTICE PROBLEM 5

Convert 32°C to degrees Fahrenheit.

Answers

4. 140°F 5. 89.6°F

✓ Concept Check Answer

a. false b. true

PRACTICE PROBLEM 6

Convert 68°F to degrees Celsius.

PRACTICE PROBLEM 7

Convert 113°F to degrees Celsius. If necessary, round to the nearest tenth of a degree.

PRACTICE PROBLEM 8

During a bout with the flu, Albert's temperature reaches 102.8°F . What is his temperature measured in degrees Celsius? Round to the nearest tenth of a degree.

Answers

6. 20°C 7. 45°C 8. 39.3°C

✓Concept Check Answer

She used the conversion for Celsius to Fahrenheit instead of Fahrenheit to Celsius.

EXAMPLE 6 Convert 59°F to degrees Celsius.

Solution: We evaluate the formula $C = \frac{5}{9}(F - 32)$ when F is 59.

$$\begin{aligned} C &= \frac{5}{9}(F - 32) \\ &= \frac{5}{9} \cdot (59 - 32) && \text{Replace } F \text{ with } 59. \\ &= \frac{5}{9} \cdot (27) && \text{Subtract inside parentheses.} \\ &= 15 && \text{Multiply.} \end{aligned}$$

Therefore, 59°F is the same temperature as 15°C .

Work Practice Problem 6

EXAMPLE 7 Convert 114°F to degrees Celsius. If necessary, round to the nearest tenth of a degree.

$$\begin{aligned} \text{Solution: } C &= \frac{5}{9}(F - 32) \\ &= \frac{5}{9}(114 - 32) && \text{Replace } F \text{ with } 114. \\ &= \frac{5}{9} \cdot (82) && \text{Subtract inside parentheses.} \\ &\approx 45.6 && \text{Multiply.} \end{aligned}$$

Therefore, 114°F is approximately 45.6°C .

Work Practice Problem 7

EXAMPLE 8 **Body Temperature**

Normal body temperature is 98.6°F . What is this temperature in degrees Celsius?

Solution: We evaluate the formula $C = \frac{5}{9}(F - 32)$ when F is 98.6.

$$\begin{aligned} C &= \frac{5}{9}(F - 32) \\ &= \frac{5}{9}(98.6 - 32) && \text{Replace } F \text{ with } 98.6. \\ &= \frac{5}{9} \cdot (66.6) && \text{Subtract inside parentheses.} \\ &= 37 && \text{Multiply.} \end{aligned}$$

Therefore, normal body temperature is 37°C .

Work Practice Problem 8

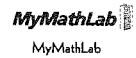
✓Concept Check Clarissa must convert 40°F to degrees Celsius. What is wrong with her work shown below?

$$\begin{aligned} F &= 1.8 \cdot C + 32 \\ F &= 1.8 \cdot 40 + 32 \\ F &= 72 + 32 \\ F &= 104 \end{aligned}$$

9.7

EXERCISE SET

FOR EXTRA HELP



Note: Because approximations are used, your answers may vary slightly from the answers given in the back of the book.

Objective **A** Convert as indicated. If necessary, round answers to two decimal places. See Examples 1 through 3.

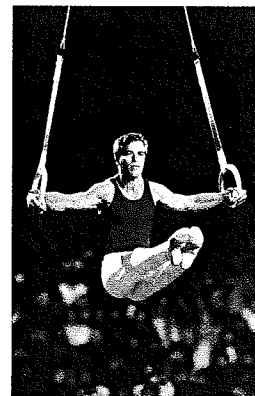
1. 756 milliliters to fluid ounces
2. 18 liters to quarts
3. 86 inches to centimeters
4. 86 miles to kilometers
5. 1000 grams to ounces
6. 100 kilograms to pounds
7. 93 kilometers to miles
8. 9.8 meters to feet
9. 14.5 liters to gallons
10. 150 milliliters to fluid ounces
11. 30 pounds to kilograms
12. 15 ounces to grams

Fill in the chart. Give exact answers or round to 1 decimal place.

	Meters	Yards	Centimeters	Feet	Inches
13. The Height of a Woman				5	
14. Statue of Liberty Length of Nose	1.37				
15. Leaning Tower of Pisa		60			
16. Blue Whale		36			

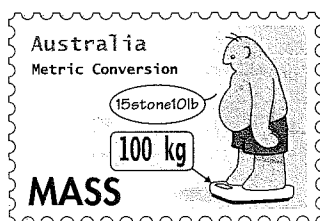
Solve. If necessary, round answers to two decimal places. See Examples 1 through 3.

17. The balance beam for female gymnasts is 10 centimeters wide. Convert this width to inches.
18. In men's gymnastics, the rings are 250 centimeters from the floor. Convert this height to inches, then to feet.

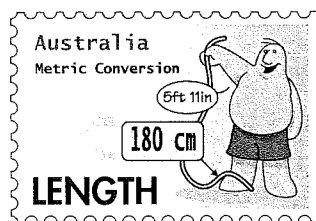


19. In many states, the maximum speed limit for recreational vehicles is 50 miles per hour. Convert this to kilometers per hour.
20. The speed limit is 70 miles per hour. Convert this to kilometers per hour.
21. Ibuprofen comes in 200 milligram tablets. Convert this to ounces. (Round your answer to this exercise to 3 decimal places.)
22. Vitamin C tablets come in 500 milligram caplets. Convert this to ounces.

23. A stone is a unit in the British customary system. Use the conversion: 14 pounds = 1 stone to check the equivalencies in this 1973 Australian stamp. Is 100 kilograms approximately 15 stone 10 pounds?



24. Convert 5 feet 11 inches to centimeters and check the conversion on this 1973 Australian stamp. Is it correct?



25. The Monarch butterfly migrates annually between the northern United States and central Mexico. The trip is about 4500 km long. Convert this to miles.
26. There is a species of African termite that builds nests up to 18 ft high. Convert this to meters.
27. A $3\frac{1}{2}$ -inch diskette is not really $3\frac{1}{2}$ inches. To find its actual width, convert this measurement to centimeters, then to millimeters. Round the result to the nearest ten.
28. The average two-year-old is 84 centimeters tall. Convert this to feet and inches.
29. For an average adult, the weight of a right lung is greater than the weight of a left lung. If the right lung weighs 1.5 pounds and the left lung weighs 1.25 pounds, find the difference in grams. (Source: *Some Body!*)
30. The skin of an average adult weighs 9 pounds and is the heaviest organ. Find the weight in grams. (Source: *Some Body!*)
31. A fast sneeze has been clocked at about 167 kilometers per hour. Convert this to miles per hour. Round to the nearest whole.
32. A Boeing 747 has a cruising speed of about 980 kilometers per hour. Convert this to miles per hour. Round to the nearest whole.
33. The General Sherman giant sequoia tree has a diameter of about 8 meters at its base. Convert this to feet. (Source: *Fantastic Book of Comparisons*)
34. The largest crater on the near side of the moon is Billy Crater. It has a diameter of 303 kilometers. Convert this to miles. (Source: *Fantastic Book of Comparisons*)
35. The total length of the track on a CD is about 4.5 kilometers. Convert this to miles. Round to the nearest whole mile.
36. The distance between Mackinaw City, Michigan, and Cheyenne, Wyoming, is 2079 kilometers. Convert this to miles. Round to the nearest whole mile.
37. A doctor orders a dosage of 5 ml of medicine every 4 hours for 1 week. How many fluid ounces of medicine should be purchased? Round up to the next whole fluid ounce.
38. A doctor orders a dosage of 12 ml of medicine every 6 hours for 10 days. How many fluid ounces of medicine should be purchased? Round up to the next whole fluid ounce.

Without actually converting, choose the most reasonable answer.

39. This math book has a height of about ____.
- a. 28 mm b. 28 cm
c. 28 m d. 28 km
40. A mile is ____ a kilometer.
- a. shorter than b. longer than
c. the same length as
41. A liter has ____ capacity than a quart.
- a. less b. greater
c. the same
42. A foot is ____ a meter.
- a. shorter than b. longer than
c. the same length as

43. A kilogram weighs _____ a pound.
- the same as
 - less than
 - greater than
44. A football field is 100 yards, which is about _____.
- 9 m
 - 90 m
 - 900 m
 - 9000 m
45. An $8\frac{1}{2}$ ounce glass of water has a capacity of about _____.
- 250 L
 - 25 L
 - 2.5 L
 - 250 ml
46. A 5-gallon gasoline can has a capacity of about _____.
- 19 L
 - 1.9 L
 - 19 ml
 - 1.9 ml
47. The weight of an average man is about _____.
- 700 kg
 - 7 kg
 - 0.7 kg
 - 70 kg
48. The weight of a pill is about _____.
- 200 kg
 - 20 kg
 - 2 kg
 - 200 mg

Objectives **B** **C** Convert as indicated. When necessary, round to the nearest tenth of a degree. See Examples 4 through 8.

49. 77°F to degrees Celsius
50. 86°F to degrees Celsius
51. 104°F to degrees Celsius
52. 140°F to degrees Celsius
53. 50°C to degrees Fahrenheit
54. 80°C to degrees Fahrenheit
55. 115°C to degrees Fahrenheit
56. 225°C to degrees Fahrenheit
57. 20°F to degrees Celsius
58. 26°F to degrees Celsius
59. 142.1°F to degrees Celsius
60. 43.4°F to degrees Celsius
61. 92°C to degrees Fahrenheit
62. 75°C to degrees Fahrenheit
63. 12.4°C to degrees Fahrenheit
64. 48.6°C to degrees Fahrenheit
65. The hottest temperature ever recorded in the United States, in Death Valley, was 134°F. Convert this temperature to degrees Celsius. (Source: National Climatic Data Center)
66. The hottest temperature ever recorded in the United States in January was 95°F in Los Angeles. Convert this temperature to degrees Celsius. (Source: National Climatic Data Center)
67. A weather forecaster in Caracas predicts a high temperature of 27°C. Find this measurement in degrees Fahrenheit.
68. While driving to work, Alan Olda notices a temperature of 18°C flash on the local bank's temperature display. Find the corresponding temperature in degrees Fahrenheit.
69. At Mack Trucks' headquarters, the room temperature is to be set at 70°F, but the thermostat is calibrated in degrees Celsius. Find the temperature to be set.
70. The computer room at Merck, Sharp, and Dohm is normally cooled to 66°F. Find the corresponding temperature in degrees Celsius.
71. In a European cookbook, a recipe requires the ingredients for caramels to be heated to 118°C, but the cook has access only to a Fahrenheit thermometer. Find the temperature in degrees Fahrenheit that should be used to make the caramels.
72. The ingredients for divinity should be heated to 127°C, but the candy thermometer that Myung Kim has is calibrated to degrees Fahrenheit. Find how hot he should heat the ingredients.

73. The temperature of Earth's core is estimated to be 4000°C . Find the corresponding temperature in degrees Fahrenheit.
74. In 2005, the average temperature of the Earth's surface was 58.1°F , the second warmest in recorded history. Convert this temperature to degrees Celsius.

Review

Perform the indicated operations. See Section 1.7.

75. $6 \cdot 4 + 5 \div 1$ 76. $10 \div 2 + 9(8)$ 77. $3[(1 + 5) \cdot (8 - 6)]$ 78. $5[(18 - 8) - 9]$

Concept Extensions







Determine whether the measurement in each statement is reasonable.

79. A 72°F room feels comfortable.
80. Water heated to 110°F will boil.
81. Josiah has a fever if a thermometer shows his temperature to be 40°F .
82. An air temperature of 20°F on a Vermont ski slope can be expected in the winter.
83. When the temperature is 30°C outside, an overcoat is needed.
84. An air-conditioned room at 60°C feels quite chilly.
85. Barbara has a fever when a thermometer records her temperature at 40°C .
86. Water cooled to 32°C will freeze.

Body surface area (BSA) is often used to calculate dosages for some drugs. BSA is calculated in square meters using a person's weight and height.

$$\text{BSA} = \sqrt{\frac{(\text{weight in kg}) \times (\text{height in cm})}{3600}}$$

For Exercises 87 through 92, calculate the BSA for each person. Round to the nearest hundredth. You will need to use the square root key on your calculator.

-  87. An adult whose height is 182 cm and weight is 90 kg.
-  88. An adult whose height is 157 cm and weight is 63 kg.
-  89. A child whose height is 40 in. and weight is 50 kg. (Hint: Don't forget to first convert inches to centimeters.)
-  90. A child whose height is 26 in. and weight is 13 kg.
-  91. An adult whose height is 60 in. and weight is 150 lb.
-  92. An adult whose height is 69 in. and weight is 172 lb.
93. On February 17, 1995, in the Tokamak Fusion Test Reactor at Princeton University, the highest temperature produced in a laboratory was achieved. This temperature was $918,000,000^{\circ}\text{F}$. Convert this temperature to degrees Celsius. Round your answer to the nearest ten million degrees. (Source: Guinness World Records)
94. The hottest-burning substance known is carbon subnitride. Its flame at one atmospheric pressure reaches 9010°F . Convert this temperature to degrees Celsius. (Source: Guinness World Records)
95. In your own words, describe how to convert from degrees Celsius to degrees Fahrenheit.



CHAPTER 9 Group Activity

Map Reading

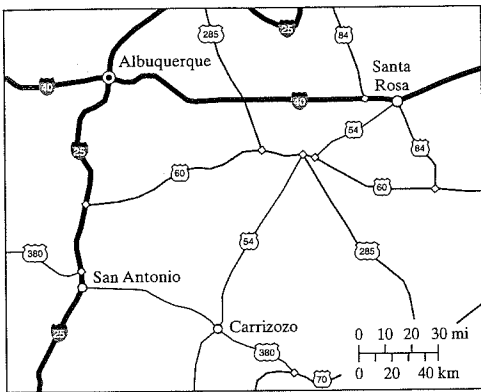
Sections 9.1 and 9.4

Materials:

- ruler
- string
- calculator

This activity may be completed by working in groups or individually.

Investigate the route you would take from Santa Rosa, New Mexico, to San Antonio, New Mexico. Use the map in the figure to answer the following questions. You may find that using string to match the roads on the map is useful when measuring distances.



1. How many miles is it from Santa Rosa to San Antonio via Interstate 40 and Interstate 25? Convert this distance to kilometers.
2. How many miles is it from Santa Rosa to San Antonio via U.S. 54 and U.S. 380? Convert this distance to kilometers.
3. Assume that the speed limit on Interstates 40 and 25 is 65 miles per hour. How long would the trip take if you took this route and traveled 65 miles per hour the entire trip?
4. At what average speed would you have to travel on the U.S. routes to make the trip from Santa Rosa to San Antonio in the same amount of time that it would take on the interstate routes? Do you think this speed is reasonable on this route? Explain your reasoning.
5. Discuss in general the factors that might affect your decision among the different routes.
6. Explain which route you would choose in this case and why.

9 Chapter Highlights

Helpful Hint

Are you preparing for your test? Don't forget to take the Chapter 9 Test on page 697. Then check your answers at the back of the text and use the Chapter Test Prep Video CD to see the fully worked-out solutions to any of the exercises you want to review.

DEFINITIONS AND CONCEPTS

EXAMPLES

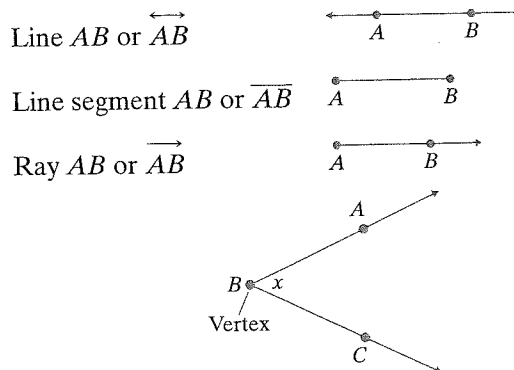
Section 9.1 Lines and Angles

A **line** is a set of points extending indefinitely in two directions. A line has no width or height, but it does have length. We name a line by any two of its points.

A **line segment** is a piece of a line with two endpoints.

A **ray** is a part of a line with one endpoint. A ray extends indefinitely in one direction.

An **angle** is made up of two rays that share the same endpoint. The common endpoint is called the **vertex**.



Section 9.2 Perimeter

PERIMETER FORMULAS

Rectangle: $P = 2l + 2w$

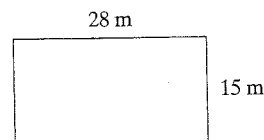
Square: $P = 4s$

Triangle: $P = a + b + c$

Circumference of a Circle: $C = 2\pi r$ or $C = \pi d$

where $\pi \approx 3.14$ or $\pi \approx \frac{22}{7}$

Find the perimeter of the rectangle.



$$\begin{aligned} P &= 2l + 2w \\ &= 2 \cdot 28 \text{ meters} + 2 \cdot 15 \text{ meters} \\ &= 56 \text{ meters} + 30 \text{ meters} \\ &= 86 \text{ meters} \end{aligned}$$

The perimeter is 86 meters.

Section 9.3 Area, Volume, and Surface Area

AREA FORMULAS

Rectangle: $A = lw$

Square: $A = s^2$

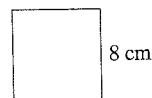
Triangle: $A = \frac{1}{2}bh$

Parallelogram: $A = bh$

Trapezoid: $A = \frac{1}{2}(b + B)h$

Circle: $A = \pi r^2$

Find the area of the square.



$$\begin{aligned} A &= s^2 \\ &= (8 \text{ centimeters})^2 \\ &= 64 \text{ square centimeters} \end{aligned}$$

The area of the square is 64 square centimeters.

DEFINITIONS AND CONCEPTS

EXAMPLES

Section 9.3 Area, Volume, and Surface Area (continued)

VOLUME FORMULAS

Surface Area Formulas: See page 633.

Rectangular Solid: $V = lwh$

Cube: $V = s^3$

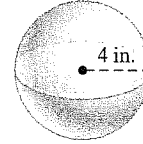
Sphere: $V = \frac{4}{3}\pi r^3$

Right Circular Cylinder: $V = \pi r^2 h$

Cone: $V = \frac{1}{3}\pi r^2 h$

Square-Based Pyramid: $V = \frac{1}{3}s^2 h$

Find the volume of the sphere. Use $\frac{22}{7}$ for π .



$$\begin{aligned} V &= \frac{4}{3}\pi r^3 \\ &\approx \frac{4}{3} \cdot \frac{22}{7} \cdot (4 \text{ inches})^3 \\ &= \frac{4 \cdot 22 \cdot 64}{3 \cdot 7} \text{ cubic inches} \\ &= \frac{5632}{21} \text{ or } 268\frac{4}{21} \text{ cubic inches} \end{aligned}$$

Section 9.4 Linear Measurement

To convert from one unit of length to another, multiply by a **unit fraction** in the form

$$\frac{\text{units to convert to}}{\text{original units}}$$

LENGTH: U.S. SYSTEM OF MEASUREMENT

12 inches (in.) = 1 foot (ft)

3 feet = 1 yard (yd)

5280 feet = 1 mile (mi)

The basic unit of length in the metric system is the **meter**.
A meter is slightly longer than a yard.

LENGTH: METRIC SYSTEM OF MEASUREMENT

Metric Unit of Length
1 kilometer (km) = 1000 meters (m)
1 hectometer (hm) = 100 m
1 dekameter (dam) = 10 m
1 meter (m) = 1 m
1 decimeter (dm) = 1/10 m or 0.1 m
1 centimeter (cm) = 1/100 m or 0.01 m
1 millimeter (mm) = 1/1000 m or 0.001 m

$$\frac{12 \text{ inches}}{1 \text{ foot}} \quad \frac{1 \text{ foot}}{12 \text{ inches}} \quad \frac{3 \text{ feet}}{1 \text{ yard}}$$

Convert 6 feet to inches.

$$\begin{aligned} 6 \text{ ft} &= \frac{6 \text{ ft}}{1} \cdot 1 \\ &= \frac{6 \cancel{\text{ft}}}{1} \cdot \frac{12 \text{ in.}}{1 \cancel{\text{ft}}} \quad \begin{array}{l} \leftarrow \text{units to convert to} \\ \leftarrow \text{original units} \end{array} \\ &= 6 \cdot 12 \text{ in.} \\ &= 72 \text{ in.} \end{aligned}$$

Convert 3650 centimeters to meters.

$$\begin{aligned} 3650 \text{ cm} &= 3650 \text{ cm} \cdot 1 \\ &= \frac{3650 \cancel{\text{cm}}}{1} \cdot \frac{0.01 \text{ m}}{1 \cancel{\text{cm}}} = 36.5 \text{ m} \end{aligned}$$

or

$$\begin{array}{cccccccc} \text{km} & \text{hm} & \text{dam} & \text{m} & \text{dm} & \text{cm} & \text{mm} \\ & & & \underbrace{\hspace{1.5cm}} & & & \\ & & & & \text{2 units to the left} & & \\ 3650 \text{ cm} & = & 36.5 \text{ m} \\ & \underbrace{\hspace{1.5cm}} & & & \text{2 places to the left} & & \end{array}$$

DEFINITIONS AND CONCEPTS

EXAMPLES

Section 9.5 Weight and Mass

Weight is really a measure of the pull of gravity. **Mass** is a measure of the amount of substance in an object and does not change.

WEIGHT: U.S. SYSTEM OF MEASUREMENT

$$16 \text{ ounces (oz)} = 1 \text{ pound (lb)}$$

$$2000 \text{ pounds} = 1 \text{ ton}$$

A **gram** is the basic unit of mass in the metric system. It is the mass of water contained in a cube 1 centimeter on each side. A paper clip weighs about 1 gram.

MASS: METRIC SYSTEM OF MEASUREMENT

Metric Unit of Mass
1 kilogram (kg) = 1000 grams (g)
1 hectogram (hg) = 100 g
1 dekagram (dag) = 10 g
1 gram (g) = 1 g
1 decigram (dg) = 1/10 g or 0.1 g
1 centigram (cg) = 1/100 g or 0.01 g
1 milligram (mg) = 1/1000 g or 0.001 g

Convert 5 pounds to ounces.

$$5 \text{ lb} = 5 \text{ lb} \cdot 1 = \frac{5 \cancel{\text{lb}}}{1} \cdot \frac{16 \text{ oz}}{1 \cancel{\text{lb}}} = 80 \text{ oz}$$

Convert 260 grams to kilograms.

$$260 \text{ g} = \frac{260 \text{ g}}{1} \cdot 1 = \frac{260 \cancel{\text{g}}}{1} \cdot \frac{1 \text{ kg}}{1000 \cancel{\text{g}}} = 0.26 \text{ kg}$$

or

$$\text{kg} \quad \text{hg} \quad \text{dag} \quad \text{g} \quad \text{dg} \quad \text{cg} \quad \text{mg}$$

3 units to the left

$$\underline{260} \text{ g} = 0.260 \text{ kg}$$

3 places to the left

Section 9.6 Capacity

CAPACITY: U.S. SYSTEM OF MEASUREMENT

$$8 \text{ fluid ounces (fl oz)} = 1 \text{ cup (c)}$$

$$2 \text{ cups} = 1 \text{ pint (pt)}$$

$$2 \text{ pints} = 1 \text{ quart (qt)}$$

$$4 \text{ quarts} = 1 \text{ gallon (gal)}$$

The **liter** is the basic unit of capacity in the metric system. It is the capacity or volume of a cube measuring 10 centimeters on each side. A liter of liquid is slightly more than 1 quart.

CAPACITY: METRIC SYSTEM OF MEASUREMENT

Metric Unit of Capacity
1 kiloliter (kl) = 1000 liters (L)
1 hectoliter (hl) = 100 L
1 dekaliter (dal) = 10 L
1 liter (L) = 1 L
1 deciliter (dl) = 1/10 L or 0.1 L
1 centiliter (cl) = 1/100 L or 0.01 L
1 milliliter (ml) = 1/1000 L or 0.001 L

Convert 5 pints to gallons.

$$1 \text{ gal} = 4 \text{ qt} = 8 \text{ pt}$$

$$5 \text{ pt} = 5 \text{ pt} \cdot 1 = \frac{5 \cancel{\text{pt}}}{1} \cdot \frac{1 \text{ gal}}{8 \cancel{\text{pt}}} = \frac{5}{8} \text{ gal}$$

Convert 1.5 liters to milliliters.

$$1.5 \text{ L} = \frac{1.5 \text{ L}}{1} \cdot 1 = \frac{1.5 \cancel{\text{L}}}{1} \cdot \frac{1000 \text{ ml}}{1 \cancel{\text{L}}} = 1500 \text{ ml}$$

or

$$\text{kl} \quad \text{hl} \quad \text{dal} \quad \text{L} \quad \text{dl} \quad \text{cl} \quad \text{ml}$$

3 units to the right

$$\underline{1.500} \text{ L} = 1500 \text{ ml}$$

3 places to the right

DEFINITIONS AND CONCEPTS

EXAMPLES

Section 9.7 Temperature and Conversions Between the U.S. and Metric Systems

To convert between systems, use approximate unit fractions.

Convert 7 feet to meters.

$$7 \text{ ft} \approx \frac{7 \cancel{\text{ft}}}{1} \cdot \frac{0.30 \text{ m}}{1 \cancel{\text{ft}}} = 2.1 \text{ m}$$

Convert 8 liters to quarts.

$$8 \text{ L} \approx \frac{8 \cancel{\text{L}}}{1} \cdot \frac{1.06 \text{ qt}}{1 \cancel{\text{L}}} = 8.48 \text{ qt}$$

Convert 363 grams to ounces.

$$363 \text{ g} \approx \frac{363 \cancel{\text{g}}}{1} \cdot \frac{0.04 \text{ oz}}{1 \cancel{\text{g}}} = 14.52 \text{ oz}$$

Convert 35°C to degrees Fahrenheit.

$$F = \frac{9}{5} \cdot 35 + 32 = 63 + 32 = 95$$

$$35^\circ\text{C} = 95^\circ\text{F}$$

Convert 50°F to degrees Celsius.

$$C = \frac{5}{9} \cdot (50 - 32) = \frac{5}{9} \cdot (18) = 10$$

$$50^\circ\text{F} = 10^\circ\text{C}$$

CELSIUS TO FAHRENHEIT

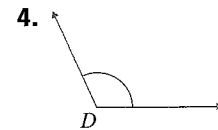
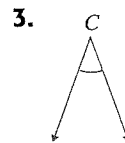
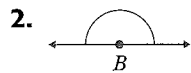
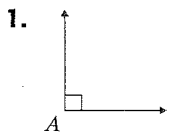
$$F = \frac{9}{5}C + 32 \quad \text{or} \quad F = 1.8C + 32$$

FAHRENHEIT TO CELSIUS

$$C = \frac{5}{9}(F - 32)$$

9 CHAPTER REVIEW

(9.1) Classify each angle as acute, right, obtuse, or straight.



5. Find the complement of a 25° angle.

6. Find the supplement of a 105° angle.

Find the measure of angle x in each figure.

