Chapter 1 Matter and Measurement

Solutions to In-Chapter Problems

1.1 Naturally occurring: ice, blood. Synthetic: gloves, mask, plastic syringe, stainless steel needle.

1.2 *Physical properties* can be observed or measured without changing the composition of the material (a and d). *Chemical properties* determine how a substance can be converted to another substance by chemical reactions (b, c, and e).

1.3 This represents a chemical change because the "particles" on the left are different from the particles on the right. For example, on the left side there are particles containing only two red balls, while on the right there are none of these.

1.4 Representation (a) is a pure substance since each particle contains one red and two gray spheres. Representation (b) is a mixture since some of the particles are only red, and some are red and black.

1.5 A *pure substance* is composed of a single substance and has a constant composition regardless of the sample size (d). A *mixture* is composed of more than one component (a, b, and c). The composition of a mixture can vary depending on the sample.

1.6 An *element* is a pure substance that cannot be broken down into simpler substances by a chemical reaction (a). A *compound* is a pure substance formed by combining two or more elements together (b, c, and d).

1.7 Use Table 1.2 to determine the prefix for each unit.
a. a million liters = megaliter
b. a thousandth of a second = millisecond
c. a hundredth of a gram = centigram
d. a tenth of a liter = deciliter

1.8 One nanometer = 0.000 000 001 m (one billionth of a meter); therefore, 1 m = 1,000,000,000 nm.

1.9 a. 0.000 001 g = one microgram (1 μg)
b. 1,000,000,000 m = one gigameter (1 Gm)
c. 0.000 000 001 s = one nanosecond (1 ns)
d. 0.01 g = one centigram (1 cg)

1.10 Use Table 1.2 to determine which quantity is larger.
a. 3 cL
b. 1 μg
c. 5 km
d. 2 mL

1.11 All nonzero digits are significant. A zero is significant only if it occurs between two nonzero digits, or at the end of a number with a decimal point. The significant figures are in **bold.**

a. **23.45**
4 significant figures

b. **23.057**
5 significant figures

c. **23**0
2 significant figures

d. **231.0**
4 significant figures

e. 0.**202**
3 significant figures

f. 0.00**3 60**
3 significant figures

g. **1,245,006**
7 significant figures

h. **1,2**00,000
2 significant figures

i. **10,04**0
4 significant figures

j. **10,040.**
5 significant figures

1.12 A zero is significant only if it occurs between two nonzero digits, or at the end of a number with a decimal point.

a. 0.003 04 — leading zeros (0.00): No; zero between 3 and 4: Yes

b. 26,045 — zero: Yes

c. 1,000,034 — zeros: Yes

d. 0.304 00 — leading zero: No; trailing zeros (4 00): Yes

1.13 When the number to be rounded off is 4 or fewer, it and all other digits to the right are dropped. When the number is 5 or greater, 1 is added to the digit to its left.

a. 1.2735 → 1.3
Since this number is 7 (5 or greater), round the 2 to its left up by one.

b. 0.002 536 22 → 0.0025
Since this number is 3 (4 or fewer), drop it and all numbers to its right.

c. 3,836.9 → 3,800
Since this number is 3 (4 or fewer), drop it and all numbers to its right.

1.14 The answers must have the same number of significant figures as the original number with the fewest number of significant figures.

a. 10.70 × 3.5 = 37.45
Since 3.5 has only two significant figures, round the answer to give it two significant figures.
37

b. 0.206 ÷ 25,993 = **0.000 007 93**
Since 0.206 has three significant figures, the answer has the appropriate number of significant figures.

c. 1,300 ÷ 41.2 = 31.553 398
Since 1,300 has only two significant figures, round the answer to give it two significant figures.
32

d. 120.5 × 26 = 3,133
Since 26 has only two significant figures, round the answer to give it two significant figures.
3,100

1.15 The answers must have the same number of decimal places as the original number with the fewest decimal places.

a. 27.8 cm + 0.246 cm = 28.046 cm
Since 27.8 has one digit after the decimal point, round the answer to one digit after the decimal point.
28.0 cm

c. 54.6 mg – 25 mg = 29.6 mg
Since 25 has zero digits after the decimal point, round the answer to the nearest whole number.
30. mg

b. 102.66 mL + 0.857 mL + 24.0 mL = 127.517 mL
Since 24.0 has one digit after the decimal point, round the answer to one digit after the decimal point.
127.5 mL

d. 2.35 s – 0.266 s = 2.084 s
Since 2.35 has two digits after the decimal point, round the answer to two digits after the decimal point.
2.08 s

1.16 To write a number in scientific notation:
[1] Move the decimal point to give a number between 1 and 10.
[2] Multiply the result by 10^x, where x is the number of places the decimal point was moved.

0.000 098 g/dL = 9.8×10^{-5} g/dL — the number of places the decimal point was moved to the right

Move the decimal point five places to the right.

1.17 To write a number in scientific notation:
[1] Move the decimal point to give a number between 1 and 10.
[2] Multiply the result by 10^x, where x is the number of places the decimal point was moved.

a. 93,200 = 9.32×10^4
The decimal point was moved four places to the left.

b. 0.000 725 = 7.25×10^{-4}
The decimal point was moved four places to the right.

c. 6,780,000 = 6.78×10^6
The decimal point was moved six places to the left.

d. 0.000 030 = 3.0×10^{-5}
The decimal point was moved five places to the right.

e. 4,520,000,000,000 = 4.52×10^{12}
The decimal point was moved 12 places to the left.

f. 0.000 000 000 028 = 2.8×10^{-11}
The decimal point was moved 11 places to the right.

1.18 The exponent in 10^x tells how many places to move the decimal point in the coefficient to generate a standard number. The decimal point goes to the right when x is positive and to the left when x is negative.

a. 6.5×10^3 = 6,500
The decimal point was moved three places to the right.

b. 3.26×10^{-5} = 0.000 032 6
The decimal point was moved five places to the left.

c. 3.780×10^{-2} = 0.037 80
The decimal point was moved two places to the left.

d. 1.04×10^8 = 104,000,000
The decimal point was moved eight places to the right.

e. 2.221×10^6 = 2,221,000
The decimal point was moved six placed to the right.

f. 4.5×10^{-10} = 0.000 000 000 45
The decimal point was moved 10 places to the left.

1.19 Use the equalities in Tables 1.3 and 1.4 to write a fraction that shows the relationship between the two units.

a. $\frac{0.621\text{ mi}}{1\text{ km}}$ $\frac{1\text{ km}}{0.621\text{ mi}}$

b. $\frac{1000\text{ mm}}{1\text{ m}}$ $\frac{1\text{ m}}{1000\text{ mm}}$

c. $\frac{454\text{ g}}{1\text{ lb}}$ $\frac{1\text{ lb}}{454\text{ g}}$

d. $\frac{1000\ \mu\text{g}}{1\text{ mg}}$ $\frac{1\text{ mg}}{1000\ \mu\text{g}}$

1.20 To convert 4,120 km to miles:
[1] Identify the original quantity and the desired quantity, including units.
[2] Write out the conversion factor(s) needed to solve the problem.
[3] Set up and solve the problem.
[4] Write the answer using the correct number of significant figures and check by estimation.

[1] 4,120 km (original quantity) → ? mi (desired quantity)

[2] Two possible conversion factors: $\frac{1 \text{ km}}{0.621 \text{ mi}}$ or $\frac{0.621 \text{ mi}}{1 \text{ km}}$ — Choose this factor to cancel the unwanted unit, km.

[3]
$$4{,}120 \text{ km} \times \frac{0.621 \text{ mi}}{1 \text{ km}} = 2{,}558.52 \text{ mi}$$
(original quantity × conversion factor = desired quantity)

The number of km (unwanted unit) cancels.

[4] The initial number has three significant figures, so the final answer is rounded to 2,560 mi.

1.21 Use conversion factors to solve the problems.

a. $25 \text{ L} \times \frac{10 \text{ dL}}{1 \text{ L}} = 250 \text{ dL}$

b. $40.0 \text{ oz} \times \frac{28.3 \text{ g}}{1 \text{ oz}} = 1{,}132 \text{ g} = 1{,}130 \text{ g}$ rounded to 3 significant figures

c. $32 \text{ in.} \times \frac{2.54 \text{ cm}}{1 \text{ in.}} = 81.28 \text{ cm} = 81 \text{ cm}$ rounded to 2 significant figures

d. $10 \text{ cm} \times \frac{10 \text{ mm}}{1 \text{ cm}} = 100 \text{ mm}$

1.22

a. 0.46 mL

b. $0.46 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{1000000 \ \mu\text{L}}{1 \text{ L}} = 460 \ \mu\text{L}$

1.23 Use conversion factors to solve the problems.

a. $6{,}250 \text{ ft} \times \frac{1 \text{ mi}}{5{,}280 \text{ ft}} \times \frac{1 \text{ km}}{0.621 \text{ mi}} = 1.91 \text{ km}$

Feet cancel. Miles cancel. Kilometers do not cancel.

b. $3 \text{ cups} \times \frac{1 \text{ qt}}{4 \text{ cups}} \times \frac{1 \text{ L}}{1.06 \text{ qt}} = 0.7 \text{ L}$

Cups cancel. Quarts cancel. Liters do not cancel.

c. $4.5\ \text{ft} \times \frac{12\ \text{in.}}{1\ \text{ft}} \times \frac{2.54\ \text{cm}}{1\ \text{in.}} = 140\ \text{cm}$

Feet cancel. Inches cancel. Centimeters do not cancel.

1.24 Use the conversion factors: 1 teaspoon = 5 mL and 80. mg acetaminophen/2.5 mL of Tylenol.

a. $2.5\ \text{tsp} \times \frac{5\ \text{mL}}{1\ \text{tsp}}$ = 12.5 mL rounded to 13 mL (2 significant figures)

b. $13\ \text{mL} \times \frac{80.\ \text{mg}}{2.5\ \text{mL}}$ = 416 mg rounded to 420 mg (2 significant figures)

1.25

$0.100\ \text{mg} \times \frac{1000\ \mu\text{g}}{1\ \text{mg}} \times \frac{1\ \text{tablet}}{25\ \mu\text{g}} = 4\ \text{tablets}$

1.26

$160\ \text{mg} \times \frac{5\ \text{mL}}{100\ \text{mg}}$ = 8 mL Children's Motrin

1.27 Convert from T_C to T_F and T_K using the formulas listed in Section 1.9.

$T_F = 1.8(T_C) + 32$

$= 1.8(28.5) + 32 = 83.3\ °F$

$T_K = T_C + 273$

$= 28.5 + 273 = 302\ K$

1.28

a. $T_F = 1.8(T_C) + 32$

$= 1.8(20.) + 32 = 68\ °F$

b. $T_C = \frac{T_F - 32}{1.8}$

$= \frac{150. - 32}{1.8} = 66\ °C$

c. $T_C = T_K - 273$

$= 298 - 273 = 25\ °C$

$T_F = 1.8(T_C) + 32$

$= 1.8(25) + 32 = 77\ °F$

d. $T_K = T_C + 273$

$= 75 + 273 = 348\ K$

1.29 a. Since the densities of **A** and **B** are the same and there is a larger volume of **B,** the mass of **B** is greater than the mass of **A.**

b. The density of **A** is twice the density of **B,** but there is three times as much volume of **B** as **A,** so the mass of **B** is greater than the mass of **A.**

c. The density of **B** is greater than the density of **A** and there is a larger volume of **B,** so the mass of **B** is greater than the mass of **A.**

1.30 To convert volume (mL) to mass (g), multiply the volume by the density (g/mL).

$$10.0\ \cancel{\text{mL}} \times \frac{0.713\ \text{g}}{\cancel{\text{mL}}} = 7.13\ \text{g}$$

Milliliters cancel.

1.31 Convert pounds of lead to grams. Then use the density of lead (11.3 g/cc) to determine the volume.

$$5\ \cancel{\text{weights}} \times \frac{2.0\ \text{lb}}{1\ \cancel{\text{weight}}} \times \frac{454\ \text{g}}{1\ \cancel{\text{lb}}} \times \frac{1\ \text{cc}}{11.3\ \cancel{\text{g}}} = 402\ \text{cc}$$

4.0×10^2 cc lead

1.32

a. $$\text{specific gravity} = \frac{\text{density of a substance (g/mL)}}{\text{density of water (g/mL)}} = \frac{0.80\ \text{g/mL}}{1\ \text{g/mL}} = 0.80$$

b. $$2.3 = \frac{\text{density of a substance (g/mL)}}{1\ \text{g/mL}} \qquad \text{density} = 2.3\ \text{g/mL}$$

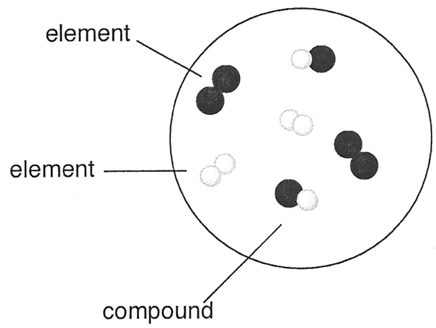
Solutions to End-of-Chapter Problems

1.33 Representation (a) is a pure element since each particle consists of a gray sphere. Representation (b) is a pure compound since each particle contains four gray spheres and one black sphere. Representation (c) is a mixture, because some of the particles contain two gray spheres, whereas others contain four gray spheres and one black sphere. Representation (d) is a mixture, because some of the particles are gray spheres, and some are blue.

1.34 Representation (d) illustrates a mixture of two elements. Representation (c) illustrates a mixture of a compound and an element.

1.35 Molecular art for an element shows spheres of one color only.
Elements: two blue spheres joined, two red spheres joined
Compounds: black sphere joined to two red spheres, red sphere joined to two gray spheres

1.36



1.37

Phase	a. Volume	b. Shape	c. Organization	d. Particle Proximity
Solid	Definite	Definite	Very organized	Very close
Liquid	Definite	Assumes shape of container	Less organized	Close
Gas	Not fixed	None	Disorganized	Far apart

1.38 A *physical property* is one that can be observed or measured without changing the chemical composition of the material, whereas a *chemical property* determines how a substance can be converted into different material(s) through a chemical reaction.

1.39 A *chemical change* converts one substance to another substance by a chemical reaction (b). A *physical change* can be observed or measured without changing the composition of the material (a and c).

1.40 a. physical change b. physical change c. chemical change

1.41 This is a physical change, because the compound CO_2 is unchanged in this transition. The same "particles" exist at the beginning and end of the process.

1.42 A chemical change has occurred. Molecules of H_2 and N_2 have been converted into molecules of NH_3 (ammonia).

1.43 a, b: The temperature on the Fahrenheit thermometer is 76.5 °F, which has three significant figures.

c. $$T_C = \frac{T_F - 32}{1.8} = \frac{76.5 - 32}{1.8} = 24.7\ ^\circ\text{C}$$

1.44 a. The length of the crayon is 4.5 cm. b. This value contains two significant figures.

c. $$4.5\text{ cm} \times \frac{1\text{ m}}{100\text{ cm}} = 4.5 \times 10^{-2}\text{ m}$$

1.45 An exact number results from counting objects or is part of a definition, such as having 20 people in a class. An inexact number results from a measurement or observation and contains some uncertainty, such as the distance from the earth to the sun, 9.3×10^7 miles.

1.46 a. 10 cloves: exact number; 2 tablespoons: inexact number
b. 5 puppies: exact number; 10 lb: inexact number
c. 4 bicycles: exact number; 250 mi: inexact number
d. 4 cm: inexact number; 12 stitches: exact number

1.47 Compare the measurements using Table 1.2. (< means *less than;* > means *greater than.*)

a. 5 mL < **5 dL** b. **10 mg** > 10 μg c. **5 cm** > 5 mm d. **10 Ms** > 10 ms

1.48 Compare the measurements using Table 1.2. (< means *less than;* > means *greater than.*)

a. **10 km** > 10 m b. **10 L** > 10 mL c. **10 g** > 10 μg d. **10 cm** > 10 mm

1.49 All nonzero digits are significant. A zero is significant only if it occurs between two nonzero digits, or at the end of a number with a decimal point. The significant figures are in **bold.**

a. **16.00**
4 significant figures
b. **160**
2 significant figures
c. 0.001 **60**
3 significant figures
d. **1,6**00,000
2 significant figures
e. **1.06**
3 significant figures
f. 0.**1600**
4 significant figures
g. **1.060** × 10^{10}
4 significant figures
h. **1.6** × 10^{-6}
2 significant figures

1.50 All nonzero digits are significant. A zero is significant only if it occurs between two nonzero digits, or at the end of a number with a decimal point. The significant figures are in **bold.**

a. **160.**
3 significant figures
b. **160.0**
4 significant figures
c. 0.000 **16**
2 significant figures
d. **1.60**
3 significant figures
e. **1,600.**
4 significant figures
f. **1.060**
4 significant figures
g. **1.600** × 10^{-10}
4 significant figures
h. **1.6** × 10^{6}
2 significant figures

1.51 When the number to be rounded off is 4 or fewer, it and all other digits to the right are dropped. When the number is 5 or greater, 1 is added to the digit to its left.

a. 25,401 = 25,400
b. 1,248,486 = 1,250,000
c. 0.001 265 982 = 0.001 27
d. 0.123 456 = 0.123
e. 195.371 = 195
f. 196.814 = 197

1.52 When the number to be rounded off is 4 or fewer, it and all other digits to the right are dropped. When the number is 5 or greater, 1 is added to the digit to its left.

a. 25,401 = 2.540 × 10^{4}
b. 1,248,486 = 1,248,000
c. 0.001 265 982 = 0.001 266
d. 0.123 456 = 0.123 5
e. 195.371 = 195.4
f. 196.814 = 196.8

1.53 The answers in problems with multiplication and division must have the same number of significant figures as the original number with the fewest significant figures. The answers in problems with addition and subtraction must have the same number of digits after the decimal point as the original number with the fewest digits after the decimal point.

a. 53.6 × 0.41 = 21.976
Since 0.41 has two significant figures, round the answer to two significant figures.
22

b. 25.825 – 3.86 = 21.965
Since 3.86 has two digits after the decimal point, round the answer to two digits after the decimal point.
21.97

c. 65.2 ÷ 12 = 5.43333
Since 12 has two significant figures, round the answer to two significant figures.
5.4

d. 41.0 + 9.135 = 50.135
Since 41.0 has one digit after the decimal point, round the answer to one digit after the decimal point.
50.1

e. 694.2 × 0.2 = 138.84
Since 0.2 has one significant figure, round the answer to one significant figure.
100

f. 1,045 – 1.26 = 1,043.74
Since 1,045 has no digits after the decimal point, round the answer to the closest whole number.
1,044

1.54 The answers in problems with multiplication and division must have the same number of significant figures as the original number with the fewest significant figures. The answers in problems with addition and subtraction must have the same number of digits after the decimal point as the original number with the fewest digits after the decimal point.

a. $49{,}682 \times 0.80 = 39{,}745.60$
Since 0.80 has two significant figures, round the answer to two significant figures.
$\mathbf{4.0 \times 10^4}$

b. $66.815 + 2.82 = 69.635$
Since 2.82 has two digits after the decimal point, round the answer to two digits after the decimal point.
69.64

c. $1{,}000 \div 2.34 = 427.35$
Since 1,000 has one significant figure, round the answer to one significant figure.
400

d. $21 - 0.88 = 20.12$
Since 21 has no digits after the decimal point, round the answer to the closest whole number.
20.

e. $25{,}000 \div 0.4356 = 57{,}392.10$
Since 25,000 has two significant figures, round the answer to two significant figures.
57,000

f. $21.5381 + 26.55 = 48.0881$
Since 26.55 has two digits after the decimal point, round the answer to two digits after the decimal point.
48.09

1.55 To write a number in scientific notation:
[1] Move the decimal point to give a number between 1 and 10.
[2] Multiply the result by 10^x, where x is the number of places the decimal point was moved.

a. 1,234 g = 1.234×10^3 g
The decimal point was moved three places to the left.
b. 0.000 016 2 m = 1.62×10^{-5} m
The decimal point was moved five places to the right.
c. 5,244,000 L = 5.244×10^6 L
The decimal point was moved six places to the left.
d. 0.005 62 g = 5.62×10^{-3} g
The decimal point was moved three places to the right.
e. 44,000 km = 4.4×10^4 km
The decimal point was moved four places to the left.

1.56 To write a number in scientific notation:
[1] Move the decimal point to give a number between 1 and 10.
[2] Multiply the result by 10^x, where x is the number of places the decimal point was moved.

a. 0.001 25 m = 1.25×10^{-3} m
The decimal point was moved three places to the right.
b. 8,100,000,000 lb = 8.1×10^9 lb
The decimal point was moved nine places to the left.
c. 54,235.6 m = 5.42356×10^4 m
The decimal point was moved four places to the left.
d. 0.000 001 899 L = 1.899×10^{-6} L
The decimal point was moved six places to the right.
e. 4,440 s = 4.44×10^3 s
The decimal point was moved three places to the left.

1.57 The exponent in 10^x tells how many places to move the decimal point in the coefficient to generate a standard number. The decimal point goes to the right when x is positive and to the left when x is negative.

a. $3.4 \times 10^8 = 340{,}000{,}000$
The decimal point was moved eight places to the right.
b. $5.822 \times 10^{-5} = 0.000\ 058\ 22$
The decimal point was moved five places to the left.
c. $3 \times 10^2 = 300$
The decimal point was moved two places to the right.
d. $6.86 \times 10^{-8} = 0.000\ 000\ 068\ 6$
The decimal point was moved eight places to the left.

1.58 The exponent in 10^x tells how many places to move the decimal point in the coefficient to generate a standard number. The decimal point goes to the right when x is positive and to the left when x is negative.

a. $4.02 \times 10^{10} = 40{,}200{,}000{,}000$
The decimal point was moved 10 places to the right.
b. $2.46 \times 10^{-3} = 0.002\ 46$
The decimal point was moved three places to the left.
c. $6.86 \times 10^9 = 6{,}860{,}000{,}000$
The decimal point was moved nine places to the right.
d. $1.00 \times 10^{-7} = 0.000\ 000\ 100$
The decimal point was moved seven places to the left.

1.59 Compare the two numbers. The number in **bold** is larger.

a. $\mathbf{4.44 \times 10^3}$ or 4.8×10^2
b. 5.6×10^{-6} or $\mathbf{5.6 \times 10^{-5}}$
c. $\mathbf{1.3 \times 10^8}$ or 52,300,000
d. $\mathbf{9.8 \times 10^{-4}}$ or 0.000 089

1.60 a. $7 \times 10^4 < 5.06 \times 10^6 < 2.5 \times 10^8$
b. $8.6 \times 10^{-6} < 2.5 \times 10^{-4} < 6.3 \times 10^{-2}$

1.61 Write the number in scientific notation.

a. 0.000 400 g of folate = 4.00×10^{-4} g
The decimal point was moved four places to the right.
b. 0.002 g of copper = 2×10^{-3} g
The decimal point was moved three places to the right.
c. 0.000 080 g of vitamin K = 8.0×10^{-5} g
The decimal point was moved five places to the right.
d. 3,400 mg of chloride = 3.4×10^3 mg
The decimal point was moved three places to the left.

1.62 Use conversion factors to solve the problem.

a. $0.40\ \cancel{\mu m} \times \dfrac{1\ m}{1 \times 10^6\ \cancel{\mu m}} = 4.0 \times 10^{-7}\ m$

b. $4.0 \times 10^{-7}\ \cancel{m} \times \dfrac{39.4\ in}{1\ \cancel{m}} = 1.6 \times 10^{-5}\ in$

1.63 The scale shows the individual has a mass of 115 lb.

$$115\ \cancel{lb} \times \frac{1\ kg}{2.20\ \cancel{lb}} = 52.3\ kg$$

1.64 The syringe contains 1.4 mL of liquid.

a. 1.4 mL

b. $1.4\ \text{mL} \times \dfrac{1\ \text{L}}{1000\ \text{mL}} = 0.0014\ \text{L} = 1.4 \times 10^{-3}\ \text{L}$

1.65 Use conversion factors to solve the problems.

a. $1.5\ \text{kg} \times \dfrac{1000\ \text{g}}{1\ \text{kg}} = 1{,}500\ \text{g}$

b. $1.5\ \text{kg} \times \dfrac{2.20\ \text{lb}}{1\ \text{kg}} = 3.3\ \text{lb}$

c. $1{,}500\ \text{g} \times \dfrac{1\ \text{oz}}{28.3\ \text{g}} = 53\ \text{oz}$

1.66 Use conversion factors to solve the problems.

a. $3.5\ \text{tablespoons} \times \dfrac{15\ \text{mL}}{1\ \text{tablespoon}} = 53\ \text{mL}$

b. $\dfrac{53\ \text{mL}}{\text{dosage}} \times \dfrac{4\ \text{dosages}}{\text{day}} \times \dfrac{7\ \text{days}}{1\ \text{week}} \times 1\ \text{week} = 1.5 \times 10^{3}\ \text{mL}$

c. $1.5 \times 10^{3}\ \text{mL} \times \dfrac{1\ \text{liter}}{1000\ \text{mL}} = 1.5\ \text{L}$

1.67 Use conversion factors to solve the problems.

a. $300\ \text{g} \times \dfrac{1000\ \text{mg}}{1\ \text{g}} = 300{,}000\ \text{mg}$

b. $2\ \text{L} \times \dfrac{1{,}000{,}000\ \mu\text{L}}{1\ \text{L}} = 2{,}000{,}000\ \mu\text{L}$

c. $5.0\ \text{cm} \times \dfrac{1\ \text{m}}{100\ \text{cm}} = 0.050\ \text{m}$

d. $300\ \text{g} \times \dfrac{1\ \text{oz}}{28.3\ \text{g}} =$ 10.60 oz = **10 oz** rounded to one significant figure

e. $2\ \text{ft} \times \dfrac{12\ \text{in.}}{1\ \text{ft}} \times \dfrac{1\ \text{m}}{39.4\ \text{in.}} =$ 0.6091 m = **0.6 m** rounded to one significant figure

f. $3.5\ \text{yd} \times \dfrac{3\ \text{ft}}{1\ \text{yd}} \times \dfrac{12\ \text{in.}}{1\ \text{ft}} \times \dfrac{1\ \text{m}}{39.4\ \text{in.}} =$ 3.198 m = **3.2 m** rounded to two significant figures

1.68 Use conversion factors to solve the problem.

a. $25\ \mu L \times \frac{1\ L}{1 \times 10^6\ \mu L} \times \frac{1000\ mL}{1\ L} = 2.5 \times 10^{-2}\ mL$

b. $35\ kg \times \frac{1000\ g}{1\ kg} = 3.5 \times 10^4\ g$

c. $2.36\ mL \times \frac{1\ L}{1000\ mL} = 2.36 \times 10^{-3}\ L$

d. $300\ mL \times \frac{1\ qt}{946\ mL} = 0.3\ qt$

e. $3\ cups \times \frac{1\ qt}{4\ cups} \times \frac{946\ mL}{1\ qt} \times \frac{1\ L}{1000\ mL} = 0.7\ L$

f. $2.5\ tons \times \frac{2000\ lb}{1\ ton} \times \frac{454\ g}{1\ lb} \times \frac{1\ kg}{1000\ g} = 2.3 \times 10^3\ kg$

1.69 Use conversion factors to solve the problems.

a. $50.\ in. \times \frac{2.54\ cm}{1\ in.} =$ 127 cm = **130 cm** rounded to two significant figures

b. $3.0\ pints \times \frac{1\ qt}{2\ pints} \times \frac{1\ L}{1.06\ qt} =$ 1.415 L = **1.4 L** rounded to two significant figures

c. $T_F = 1.8(T_C) + 32$

$= 1.8(37.7) + 32 = 99.9\ °F$

1.70 Use conversion factors to solve the problems.

a. $53.2\ kg \times \frac{2.20\ lb}{kg} = 117\ lb$

b. $5.0\ qt \times \frac{32\ fl\ oz.}{1\ qt} \times \frac{29.6\ mL}{1\ fl\ oz.} = 4.7 \times 10^3\ mL$

c. $T_c = \frac{T_F - 32}{1.8} = \frac{103.5\ °F - 32}{1.8} = 39.7\ °C$

1.71 Use conversion factors to solve the problems.

a. $1\ qt \times \frac{946\ mL}{1\ qt} =$ **946 mL** rounded to three significant figures

b. $1\ L \times \frac{1.06\ qt}{1\ L} \times \frac{32\ fl\ oz}{1\ qt} =$ 33.92 fl oz = **33.9 fl oz** rounded to three significant figures

1.72 Use conversion factors to solve the problem.

$12.4\ gal \times \frac{4\ qt}{1\ gal} \times \frac{946\ mL}{1\ qt} = 4.69 \times 10^4\ mL$

1.73 Convert from T_C to T_F and T_K using the formulas listed in Section 1.9.

a. $T_F = 1.8(T_C) + 32 = 1.8(53) + 32 = 127\ °F$

$T_K = T_C + 273 = 53 + 273 = 326\ K$

b. $T_C = \dfrac{T_F - 32}{1.8} = \dfrac{350. - 32}{1.8} = 177\ °C$

$T_K = T_C + 273 = 177 + 273 = 450.\ K$

1.74 Convert from T_C to T_F and T_F to T_C using the formulas listed in Section 1.9.

a. $T_F = 1.8(T_C) + 32 = 1.8(15) + 32 = 59\ °F$

b. $T_C = \dfrac{T_F - 32}{1.8} = \dfrac{-128.6 - 32}{1.8} = -89.2\ °C$

1.75 Convert the temperatures to a common unit to compare.

a. $T_C = \dfrac{T_F - 32}{1.8} = \dfrac{10 - 32}{1.8} = -12\ °C < \mathbf{-10\ °C}$

(−12 °C ← 10 °F; −10 °C: higher temperature)

b. $T_C = \dfrac{T_F - 32}{1.8} = \dfrac{-50 - 32}{1.8} = \mathbf{-45\ °C} > -50\ °C$

(−45 °C ← −50 °F; −45 °C: higher temperature)

1.76 a. 0 K < 0 °F < 0 °C   b. 100 K < 100 °F < 100 °C

1.77 a. Hexane is *less* dense than water, so 50 mL of hexane will be above the 100 mL of water.
b. Dichloromethane is *more* dense than water, so the 100 mL of water will be on top of the 50 mL of dichloromethane.

1.78 a. The density of the liquid in beaker **A** is less than 2.0 g/cc.
b. The density of the liquid in beaker **B** is greater than 0.90 g/cc.

1.79

$$\frac{122\ \text{g}}{121\ \text{mL}} = 1.01\ \text{g/mL}$$

1.80 Calculate the volume of water using the density of water; use that volume to calculate the density of the saline.

$$24.5\ \cancel{\text{g}} \times \frac{1\ \text{mL}}{1.00\ \cancel{\text{g}}} = 24.5\ \text{mL} \qquad \frac{25.6\ \text{g}}{24.5\ \text{mL}} = 1.04\ \text{g/mL}$$

1.81

$$1\ \text{qt} \times \frac{946\ \text{mL}}{1\ \text{qt}} \times \frac{1.03\ \text{g}}{1\ \text{mL}} \times \frac{1\ \text{kg}}{1000\ \text{g}} = 0.974\ 38\ \text{kg} = \mathbf{0.974\ kg}$$

1.82

$$1\ \text{gal} \times \frac{4\ \text{qt}}{1\ \text{gal}} \times \frac{946\ \text{mL}}{1\ \text{qt}} \times \frac{0.66\ \text{g}}{\text{mL}} \times \frac{1\ \text{kg}}{1000\ \text{g}} = 2.497\ \text{kg} = \mathbf{2.5\ kg}$$

1.83 The density of a substance determines whether it floats or sinks in a liquid. The less dense liquid is the upper layer. The density of water is 1.0 g/mL.

a. heptane
(0.684 g/mL < 1.0 g/mL)

b. olive oil
(0.92 g/mL < 1.0 g/mL)

c. water
(1.0 g/mL < 1.49 g/mL)

d. water
(1.0 g/mL < 1.59 g/mL)

1.84

a. $$\text{specific gravity} = \frac{\text{density of mercury (g/mL)}}{\text{density of water (g/mL)}} = \frac{13.6\ \text{g/mL}}{1\ \text{g/mL}} = 13.6$$

b. $$0.789 = \frac{\text{density of ethanol (g/mL)}}{1\ \text{g/mL}}$$ density = 0.789 g/mL

1.85 Use conversion factors to solve the problems.

a. $$\frac{186\ \text{mg}}{\text{dL}} \times \frac{1\ \text{g}}{1000\ \text{mg}} = 0.186\ \text{g/dL}$$

b. $$\frac{186\ \text{mg}}{\text{dL}} \times \frac{10\ \text{dL}}{1\ \text{L}} = 1{,}860\ \text{mg/L}$$

1.86 Use conversion factors to solve the problems.

a. $$\frac{15.5\ \text{g}}{\text{dL}} \times \frac{1000\ \text{mg}}{1\ \text{g}} = 1.55 \times 10^4\ \frac{\text{mg}}{\text{dL}}$$

b. $$\frac{15.5\ \text{g}}{\text{dL}} \times \frac{1 \times 10^6\ \mu\text{g}}{1\ \text{g}} = 1.55 \times 10^7\ \frac{\mu\text{g}}{\text{dL}}$$

1.87

$$1.5\ \text{g} \times \frac{1000\ \text{mg}}{1\ \text{g}} \times \frac{1\ \text{tablet}}{500\ \text{mg}} = 3\ \text{tablets}$$

1.88

$$1.8\ \text{L} \times \frac{1000\ \text{mL}}{1\ \text{L}} \times \frac{1.05\ \text{g}}{1\ \text{mL}} \times \frac{1\ \text{kg}}{1000\ \text{g}} = 1.9\ \text{kg}$$

70.7 kg + 1.9 kg = 72.6 kg; 72.6 kg – 69.3 kg = **3.3 kg sweat lost**

$$3.3\ \text{kg} \times \frac{2.20\ \text{lb}}{1\ \text{kg}} = \mathbf{7.3\ lb}$$

1.89

a. $2.0\text{ L} \times \frac{1000\text{ mL}}{1\text{ L}} \times \frac{0.94\text{ g}}{1\text{ mL}} \times \frac{1\text{ kg}}{1000\text{ g}} = 1.9\text{ kg}$

b. $1.9\text{ kg} \times \frac{2.20\text{ lb}}{1\text{ kg}} = 4.2\text{ lb}$

1.90

$13.0\text{ oz} \times \frac{250\text{ mg}}{1\text{ oz}} \times \frac{1\text{ g}}{1000\text{ mg}} = 3.25\text{ g of sodium}$

3.25 g – 2.4 g = 0.9 g more sodium than recommended daily value

1.91

a. $\frac{20\text{ mL}}{1\text{ dose}} \times \frac{\$10.00}{300.\text{ mL}} = \frac{\$0.67}{\text{dose}}$

b. 2 tablespoons = 30. mL

$\frac{30\text{ mL}}{1\text{ dose}} \times \frac{\$10.00}{300.\text{ mL}} = \frac{\$1.00}{\text{dose}}$

1.92

a. $1.93\text{ mg} \times \frac{1\text{ g}}{1000\text{ mg}} = 1.93 \times 10^{-3}\text{ g}$ $1.93 \times 10^{-3}\text{ g} \times \frac{1{,}000{,}000\ \mu\text{g}}{1\text{ g}} = 1.93 \times 10^{3}\ \mu\text{g}$

b. $20\text{ cigarettes} \times \frac{1.93\text{ mg}}{\text{cigarette}} = 38.6\text{ mg}$ 38.6 mg > 21mg ; the smoker will get less nicotine from the patch

1.93

2 tablets x 325 mg/tablet = 650. mg

$0.510\text{ kg} \times \frac{1000\text{ g}}{1\text{ kg}} \times \frac{1000\text{ mg}}{1\text{ g}} \times \frac{1\text{ dose}}{650.\text{ mg}} = 784.6 = 784\text{ full doses}$

1.94

$\frac{4\text{ times}}{\text{day}} \times \frac{2\text{ tsp}}{\text{time}} \times \frac{5.0\text{ mL}}{1\text{ tsp}} \times \frac{400.\text{ mg Al(OH)}_3}{5.0\text{ mL}} \times \frac{1\text{ g}}{1000\text{ mg}} = 3.2\text{ g Al(OH)}_3$

$\frac{4\text{ times}}{\text{day}} \times \frac{2\text{ tsp}}{\text{time}} \times \frac{5.0\text{ mL}}{1\text{ tsp}} \times \frac{400.\text{ mg Mg(OH)}_2}{5.0\text{ mL}} \times \frac{1\text{ g}}{1000\text{ mg}} = 3.2\text{ g Mg(OH)}_2$

$\frac{4\text{ times}}{\text{day}} \times \frac{2\text{ tsp}}{\text{time}} \times \frac{5.0\text{ mL}}{1\text{ tsp}} \times \frac{40.\text{ mg simethicone}}{5.0\text{ mL}} \times \frac{1\text{ g}}{1000\text{ mg}} = 0.32\text{ g simethicone}$

1.95

$4\text{ times} \times \frac{2.0\text{ g}}{\text{time}} \times \frac{1000\text{ mg}}{1\text{ g}} \times \frac{1\text{ tablet}}{500.\text{ mg}} = 16\text{ tablets}$

1.96

a. $20.\ \text{min} \times \frac{1\ \text{h}}{60\ \text{min}} \times \frac{150\ \text{mL}}{1\ \text{h}} = 50.\ \text{mL}$

b. $90.\ \text{mL} \times \frac{1\ \text{h}}{150\ \text{mL}} \times \frac{60\ \text{min}}{1\ \text{h}} = 36\ \text{min}$

c. $600.\ \text{mL} \times \frac{1\ \text{h}}{150\ \text{mL}} \times \frac{60\ \text{min}}{1\ \text{h}} = 240\ \text{min}$

d. $2.0\ \text{g} \times \frac{1000\ \text{mg}}{1\ \text{g}} \times \frac{1\ \text{mL}}{90.\ \text{mg}} \times \frac{1\ \text{h}}{150\ \text{mL}} \times \frac{60\ \text{min}}{1\ \text{h}} = 8.9\ \text{min}$

1.97

$\frac{2.0\ \text{mg}}{1\ \text{kg}} \times \frac{1\ \text{kg}}{2.20\ \text{lb}} \times 110\ \text{lb} = 1.0 \times 10^2\ \text{mg}$

1.98

$28\ \text{kg} \times \frac{10\ \text{mg}}{\text{kg dose}} \times \frac{3\ \text{doses}}{\text{day}} \times 7\ \text{days} \times \frac{1\ \text{g}}{1000\ \text{mg}} = 5.9\ \text{g}$

1.99 Convert mass and height to kg and m, respectively. Use the formula, BMI = kg/m^2, to solve the problem.

$180\ \text{lb} \times \frac{1\ \text{kg}}{2.20\ \text{lb}} = 82\ \text{kg}$

6 ft 1 in. = 73 in.

$73\ \text{in.} \times \frac{1\ \text{m}}{39.4\ \text{in.}}\ \ 1.9\ \text{m}$

$\text{BMI} = \frac{\text{kg}}{\text{m}^2} = \frac{82}{(1.9)^2} = \frac{82}{3.61} = 23$

The BMI is in the normal range.

1.100

a. $150.\ \text{lb} \times \frac{1\ \text{kg}}{2.20\ \text{lb}} = 68.2\ \text{kg}$ $\qquad 3\ \text{tablets} \times \frac{200.\ \text{mg}}{1\ \text{tablet}} = 600.\ \text{mg}$

$\frac{600.\ \text{mg}}{68.2\ \text{kg}} = 8.80\ \text{mg/kg}$

b. $45\ \text{kg} \times \frac{8.80\ \text{mg}}{1\ \text{kg}} = 4.0 \times 10^2\ \text{mg}$

1.101

$42\ \text{lb} \times \frac{1\ \text{kg}}{2.20\ \text{lb}} \times \frac{10\ \text{mg}}{1\ \text{kg}} \times \frac{1\ \text{tablet}}{80\ \text{mg}} = 2.4 =$ **2 tablets**

1.102

160 mg + 4(80. mg) = 480 mg — amount of dosage from tablets

3.2 mg/kg + 4(1.6 mg/kg) = 9.6 mg/kg — amount of dosage from injection

a. 40. kg x 9.6 mg/kg = 3.8×10^2 mg — tablet form gives higher dosage

b. 100. kg x 9.6 mg/kg = 9.6×10^2 mg — injections give higher dosage

1.103

$$1.5\ \text{tsp} \times \frac{5.0\ \text{mL}}{1\ \text{tsp}} \times \frac{100.\ \text{mg}}{5\ \text{mL}} \times \frac{1\ \text{g}}{1000\ \text{mg}} = 0.15\ \text{g}$$

1.104

$$200\ \text{lb} \times \frac{1\ \text{kg}}{2.20\ \text{lb}} \times \frac{10\ \mu\text{g}}{1\ \text{kg}} \times \frac{1\ \text{mg}}{1000\ \mu\text{g}} = 0.909\ \text{mg} = \mathbf{0.9\ mg}$$