1 Chemical Tools: Experimentation and Measurement

1.1 5.0×10^{-8} m; 5.0×10^{-8} m = 50×10^{-9} m = 50 nm

1.2 (a) 7×10^{-5} m (b) 2×10^{13} kg

1.3 $°C = \frac{5}{9} \times (°F - 32) = \frac{5}{9} \times (1474 - 32) = 801\ °C$

$K = °C + 273.15 = 801 + 273.15 = 1074.15$ K or 1074 K

1.4 The melting point of gallium is converted from 302.91 K to °F for comparison.

$°C = K - 273.15 = 302.91 - 273.15 = 29.76\ °C$

$°F = (\frac{9}{5} \times °C) + 32 = (\frac{9}{5} \times 29.76) + 32 = 85.57\ °F$

The temperature in the compartment (88 °F) is above the melting point, so the liquid state exists.

1.5 $\text{Volume} = 9.37\ g \times \frac{1\ mL}{1.483\ g} = 6.32\ mL$

1.6 Bracelet mass = 80.0 g

Bracelet volume = 17.61 mL – 10.0 mL = 7.61 mL

$\text{Bracelet density} = \frac{80.0\ g}{7.61\ mL} = 10.5\ g/mL$

The density of the bracelet matches the density of silver. Since density is one way to identify an unknown substance, it is likely that the bracelet is made of pure silver.

1.7 6.6×10^{-24} g = 6.6×10^{-27} kg

$E_K = \frac{1}{2}mv^2 = \frac{1}{2}(6.6 \times 10^{-27}\ kg)\left(\frac{1.5 \times 10^7\ m}{s}\right)^2 = 7.4 \times 10^{-13}\ \frac{kg \cdot m^2}{s^2} = 7.4 \times 10^{-13}\ J$

1.8 450 g = 0.450 kg; $E_K = 406\ J = 406\ \frac{kg \cdot m^2}{s^2}$

$E_K = \frac{1}{2}mv^2$

$v = \sqrt{\frac{2 \times E_K}{m}} = \sqrt{\frac{2 \times 406\ kg \cdot m^2/s^2}{0.450\ kg}} = 42.5\ m/s$

1.9 (a) 0.003 00 mL has 3 significant figures because zeros at the beginning of a number are not significant and zeros at the end of a number and after the decimal point are always significant.
(b) 2070 mi has 3 or 4 significant figures because a zero in the middle of a number is significant and a zero at the end of a number and before the decimal point may or may not be significant.
(c) 47.60 mL has 4 significant figures because a zero at the end of a number and after the decimal point is always significant.

1.10 To indicate the uncertainty in a measurement, the value you record should use all the digits you are sure of plus one additional digit that you estimate. The volume can be read to the tenths place and therefore the hundredths place should be estimated. The volume reported to the correct number of significant figures is 4.55 mL.

1.11 In figure (c) darts are scattered (low precision) and are away from the bull's-eye (low accuracy).

1.12 The three measurements are 0.7783 g, 0.7780 g, and 0.7786 g. There is little variation between the three measurements so they have fairly high precision. However, the measurements are all lower than the true value and therefore, the accuracy is low.

1.13 (a)

$$\begin{array}{r} 24.567\ \ \ \ \ \text{g} \\ +\ \ 0.044\ 78\ \text{g} \\ \hline 24.611\ 78\ \text{g} \end{array}$$

This result should be expressed with 3 decimal places. Because the digit to be dropped (7) is greater than 5, round up. The result is 24.612 g (5 significant figures).

(b) 4.6742 g / 0.003 71 L = 1259.89 g/L
0.003 71 has only 3 significant figures so the result of the division should have only 3 significant figures. Because the digit to be dropped (first 9) is greater than 5, round up. The result is 1260 g/L (3 significant figures), or 1.26×10^3 g/L.

1.14 NaCl mass = 36.2365 g – 35.6783 g = 0.5582 g
NaCl concentration = 0.5582 g/25.0 mL = 0.0223 g/mL = 2.23×10^{-2} g/mL

1.15 1 carat = 200 mg = 200×10^{-3} g = 0.200 g

Mass of Hope Diamond in grams = $44.4 \text{ carats} \times \dfrac{0.200 \text{ g}}{1 \text{ carat}} = 8.88 \text{ g}$

1 ounce = 28.35 g

Mass of Hope Diamond in ounces = $8.88 \text{ g} \times \dfrac{1 \text{ ounce}}{28.35 \text{ g}} = 0.313 \text{ ounces}$

1.16 Volume of Hope Diamond = $8.88 \text{ g} \times \dfrac{1 \text{ cm}^3}{3.52 \text{ g}} = 2.52 \text{ cm}^3$

1.17 area = $1.08 \times 10^4 \text{ m}^2 \times \left(\dfrac{3.28 \text{ ft}}{1 \text{ m}}\right)^2 = 1.16 \times 10^5 \text{ ft}^2$

1.18 Volume of a cylinder = $\pi r^2 h$
Cell radius = 6×10^{-6} m/2 = 3×10^{-6} m
Cell volume = $\pi(3 \times 10^{-6}\ m)^2(2 \times 10^{-6}\ m) = 6 \times 10^{-17}\ m^3$

$$\text{Cell volume} = 6 \times 10^{-17}\ m^3 \times \left(\frac{1\ cm}{1 \times 10^{-2}\ m}\right)^3 = 6 \times 10^{-11}\ cm^3 = 6 \times 10^{-11}\ mL$$

$$\text{Cell volume} = 6 \times 10^{-11}\ mL \times \frac{1 \times 10^{-3}\ L}{1\ mL} = 6 \times 10^{-14}\ L = 0.06 \times 10^{-12}\ L = 0.06\ pL$$

1.19 Only (b), a cell.

1.20 Both (c), a virus, and (d), a molecule.

1.21 The diameter of a human hair (~1×10^{-5} m) is approximately 1,000 times larger than the diameter of a 10 nm nanoparticle. (b) A red blood cell (~1×10^{-6} m) is approximately 10,000 times larger than a glucose molecule (1×10^{-10} m).

1.22 (a), (b) and (c)

1.23 (a)

1.24 radius = 5.0 nm/2 = 2.5 nm = 2.5×10^{-9} m = 0.0025×10^{-6} m = 0.0025 μm
(a) SA = $4\pi r^2 = 4\pi(0.0025\ \mu m)^2 = 7.9 \times 10^{-5}\ \mu m^2$

(b) Volume = $\frac{4}{3}\pi r^3 = \frac{4}{3}\pi(0.0025\ \mu m)^3 = 6.5 \times 10^{-8}\ \mu m^3$

(c) $$\frac{SA}{Volume} = \frac{7.9 \times 10^{-5}\ \mu m^2}{6.5 \times 10^{-8}\ \mu m^3} = 1{,}200\ \mu m^{-1}$$

(d) 1,200 μm^{-1}/0.6 μm^{-1} = 2,000 times

1.25 (a) An atom on the surface of a nanoparticle is more reactive.

1.26 Assume that individual atoms pack as cubes in the nanoparticle.
5.0 nm = 5.0×10^{-9} m; 10.0 nm = 10.0×10^{-9} m; 250 pm = 250×10^{-12} m
Atom volume = $(250 \times 10^{-12}\ m)^3 = 1.6 \times 10^{-29}\ m^3$
(a) Particle volume = $(5.0 \times 10^{-9}\ m)^3 = 1.3 \times 10^{-25}\ m^3$

$$\text{Atoms/particle} = \frac{\text{particle volume}}{\text{atom volume}} = \frac{1.3 \times 10^{-25}\ m^3/\text{particle}}{1.6 \times 10^{-29}\ m^3/\text{atom}} = 8125\ \text{atoms/particle}$$

Atom face area = $(250 \times 10^{-12}\ m)^2 = 6.25 \times 10^{-20}\ m^2$
Particle face area = $(5.0 \times 10^{-9}\ m)^2 = 2.5 \times 10^{-17}\ m^2$

$$\text{Atoms/particle face} = \frac{\text{particle face area}}{\text{atom face area}} = \frac{2.5 \times 10^{-17}\ m^2/\text{particle}}{6.25 \times 10^{-20}\ m^2/\text{atom}} = 400\ \text{atoms/particle face}$$

$$\%\ \text{atoms on surface} = \frac{(6\ \text{faces})(400\ \text{atoms/face})}{8125\ \text{atoms}} \times 100 = 30\%$$

(b) Particle volume = $(10.0 \times 10^{-9}\ m)^3 = 1.0 \times 10^{-24}\ m^3$

$$\text{Atoms/particle} = \frac{\text{particle volume}}{\text{atom volume}} = \frac{1.0 \times 10^{-24}\ m^3/\text{particle}}{1.6 \times 10^{-29}\ m^3/\text{atom}} = 62{,}500\ \text{atoms/particle}$$

Atom face area = $(250 \times 10^{-12}\ m)^2 = 6.25 \times 10^{-20}\ m^2$

Particle face area = $(10.0 \times 10^{-9}\ m)^2 = 1.0 \times 10^{-16}\ m^2$

$$\text{Atoms/particle face} = \frac{\text{particle face area}}{\text{atom face area}} = \frac{1.0 \times 10^{-16}\ m^2/\text{particle}}{6.25 \times 10^{-20}\ m^2/\text{atom}} = 1{,}600\ \text{atoms/particle face}$$

$$\%\ \text{atoms on surface} = \frac{(6\ \text{faces})(1{,}600\ \text{atoms/face})}{62{,}500\ \text{atoms}} \times 100\% = 15\%$$

Conceptual Problems

1.27 For balance (a), the mass of the red block is greater than the mass of the green block. The volume of the red block is less than the volume of the green block.

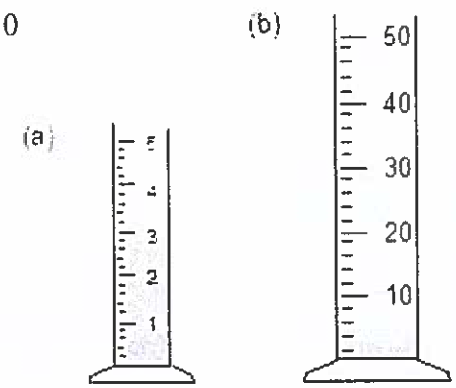
Because density $= \frac{\text{mass}}{\text{volume}}$, the red block is more dense.

For balance (b), the mass of the green block is greater than the mass of the red block. The volume of both blocks is the same. Because density $= \frac{\text{mass}}{\text{volume}}$, the green block is more dense.

1.28 The level of the liquid in the thermometer is just past the 32 °C mark on the thermometer. The temperature is 32.2°C (3 significant figures).

1.29 (a) 32.0 mL (3 significant figures) (b) 2.72 cm (3 significant figures)

1.30



The 5 mL graduated cylinder is marked every 0.2 mL and can be read to ± 0.02 mL. The 50 mL graduated cylinder is marked every 2 mL and can only be read to ± 0.2 mL. The 5 mL graduated cylinder will give more accurate measurements.

1.31 A liquid that is less dense than another will float on top of it. The most dense liquid is mercury, and it is at the bottom of the cylinder. Because water is less dense than mercury but more dense than vegetable oil, it is the middle liquid in the cylinder. Vegetable oil is the least dense of the three liquids and is the top liquid in the cylinder.

Section Problems

Scientific Method (Section 1.1)

1.32 (a) experiment (b) hypothesis (c) observation

1.33 (a) hypothesis (b) observation (c) experiment

1.34 (a), (b) and (d) are quantitative. (c) and (e) are qualitative.

1.35 (b) and (d) are quantitative. (a) and (c) are qualitative.

1.36 A theory.

1.37 (c) is the correct statement.

SI Units and Scientific Notation (Section 1.2)

1.38 (a) kilogram, kg (b) meter, m (c) kelvin, K
(d) cubic meter, m^3 (e) joule, $(kg \cdot m^2)/s^2$ (f) kg/m^3 or g/cm^3

1.39

Prefix	Abbreviation	Exponential Factor
mega	M	10^6
micro	μ	10^{-6}
kilo	k	10^3
mili	m	10^{-3}
nano	n	10^{-9}
giga	G	10^9
pico	p	10^{-12}

1.40 (a) 1 km = 10^3 m = 1000 m (b) 1m = 10^{-3} km = 0.001 km
(c) 1mmol = 10^{-3} mol = 0.001 mol (d) 1 mol = 10^3 mmol = 1000 mmol

1.41 (a) 1 L = 10^3 mL = 1000 mL (b) 1 mL = 10^{-3} L = 0.001 L
(c) 1 L = 10^9 nL = 1,000,000,000 nL (d) 1 nL = 10^{-9} L = 0.000 000 001 L

1.42 cL is centiliter (10^{-2} L)

1.43 (a) Convert cm to km and compare the two quantities.

$$5.63 \times 10^6 \text{ cm} \times \frac{1 \times 10^{-2}\text{ m}}{1\text{ cm}} \times \frac{1\text{ km}}{1{,}000\text{ m}} = 5.63 \times 10^1 \text{ km}$$

6.02×10^1 km is larger.

(b) Convert μs to ms and compare the two quantities.

$$46\ \mu\text{s} \times \frac{1 \times 10^{-6}\text{ s}}{1\ \mu\text{s}} \times \frac{1\text{ ms}}{1 \times 10^{-3}\text{ s}} = 4.6 \times 10^{-2}\text{ ms}$$

46 μs is larger.

(c) Convert g to kg and compare the two quantities.

$$200{,}098\text{ g} \times \frac{1\text{ kg}}{1000\text{ g}} = 20.0098 \times 10^1\text{ kg}$$

200,098 g is larger.

1.44 (a) Convert pm to cm and compare the two quantities.

$$154\text{ pm} \times \frac{1 \times 10^{-12}\text{ m}}{1\text{ pm}} \times \frac{1\text{ cm}}{1 \times 10^{-2}\text{ m}} = 15.4 \times 10^{-9}\text{ cm}$$

7.7×10^{-9} cm is smaller.

(b) Convert μm to km and compare the two quantities.

$$1.86 \times 10^{11}\ \mu\text{m} \times \frac{1 \times 10^{-6}\text{ m}}{1\ \mu\text{m}} \times \frac{1\text{ km}}{1000\text{ m}} = 1.86 \times 10^2\text{ km}$$

1.86×10^{11} μm is smaller.

(c) Convert GA to μA and compare the two quantities.

$$2.9\text{ GA} \times \frac{1 \times 10^9\text{ A}}{1\text{ GA}} \times \frac{1\ \mu\text{A}}{1 \times 10^{-6}\text{ A}} = 2.9 \times 10^{15}\ \mu\text{A}$$

2.9 GA is smaller.

1.45 $1\text{ mg} = 1 \times 10^{-3}\text{ g}$ and $1\text{ pg} = 1 \times 10^{-12}\text{ g}$

$$\frac{1 \times 10^{-3}\text{ g}}{1\text{ mg}} \times \frac{1\text{ pg}}{1 \times 10^{-12}\text{ g}} = 1 \times 10^9\text{ pg/mg}$$

$35\text{ ng} = 35 \times 10^{-9}\text{ g}$

$$\frac{35 \times 10^{-9}\text{ g}}{35\text{ ng}} \times \frac{1\text{ pg}}{1 \times 10^{-12}\text{ g}} = 3.5 \times 10^4\text{ pg/35 ng}$$

1.46 $1\ \mu\text{L} = 10^{-6}\text{ L}$

$$\frac{1\ \mu\text{L}}{10^{-6}\text{ L}} = 10^6\ \mu\text{L/L}$$

$20\text{ mL} = 20 \times 10^{-3}\text{ L}$

$$\frac{20 \times 10^{-3}\text{ L}}{20\text{ mL}} \times \frac{1\ \mu\text{L}}{10^{-6}\text{ L}} = 2 \times 10^4\ \mu\text{L/20 mL}$$

1.47 (a) $5\text{ pm} = 5 \times 10^{-12}\text{ m}$

$$5 \times 10^{-12}\text{ m} \times \frac{1\text{ cm}}{1 \times 10^{-2}\text{ m}} = 5 \times 10^{-10}\text{ cm}$$

$$5 \times 10^{-12}\text{ m} \times \frac{1\text{ nm}}{1 \times 10^{-9}\text{ m}} = 5 \times 10^{-3}\text{ nm}$$

(b) $8.5\ \text{cm}^3 \times \left(\dfrac{1 \times 10^{-2}\ \text{m}}{1\ \text{cm}}\right)^3 = 8.5 \times 10^{-6}\ \text{m}^3$

$8.5\ \text{cm}^3 \times \left(\dfrac{10\ \text{mm}}{1\ \text{cm}}\right)^3 = 8.5 \times 10^3\ \text{mm}^3$

(c) $65.2\ \text{mg} \times \dfrac{1 \times 10^{-3}\ \text{g}}{1\ \text{mg}} = 0.0652\ \text{g}$

$65.2\ \text{mg} \times \dfrac{1 \times 10^{-3}\ \text{g}}{1\ \text{mg}} \times \dfrac{1\ \text{pg}}{1 \times 10^{-12}\ \text{g}} = 6.52 \times 10^{10}\ \text{pg}$

1.48 (a) To convert 453.32 mg to scientific notation, move the decimal point 2 places to the left and include an exponent of 10^2. The result is 4.5332×10^2 mg.
(b) To convert 0.000 042 1 mL to scientific notation, move the decimal point 5 places to the right and include an exponent of 10^{-5}. The result is 4.21×10^{-5} mL.
(c) To convert 667,000 g to scientific notation, move the decimal point 5 places to the left and include an exponent of 10^5. The result is 6.67×10^5 g.

1.49 (a) Because the exponent is a negative 3, move the decimal point 3 places to the left to get 0.003 221 mm.
(b) Because the exponent is a positive 5, move the decimal point 5 places to the right to get 894,000 m.
(c) Because the exponent is a negative 12, move the decimal point 12 places to the left to get 0.000 000 000 001 350 82 m^3.
(d) Because the exponent is a positive 2, move the decimal point 2 places to the right to get 641.00 km.

Measurement of Mass, Length, and Temperature (Sections 1.3–1.5)

1.50 (b) 0.2500

1.51 nano, n (52 nm)

1.52 A Celsius degree is larger than a Fahrenheit degree by a factor of $\frac{9}{5}$.

1.53 A kelvin and Celsius degree are the same size.

1.54 $^\circ\text{F} = (\frac{9}{5} \times {}^\circ\text{C}) + 32$

$^\circ\text{F} = (\frac{9}{5} \times 39.9^\circ\text{C}) + 32 = 103.8\ ^\circ\text{F}$ (goat)

$^\circ\text{F} = (\frac{9}{5} \times 22.2^\circ\text{C}) + 32 = 72.0\ ^\circ\text{F}$ (Australian spiny anteater)

1.55 For Hg: mp is $\left[\frac{9}{5} \text{ x } (-38.87)\right] + 32 = -37.97\ ^\circ\text{F}$

For Br_2: mp is $\left[\frac{9}{5} \text{ x } (-7.2)\right] + 32 = 19.0\ ^\circ\text{F}$

For Cs: mp is $\left[\frac{9}{5} \text{ x } (28.40)\right] + 32 = 83.12\ ^\circ\text{F}$

For Ga: mp is $\left[\frac{9}{5} \text{ x } (29.78)\right] + 32 = 85.60\ ^\circ\text{F}$

1.56 $^\circ\text{F} = (\frac{9}{5} \text{ x } ^\circ\text{C}) + 32 = (\frac{9}{5} \text{ x } 175) + 32 = 347\ ^\circ\text{F}$

1.57 $^\circ\text{C} = \frac{5}{9} \text{ x } (^\circ\text{F} - 32) = \frac{5}{9} \text{ x } (6192 - 32) = 3422\ ^\circ\text{C}$

$\text{K} = ^\circ\text{C} + 273.15 = 3422 + 273.15 = 3695.15 \text{ K or } 3695 \text{ K}$

1.58

Ethanol boiling point	78.5 °C	173.3 °F	200 °E
Ethanol melting point	–117.3 °C	–179.1 °F	0 °E

(a) $\frac{200\ ^\circ\text{E}}{[78.5\ ^\circ\text{C} - (-117.3\ ^\circ\text{C})]} = \frac{200\ ^\circ\text{E}}{195.8\ ^\circ\text{C}} = 1.021\ ^\circ\text{E}/^\circ\text{C}$

(b) $\frac{200\ ^\circ\text{E}}{[173.3\ ^\circ\text{F} - (-179.1\ ^\circ\text{F})]} = \frac{200\ ^\circ\text{E}}{352.4\ ^\circ\text{F}} = 0.5675\ ^\circ\text{E}/^\circ\text{F}$

(c) $^\circ\text{E} = \frac{200}{195.8} \text{ x } (^\circ\text{C} + 117.3)$

H_2O melting point = 0°C; $^\circ\text{E} = \frac{200}{195.8} \text{ x } (0 + 117.3) = 119.8\ ^\circ\text{E}$

H_2O boiling point = 100°C; $^\circ\text{E} = \frac{200}{195.8} \text{ x } (100 + 117.3) = 222.0\ ^\circ\text{E}$

(d) $^\circ\text{E} = \frac{200}{352.4} \text{ x } (^\circ\text{F} + 179.1) = \frac{200}{352.4} \text{ x } (98.6 + 179.1) = 157.6\ ^\circ\text{E}$

(e) $^\circ\text{F} = \left(^\circ\text{E} \text{ x } \frac{352.4}{200}\right) - 179.1 = \left(130 \text{ x } \frac{352.4}{200}\right) - 179.1 = 50.0\ ^\circ\text{F}$

Because the outside temperature is 50.0°F, I would wear a sweater or light jacket.

1.59

NH_3 boiling point	–33.4 °C	–28.1 °F	100 °A
NH_3 melting point	–77.7 °C	–107.9 °F	0° A

(a) $\frac{100\ ^\circ\text{A}}{[-33.4 - (-77.7\ ^\circ\text{C})]} = \frac{100\ ^\circ\text{A}}{44.3\ ^\circ\text{C}} = 2.26\ ^\circ\text{A}/^\circ\text{C}$

(b) $\frac{100\ ^\circ\text{A}}{[-28.1 - (-107.9\ ^\circ\text{F})]} = \frac{100\ ^\circ\text{A}}{79.8\ ^\circ\text{F}} = 1.25\ ^\circ\text{A}/^\circ\text{F}$

(c) $°A = \frac{100}{44.3} \times (°C + 77.7)$

H_2O melting point = 0°C; $°A = \frac{100}{44.3} \times (0 + 77.7) = 175\ °A$

H_2O boiling point = 100°C; $°A = \frac{100}{44.3} \times (100 + 77.7) = 401\ °A$

(d) $°A = \frac{100}{79.8} \times (°F + 107.9) = \frac{100}{79.8} \times (98.6 + 107.9) = 259\ °A$

1.60 NaCl melting point = 1074 K
°C = K – 273.15 = 1074 – 273.15 = 800.85 °C = 801 °C

$°F = (\frac{9}{5} \times °C) + 32 = (\frac{9}{5} \times 800.85) + 32 = 1473.53\ °F = 1474\ °F$

NaCl boiling point = 1686 K
°C = K – 273.15 = 1686 – 273.15 = 1412.85 °C = 1413 °C

$°F = (\frac{9}{5} \times °C) + 32 = (\frac{9}{5} \times 1412.85) + 32 = 2575.13\ °F = 2575\ °F$

1.61 Convert 8 min, 25 s to s. $8\ \text{min} \times \frac{60\ \text{s}}{1\ \text{min}} + 25\ \text{s} = 505\ \text{s}$

Convert 293.2 K to °F:

293.2 – 273.15 = 20.05 °C and $°F = (\frac{9}{5} \times 20.05) + 32 = 68.09\ °F$

Final temperature = $68.09\ °F + 505\ \text{s} \times \frac{3.0\ °F}{60\ \text{s}} = 93.34\ °F$

$$°C = \frac{5}{9} \times (93.34 - 32) = 34.1\ °C$$

Derived Units: Volume and Density (Sections 1.6–1.7)

1.62 There are only seven fundamental (base) SI units for scientific measurement. A derived SI unit is some combination of two or more base SI units.
Base SI unit: Mass, kg; Derived SI unit: Density, kg/m^3

1.63 (a) 10 L is 10 times larger than 1000 mL (b) 1 m^3 is 10,000 times larger than 1 dL.

1.64 7.0 dm = 7.0 x 10^{-1} m = 0.70 m and 1 L = 10^{-3} m^3

$V = (0.70\ \text{m})^3 \times \frac{1\ \text{L}}{10^{-3}\ \text{m}^3} = 343\ \text{L} = 340\ \text{L}$

1.65 1 mL = 1 cm^3

$V = (2.5\ \text{cm})^3 \times \frac{1\ \text{mL}}{1\ \text{cm}^3} = 15.6\ \text{mL} = 16\ \text{mL}$

1.66 $d = \frac{m}{V} = \frac{27.43\ \text{g}}{12.40\ \text{cm}^3} = 2.212\ \text{g/cm}^3$

1.67 $d = \dfrac{m}{V} = \dfrac{206.77\text{ g}}{15.50\text{ cm}^3} = 13.34\ \dfrac{\text{g}}{\text{cm}^3}$

1.68 $3.10\text{ g/cm}^3 = 3.10\text{ g/mL}$

$\text{mass} = 3.10\text{ g/mL} \times \dfrac{1\text{ kg}}{1000\text{ g}} \times \dfrac{1\text{ mL}}{1 \times 10^{-3}\text{ L}} \times 4.67\text{ L} = 14.5\text{ kg}$

1.69 $250\text{ mg} \times \dfrac{1 \times 10^{-3}\text{ g}}{1\text{ mg}} = 0.25\text{ g};\quad V = 0.25\text{ g} \times \dfrac{1\text{ cm}^3}{1.40\text{ g}} = 0.18\text{ cm}^3$

$500\text{ lb} \times \dfrac{453.59\text{ g}}{1\text{ lb}} = 226{,}795\text{ g};\quad V = 226{,}795\text{ g} \times \dfrac{1\text{ cm}^3}{1.40\text{ g}} = 161{,}996\text{ cm}^3 = 162{,}000\text{ cm}^3$

Assume that 250 and 500 have 3 significant figures.

1.70 For H_2: $V = 1.0078\text{ g} \times \dfrac{1\text{ L}}{0.0899\text{ g}} = 11.2\text{ L}$

For Cl_2: $V = 35.45\text{ g} \times \dfrac{1\text{ L}}{3.214\text{ g}} = 11.03\text{ L}$

1.71 $\text{mass} = 10.5\text{ g/cm}^3 \times \dfrac{1\text{ kg}}{1000\text{ g}} \times \left(\dfrac{1\text{ cm}}{1 \times 10^{-2}\text{ m}}\right)^3 \times (0.62\text{ m})^3 = 2500\text{ kg}$

1.72 $d = \dfrac{m}{V} = \dfrac{220.9\text{ g}}{(0.50 \times 1.55 \times 25.00)\text{ cm}^3} = 11.4\ \dfrac{\text{g}}{\text{cm}^3} = 11\ \dfrac{\text{g}}{\text{cm}^3}$

1.73 diameter = 2.40 mm = 0.240 cm, r = diameter/2 = 0.120 cm, and $V = \pi r^2 h$

$d = \dfrac{m}{V} = \dfrac{0.3624\text{ g}}{(3.1416)(0.120\text{ cm})^2(15.0\text{ cm})} = 0.534\text{ g/cm}^3$

1.74 Silverware mass = 80.56 g

Silverware volume = 15.90 mL – 10.00 mL = 5.90 mL

Silverware density = $\dfrac{80.56\text{ g}}{5.90\text{ mL}} = 13.7\text{ g/mL}$

The density of the silverware and pure silver are different. The silverware is not pure silver.

1.75 Mass of 10 pennies = 24.656 g

Volume of 10 pennies = 12.90 mL – 10.0 mL = 2.90 mL

Pennies density = $\dfrac{24.656\text{ g}}{2.90\text{ mL}} = 8.50\text{ g/mL}$

The density of the pennies and pure copper are different. The pennies are not pure copper.

1.76 $V = 112.5\text{ g} \times \frac{1\text{ mL}}{1.4832\text{ g}} = 75.85\text{ mL}$

1.77 1 lb = 453.59 g

$\text{volume} = 3.6 \times 10^{11}\text{ lb} \times \frac{453.59\text{ g}}{1\text{ lb}} \times \frac{1\text{ cm}^3}{1.8302\text{ g}} \times \frac{1\text{ L}}{1000\text{ cm}^3} = 8.9 \times 10^{10}\text{ L}$

Energy (Section 1.8)

1.78 Car: $E_K = \frac{1}{2}(1400\text{ kg})\left(\frac{115 \times 10^3\text{ m}}{3600\text{ s}}\right)^2 = 7.1 \times 10^5\text{ J}$

Truck: $E_K = \frac{1}{2}(12{,}000\text{ kg})\left(\frac{38 \times 10^3\text{ m}}{3600\text{ s}}\right)^2 = 6.7 \times 10^5\text{ J}$

The car has more kinetic energy.

1.79 Heat = q = 7.1×10^5 J (from Problem 1.78)

q = (specific heat) x m x ΔT

$$m = \frac{q}{(\text{specific heat}) \times \Delta T} = \frac{7.1 \times 10^5\text{ J}}{\left(4.18\ \frac{\text{J}}{\text{g}\cdot{}^\circ\text{C}}\right)(50\,^\circ\text{C} - 20\,^\circ\text{C})} = 5.7 \times 10^3\text{ g of water}$$

1.80 1 oz = 28.35 g

$\text{energy} = 0.450\text{ oz} \times \frac{28.35\text{ g}}{1\text{ oz}} \times \frac{2498\text{ kJ}}{45.0\text{ g}} \times \frac{1\text{ kcal}}{4.184\text{ kJ}} = 169\text{ kcal}$

1.81 $\text{g Na} = \frac{1.00\text{ g Na}}{17.9\text{ kJ}} \times \frac{4.184\text{ kJ}}{1\text{ kcal}} \times 171\text{ kcal} = 40.0\text{ g Na}$

$\text{g Cl} = \frac{1.54\text{ g Cl}}{1.00\text{ g Na}} \times 40.0\text{ g Na} = 61.6\text{ g Cl}$

1.82 (a) $540\text{ Cal} \times \frac{1000\text{ cal}}{1\text{ Cal}} \times \frac{4.184\text{ J}}{1\text{ cal}} \times \frac{1\text{ kJ}}{1000\text{ J}} = 2259\text{ kJ} = 2300\text{ kJ}$

(b) 100 watts = 100 J/s

$\text{time} = 2259\text{ kJ} \times \frac{1000\text{ J}}{1\text{ kJ}} \times \frac{1\text{ s}}{100\text{ J}} \times \frac{1\text{ min}}{60\text{ s}} \times \frac{1\text{ h}}{60\text{ min}} = 6.275\text{ h} = 6.3\text{ h}$

1.83 (a) $238\text{ Cal} \times \frac{1000\text{ cal}}{1\text{ Cal}} \times \frac{4.184\text{ J}}{1\text{ cal}} \times \frac{1\text{ kJ}}{1000\text{ J}} = 996\text{ kJ}$

(b) 75 watts = 75 J/s

$\text{time} = 996\text{ kJ} \times \frac{1000\text{ J}}{1\text{ kJ}} \times \frac{1\text{ s}}{75\text{ J}} \times \frac{1\text{ min}}{60\text{ s}} \times \frac{1\text{ h}}{60\text{ min}} = 3.69\text{ h}$

Accuracy, Precision, and Significant Figures (Sections 1.9–1.10)

1.84 (a) and (b) are exact numbers because they are both definitions.
(c) and (d) are not exact numbers because they result from measurements.

1.85

$$\begin{array}{r} 4.8673\text{ g} \\ -\ 4.8\text{ g} \\ \hline 0.0673\text{ g} \end{array}$$

The result should contain only 1 decimal place. Because the digit to be dropped (6) is greater than 5, round up. The result is 0.1 g.

1.86 (a) 35.0445 g has 6 significant figures because zeros in the middle of a number are significant.
(b) 59.0001 cm has 6 significant figures because zeros in the middle of a number are significant.
(c) 0.030 03 kg has 4 significant figures because zeros at the beginning of a number are not significant and zeros in the middle of a number are significant.
(d) 0.004 50 m has 3 significant figures because zeros at the beginning of a number are not significant and zeros at the end of a number and after the decimal point are always significant.
(e) 67,000 m^2 has 2, 3, 4, or 5 significant figures because zeros at the end of a number and before the decimal point may or may not be significant.
(f) 3.8200×10^3 L has 5 significant figures because zeros at the end of a number and after the decimal point are always significant.

1.87 (a) $130.95 is an exact number and has an infinite number of significant figures.
(b) 2000.003 has 7 significant figures because zeros in the middle of a number are significant.
(c) The measured quantity, 5 ft 3 in., has 2 significant figures. The 5 ft is certain and the 3 in. is an estimate.
(d) 510 J has 2 or 3 significant figures because zeros at the end of a number and before the decimal point may or may not be significant.
(e) 5.10×10^2 J has 3 significant figures because zeros at the end of a number and after the decimal point are always significant.
(f) 10 students is a count, therefore 10 is an exact number with an infinite number of significant figures.

1.88 To convert 3,666,500 m^3 to scientific notation, move the decimal point 6 places to the left and include an exponent of 10^6. The result is 3.6665×10^6 m^3. Because the digit to be dropped is 5 with nothing following, round down. The result is 3.666×10^6 m^3 (4 significant figures). Because the digit to be dropped (the second 6) is greater than 5, round up. The result is 3.7×10^6 m^3 (2 significant figures).

1.89 Because the digit to be dropped (3) is less than 5, round down. The result to 4 significant figures is 7926 mi or 7.926×10^3 mi.
Because the digit to be dropped (2) is less than 5, round down. The result to 2 significant figures is 7900 mi or 7.9×10^3 mi.

1.90 (a) Because the digit to be dropped (0) is less than 5, round down. The result is 3.567×10^4 or 35,670 m (4 significant figures).
Because the digit to be dropped (the second 6) is greater than 5, round up. The result is 35,670.1 m (6 significant figures).
(b) Because the digit to be dropped is 5 with nonzero digits following, round up. The result is 69 g (2 significant figures).
Because the digit to be dropped (0) is less than 5, round down. The result is 68.5 g (3 significant figures).
(c) Because the digit to be dropped is 5 with nothing following, round down. The result is 4.99×10^3 cm (3 significant figures).
(d) Because the digit to be dropped is 5 with nothing following, round down. The result is 2.3098×10^{-4} kg (5 significant figures).

1.91 (a) Because the digit to be dropped (1) is less than 5, round down. The result is 7.000 kg.
(b) Because the digit to be dropped is 5 with nothing following, round down. The result is 1.60 km.
(c) Because the digit to be dropped (1) is less than 5, round down. The result is 13.2 g/cm^3.
(d) Because the digit to be dropped (1) is less than 5, round down. The result is 2,300,000. or $2.300\ 000 \times 10^6$.

1.92 (a) $4.884 \times 2.05 = 10.012$
The result should contain only 3 significant figures because 2.05 contains 3 significant figures (the smaller number of significant figures of the two). Because the digit to be dropped (1) is less than 5, round down. The result is 10.0.
(b) $94.61 / 3.7 = 25.57$
The result should contain only 2 significant figures because 3.7 contains 2 significant figures (the smaller number of significant figures of the two). Because the digit to be dropped (second 5) is 5 with nonzero digits following, round up. The result is 26.
(c) $3.7 / 94.61 = 0.0391$
The result should contain only 2 significant figures because 3.7 contains 2 significant figures (the smaller number of significant figures of the two). Because the digit to be dropped (1) is less than 5, round down. The result is 0.039.

(d)
$$\begin{array}{r} 5502.3 \\ 24 \\ +\ \ 0.01 \\ \hline 5526.31 \end{array}$$
This result should be expressed with no decimal places. Because the digit to be dropped (3) is less than 5, round down. The result is 5526.

(e)
$$\begin{array}{r} 86.3 \\ +\ 1.42 \\ -\ 0.09 \\ \hline 87.63 \end{array}$$
This result should be expressed with only 1 decimal place. Because the digit to be dropped (3) is less than 5, round down. The result is 87.6.

(f) $5.7 \times 2.31 = 13.167$
The result should contain only 2 significant figures because 5.7 contains 2 significant figures (the smaller number of significant figures of the two). Because the digit to be dropped (second 1) is less than 5, round down. The result is 13.

1.93 (a) $\frac{3.41 - 0.23}{5.233} \times 0.205 = \frac{3.18}{5.233} \times 0.205 = 0.12457 = 0.125$

Complete the subtraction first. The result has 2 decimal places and 3 significant figures. The result of the multiplication and division must have 3 significant figures. Because the digit to be dropped is 5 with nonzero digits following, round up.

(b) $\frac{5.556 \times 2.3}{4.223 - 0.08} = \frac{5.556 \times 2.3}{4.143} = 3.08 = 3.1$

Complete the subtraction first. The result of the subtraction should have 2 decimal places and 3 significant figures (an extra digit is being carried until the calculation is completed). The result of the multiplication and division must have 2 significant figures. Because the digit to be dropped (8) is greater than 5, round up.

Unit Conversions (Section 1.11)

1.94 (a) $0.25 \text{ lb} \times \frac{453.59 \text{ g}}{1 \text{ lb}} = 113.4 \text{ g} = 110 \text{ g}$

(b) $1454 \text{ ft} \times \frac{12 \text{ in.}}{1 \text{ ft}} \times \frac{2.54 \text{ cm}}{1 \text{ in.}} \times \frac{1 \times 10^{-2} \text{ m}}{1 \text{ cm}} = 443.2 \text{ m}$

(c) $2{,}941{,}526 \text{ mi}^2 \times \left(\frac{1.6093 \text{ km}}{1 \text{ mi}}\right)^2 \times \left(\frac{1000 \text{ m}}{1 \text{ km}}\right)^2 = 7.6181 \times 10^{12} \text{ m}^2$

1.95 (a) $5.4 \text{ in.} \times \frac{2.54 \text{ cm}}{1 \text{ in.}} \times \frac{1 \times 10^{-2} \text{ m}}{1 \text{ cm}} = 0.14 \text{ m}$

(b) $66.31 \text{ lb} \times \frac{1 \text{ kg}}{2.2046 \text{ lb}} = 30.08 \text{ kg}$

(c) $0.5521 \text{ gal} \times \frac{3.7854 \text{ L}}{1 \text{ gal}} \times \frac{1 \times 10^{-3} \text{ m}^3}{1 \text{ L}} = 2.090 \times 10^{-3} \text{ m}^3$

(d) $65 \frac{\text{mi}}{\text{h}} \times \frac{1.6093 \text{ km}}{1 \text{ mi}} \times \frac{1000 \text{ m}}{1 \text{ km}} \times \frac{1 \text{ h}}{60 \text{ min}} \times \frac{1 \text{ min}}{60 \text{ s}} = 29 \frac{\text{m}}{\text{s}}$

(e) $978.3 \text{ yd}^3 \times \left(\frac{1 \text{ m}}{1.0936 \text{ yd}}\right)^3 = 748.0 \text{ m}^3$

(f) $2.380 \text{ mi}^2 \times \left(\frac{1.6093 \text{ km}}{1 \text{ mi}}\right)^2 \times \left(\frac{1000 \text{ m}}{1 \text{ km}}\right)^2 = 6.164 \times 10^6 \text{ m}^2$

1.96 1 mile = 1.6093 km; The time is 1 h, 5 min, and 26.6 s.

Convert the time to seconds and then hours.

$\text{time} = \left(1 \text{ hr} \times \frac{60 \text{ min}}{1 \text{ h}} \times \frac{60 \text{ s}}{1 \text{ min}}\right) + \left(5 \text{ min} \times \frac{60 \text{ s}}{1 \text{ min}}\right) + 26.6 \text{ s} = 3926.6 \text{ s}$

$\text{time} = 3926.6 \text{ s} \times \frac{1 \text{ min}}{60 \text{ s}} \times \frac{1 \text{ h}}{60 \text{ min}} = 1.0907 \text{ h}$

Convert meters to miles.

$$20{,}000 \text{ m} \times \frac{1 \text{ km}}{1000 \text{ m}} \times \frac{1 \text{ mi}}{1.6093 \text{ km}} = 12.4278 \text{ mi}$$

$$\text{average speed} = \frac{12.4278 \text{ mi}}{1.0907 \text{ h}} = 11.394 \text{ mi/h}$$

1.97 1 mile = 1.6093 km

Convert g to mg.

$$12.0 \text{ g} \times \frac{1000 \text{ mg}}{1 \text{ g}} = 12{,}000 \text{ mg}$$

Convert km to miles.

$$1 \text{ km} \times \frac{1 \text{ mi}}{1.6093 \text{ km}} = 0.6214 \text{ mi}$$

$$\text{CO limit} = \frac{1.20 \times 10^4 \text{ mg}}{0.6214 \text{ mi}} = 1.93 \times 10^4 \text{ mg/mi}$$

1.98 (a) $1 \text{ acre-ft} \times \frac{1 \text{ mi}^2}{640 \text{ acres}} \times \left(\frac{5280 \text{ ft}}{1 \text{ mi}}\right)^2 = 43{,}560 \text{ ft}^3$

(b) $116 \text{ mi}^3 \times \left(\frac{5280 \text{ ft}}{1 \text{ mi}}\right)^3 \times \frac{1 \text{ acre-ft}}{43{,}560 \text{ ft}^3} = 3.92 \times 10^8 \text{ acre-ft}$

1.99 (a) $18.6 \text{ hands} \times \frac{1/3 \text{ ft}}{1 \text{ hand}} \times \frac{12 \text{ in.}}{1 \text{ ft}} \times \frac{2.54 \text{ cm}}{1 \text{ in.}} = 189 \text{ cm}$

(b) $(6 \times 2.5 \times 15) \text{ hands}^3 \times \left(\frac{1/3 \text{ ft}}{1 \text{ hand}}\right)^3 \times \left(\frac{12 \text{ in.}}{1 \text{ ft}}\right)^3 \times \left(\frac{2.54 \text{ cm}}{1 \text{ in.}}\right)^3 \times \left(\frac{1 \times 10^{-2} \text{ m}}{1 \text{ cm}}\right)^3 = 0.2 \text{ m}^3$

1.100 $8.65 \text{ stones} \times \frac{14 \text{ lb}}{1 \text{ stone}} = 121 \text{ lb}$

1.101 (a) $\frac{200 \text{ mg}}{100 \text{ mL}} \times \frac{1 \text{ mL}}{1 \times 10^{-3} \text{ L}} = 2000 \text{ mg/L}$

(b) $\frac{200 \text{ mg}}{100 \text{ mL}} \times \frac{1 \times 10^{-3} \text{ g}}{1 \text{ mg}} \times \frac{1 \text{ } \mu\text{g}}{1 \times 10^{-6} \text{ g}} = 2000 \text{ } \mu\text{g/mL}$

(c) $\frac{200 \text{ mg}}{100 \text{ mL}} \times \frac{1 \times 10^{-3} \text{ g}}{1 \text{ mg}} \times \frac{1 \text{ mL}}{1 \times 10^{-3} \text{ L}} = 2 \text{ g/L}$

(d) $\frac{200 \text{ mg}}{100 \text{ mL}} \times \frac{1 \times 10^{-3} \text{ g}}{1 \text{ mg}} \times \frac{1 \text{ mL}}{1 \times 10^{-3} \text{ L}} \times \frac{1 \text{ ng}}{1 \times 10^{-9} \text{ g}} \times \frac{1 \times 10^{-6} \text{ L}}{1 \text{ } \mu\text{L}} = 2000 \text{ ng/}\mu\text{L}$

(e) $2 \text{ g/L} \times 5 \text{ L} = 10 \text{ g}$

1.102 $160 \text{ lb} \times \frac{1 \text{ kg}}{2.2046 \text{ lb}} = 72.6 \text{ kg}$

$72.6 \text{ kg} \times \frac{20\ \mu\text{g}}{1 \text{ kg}} \times \frac{1 \text{ mg}}{1 \times 10^3\ \mu\text{g}} = 1.452 \text{ mg} = 1.5 \text{ mg}$

1.103 $55 \frac{\text{mi}}{\text{h}} \times \frac{5280 \text{ ft}}{1 \text{ mi}} \times \frac{12 \text{ in.}}{1 \text{ ft}} \times \frac{2.54 \text{ cm}}{1 \text{ in.}} \times \frac{1 \text{ h}}{3600 \text{ s}} \times \frac{2.5 \times 10^{-4} \text{ s}}{1 \text{ shake}} = 0.61 \frac{\text{cm}}{\text{shake}}$

1.104 (a) A liter is just slightly larger than a quart.
(b) A mile is about twice as long as a kilometer.
(c) An ounce is about 30 times larger than a gram.
(d) An inch is about 2.5 times larger than a centimeter.

1.105 $d = 0.037 \frac{\text{lbs}}{\text{in}^3} \times \frac{453.59 \text{ g}}{1 \text{ lb}} \times \left(\frac{1 \text{ in}}{2.54 \text{ cm}}\right)^3 = 1.0 \text{ g/cm}^3$

1.106 $d = 0.55 \frac{\text{oz}}{\text{in}^3} \times \frac{1 \text{ lb}}{16 \text{ oz}} \times \frac{453.59 \text{ g}}{1 \text{ lb}} \times \left(\frac{1 \text{ in}}{2.54 \text{ cm}}\right)^3 = 0.95 \text{ g/cm}^3$

1.107 1 gal = 3.7854 L

(a) volume $= 3.4 \times 10^4 \text{ L} \times \frac{1 \text{ gal}}{3.7854 \text{ L}} = 9.0 \times 10^3 \text{ gal}$

(b) value $= 9.0 \times 10^3 \text{ gal} \times \frac{\$3.00}{1 \text{ gal}} = \$27{,}000$

1.108 amount of chocolate =

$2.0 \text{ cups coffee} \times \frac{105 \text{ mg caffeine}}{1 \text{ cup coffee}} \times \frac{1.0 \text{ ounce chocolate}}{15 \text{ mg caffeine}} = 14 \text{ ounces of chocolate}$

14 ounces of chocolate is just under 1 pound.

Multiconcept Problems

1.109 $d = \frac{m}{V} = \frac{8.763 \text{ g}}{(28.76 - 25.00) \text{ mL}} = \frac{8.763 \text{ g}}{3.76 \text{ mL}} = 2.331 \frac{\text{g}}{\text{cm}^3} = 2.33 \frac{\text{g}}{\text{cm}^3}$

1.110 volume of sphere $= \frac{4}{3}\pi r^3$; sphere radius = 7.60 cm/2 = 3.80 cm

(a) $d = \frac{m}{V} = \frac{313 \text{ g}}{\frac{4}{3}\pi(3.80 \text{ cm})^3} = 1.36 \text{ g/cm}^3 = 1.36 \text{ g/mL}$

(b) Because the density is greater than 1.0 g/mL, the sphere will sink in water.
(c) Because the density is less than 1.48 g/mL, the sphere will float in chloroform.

1.111 (a) density = $\frac{1\text{ lb}}{1\text{ pint}} \times \frac{8\text{ pints}}{1\text{ gal}} \times \frac{1\text{ gal}}{3.7854\text{ L}} \times \frac{453.59\text{ g}}{1\text{ lb}} \times \frac{1\text{ L}}{1000\text{ mL}} = 0.958\ 61\text{ g/mL}$

(b) area in m^2 =

$$1\text{ acre} \times \frac{1\text{ mi}^2}{640\text{ acres}} \times \left(\frac{5280\text{ ft}}{1\text{ mi}}\right)^2 \times \left(\frac{12\text{ in.}}{1\text{ ft}}\right)^2 \times \left(\frac{2.54\text{ cm}}{1\text{ in.}}\right)^2 \times \left(\frac{1 \times 10^{-2}\text{ m}}{1\text{ cm}}\right)^2 = 4047\text{ m}^2$$

(c) mass of wood =

$$1\text{ cord} \times \frac{128\text{ ft}^3}{1\text{ cord}} \times \left(\frac{12\text{ in.}}{1\text{ ft}}\right)^3 \times \left(\frac{2.54\text{ cm}}{1\text{ in.}}\right)^3 \times \frac{0.40\text{ g}}{1\text{ cm}^3} \times \frac{1\text{ kg}}{1000\text{ g}} = 1450\text{ kg} = 1400\text{ kg}$$

(d) mass of oil =

$$1\text{ barrel} \times \frac{42\text{ gal}}{1\text{ barrel}} \times \frac{3.7854\text{ L}}{1\text{ gal}} \times \frac{1\text{ mL}}{1 \times 10^{-3}\text{ L}} \times \frac{0.85\text{ g}}{1\text{ mL}} \times \frac{1\text{ kg}}{1000\text{ g}} = 135.1\text{ kg} = 140\text{ kg}$$

(e) fat Calories =

$$0.5\text{ gal} \times \frac{32\text{ servings}}{1\text{ gal}} \times \frac{165\text{ Calories}}{1\text{ serving}} \times \frac{30.0\text{ Cal from fat}}{100\text{ Cal total}} = 792\text{ Cal from fat}$$

1.112 (a) number of Hershey's Kisses =

$$2.0\text{ lb} \times \frac{453.59\text{ g}}{1\text{ lb}} \times \frac{1\text{ serving}}{41\text{ g}} \times \frac{9\text{ kisses}}{1\text{ serving}} = 199\text{ kisses} = 200\text{ kisses}$$

(b) Hershey's Kiss volume = $\frac{41\text{ g}}{1\text{ serving}} \times \frac{1\text{ serving}}{9\text{ kisses}} \times \frac{1\text{ mL}}{1.4\text{ g}} = 3.254\text{ mL} = 3.3\text{ mL}$

(c) Calories/Hershey's Kiss = $\frac{230\text{ Cal}}{1\text{ serving}} \times \frac{1\text{ serving}}{9\text{ kisses}} = 25.55\text{ Cal/kiss} = 26\text{ Cal/kiss}$

(d) % fat Calories =

$$\frac{13\text{ g fat}}{1\text{ serving}} \times \frac{9\text{ Cal from fat}}{1\text{ g fat}} \times \frac{1\text{ serving}}{230\text{ Cal total}} \times 100\% = 51\%\text{ Calories from fat}$$

1.113 Let Y equal volume of vinegar and ($422.8\text{ cm}^3 - Y$) equal the volume of oil.

Mass = volume x density

$397.8\text{ g} = (Y \times 1.006\text{ g/cm}^3) + [(422.8\text{ cm}^3 - Y) \times 0.918\text{ g/cm}^3]$

$397.8\text{ g} = (1.006\text{ g/cm}^3)Y + 388.1\text{ g} - (0.918\text{ g/cm}^3)Y$

$397.8\text{ g} - 388.1\text{ g} = (1.006\text{ g/cm}^3)Y - (0.918\text{ g/cm}^3)Y$

$9.7\text{ g} = (0.088\text{ g/cm}^3)Y$

$Y = \text{vinegar volume} = \frac{9.7\text{ g}}{0.088\text{ g/cm}^3} = 110\text{ cm}^3$

oil volume $= (422.8\text{ cm}^3 - Y) = (422.8\text{ cm}^3 - 110\text{ cm}^3) = 313\text{ cm}^3$

1.114 $°C = \frac{5}{9} \times (°F - 32)$

Set °C = °F: $°C = \frac{5}{9} \times (°C - 32)$

Solve for °C: $°C \times \frac{9}{5} = °C - 32$

$(°C \times \frac{9}{5}) - °C = -32$

$°C \times \frac{4}{5} = -32$

$°C = \frac{5}{4}(-32) = -40\ °C$

The Celsius and Fahrenheit scales "cross" at –40 °C (–40 °F).

1.115 Cork: volume = 1.30 cm x 5.50 cm x 3.00 cm = 21.45 cm^3

$$\text{mass} = 21.45\ cm^3 \times \frac{0.235\ g}{1\ cm^3} = 5.041\ g$$

Lead: volume = $(1.15\ cm)^3$ = 1.521 cm^3

$$\text{mass} = 1.521\ cm^3 \times \frac{11.35\ g}{1\ cm^3} = 17.26\ g$$

total mass = 5.041 g + 17.26 g = 22.30 g
total volume = 21.45 cm^3 + 1.521 cm^3 = 22.97 cm^3

average density = $\frac{22.30\ g}{22.97\ cm^3} = 0.971\ g/cm^3$ so the cork and lead will float.

1.116 Ethyl alcohol density = $\frac{19.7325\ g}{25.00\ mL} = 0.7893\ g/mL$

total mass = metal mass + ethyl alcohol mass = 38.4704 g
ethyl alcohol mass = total mass – metal mass = 38.4704 g – 25.0920 g = 13.3784 g

ethyl alcohol volume = $13.3784\ g \times \frac{1\ mL}{0.7893\ g} = 16.95\ mL$

metal volume = total volume – ethyl alcohol volume = 25.00 mL – 16.95 mL = 8.05 mL

metal density = $\frac{25.0920\ g}{8.05\ mL} = 3.12\ g/mL$

1.117 Average brass density = $(0.670)(8.92\ g/cm^3) + (0.330)(7.14\ g/cm^3) = 8.333\ g/cm^3$

length = $1.62\ in. \times \frac{2.54\ cm}{1\ in.} = 4.115\ cm$

diameter = $0.514\ in. \times \frac{2.54\ cm}{1\ in.} = 1.306\ cm$

volume = $\pi r^2 h = (3.1416)[(1.306\ cm)/2]^2(4.115\ cm) = 5.512\ cm^3$

mass = $5.512\ cm^3 \times \frac{8.333\ g}{1\ cm^3} = 45.9\ g$

1.118 $35 \text{ sv} = 35 \times 10^9 \dfrac{\text{m}^3}{\text{s}}$

(a) $\text{gulf stream flow} = \left(35 \times 10^9 \dfrac{\text{m}^3}{\text{s}}\right)\left(\dfrac{1\text{ cm}}{1 \times 10^{-2}\text{ m}}\right)^3\left(\dfrac{1\text{ mL}}{1\text{ cm}^3}\right)\left(\dfrac{60\text{ s}}{1\text{ min}}\right) = 2.1 \times 10^{18}\text{ mL/min}$

(b) $\text{mass of } H_2O = \left(2.1 \times 10^{18} \dfrac{\text{mL}}{\text{min}}\right)\left(\dfrac{60\text{ min}}{1\text{ h}}\right)(24\text{ h})\left(\dfrac{1.025\text{ g}}{1\text{ mL}}\right) = 3.1 \times 10^{21}\text{ g} = 3.1 \times 10^{18}\text{ kg}$

(c) $\text{time} = (1.0 \times 10^{15}\text{ L})\left(\dfrac{1\text{ mL}}{1 \times 10^{-3}\text{ L}}\right)\left(\dfrac{1\text{ min}}{2.1 \times 10^{18}\text{ mL}}\right) = 0.48\text{ min}$

1.119 (a) $\text{Ga density} = \dfrac{0.2133\text{ lb}}{1\text{ in.}^3} \times \dfrac{453.59\text{ g}}{1\text{ lb}} \times \dfrac{1\text{ in.}^3}{(2.54\text{ cm})^3} = 5.904\text{ g/cm}^3$

(b)

Ga boiling point	2204 °C	1000 °G
Ga melting point	29.78 °C	0 °G

$$\frac{1000\text{ °G} - 0\text{ °G}}{2204\text{ °C} - 29.78\text{ °C}} = \frac{1000\text{ °G}}{2174.22\text{ °C}} = 0.4599\text{ °G/°C}$$

°G = 0.4599 x (°C – 29.78)
°G = 0.4599 x (801 – 29.78) = 355 °G

The melting point of sodium chloride (NaCl) on the gallium scale is 355 °G.