짝수 예제문제 해답

Note: Solutions that involve calculations of measurements are rounded up or down to conform to the rules for significant figures.

CHAPTER 1

1.2 $m = 15.0\ \text{g}$

$V = 4.50\ \text{cm}^3$

$\rho = ?$

$$\rho = \frac{m}{V} = \frac{15.0\ \text{g}}{4.50\ \text{cm}^3} = \boxed{3.33\ \frac{\text{g}}{\text{cm}^3}}$$

CHAPTER 2

2.2 $\bar{v} = 8.00\ \text{km/h}$

$t = 10.0\ \text{s}$

$d = ?$

The bicycle has a speed of 8.00 km/h, and the time factor is 10.0 s, so km/h must be converted to m/s:

$$\bar{v} = \frac{0.2778\ \frac{\text{m}}{\text{s}}}{\frac{\text{km}}{\text{h}}} \times 8.00\ \frac{\text{km}}{\text{h}}$$

$$= (0.2778)(8.00)\ \frac{\text{m}}{\text{s}} \times \frac{\text{h}}{\text{km}} \times \frac{\text{km}}{\text{h}}$$

$$= 2.22\ \frac{\text{m}}{\text{s}}$$

$$\bar{v} = \frac{d}{t}$$

$$\bar{v}t = \frac{dt}{t}$$

$$d = \bar{v}t$$

$$= \left(2.22\ \frac{\text{m}}{\text{s}}\right)(10.0\ \text{s})$$

$$= (2.22)(10.0)\ \frac{\text{m}}{\text{s}} \times \frac{\text{s}}{1}$$

$$= \boxed{22.2\ \text{m}}$$

2.4 $v_i = 0\ \frac{\text{m}}{\text{s}}$

$v_f = ?$

$a = 5\ \frac{\text{m}}{\text{s}^2}$

$t = 6\ \text{s}$

$$a = \frac{v_f - v_i}{t} \quad \therefore \quad v_f = at + v_i$$

$$= \left(5\ \frac{\text{m}}{\text{s}^2}\right)(6\ \text{s}) + 0$$

$$= (5)(6)\ \frac{\text{m}}{\text{s}^2} \times \frac{\text{s}}{1}$$

$$= \boxed{30\ \frac{\text{m}}{\text{s}}}$$

2.6 $m = 20\ \text{kg}$

$F = 40\ \text{N}$

$a = ?$

$$F = ma \quad \therefore \quad a = \frac{F}{m}$$

$$= \frac{40\ \frac{\text{kg}\cdot\text{m}}{\text{s}^2}}{20\ \text{kg}}$$

$$= \frac{40}{20}\ \frac{\text{kg}\cdot\text{m}}{\text{s}^2} \times \frac{1}{\text{kg}}$$

$$= \boxed{2\ \frac{\text{m}}{\text{s}^2}}$$

2.8 $m = 60.0\ \text{kg}$

$w = 100.0\ \text{N}$

$g = ?$

$$w = mg \quad \therefore \quad g = \frac{w}{m}$$

$$= \frac{100.0\ \frac{\text{kg}\cdot\text{m}}{\text{s}^2}}{60.0\ \text{kg}}$$

$$= \frac{100.0}{60.0}\ \frac{\text{kg}\cdot\text{m}}{\text{s}^2} \times \frac{1}{\text{kg}}$$

$$= \boxed{1.67\ \frac{\text{m}}{\text{s}^2}}$$

2.10 $m = 0.25$ kg
$r = 0.25$ m
$v = 2.0$ m/s
$F = ?$

$$F = \frac{mv^2}{r}$$
$$= \frac{(0.25\text{ kg})\left(2.0\,\frac{\text{m}}{\text{s}}\right)^2}{0.25\text{ m}}$$
$$= \frac{(0.25\text{ kg})\left(4.0\,\frac{\text{m}^2}{\text{s}^2}\right)}{0.25\text{ m}}$$
$$= \frac{(0.25)(4.0)}{0.25}\,\frac{\text{kg}\cdot\text{m}^2}{\text{s}^2} \times \frac{1}{\text{m}}$$
$$= 4.0\,\frac{\text{kg}\cdot\text{m}}{\text{s}^2}$$
$$= \boxed{4.0\text{ N}}$$

CHAPTER 3

3.2 $m = 25$ kg
$g = 9.8\text{ m/s}^2$
$w = ?$

$$w = mg = (25\text{ kg})(9.8\text{ m/s}^2)$$
$$= (25)(9.8)\text{ kg} \times \text{m/s}^2$$
$$= 245\text{ N}$$

$F = 245$ N
$d = 0.6$ m
$W = ?$

$$W = Fd$$
$$= (245\text{ N})(0.6\text{ m})$$
$$= (245)(0.6)\text{ N}\cdot\text{m}$$
$$= \boxed{147\text{ J}}$$

3.4 $w = 75$ kg
$h = 4.5$ m
$t = 10.0$ s
$P = ?$

$$P = \frac{mgh}{t}$$
$$= \frac{(75\text{ kg})(9.8\text{ m/s}^2)(4.5\text{ m})}{10.0\text{ s}}$$
$$= \frac{(75)(9.8)(4.5)}{10.0}\,\frac{\text{kg}\cdot\text{m/s}^2\cdot\text{m}}{\text{s}}$$
$$= 330\,\frac{\text{N}\cdot\text{m}}{\text{s}}$$
$$= 330\,\frac{\text{J}}{\text{s}}$$
$$= 330\text{ W}$$

$$330\text{ W} \times \frac{\text{hp}}{746\text{ W}} = 0.44\text{ hp}$$

3.6 $m = 5.00$ kg
$g = 9.8\text{ m/s}^2$
$h = 5.00$ m
$W = ?$

$$W = Fd$$
$$W = mgh$$
$$= (5.00\text{ kg})\left(9.8\,\frac{\text{m}}{\text{s}^2}\right)(5.00\text{ m})$$
$$= (5.00)(9.8)(5.00)\,\frac{\text{kg}\cdot\text{m}}{\text{s}^2} \times \text{m}$$
$$= 245\text{ N}\cdot\text{m}$$
$$= \boxed{250\text{ J}}$$

3.8 $m = 100.0$ kg
$v = 6.0$ m/s
$W = ?$

$$W = K.E.$$
$$K.E. = \frac{1}{2}mv^2$$
$$= \frac{1}{2}(100.0\text{ kg})\left(6.0\,\frac{\text{m}}{\text{s}}\right)^2$$
$$= \frac{1}{2}(100.0\text{ kg})\left(36\,\frac{\text{m}^2}{\text{s}^2}\right)$$
$$= \frac{1}{2}(100.0)(36)\,\frac{\text{kg}\cdot\text{m}}{\text{s}^2} \times \text{m}$$
$$= 1{,}800\text{ N}\cdot\text{m}$$
$$= \boxed{1{,}800\text{ J}}$$

CHAPTER 4

4.2 $T_C = 20°$
$T_F = ?$

$$T_F = \frac{9}{5}T_C + 32°$$
$$= \frac{9}{5}20° + 32°$$
$$= \frac{180°}{5} + 32°$$
$$= 36° + 32°$$
$$= \boxed{68°\text{F}}$$

4.4

$$T_F = \frac{9}{5}T_C + 32°$$
$$= \frac{9}{5}(-10°\text{ C}) + 32°$$
$$= \frac{-90°\text{ C}}{5} + 32°$$
$$= -18°\text{ C} + 32°$$
$$= \boxed{14°\text{ F}}$$

4.6 $PE = mgh$

$= (5\text{ kg})\left(9.8\,\frac{\text{m}}{\text{s}^2}\right)(15\text{ m})$

$= 735\text{ J}$

then,

$$(735\text{ J})\left(\frac{1\text{ kcal}}{4{,}184\text{ J}}\right)$$

$$\frac{735}{4{,}184}\,\frac{\cancel{\text{J}}\cdot\text{kcal}}{\cancel{\text{J}}}$$

$$\boxed{0.18\text{ kcal}}$$

4.8 $m = 2\text{ kg}$
$Q = 1.2\text{ kcal}$
$\Delta T = 20\text{ C}°$
$c = ?$

$$Q = mc\Delta T \quad \therefore \quad c = \frac{Q}{m\Delta T}$$

$$= \frac{1.2\text{ kcal}}{(2\text{ kg})(20.0\text{ C}°)}$$

$$= \frac{1.2}{(2)(20.0)}\,\frac{\text{kcal}}{\text{kgC}°}$$

$$= \boxed{0.03\,\frac{\text{kcal}}{\text{kgC}°}}$$

4.10 The energy required to change ice at 0°C to liquid water at 0°C is $Q = mL_f$

$$Q = mL_f$$

$$= (40\text{ g})\left(80.0\,\frac{\text{cal}}{\text{g}}\right)$$

$$= (40)(80)\text{ g} \times \frac{\text{cal}}{\text{g}}$$

$$= 3{,}200\text{ cal}$$

$$= 3.2\text{ kcal}$$

Then the energy required to change 0°C water to 20°C water is $Q = mc\Delta T$

$$Q = mc\Delta T$$

$$= (40\text{ g})\left(1\,\frac{\text{cal}}{\text{g}°\text{C}}\right)(20°\text{ C} - 0°\text{ C})$$

$$= (40)(1)(20)\text{ g} \times \frac{\text{cal}}{\text{g}\cdot\text{C}°} \times \text{C}°$$

$$= 80\text{ cal}$$

$$= 0.080\text{ kcal}$$

thus, $3.2\text{ kcal} + 0.08\text{ kcal} = \boxed{3.3\text{ kcal}}$

4.12 If $W = J(Q_H - Q_L)$ then,

$$\frac{W}{J} = Q_H - Q_L$$

$$Q_L + \frac{W}{J} = Q_H$$

So, using $Q_H = Q_L + \dfrac{W}{J}$

$$= 25\text{ kcal} + \frac{(50{,}000\text{ J})}{\left(4{,}184\,\frac{\text{J}}{\text{kcal}}\right)}$$

$$= \frac{(25)(50{,}000)}{4{,}184}\text{ kcal} \times \frac{\cancel{\text{J}}}{\cancel{\text{J}}}$$

$$= \boxed{52\text{ kcal}}$$

CHAPTER 5

5.2 $f = 0.022$
$T = ?$

$$T = \frac{1}{f}$$

$$= \frac{1}{0.022}\,\frac{\text{s}}{\text{cycles}}$$

$$= \boxed{45\text{ s}}$$

5.4 $f = 2{,}500\text{ Hz}$
$v = 330\text{ m/s}$
$\lambda = ?$

$$v = \lambda f \quad \therefore \quad \lambda = \frac{v}{f}$$

$$= \frac{330\,\frac{\text{m}}{\text{s}}}{2{,}500\,\frac{1}{\text{s}}}$$

$$= \frac{330}{2{,}500}\,\frac{\text{m}}{\text{s}} \times \frac{\text{s}}{1}$$

$$= 0.13\text{ m} \quad \text{or} \quad \boxed{13\text{ cm}}$$

CHAPTER 6

6.2 $q_1 = 1.60 \times 10^{-19}\text{ C}$
$q_2 = 1.60 \times 10^{-19}\text{ C}$
$F = 5.50 \times 10^{-8}\text{ N}$
$k = 9.00 \times 10^9\,\frac{\text{N}\cdot\text{m}^2}{\text{C}^2}$
$d = ?$

$$F = k\frac{q_1 q_2}{d^2}$$

$$d^2 = k\frac{q_1 q_2}{F}$$

$$d = \sqrt{\frac{(9.00 \times 10^9)(1.60 \times 10^{-19})(1.60 \times 10^{-19})}{(5.50 \times 10^{-8})}\,\frac{\text{N}\cdot\text{m}^2}{\text{C}^2}\cdot\frac{1}{\text{N}}\cdot\text{C}\cdot\text{C}}$$

$$= \boxed{6.47 \times 10^{-11}\text{ m}}$$

6.4 $I = 2.40$ A
$q = 2.00 \times 10^3$ C
$t = ?$

$$I = \frac{q}{t}$$
$$t = \frac{q}{I}$$
$$= \frac{(2.00 \times 10^3)}{2.40}\,\frac{\text{A}}{\text{C}}$$
$$= \boxed{833\ \text{s}}$$

6.6 $V = 120$ V
$R = 30\ \Omega$
$I = ?$

$$V = IR \qquad \therefore\ I = \frac{V}{R}$$
$$= \frac{120\ \text{V}}{30\ \dfrac{\text{V}}{\text{A}}}$$
$$= \frac{120}{30}\,\frac{\text{V}}{1} \times \frac{\text{A}}{\text{V}}$$
$$= \boxed{4\ \text{A}}$$

6.8 $I = 0.5$ A
$V = 120$ V
$P = ?$

$$P = IV$$
$$= (0.5\ \text{A})(120\ \text{V})$$
$$= (0.5)(120)\,\frac{\text{C}}{\text{s}} \times \frac{\text{J}}{\text{C}}$$
$$= 60\,\frac{\text{J}}{\text{s}}$$
$$= \boxed{60\ \text{W}}$$

6.10 $I = 0.5$ A
$V = 120$ V
$P = IV = 60$ W
Rate = 100원/kWh
Cost = ?

$$\text{cost} = \frac{(\text{watts})(\text{time})(\text{rate})}{1{,}000\ \dfrac{\text{W}}{\text{kW}}}$$
$$= \frac{(60\ \text{W})(1.00\ \text{h})(100\text{원/kwh})}{1{,}000\ \dfrac{\text{W}}{\text{kW}}}$$
$$= \frac{(60)(1.00)(100)}{1{,}000}\,\frac{\text{W}}{1} \times \frac{\text{h}}{1} \times \frac{\text{원}}{\text{kWh}} \times \frac{\text{kW}}{\text{W}}$$
$$= \boxed{6\text{원}}$$

6.12 $N_p = 10.0$ loops
$N_s = 20.0$ loops
$V_p = ?$
$V_s = 220$ V

$$\frac{V_p}{N_p} = \frac{V_s}{N_s}$$
$$V_p = \frac{V_s}{N_s} \times N_p$$
$$= \frac{(220)}{(20.0)} \times 10.0 \times \frac{\text{V}}{\cancel{\text{loops}}} \times \cancel{\text{loops}}$$
$$= \boxed{110\ \text{V}}$$

6.14 $V_p = 220$ V
$I_p = ?$
$V_s = 480$ V
$I_s = 2.0$ A

$$V_p I_p = V_s I_s$$
$$I_p = \frac{V_s I_s}{V_p}$$
$$= \frac{(480\ \text{V})(2.0\ \text{A})}{(220\ \text{V})}$$
$$= \frac{(480)(2.0)}{(220)}\,\frac{\cancel{\text{V}}\cdot\text{A}}{\cancel{\text{V}}}$$
$$= \boxed{4.4\ \text{A}}$$

CHAPTER 7

7.2 $c = 3.00 \times 10^8$ m/s
$v = 1.93 \times 10^8$ m/s
$n_{\text{amber}} = ?$

$$n = \frac{c}{v}$$
$$= \frac{3.00 \times 10^8\ \text{m/s}}{1.93 \times 10^8\ \text{m/s}}$$
$$= \boxed{1.55}$$

7.4 $c = 3.00 \times 10^8$ m/s
$f = 960.0$ kHz $= 960.0 \times 10^3$ Hz
$\lambda = ?$

$$c = \lambda f$$
$$\lambda = \frac{c}{f}$$
$$= \frac{3.00 \times 10^8\ \text{m/s}}{960.0 \times 10^3\ \text{Hz}}$$
$$= \frac{(3.00 \times 10^8)}{(9.60 \times 10^5)}\,\frac{\text{m/s}}{1/\text{s}}$$
$$= \boxed{313\ \text{m}}$$

7.6 $f = 7.00 \times 10^{14}$ Hz
$h = 6.63 \times 10^{-34}$ J·s
$E = ?$

$$E = hf$$
$$= (6.63 \times 10^{-34}\ \text{J·s})\left(7.00 \times 10^{14}\,\frac{1}{\text{s}}\right)$$
$$= (6.63 \times 10^{-34})(7.00 \times 10^{14})\ \text{J·s} \times \frac{1}{\text{s}}$$
$$= \boxed{4.64 \times 10^{-19}\ \text{J}}$$

CHAPTER 8

8.2 Calcium-40 has an even number of protons and an even number of neutrons, containing 20 of each. The number 20 is a particularly stable number of protons or neutrons. In addition, the neutron-to-proton ratio is 1:1, placing it within the band of stability. All indications are that calcium-40 is stable, not radioactive.

8.4 Plutonium-241 has 94 protons and 241 minus 94, or 147 neutrons, in the nucleus. This nucleus is to the upper right, beyond the band of stability. It can move back toward stability by emitting an alpha particle, losing 2 protons and 2 neutrons from the nucleus. The nuclear equation is

$$^{241}_{94}\text{Pu} \longrightarrow {}^{237}_{92}\text{U} + {}^{4}_{2}\text{He}$$

CHAPTER 9

9.2
$$\bar{v} = \frac{d}{t} \Rightarrow d = \bar{v}\cdot t$$
$$d = \left(9.5 \times 10^{12}\,\frac{\text{km}}{\cancel{\text{yr}}}\right)(1.0 \times 10^{5}\ \cancel{\text{yr}})$$
$$d = \boxed{9.5 \times 10^{17}\ \text{km}}$$

9.4 If the star Altair was at a standard distance of 32.6 light-years, it would have an apparent magnitude of about +2. However, when we look at it in the sky, it appears much brighter, at an apparent magnitude of about +1, so it must be closer than the standard distance of 32.6 light-years.

9.6 $b_2/b_1 = 100$
$\text{Magnitude}_A = -1$
$\text{Magnitude}_B = ?$

$$2.51^{x} = b_2/b_1$$
$$2.51^{(b-1)} = 100$$
$$2.51^{b+1} = 100$$
$$b + 1 = 5$$
$$b = \boxed{4}$$

9.8 $\lambda_{peak} = 8{,}500$ angstroms
$T = ?$

$$T = \frac{2.897 \times 10^{7}\ \text{K·ang}}{\lambda_{peak}}$$
$$= \frac{2.897 \times 10^{7}\ \text{K·ang}}{8{,}500\ \text{ang}}$$
$$= \boxed{3.4 \times 10^{3}\ \text{K, red, type M}}$$

9.10 $H_0 = 21.5$ km/s/Mly
$v = 15{,}000$ km/s
$d = ?$

$$v = H_0 d$$
$$d = v/H_0$$
$$= \frac{(15{,}000\ \text{km/s})}{\left(\dfrac{21.5\ \text{km/s}}{\text{Mly}}\right)}$$
$$= \boxed{700\ \text{Mly}}$$

CHAPTER 10

10.2 Determine the ratio in hours between an apparent solar day and a sidereal day, and multiply by the number of mean solar days in one sidereal year.

$$\text{day length}_{sidereal} = 23\ \text{h}\ 56\ \text{min}\ 4\ \text{s}$$
$$\text{day length}_{mean\ solar} = 24\ \text{h}$$
$$\text{year length} = 365.25636\ \text{mean solar days (msd)}$$
$$\text{sidereal days} = ?$$

$$\text{sidereal days} = \text{year length}\left(\frac{\text{day length}_{mean\ solar}}{\text{day length}_{sidereal}}\right)$$

Convert time of sidereal day to hours.

$$\text{day length}_{sidereal} = 23\ \text{h} + 56\ \text{min}\left(\frac{1\ \text{h}}{60\ \text{min}}\right) + 4\,\text{s}\left(\frac{1\ \text{h}}{60\ \text{min}}\right)\left(\frac{1\ \text{min}}{60\ \text{s}}\right)$$
$$= 23\ \text{h} + \frac{56}{60}\,\cancel{\text{min}}\left(\frac{\text{h}}{\cancel{\text{min}}}\right) + \frac{4}{60^2}\,\cancel{\text{s}}\left(\frac{\text{h}}{\cancel{\text{min}}}\right)\left(\frac{\cancel{\text{min}}}{\cancel{\text{s}}}\right)$$
$$= 23\ \text{h} + 0.9333\ \text{h} + 0.0011\ \text{h}$$
$$= 23.9344\ \text{h}$$
$$= \text{year length}\left(\frac{\text{day length}_{mean\ solar}}{\text{day length}_{sidereal}}\right)$$
$$= 365.25636\ \text{msd}\left(\frac{24\,\dfrac{\text{h}}{\text{msd}}}{23.934\,\dfrac{\text{h}}{\text{day}_{sidereal}}}\right)$$
$$= 365.25636\left(\frac{24}{23.9344}\right)\cancel{\text{msd}}\left(\frac{\dfrac{\cancel{\text{h}}}{\cancel{\text{msd}}}}{\dfrac{\cancel{\text{h}}}{\text{day}_{sidereal}}}\right)$$
$$= 365.25636\ (1.00274)\ \text{day}_{sidereal}$$
$$= \boxed{367.247\ \text{day}_{sidereal}}$$

10.4 $2t = 2.65$ s
$t = 1.33$ s
$v = 3 \times 10^{5}$ km/s
$d = ?$

$$d = vt$$
$$= (3 \times 10^{5}\ \text{km/s})(1.33\ \text{s})$$
$$= \boxed{397{,}500\ \text{km}}$$

CHAPTER 11

11.2 $z_{crust} = 35$ km

$\rho_{mantle} = 3.3 \dfrac{g}{cm^3}$

$\rho_{crust} = 2.7 \dfrac{g}{cm^3}$

$h = ?$

$$h = z_{crust} - z_{crust}\left(\frac{\rho_{crust}}{\rho_{mantle}}\right)$$

$$= 35.0\text{ km} - 35.0\text{ km}\left(\frac{2.7\,\frac{g}{cm^3}}{3.3\,\frac{g}{cm^3}}\right)$$

$$= 35.0\text{ km} - 35.0\left(\frac{2.7}{3.3}\right)\text{cm}\ \frac{\cancel{\frac{g}{cm^3}}}{\cancel{\frac{g}{cm^3}}}$$

$$= 35.0\text{ km} - 35.0\ (0.82)\text{ km}$$

$$= 35.0\text{ km} - 28.7\text{ km}$$

$$= \boxed{6.3\text{ km}}$$

From Example 11.1:

$$h_{oceanic} = 0.6\text{ km}$$

$$\text{difference} = h_{continental} - h_{oceanic}$$

$$= 6.3\text{ km} - 0.6\text{ km}$$

$$= \boxed{5.7\text{ km}}$$

11.4 $d = 6.9 \times 10^6$ m

$v = 3.25 \times 10^{-2}$ m/yr

$t = ?$

$$d = vt$$

$$t = d/v$$

$$= \frac{6.9 \times 10^6\text{ m}}{3.25 \times 10^{-2}\text{ m/yr}}$$

$$= \boxed{2.12 \times 10^8\text{ years}}$$

CHAPTER 12

12.2 If the starting time is 11:51:51 a.m. and there are 60 seconds in each minute, then it takes 9 seconds to be 11:52:00 A.M. After 69 seconds, the time is 11:53:00 a.m. Then, 6 more seconds to be a total of 75 seconds transpiring, to be 11:53:06 A.M.

12.4 Each magnitude step represents 10 times more energy, so if there are two steps between 5.2 and 7.2, then 10 × 10 = 100 times more energy.

12.6 $d = 11{,}000$ km

$v = 780$ km/hr

$t = ?$

$$v = \frac{d}{t} \Rightarrow t = \frac{d}{v}$$

$$= \frac{11{,}000\text{ km}}{780\text{ km/hr}}$$

$$= \frac{11{,}000}{780}\ \frac{\cancel{\text{km}}}{\cancel{\text{km}}/\text{hr}}$$

$$= \boxed{14\text{ hrs}}$$

CHAPTER 13

13.2 Rearrange the pressure-volume equation to solve for volume at a pressure of 850 millibars.

$P_1 = 1{,}013$ millibars

$V_1 = 825.0\text{ cm}^3$

$P_2 = 850$ millibars

$V_2 = ?$

$$P_1V_1 = P_2V_2 \quad \therefore \quad V_2 = \frac{P_1V_1}{P_2}$$

$$V_2 = \frac{(1{,}013\text{ millibars})(825.0\text{ cm}^3)}{(850\text{ millibars})}$$

$$= \frac{(1{,}013)(825.0)}{(850)}\ \frac{(\cancel{\text{millibar}})(\text{cm}^3)}{(\cancel{\text{millibar}})}$$

$$= \boxed{983\text{ cm}^3}$$

13.4 relative humidity = 80%

absolute maximum humidity = 37.5 g/m^3

absolute humidity = ?

$$\text{relative humidity} = \frac{\text{absolute humidity}}{\text{absolute maximum humidity}} \times 100\%$$

$$\text{absolute humidity} = \left(\text{relative humidity}\right) \times \left(\text{absolute maximum humidity}\right) \times \frac{1}{100\%}$$

$$= \frac{80\cancel{\%} \times 37.5\text{ g/m}^3}{100\cancel{\%}}$$

$$= \boxed{30\text{ g/m}^3}$$

CHAPTER 14

14.2 Multiply the groundwater discharge component of the budget by the drainage area to obtain volume. Perform the necessary unit conversions so the units are in cubic meters.

$Q_G = 68$ mm

$A = 12\text{ km}^2$

volume = ?

volume = Q_GA

Convert mm to m:

$$68\ \cancel{\text{mm}}\left(\frac{1\text{ m}}{1 \times 10^3\ \cancel{\text{mm}}}\right)$$

6.8×10^{-2} m

Convert km^2 to m^2:

$$12\ \cancel{\text{km}^2}\left(\frac{1\text{ m}^2}{1 \times 10^{-6}\ \cancel{\text{km}^2}}\right)$$

$1.2 \times 10^7\text{ m}^2$

$$\text{volume} = 6.8 \times 10^{-2}\text{ m}(1.2 \times 10^7\text{ m}^2)$$

$$= \boxed{8.2 \times 10^5\text{ m}^3}$$

14.4 $V = 1\text{ L}$
$\rho_{seawater} = 1.03\text{ g/cm}^3$
salinity = 34‰
$m_{salt} = ?$

Determine new mass of seawater

$$\rho = \frac{m}{V} \quad \therefore \quad m = \rho V$$

$$m = (1.03\text{ g/cm}^3)(1\text{ L})\left(\frac{1{,}000\text{ cm}^3}{1\text{ L}}\right)$$
$$= 1{,}030\text{ g}$$

Determine mass of salt needed to make 34‰

$$m_{salt} = m_{seawater} \times \text{salinity}$$
$$= (1030\text{ g})(0.034)$$
$$= \boxed{35\text{ g of salt}}$$

14.6 Determine the water depth 165 m offshore, using the slope of the bottom.

$\text{slope} = 2.1\,\frac{\text{cm}}{\text{m}}$
$\Delta X = 165\text{ m}$
$\Delta Y = ?$

$$\text{slope} = \frac{\Delta Y}{\Delta X} \quad \therefore \; \Delta Y = \Delta X\text{ slope}$$

Convert $\frac{\text{cm}}{\text{m}}$ to $\frac{\text{m}}{\text{m}}$:

$$2.1\frac{\cancel{\text{cm}}}{\cancel{\text{m}}}\left(\frac{\cancel{1\text{ m}}}{1 \times 10^2\,\cancel{\text{cm}}}\right)$$
$$2.1 \times 10^{-2}$$
$$\Delta Y = 165\text{ m }(2.1 \times 10^{-2})$$
$$= 3.5\text{ m}$$

The breakers occur where the water depth is about 1.33 times the wave height, so the wave height can be calculated from the water depth.
water depth = 3.5 m
wave height = ?

$$\text{water depth} = 1.33\text{ (wave height)}$$
$$\therefore \text{wave height} = \frac{\text{water depth}}{1.33}$$
$$\text{wave height} = \frac{3.5\text{ m}}{1.33}$$
$$= \boxed{2.6\text{ m}}$$

CHAPTER 15

15.2 $f = 7.30 \times 10^{14}\text{ Hz}$
$h = 6.63 \times 10^{-34}\text{ J}\cdot\text{s}$
$E = ?$

$$E = hf$$
$$= (6.63 \times 10^{-34}\text{ J}\cdot\text{s})\left(7.30 \times 10^{14}\,\frac{1}{\text{s}}\right)$$
$$= (6.63 \times 10^{-34})(7.30 \times 10^{14})\text{ J}\cdot\text{s} \times \frac{1}{\text{s}}$$
$$= \boxed{4.84 \times 10^{-19}\text{ J}}$$

15.4 $E_H = -1.36 \times 10^{-19}\text{ J}$
$E_L = -2.42 \times 10^{-19}\text{ J}$
$h = 6.63 \times 10^{-34}\text{ J}\cdot\text{s}$
$f = ?$

$$hf = E_H - E_L \quad \therefore \; f = \frac{E_H - E_L}{h}$$
$$= \frac{(-1.36 \times 10^{-19}\text{ J}) - (-2.42 \times 10^{-19}\text{ J})}{6.63 \times 10^{-34}\text{ J}\cdot\text{s}}$$
$$= \frac{1.06 \times 10^{-19}}{6.63 \times 10^{-34}}\,\frac{\cancel{\text{J}}}{\cancel{\text{J}}\cdot\text{s}}$$
$$= 1.60 \times 10^{14}\,\frac{1}{\text{s}}$$
$$= \boxed{1.60 \times 10^{14}\text{ Hz}}$$

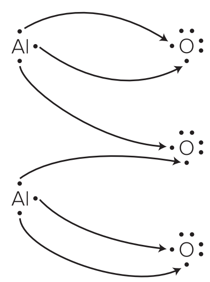
CHAPTER 16

16.2 From the list of elements provided in the Table of Atomic Weights, the symbol for aluminum is Al, and the atomic number is 13. Using the periodic table, you can find that Al is in family IIIA, which means that calcium has three valence electrons.

According to the octet rule, the aluminum ion must lose three electrons to acquire the stable outer arrangement of the noble gases. Since the atomic number is 13, a calcium atom has twenty protons (13 +) and twenty electrons (13 −). When it is ionized, the aluminum ion will lose three electrons for a total charge of (13 +) + (10 −), or 3 +.

The calcium ion is represented by the chemical symbol for calcium and the charge shown as a superscript: Al^{3+}.

16.4



$\boxed{Al_2O_3}$

16.6 **(a)** Lead is a variable-charge transition element (table 16.3), and fluorine ions are F^{1-}. The lead ion must be Pb^{2+} because the compound PbF_2 is electrically neutral. Therefore, the name is lead(II) fluoride.

(b) The Roman numeral tells you the charge on the copper ion, so the ions are Cu^{1+} and S^{2-}. The formula is Cu_2S.

CHAPTER 17

17.2 Looking at the solubility values for KCl and NaCl on figure 17.6, the lines cross showing identical solubility at a temperature equal to 37°C.

17.4 $1.563°\text{C} \times \frac{342\text{ g}}{0.521°\text{C}} = \boxed{1{,}026\text{ g}}$

CHAPTER 18

18.2 Because carbon has a molecular weight of 12.0 units and hydrogen has a molecular weight of 1.0 unit, the total molecular weight of C_5H_{10} is 5(12.0 units) + 10(1.0 units) = 70.0 units.

CHAPTER 19

19.2 $$\text{number} = 8.6 \times 10^{-19}\ \cancel{\text{m}^3} \times \frac{1\ \text{atom}}{6.2 \times 10^{-31}\ \cancel{\text{m}^3}}$$
$$= \boxed{1.4 \times 10^{12}\ \text{atoms}}$$

19.4 $$= 500 \times 10^{-6}\ \text{m} \times \left(\frac{1\ \textit{water molecule}}{2.75 \times 10^{-10}\ \text{m}}\right)$$
$$= 5.0 \times 10^{-4}\ \cancel{\text{m}} \times \left(\frac{1\ \textit{water molecule}}{2.75 \times 10^{-10}\ \cancel{\text{m}}}\right)$$
$$\boxed{= 1.8 \times 10^{6}\ \textit{water molecules}}$$

CHAPTER 20

20.2 If the reproduction rate is 2^t and $t = 6$, then the number of bacteria is 2^6 or 64 bacteria.

CHAPTER 21

21.2 $$\text{ratio} = \frac{\text{height}_{\text{modern}}}{\text{height}_{\text{Lucy}}} = \frac{1.8\ \cancel{\text{m}}}{1.5\ \cancel{\text{m}}} = \boxed{1.2\ \text{times taller}}$$

CHAPTER 22

22.2 $$\begin{matrix}\text{number of people} \\ \text{with brown eyes}\end{matrix} = \begin{matrix}\text{total} \\ \text{population}_{\text{Earth}}\end{matrix} \times \begin{matrix}\text{percentage of} \\ \text{people}_{\text{brown eyes}}\end{matrix}$$
$$= 7.5 \times 10^{9}\ \text{people} \times 55\%$$
$$= \boxed{4.1 \times 10^{9}\ \text{people}}$$

연습문제 해답

Note: Solutions that involve calculations of measurements are rounded up or down to conform to the rules for significant figures.

CHAPTER 1

1.1 Answers will vary but should have the relationship of 100 cm in 1 m, for example, 178 cm = 1.78 m.

1.2 Since density is given by the relationship $\rho = m/V$, then

$$\rho = \frac{m}{V} = \frac{272 \text{ g}}{20.0 \text{ cm}^3}$$
$$= \frac{272}{20.0}\ \frac{\text{g}}{\text{cm}^3}$$
$$= \boxed{13.6\ \frac{\text{g}}{\text{cm}^3}}$$

1.3 The volume of a sample of lead is given and the problem asks for the mass. From the relationship of $\rho = m/V$, solving for the mass (m) tells you that the density (ρ) times the volume (V) equals the mass, or $m = \rho V$. The density of lead, 11.4 g/cm^3, can be obtained from table 1.2, so

$$\rho = \frac{m}{V}$$
$$V\rho = \frac{m\cancel{V}}{\cancel{V}}$$
$$m = \rho V$$
$$m = \left(11.4\ \frac{\text{g}}{\text{cm}^3}\right)(10.0 \text{ cm}^3)$$
$$= 11.4 \times 10.0\ \frac{\text{g}}{\text{cm}^3} \times \text{cm}^3$$
$$= 11.4\ \frac{\text{g}\cdot\cancel{\text{cm}^3}}{\cancel{\text{cm}^3}}$$
$$= \boxed{114 \text{ g}}$$

1.4 Solving the relationship $\rho = m/V$ for volume gives $V = m/\rho$, and

$$\rho = \frac{m}{V}$$
$$V\rho = \frac{m\cancel{V}}{\cancel{V}}$$
$$\frac{V\cancel{\rho}}{\cancel{\rho}} = \frac{m}{\rho}$$
$$V = \frac{m}{\rho}$$
$$V = \frac{600 \text{ g}}{3.00\ \frac{\text{g}}{\text{cm}^3}}$$
$$= \frac{600}{3.00}\ \frac{\text{g}}{1} \times \frac{\text{cm}^3}{\text{g}}$$
$$= 200\ \frac{\cancel{\text{g}}\cdot\text{cm}^3}{\cancel{\text{g}}}$$
$$= \boxed{200 \text{ cm}^3}$$

1.5 A 50.0 cm^3 sample with a mass of 34.0 grams has a density of

$$\rho = \frac{m}{V} = \frac{34.0 \text{ g}}{50.0 \text{ cm}^3}$$
$$= \frac{34.0}{50.0}\ \frac{\text{g}}{\text{cm}^3}$$
$$= \boxed{0.680\ \frac{\text{g}}{\text{cm}^3}}$$

According to table 1.2, 0.680 g/cm^3 is the density of gasoline, so the substance must be gasoline.

1.6 The problem asks for a mass and gives a volume, so you need a relationship between mass and volume. Table 1.2 gives the density of water as 1.00 g/cm^3, which is a density that is easily remembered. The volume is given in liters (L), which should first be converted to cm^3 because this is the unit in which density is expressed. The relationship of $\rho = m/V$ solved for mass is ρV, so the solution is

$$\rho = \frac{m}{V} \qquad \therefore m = \rho V$$
$$= \left(1.00\ \frac{\text{g}}{\text{cm}^3}\right)(40{,}000 \text{ cm}^3)$$
$$= 1.00 \times 40{,}000\ \frac{\text{g}}{\text{cm}^3} \times \text{cm}^3$$
$$= 40{,}000\ \frac{\text{g}\cdot\cancel{\text{cm}^3}}{\cancel{\text{cm}^3}}$$
$$= 40{,}000 \text{ g}$$
$$= \boxed{40 \text{ kg}}$$

1.7 From table 1.2, the density of aluminum is given as 2.70 g/cm^3. Converting 2.1 kg to the same units as the density gives 2,100 g. Solving $\rho = m/V$ for the volume gives

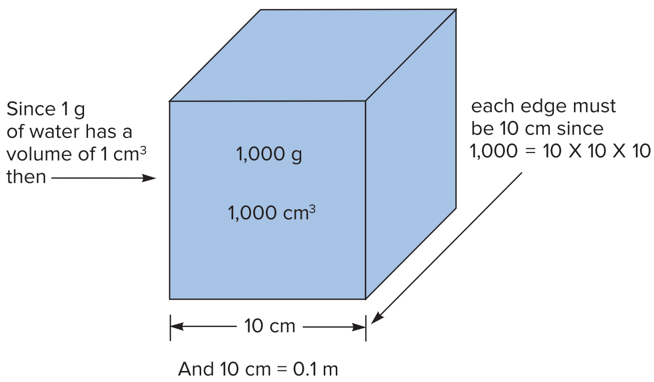
$$V = \frac{m}{\rho} = \frac{2{,}100 \text{ g}}{2.70 \frac{\text{g}}{\text{cm}^3}}$$

$$= \frac{2{,}100}{2.70}\frac{\text{g}}{1} \times \frac{\text{cm}^3}{\text{g}}$$

$$= 777.78 \frac{\cancel{\text{g}}\cdot\text{cm}^3}{\cancel{\text{g}}}$$

$$= \boxed{780 \text{ cm}^3}$$

1.8 The length of one side of the box is 0.1 m. Reasoning: Since the density of water is 1.00 g/cm^3, then the volume of 1,000 g of water is 1,000 cm^3. A cubic box with a volume of 1,000 cm^3 is 10 cm (since $10 \times 10 \times 10 = 1{,}000$). Converting 10 cm to m units, the cube is 0.1 m on each edge.



1.9 The relationship between mass, volume, and density is $\rho = m/V$. The problem gives a volume but not a mass. The mass, however, can be assumed to remain constant during the compression of the bread, so the mass can be obtained from the original volume and density, or

$$\rho = \frac{m}{V} \qquad \therefore m = \rho V = \left(0.2 \frac{\text{g}}{\text{cm}^3}\right)(3{,}000 \text{ cm}^3)$$

$$= 0.2 \times 3{,}000 \frac{\text{g}}{\text{cm}^3} \times \text{cm}^3$$

$$= 600 \frac{\text{g}\cdot\cancel{\text{cm}^3}}{\cancel{\text{cm}^3}}$$

$$= 600 \text{ g}$$

A mass of 600 g and the new volume of 1,500 cm^3 means that the new density of the crushed bread is

$$\rho = \frac{m}{V} = \frac{600 \text{ g}}{1{,}500 \text{ cm}^3}$$

$$= \frac{600}{1{,}500}\frac{\text{g}}{\text{cm}^3}$$

$$= \boxed{0.4 \frac{\text{g}}{\text{cm}^3}}$$

1.10 According to table 1.2, lead has a density of 11.4 g/cm^3. Therefore, a 1.00 cm^3 sample of lead would have a mass of

$$\rho = \frac{m}{V} \qquad \therefore m = \rho V$$

$$= \left(11.4 \frac{\text{g}}{\text{cm}^3}\right)(1.00 \text{ cm}^3)$$

$$= 11.4 \times 1.00 \frac{\text{g}}{\text{cm}^3} \times \text{cm}^3$$

$$= 11.4 \frac{\text{g}\cdot\cancel{\text{cm}^3}}{\cancel{\text{cm}^3}}$$

$$= 11.4 \text{ g}$$

Also according to table 1.2, copper has a density of 8.96 g/cm^3. To balance a mass of 11.4 g of lead, a volume of this much copper would be required:

$$\rho = \frac{m}{V} \qquad \therefore V = \frac{m}{\rho}$$

$$= \frac{11.4 \text{ g}}{8.96 \frac{\text{g}}{\text{cm}^3}}$$

$$= \frac{11.4}{8.96}\frac{\text{g}}{1} \times \frac{\text{cm}^3}{\text{g}}$$

$$= 1.27232 \frac{\cancel{\text{g}}\cdot\text{cm}^3}{\cancel{\text{g}}}$$

$$= \boxed{1.27 \text{ cm}^3}$$

CHAPTER 2

2.1 Listing the quantities with their symbols, we can see the problem involves the quantities found in the definition of average speed:

$$\bar{v} = 350.0 \text{ m/s}$$
$$t = 5.00 \text{ s}$$
$$d = ?$$

$$\bar{v} = \frac{d}{t} \qquad \therefore d = \bar{v}t$$

$$= \left(350.0 \frac{\text{m}}{\text{s}}\right)(5.00 \text{ s})$$

$$= (350.0)(5.00) \frac{\text{m}}{\text{s}} \times \text{s}$$

$$= \boxed{1{,}750 \text{ m}}$$

2.2 The initial velocity, final velocity, and time are known and the problem asked for the acceleration. Listing these quantities with their symbols, we have

$$v_i = 0 \text{ m/s}$$
$$v_f = 15.0 \text{ m/s}$$
$$t = 10.0 \text{ s}$$
$$a = ?$$

These are the quantities involved in the acceleration equation, which is already solved for the unknown:

$$a = \frac{v_f - v_i}{t}$$

$$a = \frac{15.0 \text{ m/s} - 0 \text{ m/s}}{10.0 \text{ s}}$$

$$= \frac{15.0}{10.0}\frac{\text{m}}{\text{s}} \times \frac{1}{\text{s}}$$

$$= \boxed{1.50 \frac{\text{m}}{\text{s}^2}}$$

2.3 The distance (d) and the time (t) quantities are given in the problem, and

$$\bar{v} = \frac{d}{t} = \frac{160 \text{ km}}{2.0 \text{ h}}$$

$$= \frac{160}{2.0}\frac{\text{km}}{\text{h}}$$

$$= \boxed{80 \text{ km/h}}$$

The units cannot be simplified further. Note two significant figures in the answer, which is the least number of significant figures involved in the division operation.

2.4 Listing the known and unknown quantities:

$$m = 40.0 \text{ kg}$$
$$a = 2.4 \text{ m/s}^2$$
$$F = ?$$

These are the quantities found in Newton's second law of motion, $F = ma$, which is already solved for force (F). Thus,

$$F = (40.0 \text{ kg})\left(2.4 \frac{\text{m}}{\text{s}^2}\right)$$

$$= 40.0 \times 2.4 \frac{\text{kg·m}}{\text{s}^2}$$

$$= \boxed{96 \text{ N}}$$

2.5 List the known and unknown quantities for the first situation, using an unbalanced force of 18.0 N to give the object an acceleration of 3 m/s^2:

$$F_1 = 18 \text{ N}$$
$$a_1 = 3 \text{ m/s}^2$$

For the second situation, we are asked to find the force needed for an acceleration of 10 m/s^2:

$$a_2 = 10 \text{ m/s}^2$$
$$F = ?$$

These are the quantities of Newton's second law of motion, $F = ma$, but the mass appears to be missing. The mass can be found from

$$F = ma \qquad \therefore m_1 = \frac{F_1}{a_1} = \frac{18 \frac{\text{kg·m}}{\text{s}^2}}{3 \frac{\text{m}}{\text{s}^2}}$$

$$= \frac{18}{3}\frac{\text{kg·m}}{\text{s}^2} \times \frac{\text{s}^2}{\text{m}}$$

$$= 6 \text{ kg}$$

Now that we have the mass, we can easily find the force needed for an acceleration of 10 m/s^2:

$$F_2 = m_2 a_2$$

$$= (6 \text{ kg})\left(10 \frac{\text{m}}{\text{s}^2}\right)$$

$$= 6 \times 10 \frac{\text{kg·m}}{\text{s}^2}$$

$$= \boxed{60 \text{ N}}$$

2.6 Listing the known and unknown quantities:

$$m = 70.0 \text{ kg} \qquad w = mg$$
$$g = 9.8 \text{ m/s}^2$$
$$w = ?$$

$$w = (70.0 \text{ kg})\left(9.8 \frac{\text{m}}{\text{s}^2}\right)$$

$$= 70.0 \times 9.8 \text{kg} \times \frac{\text{m}}{\text{s}^2}$$

$$= 686 \frac{\text{kg·m}}{\text{s}^2}$$

$$= \boxed{690 \text{ N}}$$

2.7 Listing the known and unknown quantities:

$$m = 100 \text{ kg}$$
$$v = 6 \text{ m/s}$$
$$p = ?$$

These are the quantities found in the equation for momentum, $p = mv$, which is already solved for momentum (p). Thus,

$$p = mv$$

$$= (100 \text{ kg})\left(6 \frac{\text{m}}{\text{s}}\right)$$

$$= \boxed{600 \frac{\text{kg·m}}{\text{s}}}$$

(Note the lowercase p is the symbol used for momentum. This is one of the few cases where the English letter does not provide a clue about what it stands for. The units for momentum are also somewhat unusual for metric units since they do not have a name or single symbol to represent them.)

2.8 Listing the known and unknown quantities:

$$w = 13{,}720 \text{ N}$$
$$v = 91 \text{ km/h}$$
$$p = ?$$

The equation for momentum is $p = mv$, which is already solved for momentum (p). The weight unit must be first converted to a mass unit:

$$w = mg \qquad \therefore m = \frac{w}{g} = \frac{13{,}720 \frac{\text{kg·m}}{\text{s}^2}}{9.8 \frac{\text{m}}{\text{s}^2}}$$

$$= \frac{13{,}720}{9.8}\frac{\text{kg·m}}{\text{s}^2} \times \frac{\text{s}^2}{\text{m}}$$

$$= 1{,}400 \text{ kg}$$

The km/h unit should next be converted to m/s. Using the conversion factor from inside the front cover:

$$\frac{0.2778 \frac{\text{m}}{\text{s}}}{1 \frac{\text{km}}{\text{h}}} \times 91 \frac{\text{km}}{\text{h}}$$

$$0.2778 \times 91 \frac{\text{m}}{\text{s}} \times \frac{\text{h}}{\text{km}} \times \frac{\text{km}}{\text{h}}$$

$$25.2798 \frac{\text{m}}{\text{s}}$$

$$25 \frac{\text{m}}{\text{s}}$$

Now, listing the converted known and unknown quantities:

$$m = 1{,}400 \text{ kg}$$
$$v = 25 \text{ m/s}$$
$$p = ?$$

and solving for momentum (p),

$$\begin{aligned} p &= mv \\ &= (1{,}400 \text{ kg})\left(25 \frac{\text{m}}{\text{s}}\right) \\ &= \boxed{35{,}000 \frac{\text{kg·m}}{\text{s}}} \end{aligned}$$

2.9 Listing the known and unknown quantities:

Bullet $\longrightarrow m = 0.015$ kg Rifle $\longrightarrow m = 6$ kg
Bullet $\longrightarrow v = 200$ m/s Rifle $\longrightarrow v = ?$ m/s

Note the mass of the bullet was converted to kilograms. This is a conservation of momentum question, where the bullet and rifle can be considered as a system of interacting objects:

$$\text{Bullet momentum} = -\text{rifle momentum}$$
$$(mv)_\text{b} = -(mv)_\text{r}$$
$$(mv)_\text{b} - (mv)_\text{r} = 0$$
$$(0.015 \text{ kg})\left(200 \frac{\text{m}}{\text{s}}\right) - (6 \text{ kg})v_\text{r} = 0$$
$$\left(3 \text{ kg·}\frac{\text{m}}{\text{s}}\right) - (6 \text{ kg} \cdot v_\text{r}) = 0$$
$$\left(3 \text{ kg} \cdot \frac{\text{m}}{\text{s}}\right) = (6 \text{ kg} \cdot v_\text{r})$$

$$\begin{aligned} v_\text{r} &= \frac{3 \text{ kg} \cdot \frac{\text{m}}{\text{s}}}{6 \text{ kg}} \\ &= \frac{3}{6}\frac{\text{kg}}{1} \times \frac{1}{\text{kg}} \times \frac{\text{m}}{\text{s}} \\ &= \boxed{0.5 \frac{\text{m}}{\text{s}}} \end{aligned}$$

The rifle recoils with a velocity of 0.5 m/s.

2.10 A unit conversion is needed:

$$\left(90.0 \frac{\text{km}}{\text{h}}\right)\left(0.2778 \frac{\frac{\text{m}}{\text{s}}}{\frac{\text{km}}{\text{h}}}\right) = 25.0 \text{ m/s}$$

a. $F = ma \quad \therefore m = \dfrac{F}{a}$ and $a = \dfrac{v_\text{f} - v_\text{i}}{t}$, so

$$\begin{aligned} m = \frac{F}{\frac{v_\text{f} - v_\text{i}}{t}} &= \frac{5{,}000.0 \frac{\text{kg·m}}{\text{s}^2}}{\frac{25.0 \text{ m/s} - 0}{5.0 \text{ s}}} \\ &= \frac{5{,}000.0 \frac{\text{kg·m}}{\text{s}^2}}{5.0 \frac{\text{m}}{\text{s}^2}} \\ &= \frac{5{,}000.0}{5.0}\frac{\text{kg·m}}{\text{s}^2} \times \frac{\text{s}^2}{\text{m}} \\ &= 1{,}000 \frac{\text{kg·}\cancel{\text{m}}\text{·}\cancel{\text{s}^2}}{\cancel{\text{m}}\text{·}\cancel{\text{s}^2}} \\ &= \boxed{1.0 \times 10^3 \text{ kg}} \end{aligned}$$

b.

$$\begin{aligned} w &= mg \\ &= (1.0 \times 10^3 \text{ kg})\left(9.8 \frac{\text{m}}{\text{s}^2}\right) \\ &= (1.0 \times 10^3)(9.8) \text{ kg} \times \frac{\text{m}}{\text{s}^2} \\ &= 9.8 \times 10^3 \frac{\text{kg·m}}{\text{s}^2} \\ &= \boxed{9.8 \times 10^3 \text{ N}} \end{aligned}$$

2.11

$$\begin{aligned} F &= \frac{mv^2}{r} \\ &= \frac{(0.20 \text{ kg})\left(3.0 \frac{\text{m}}{\text{s}}\right)^2}{1.5 \text{ m}} \\ &= \frac{(0.20 \text{ kg})\left(9.0 \frac{\text{m}^2}{\text{s}^2}\right)}{1.5 \text{ m}} \\ &= \frac{0.20 \times 9.0}{1.5}\frac{\text{kg·m}^2}{\text{s}^2} \times \frac{1}{\text{m}} \\ &= 1.2 \frac{\text{kg·m·}\cancel{\text{m}}}{\text{s}^2\text{·}\cancel{\text{m}}} \\ &= \boxed{1.2 \text{ N}} \end{aligned}$$

CHAPTER 3

3.1 Listing the known and unknown quantities:

$$F = 200 \text{ N}$$
$$d = 3 \text{ m}$$
$$w = ?$$

These are the quantities found in the equation for work, $W = Fd$, which is already solved for work (W). Thus,

$$\begin{aligned} w &= Fd \\ &= \left(200 \frac{\text{kg}\cdot\text{m}}{\text{s}^2}\right)(3 \text{ m}) \\ &= (200)(3)\text{N}\cdot\text{m} \\ &= \boxed{600 \text{ J}} \end{aligned}$$

3.2 Listing the known and unknown quantities:

$$F = 440 \text{ N}$$
$$d = 5.0 \text{ m}$$
$$w = 880 \text{ N}$$
$$W = ?$$

These are the quantities found in the equation for work, $W = Fd$, which is already solved for work (W). As you can see in the equation, the force exerted and the distance the box was moved are the quantities used in determining the work accomplished. The weight of the box is a different variable and one that is not used in this equation. Thus,

$$\begin{aligned} W &= Fd \\ &= \left(440 \frac{\text{kg}\cdot\text{m}}{\text{s}^2}\right)(5.0 \text{ m}) \\ &= 2{,}200 \text{ N}\cdot\text{m} \\ &= \boxed{2{,}200 \text{ J}} \end{aligned}$$

3.3 Note that 10.0 kg is a mass quantity and not a weight quantity. Weight is found from $w = mg$, a form of Newton's second law of motion. Thus, the force that must be exerted to lift the backpack is its weight, or (10.0 kg) × (9.8 m/s^2), which is 98 N. Therefore, a force of 98 N was exerted on the backpack through a distance of 1.5 m, and

$$\begin{aligned} W &= Fd \\ &= \left(98 \frac{\text{kg}\cdot\text{m}}{\text{s}^2}\right)(1.5 \text{ m}) \\ &= 147 \text{ N}\cdot\text{m} \\ &= \boxed{150 \text{ J}} \end{aligned}$$

3.4 Weight is defined as the force of gravity acting on an object, and the greater the force of gravity, the harder it is to lift the object. The force is proportional to the mass of the object, as the equation $w = mg$ tells you. Thus, the force you exert when lifting is $F = w = mg$, so the work you do on an object you lift must be $W = mgh$.
You know the mass of the box and you know the work accomplished. You also know the value of the acceleration due to gravity, g, so the list of known and unknown quantities is:

$$m = 102 \text{ kg}$$
$$g = 9.8 \text{ m/s}^2$$
$$W = 5{,}000 \text{ J}$$
$$h = ?$$

The equation $W = mgh$ is solved for work, so the first thing to do is to solve it for h, the unknown height in this problem (note that height is also a distance):

$$\begin{aligned} W = mgh \qquad \therefore h &= \frac{W}{mg} \\ &= \frac{5{,}000 \frac{\text{kg}\cdot\text{m}}{\text{s}^2} \times \text{m}}{(102 \text{ kg})\left(9.8 \frac{\text{m}}{\text{s}^2}\right)} \\ &= \frac{5{,}000.0}{102 \times 9.8} \frac{\text{kg}\cdot\text{m}}{\text{s}^2} \times \frac{\text{m}}{1} \times \frac{1}{\text{kg}} \times \frac{\text{s}^2}{\text{m}} \\ &= \frac{5{,}000}{999.6} \text{ m} \\ &= \boxed{5 \text{ m}} \end{aligned}$$

3.5 A student running up the stairs has to lift herself, so her weight is the required force needed. Thus, the force exerted is $F = w = mg$, and the work done is $W = mgh$. You know the mass of the student, the height, and the time. You also know the value of the acceleration due to gravity, g, so the list of known and unknown quantities is:

$$m = 60.0 \text{ kg}$$
$$g = 9.8 \text{ m/s}^2$$
$$h = 5.00 \text{ m}$$
$$t = 3.92 \text{ s}$$
$$p = ?$$

The equation $p = \dfrac{mgh}{t}$ is already solved for power, so:

a.
$$\begin{aligned} p &= \frac{mgh}{t} \\ &= \frac{(60.0 \text{ kg})\left(9.8 \frac{\text{m}}{\text{s}^2}\right)(5.00 \text{ m})}{3.92 \text{ s}} \\ &= \frac{(60.0)(9.8)(5.00)}{(3.92)} \frac{\left(\frac{\text{kg}\cdot\text{m}}{\text{s}^2}\right) \times \text{m}}{\text{s}} \\ &= \frac{2940}{3.92} \frac{\text{N}\cdot\text{m}}{\text{s}} \\ &= 750 \frac{\text{J}}{\text{s}} \\ &= \boxed{750 \text{ W}} \end{aligned}$$

b. A power of 750 watts is almost one horsepower.

3.6 Listing the known and unknown quantities:

$$m = 2{,}000 \text{ kg}$$
$$v = 72 \text{ km/h}$$
$$KE = ?$$

These are the quantities found in the equation for kinetic energy, $KE = 1/2mv^2$, which is already solved. However, note that the velocity is in units of km/h, which must be changed to m/s before doing anything else (it must be m/s because all energy and work units are in units of the joule [J]. A joule is a newton-meter, and a newton is a kg · m/s^2). Using the conversion factor from inside the front cover of your text,

$$\frac{0.2778 \frac{\text{m}}{\text{s}}}{1.0 \frac{\text{km}}{\text{h}}} \times 72 \frac{\text{km}}{\text{h}}$$

$$(0.2778)(72) \frac{\text{m}}{\text{s}} \times \frac{\text{h}}{\text{km}} \times \frac{\text{km}}{\text{h}}$$

$$20 \frac{\text{m}}{\text{s}}$$

and

$$\begin{aligned} KE &= \frac{1}{2}mv^2 \\ &= \frac{1}{2}(2{,}000 \text{ kg})\left(20 \frac{\text{m}}{\text{s}}\right)^2 \\ &= \frac{1}{2}(2{,}000 \text{ kg})\left(400 \frac{\text{m}^2}{\text{s}^2}\right) \\ &= \frac{1}{2} \times 2{,}000 \times 400 \frac{\text{kg·m}^2}{\text{s}^2} \\ &= 400{,}000 \frac{\text{kg·m}}{\text{s}^2} \times \text{m} \\ &= 400{,}000 \text{ N·m} \\ &= \boxed{4 \times 10^5 \text{ J}} \end{aligned}$$

Scientific notation is used here to simplify a large number and to show one significant figure.

3.7 Recall the relationship between work and energy—that you do work on an object when you throw it, giving it kinetic energy, and the kinetic energy it has will do work on something else when stopping. Because of the relationship between work and energy, you can calculate (1) the work you do, (2) the kinetic energy a moving object has as a result of your work, and (3) the work it will do when coming to a stop, and all three answers should be the same. Thus, you do not have a force or a distance to calculate the work needed to stop a moving car, but you can simply calculate the kinetic energy of the car. Both answers should be the same.

Before you start, note that the velocity is in units of km/h, which must be changed to m/s before doing anything else (it must be m/s because all energy and work units are in units of the joule [J]. A joule is a newton-meter, and a newton is a kg · m/s^2). Using the conversion factor from inside the front cover,

$$\frac{0.2778 \frac{\text{m}}{\text{s}}}{1.0 \frac{\text{km}}{\text{h}}} \times 54.0 \frac{\text{km}}{\text{h}}$$

$$0.2778 \times 54.0 \frac{\text{m}}{\text{s}} \times \frac{\text{h}}{\text{km}} \times \frac{\text{km}}{\text{h}}$$

$$15.0 \frac{\text{m}}{\text{s}}$$

and

$$\begin{aligned} KE = \frac{1}{2}mv^2 &= \frac{1}{2}(1{,}000.0 \text{ kg})\left(15.0 \frac{\text{m}}{\text{s}}\right)^2 \\ &= \frac{1}{2}(1{,}000.0 \text{ kg})\left(225 \frac{\text{m}^2}{\text{s}^2}\right) \\ &= \frac{1}{2} \times 1{,}000.0 \times 225 \frac{\text{kg·m}^2}{\text{s}^2} \\ &= 112{,}500 \frac{\text{kg·m}}{\text{s}^2} \times \text{m} \\ &= 112{,}500 \text{ N·m} \\ &= \boxed{1.13 \times 10^5 \text{ J}} \end{aligned}$$

Scientific notation is used here to simplify a large number and to easily show three significant figures. The answer could likewise be expressed as 113 kJ.

3.8 **a.** How much energy was used by a 1,000 kg car climbing a hill 51.02 m high is answered by how much work the car did. In this case, $W = Fd$ and the force exerted is the weight of the car, $w = mgh$. Thus,

$$\begin{aligned} w &= mgh \\ &= (1{,}000 \text{ kg})\left(9.8 \frac{\text{m}}{\text{s}^2}\right)(51.02 \text{ m}) \\ &= 1{,}000 \times 9.8 \times 51.02 \text{ kg} \times \frac{\text{m}}{\text{s}^2} \times \text{m} \\ &= 499{,}996 \frac{\text{kg·m}}{\text{s}^2} \times \text{m} \\ &= 500{,}000 \text{ N·m} \\ &= 5 \times 10^5 \text{ J (or 500 kJ)} \end{aligned}$$

b. How much potential energy the car has is found in the potential energy equation, $PE = mgh$. Note the potential energy is path independent, that is, depends only on the vertical height of the hill. Thus,

$$\begin{aligned} PE = mgh &= (1{,}000 \text{ kg})\left(9.8 \frac{\text{m}}{\text{s}^2}\right)(51.02 \text{ m}) \\ &= 1{,}000 \times 9.8 \times 51.02 \text{ kg} \times \frac{\text{m}}{\text{s}^2} \times \text{m} \\ &= 499{,}996 \frac{\text{kg·m}}{\text{s}^2} \times \text{m} \\ &= 500{,}000 \text{ N·m} \\ &= \boxed{5 \times 10^5 \text{ J (or 500 kJ)}} \end{aligned}$$

As you can see, the potential energy of the car is exactly the same as the amount of energy used to climb the hill.

3.9 a.

$$\begin{aligned} W &= Fd \\ &= (5\ \text{N})(1.5\ \text{m}) \\ &= (5)(1.5)\ \text{N}\cdot\text{m} \\ &= 7.5\ \text{J} \end{aligned}$$

b. The distance of the bookcase from some horizontal reference level did not change, so the gravitational potential energy does not change.

3.10 The force (F) needed to lift the book is equal to the weight (w) of the book, or $F = w$. Since $w = mg$, then $F = mg$. Work is defined as the product of a force moved through a distance, or $W = Fd$. The work done in lifting the book is therefore $W = mgh$, and:

a.

$$\begin{aligned} W &= mgh \\ &= (2.0\ \text{kg})(9.8\ \text{m/s}^2)(2.00\ \text{m}) \\ &= (2.0)(9.8)(2.00)\frac{\text{kg}\cdot\text{m}}{\text{s}^2} \times \text{m} \\ &= 39.2\ \frac{\text{kg}\cdot\text{m}^2}{\text{s}^2} \\ &= 39.2\ \text{J} = \boxed{39\ \text{J}} \end{aligned}$$

b.

$$PE = mgh = \boxed{39\ \text{J}}$$

c.

$$PE_{\text{lost}} = KE_{\text{gained}} = mgh = \boxed{39\ \text{J}}$$

(or)

$$\begin{aligned} v &= \sqrt{2\,gh} = \sqrt{(2)(9.8\ \text{m/s}^2)(2.00\ \text{m})} \\ &= \sqrt{39.2\ \text{m}^2/\text{s}^2} \\ &= 6.26\ \text{m/s} \end{aligned}$$

$$\begin{aligned} KE &= \frac{1}{2}mv^2 = \left(\frac{1}{2}\right)(2.0\ \text{kg})(6.26\ \text{m/s})^2 \\ &= \left(\frac{1}{2}\right)(2.0\ \text{kg})(39.2\ \text{m}^2/\text{s}^2) \\ &= (1.0)(39.2)\ \frac{\text{kg}\cdot\text{m}^2}{\text{s}^2} \\ &= \boxed{39\ \text{J}} \end{aligned}$$

3.11

$$\begin{aligned} KE &= \frac{1}{2}mv^2 = \frac{1}{2}(60.0\ \text{kg})\left(2.0\ \frac{\text{m}}{\text{s}}\right)^2 \\ &= \frac{1}{2}(60.0\ \text{kg})\left(4.0\ \frac{\text{m}^2}{\text{s}^2}\right) \\ &= 30.0 \times 4.0\ \text{kg} \times \left(\frac{\text{m}^2}{\text{s}^2}\right) \\ &= \boxed{120\ \text{J}} \end{aligned}$$

$$\begin{aligned} KE &= \frac{1}{2}mv^2 = \frac{1}{2}(60.0\ \text{kg})\left(4.0\ \frac{\text{m}}{\text{s}}\right)^2 \\ &= \frac{1}{2}(60.0\ \text{kg})\left(16\ \frac{\text{m}^2}{\text{s}^2}\right) \\ &= 30.0 \times 16\ \text{kg} \times \left(\frac{\text{m}^2}{\text{s}^2}\right) \\ &= \boxed{480\ \text{J}} \end{aligned}$$

Thus, doubling the speed results in a fourfold increase in kinetic energy.

3.12 a. The force needed is equal to the weight of the student. The English unit of a pound is a force unit, so

$$\begin{aligned} W &= Fd \\ &= (85\ \text{kg})(9.8\ \text{m/s}^2)(7.5\ \text{m}) \\ &= \boxed{6{,}200\ \text{N}\cdot\text{m}} \end{aligned}$$

b. Work (W) is defined as a force (F) moved through a distance (d), or $W = Fd$. Power (P) is defined as work (W) per unit of time (t), or $P = W/t$. Therefore,

$$\begin{aligned} P &= \frac{Fd}{t} \\ &= \frac{(85\ \text{kg})(9.8\ \text{m/s}^2)(7.5\ \text{m})}{10.0\ \text{s}} \\ &= \frac{(85)(9.8)(7.5)}{10.0}\ \frac{\text{kg}\cdot\text{m/s}^2\cdot\text{m}}{\text{s}} \\ &= 624.75\ \frac{\text{N}\cdot\text{m}}{\text{s}} = 624.75\ \frac{\text{J}}{\text{s}} \\ &= 624.75\ \text{W} \end{aligned}$$

One hp is defined as

$$746\ \text{W}$$

and

$$624.75\ \text{W} \times \frac{\text{hp}}{746\ \text{W}} = \boxed{0.83\ \text{hp}}$$

(Note that the student's power rating [624.75 W] is less than the power rating defined as 1 horsepower [746 W]. Thus, the student's horsepower must be less than 1 horsepower. A simple analysis such as this will let you know if you inverted the ratio or not.)

CHAPTER 4

4.1 Listing the known and unknown quantities: body temperature

$$T_{\text{F}} = 98.6°$$
$$T_{\text{C}} = ?$$

These are the quantities found in the equation for conversion of Fahrenheit to Celsius, $T_{\text{C}} = \frac{5}{9}(T_{\text{F}} - 32°)$, where T_F is the temperature in Fahrenheit and T_{C} is the temperature in Celsius. This equation describes a relationship between the two temperature scales and is used to convert a Fahrenheit temperature to Celsius. The equation is already solved for the Celsius temperature, T_{C}. Thus,

$$\begin{aligned} T_{\text{C}} &= \frac{5}{9}(T_{\text{F}} - 32°) \\ &= \frac{5}{9}(98.6° - 32°) \\ &= \frac{333°}{9} \\ &= \boxed{37°\text{C}} \end{aligned}$$

4.2
$$Q = mc\Delta T$$
$$= (221\text{ g})\left(0.093\,\frac{\text{cal}}{\text{gC°}}\right)(38.0°\text{C} - 20.0°\text{C})$$
$$= (221)(0.093)(18.0)\text{ g} \times \frac{\text{cal}}{\text{gC°}} \times °\text{C}$$
$$= 370\,\frac{\cancel{\text{g}}\cdot\text{cal}\cdot\cancel{\text{C}}°}{\cancel{\text{g}}\,\cancel{\text{C}}°}$$
$$= \boxed{370\text{ cal}}$$

4.3 First, you need to know the energy of the moving bike and rider. Since the speed is given as 36.0 km/h, convert to m/s by multiplying times 0.2778 m/s per km/h:

$$\left(36.0\,\frac{\text{km}}{\text{h}}\right)\left(0.2778\,\frac{\text{m/s}}{\text{km/h}}\right)$$
$$= (36.0)(0.2778)\,\frac{\text{km}}{\text{h}} \times \frac{\text{h}}{\text{km}} \times \frac{\text{m}}{\text{s}}$$
$$= 10.0\text{ m/s}$$

Then,

$$KE = \frac{1}{2}mv^2$$
$$= \frac{1}{2}(100.0\text{ kg})(10.0\text{ m/s})^2$$
$$= \frac{1}{2}(100.0\text{ kg})(100.0\text{ m}^2/\text{s}^2)$$
$$= \frac{1}{2}(100.0)(100)\,\frac{\text{kg}\cdot\text{m}^2}{\text{s}^2}$$
$$= 5{,}000\text{ J}$$

Second, this energy is converted to the calorie heat unit through the mechanical equivalent of heat relationship, that 1.0 kcal = 4,184 J, or that 1.0 cal = 4.184 J. Thus,

$$\frac{5{,}000\text{ J}}{4{,}184\,\frac{\text{J}}{\text{kcal}}}$$
$$1.195\,\frac{\text{J}}{1} \times \frac{\text{kcal}}{\text{J}}$$
$$\boxed{1.20\text{ kcal}}$$

4.4 First, you need to find the energy of the falling bag. Since the potential energy lost equals the kinetic energy gained, the energy of the bag just as it hits the ground can be found from

$$PE = mgh$$
$$= (15.53\text{ kg})(9.8\text{ m/s}^2)(5.50\text{ m})$$
$$= (15.53)(9.8)(5.50)\,\frac{\text{kg}\cdot\text{m}}{\text{s}^2} \times \text{m}$$
$$= 837\text{ J}$$

In calories, this energy is equivalent to

$$\frac{837\text{ J}}{4{,}184\,\frac{\text{J}}{\text{kcal}}} = 0.200\text{ kcal}$$

Second, the temperature change can be calculated from the equation giving the relationship between a quantity of heat (Q), mass (m), specific heat of the substance (c), and the change of temperature:

$$Q = mc\Delta T \quad \therefore \Delta T = \frac{Q}{mc}$$
$$= \frac{0.200\text{ kcal}}{(15.53\text{ kg})\left(0.200\,\frac{\text{kcal}}{\text{kgC°}}\right)}$$
$$= \frac{0.200}{(15.53)(0.200)}\,\frac{\text{kcal}}{1} \times \frac{1}{\text{kg}} \times \frac{\text{kgC°}}{\text{kcal}}$$
$$= 0.064\,\frac{\cancel{\text{kcal}}\cdot\cancel{\text{kg}}\text{C°}}{\cancel{\text{kcal}}\cdot\cancel{\text{kg}}}$$
$$= \boxed{6.4 \times 10^{-2}\text{ C°}}$$

4.5 The Calorie used by dietitians is a kilocalorie; thus, 250.0 Cal is 250.0 kcal. The mechanical energy equivalent is 1 kcal = 4,184 J, so (250.0 kcal)(4,184 J/kcal) = 1,046,250 J.
Since $W = Fd$ and the force needed is equal to the weight (mg) of the person, $W = mgh$ = (75.0 kg)(9.8 m/s^2)(10.0 m) = 7,350 J for each stairway climbed.
A total of 1,046,250 J of energy from the french fries would require 1,046,250 J/7,350 J per climb, or 142.3 trips up the stairs.

4.6 *Glass bowl:*

$$Q = mc\Delta T = (0.5\text{ kg})\left(0.2\,\frac{\text{kcal}}{\text{kgC°}}\right)(20°\text{C})$$
$$= (0.5)(0.2)(20)\,\frac{\text{kg}}{1} \times \frac{\text{kcal}}{\text{kgC°}} \times \frac{\text{C°}}{1}$$
$$= \boxed{2\text{ kcal}}$$

Iron pan:

$$Q = mc\Delta T = (0.5\text{ kg})\left(0.11\,\frac{\text{kcal}}{\text{kgC°}}\right)(20°\text{C})$$
$$= (0.5)(0.11)(20)\text{ kg} \times \frac{\text{kcal}}{\text{kgC°}} \times \text{C°}$$
$$= \boxed{1\text{ kcal}}$$

4.7 Note that a specific heat expressed in cal/gC° has the same numerical value as a specific heat expressed in kcal/kgC° because you can cancel the k units. You could convert 896 cal to 0.896 kcal, but one of the two conversion methods is needed for consistency with other units in the problem.

$$Q = mc\Delta T \quad \therefore m = \frac{Q}{c\Delta T}$$
$$= \frac{896\text{ cal}}{\left(0.056\,\frac{\text{cal}}{\text{gC°}}\right)(80.0\text{C°})}$$
$$= \frac{896}{(0.056)(80.0)}\,\frac{\text{cal}}{1} \times \frac{\text{gC°}}{\text{cal}} \times \frac{1}{\text{C°}}$$
$$= 200\text{ g}$$
$$= \boxed{0.20\text{ kg}}$$

4.8 Since a watt is defined as a joule/s, finding the total energy in joules will tell the time:

$$
\begin{aligned}
Q &= mc\Delta T \\
&= (250.0\ \text{g})\left(1.00\ \frac{\text{cal}}{\text{gC}^\circ}\right)(60.0\ \text{C}^\circ) \\
&= (250.0)(1.00)(60.0)\text{g} \times \frac{\text{cal}}{\text{gC}^\circ} \times \text{C}^\circ \\
&= 1.05 \times 10^4\ \text{cal}
\end{aligned}
$$

This energy in joules is

$$(1.50 \times 10^4\ \text{cal})\left(4.184\ \frac{\text{J}}{\text{cal}}\right) = 62{,}800\ \text{J}$$

A 300 watt heater uses energy at a rate of $300\ \frac{\text{J}}{\text{s}}$, so $\frac{62{,}800\ \text{J}}{300\ \text{J/s}} = 209\ \text{s}$ is required, which is $\frac{209\ \text{s}}{60\ \frac{\text{s}}{\text{min}}} = 3.48\ \text{min}$,

or

$$\boxed{\text{about } 3\frac{1}{2}\ \text{min}}$$

4.9

$$
\begin{aligned}
Q = mc\Delta \quad \therefore c &= \frac{Q}{m\Delta T} \\
&= \frac{60.0\ \text{cal}}{(100.0\ \text{g})(20.0°\text{C})} \\
&= \frac{60.0}{(100.0)(20.0)}\ \frac{\text{cal}}{\text{gC}^\circ} \\
&= \boxed{0.0300\ \frac{\text{cal}}{\text{gC}^\circ}}
\end{aligned}
$$

4.10 To change water at 80.0°C to steam at 100.0°C requires two separate quantities of heat that can be called Q_1 and Q_2. The quantity Q_1 is the amount of heat needed to warm the water from 80.0°C to the boiling point, which is 100.0°C at sea-level pressure ($\Delta T = 20.0$ C°). The relationship between the variables involved is $Q = mc\Delta T$. The quantity Q_2 is the amount of heat needed to take 100.0°C water through the phase change to steam (water vapor) at 100.0°C. The phase change from a liquid to a gas (or gas to liquid) is concerned with the latent heat of vaporization. For water, the latent heat of vaporization is given as 540.0 cal/g.

$$
\begin{aligned}
m &= 250.0\ \text{g} \\
L_{\text{v(water)}} &= 540.0\ \text{cal/g} \\
Q &= ?
\end{aligned}
$$

$$
\begin{aligned}
Q_1 &= mc\Delta T \\
&= (250.0\ \text{g})\left(1.00\ \frac{\text{cal}}{\text{gC}^\circ}\right)(20.0\ \text{C}^\circ) \\
&= (250.0)(1.00)(20.0)\ \text{g} \times \frac{\text{cal}}{\text{gC}^\circ} \times \text{C}^\circ \\
&= 5{,}000\ \frac{\cancel{\text{g}} \cdot \text{cal} \cdot \cancel{\text{C}^\circ}}{\cancel{\text{g}}\cancel{\text{C}^\circ}} \\
&= 5{,}000\ \text{cal} \\
&= 5.00\ \text{kcal}
\end{aligned}
$$

$$
\begin{aligned}
Q_2 &= mL_{\text{v}} \\
&= (250.0\ \text{g})\left(540.0\ \frac{\text{cal}}{\text{g}}\right) \\
&= 250.0 \times 540.0\ \frac{\cancel{\text{g}}\cdot\text{cal}}{\cancel{\text{g}}} \\
&= 135{,}000\ \text{cal} \\
&= 135.0\ \text{kcal}
\end{aligned}
$$

$$
\begin{aligned}
Q_{\text{total}} &= Q_1 + Q_2 \\
&= 5.00\ \text{kcal} + 135.0\ \text{kcal} \\
&= \boxed{140.0\ \text{kcal}}
\end{aligned}
$$

4.11 To change 20.0°C water to steam at 125.0°C requires three separate quantities of heat. First, the quantity Q_1 is the amount of heat needed to warm the water from 20.0°C to 100.0°C ($\Delta T = 80.0$ C°). The quantity Q_2 is the amount of heat needed to take 100.0°C water to steam at 100.0°C. Finally, the quantity Q_3 is the amount of heat needed to warm the steam from 100.0°C to 125.0°C. According to table 4.3, the c for steam is 0.480 cal/gC°.

$$
\begin{aligned}
m &= 100.0\ \text{g} \\
\Delta T_{\text{water}} &= 80.0\ \text{C}^\circ \\
\Delta T_{\text{steam}} &= 25.0\ \text{C}^\circ \\
L_{\text{v(water)}} &= 540.0\ \text{cal/g} \\
c_{\text{steam}} &= 0.480\ \text{cal/gC}^\circ
\end{aligned}
$$

$$
\begin{aligned}
Q_1 &= mc\Delta T \\
&= (100.0\ \text{g})\left(1.00\ \frac{\text{cal}}{\text{gC}^\circ}\right)(80.0\ \text{C}^\circ) \\
&= (100.0)(1.00)(80.0)\ \text{g} \times \frac{\text{cal}}{\text{gC}^\circ} \times \text{C}^\circ \\
&= 8{,}000\ \frac{\cancel{\text{g}} \cdot \text{cal} \cdot \cancel{\text{C}^\circ}}{\cancel{\text{g}}\cancel{\text{C}^\circ}} \\
&= 8{,}000\ \text{cal} \\
&= 8.00\ \text{kcal}
\end{aligned}
$$

$$
\begin{aligned}
Q_2 &= mL_{\text{v}} \\
&= (100.0\ \text{g})\left(540.0\ \frac{\text{cal}}{\text{g}}\right) \\
&= 100.0 \times 540.0\ \frac{\cancel{\text{g}}\cdot\text{cal}}{\cancel{\text{g}}} \\
&= 54{,}000\ \text{cal} \\
&= 54.0\ \text{kcal}
\end{aligned}
$$

$$
\begin{aligned}
Q_3 &= mc\Delta T \\
&= (100.0\ \text{g})\left(0.480\ \frac{\text{cal}}{\text{gC}^\circ}\right)(25.0\ \text{C}^\circ) \\
&= (100.0)(0.480)(25.0)\ \text{g} \times \frac{\text{cal}}{\text{gC}^\circ} \times \text{C}^\circ \\
&= 1{,}200\ \frac{\cancel{\text{g}}\cdot\text{cal}\cdot\cancel{\text{C}^\circ}}{\cancel{\text{g}}\cdot\cancel{\text{C}^\circ}} \\
&= 1{,}200\ \text{cal} \\
&= 1.20\ \text{kcal}
\end{aligned}
$$

$$
\begin{aligned}
Q_{\text{total}} &= Q_1 + Q_2 + Q_3 \\
&= 8.00\ \text{kcal} + 54.00\ \text{kcal} + 1.20\ \text{kcal} \\
&= \boxed{63.20\ \text{kcal}}
\end{aligned}
$$

4.12 a. Step 1: Cool the water from 18.0°C to 0°C.

$$
\begin{aligned}
Q_1 &= mc\Delta T \\
&= (400.0\text{ g})\left(1.00\,\frac{\text{cal}}{\text{gC°}}\right)(18.0\text{ C°}) \\
&= (400.0)(1.00)(18.0)\text{ g} \times \frac{\text{cal}}{\text{gC°}} \times \text{C°} \\
&= 7{,}200\,\frac{\cancel{\text{g}}\cdot\text{cal}\cdot\cancel{\text{C°}}}{\cancel{\text{g}}\,\cancel{\text{C°}}} \\
&= 7{,}200\text{ cal} \\
&= 7.20\text{ kcal}
\end{aligned}
$$

Step 2: Find the energy needed for the phase change of water at 0°C to ice at 0°C.

$$
\begin{aligned}
Q_2 &= mL_f \\
&= (400.0\text{ g})\left(80.0\,\frac{\text{cal}}{\text{g}}\right) \\
&= 400.0 \times 80.0\,\frac{\cancel{\text{g}}\cdot\text{cal}}{\cancel{\text{g}}} \\
&= 32{,}000\text{ cal} \\
&= 32.0\text{ kcal}
\end{aligned}
$$

Step 3: Cool the ice from 0°C to ice at −5.00°C.

$$
\begin{aligned}
Q_3 &= mc\Delta T \\
&= (400.0\text{ g})\left(0.50\,\frac{\text{cal}}{\text{gC°}}\right)(5.00\text{ C°}) \\
&= 400.0 \times 0.50 \times 5.00\text{ g} \times \frac{\text{cal}}{\text{gC°}} \times \text{C°} \\
&= 1{,}000\,\frac{\cancel{\text{g}}\cdot\text{cal}\cdot\cancel{\text{C°}}}{\cancel{\text{g}}\cdot\cancel{\text{C°}}} \\
&= 1{,}000\text{ cal} \\
&= 1.0\text{ kcal}
\end{aligned}
$$

$$
\begin{aligned}
Q_{total} &= Q_1 + Q_2 + Q_3 \\
&= 7.20\text{ kcal} + 32.0\text{ kcal} + 1.0\text{ kcal} \\
&= \boxed{40.2\text{ kcal}}
\end{aligned}
$$

CHAPTER 5

5.1

$$
\begin{aligned}
v &= f\lambda \\
&= \left(10\,\frac{1}{\text{s}}\right)(0.50\text{ m}) \\
&= 5\,\frac{\text{m}}{\text{s}}
\end{aligned}
$$

5.2 The distance between two *consecutive* condensations (or rarefactions) is one wavelength, so $\lambda = 3.00$ m and

$$
\begin{aligned}
v &= f\lambda \\
&= \left(112.0\,\frac{1}{\text{s}}\right)(3.00\text{ m}) \\
&= 336\,\frac{\text{m}}{\text{s}}
\end{aligned}
$$

5.3 a. One complete wave every 4 s means that $T = 4.00$ s. (Note that the symbol for the *time of a cycle is T*. Do not confuse this symbol with the symbol for temperature.)

b.

$$
\begin{aligned}
f &= \frac{1}{T} \\
&= \frac{1}{4.0\text{ s}} \\
&= \frac{1}{4.0}\,\frac{1}{\text{s}} \\
&= 0.25\,\frac{1}{\text{s}} \\
&= \boxed{0.25\text{ Hz}}
\end{aligned}
$$

5.4 The distance from one condensation to the next is one wavelength, so

$$
\begin{aligned}
v = f\lambda \qquad \therefore \lambda &= \frac{v}{f} \\
&= \frac{330\,\frac{\text{m}}{\text{s}}}{260\,\frac{1}{\text{s}}} \\
&= \frac{330}{260}\,\frac{\text{m}}{\text{s}} \times \frac{\text{s}}{1} \\
&= \boxed{1.3\text{ m}}
\end{aligned}
$$

5.5 a. $v = f\lambda = \left(256\,\frac{1}{\text{s}}\right)(1.34\text{ m}) = \boxed{343\text{ m/s}}$

b. $= \left(440.0\,\frac{1}{\text{s}}\right)(0.780\text{ m}) = \boxed{343\text{ m/s}}$

c. $= \left(750.0\,\frac{1}{\text{s}}\right)(0.457\text{ m}) = \boxed{343\text{ m/s}}$

d. $= \left(2{,}500.0\,\frac{1}{\text{s}}\right)(0.137\text{ m}) = \boxed{343\text{ m/s}}$

5.6 The speed of sound and time are given and you are looking for a distance.

$$
\begin{aligned}
v &= 335\text{ m/s} \\
t &= 4.80\text{ s} \\
d &= ?
\end{aligned}
$$

Calculating the total distance the sound traveled,

$$
\begin{aligned}
v = \frac{d}{t} \qquad \therefore d &= vt \\
&= \left(335\,\frac{\text{m}}{\text{s}}\right)(4.80\text{ s}) \\
&= (335)(4.80)\,\frac{\text{m}}{\text{s}} \times \text{s} \\
&= 1{,}608\text{ m}
\end{aligned}
$$

Since the sound travels from you to the cliff, then back to you, the cliff must be half the total distance:

$$
\frac{1{,}608\text{ m}}{2} = \boxed{804\text{ m}}
$$

5.7 The speed of the sound and the time between the lightning and thunder are given:

$$v = 345 \text{ m/s}$$
$$t = 4.63 \text{ s}$$
$$d = ?$$

The distance that a sound with this velocity travels in the given time is

$$v = \frac{d}{t} \qquad \therefore d = vt$$
$$= \left(345 \frac{\text{m}}{\text{s}}\right)(4.63 \text{ s})$$
$$= (345)(4.63)\frac{\text{m}}{\text{s}} \times \text{s}$$
$$= \boxed{1{,}600 \text{ m}}$$

CHAPTER 6

6.1 First, recall that a negative charge means an excess of electrons. Second, the relationship between the total charge (q), the number of electrons (n), and the charge of a single electron (e) is $q = ne$. The fundamental charge of a single ($n = 1$) electron (e) is 1.60×10^{-19} C. Thus

$$q = ne \qquad \therefore n = \frac{q}{e}$$
$$= \frac{1.00 \times 10^{-14} \text{ C}}{1.60 \times 10^{-19} \frac{\text{C}}{\text{electron}}}$$
$$= \frac{1.00 \times 10^{-14}}{1.60 \times 10^{-19}} \frac{\text{C}}{1} \times \frac{\text{electron}}{\text{C}}$$
$$= 6.25 \times 10^{4} \frac{\not{\text{C}} \cdot \text{electron}}{\not{\text{C}}}$$
$$= \boxed{6.25 \times 10^{4} \text{ electron}}$$

6.2

$$\text{electric current} = \frac{\text{charge}}{\text{time}}$$

or

$$I = \frac{q}{t}$$
$$= \frac{6.00 \text{ C}}{2.00 \text{ s}}$$
$$= 3.00 \frac{\text{C}}{\text{s}}$$
$$= \boxed{3.00 \text{ A}}$$

6.3

$$R = \frac{V}{I}$$
$$= \frac{120.0 \text{ V}}{4.00 \text{ A}}$$
$$= 30.0 \frac{\text{V}}{\text{A}}$$
$$= \boxed{30.0\ \Omega}$$

6.4

$$R = \frac{V}{I} \qquad \therefore I = \frac{V}{R}$$
$$= \frac{120.0 \text{ V}}{60.0 \frac{\text{V}}{\text{A}}}$$
$$= \frac{120.0}{60.0} \not{\text{V}} \times \frac{\text{A}}{\not{\text{V}}}$$
$$= \boxed{2.00 \text{ A}}$$

6.5 **a.** $R = \frac{V}{I} \qquad \therefore V = IR$

$$= (1.20 \text{ A})\left(10.0 \frac{\text{V}}{\text{A}}\right)$$
$$= \boxed{12.0 \text{ V}}$$

b. Power = (current)(potential difference)

or

$$P = IV$$
$$= \left(1.20 \frac{\text{C}}{\text{s}}\right)\left(12.0 \frac{\text{J}}{\text{C}}\right)$$
$$= (1.20)(12.0) \frac{\not{\text{C}}}{\text{s}} \times \frac{\text{J}}{\not{\text{C}}}$$
$$= 14.4 \frac{\text{J}}{\text{s}}$$
$$= \boxed{14.4 \text{ W}}$$

6.6 Note that there are two separate electrical units that are rates: (1) the amp (coulomb/s) and (2) the watt (joule/s). The question asked for a rate of using energy. Energy is measured in joules, so you are looking for the power of the radio in watts. To find watts ($P = IV$), you will need to calculate the current (I) since it is not given. The current can be obtained from the relationship of Ohm's law:

$$I = \frac{V}{R}$$
$$= \frac{3.00 \text{ V}}{15.0 \frac{\text{V}}{\text{A}}}$$
$$= 0.200 \text{ A}$$
$$P = IV$$
$$= (0.200 \text{ C/s})(3.00 \text{ J/C})$$
$$= \boxed{0.600 \text{ W}}$$

6.7

$$\frac{(1{,}200 \text{ W})(0.25 \text{ h})(100\text{원/kWh})}{1{,}000 \frac{\text{W}}{\text{kW}}}$$

$$\frac{(1{,}200)(0.25)(100)}{1{,}000} \frac{\text{W}}{1} \times \frac{\text{h}}{1} \times \frac{\text{원}}{\text{kWh}} \times \frac{\text{kW}}{\text{W}}$$

$$\boxed{30\text{원}}$$

6.8 The relationship between power (P), current (I), and voltage (V) will provide a solution. Since the relationship considers power in watts, the first step is to convert horsepower to watts. One horsepower is equivalent to 746 watts, so:

$$(746 \text{ W/hp})(2.00 \text{ hp}) = 1{,}492 \text{ W}$$

$$P = IV \quad \therefore I = \frac{P}{V}$$

$$= \frac{1{,}492 \frac{\text{J}}{\text{s}}}{12.0 \frac{\text{J}}{\text{C}}}$$

$$= \frac{1{,}492}{12.0} \frac{\cancel{\text{J}}}{\text{s}} \times \frac{\text{C}}{\cancel{\text{J}}}$$

$$= 124.3 \frac{\text{C}}{\text{s}}$$

$$= \boxed{124 \text{ A}}$$

6.9 **a.** The rate of using energy is joule/s, or the watt. Since 1.00 hp = 746 W,

inside motor: (746 W/hp)(1/3 hp) = 249 W

outside motor: (746 W/hp)(1/3 hp) = 249 W

compressor motor: (746 W/hp)(3.70 hp) = 2,760 W

$249 \text{ W} + 249 \text{ W} + 2{,}760 \text{ W} = \boxed{3{,}258 \text{ W}}$

b. $\dfrac{(3{,}258 \text{ W})(1.00 \text{ h})(100\text{원/kWh})}{1{,}000 \text{ W/kW}} = \text{시간당 } 326\text{원}$

c. $(326\text{원/h})(12 \text{ h/day})(30 \text{ day/mo}) = \boxed{117{,}360\text{원}}$

6.10 The solution is to find how much current each device draws and then to see if the total current is less or greater than the breaker rating:

Toaster: $I = \dfrac{V}{R} = \dfrac{120 \text{ V}}{15 \text{ V/A}} = 8.0 \text{ A}$

Motor: (0.20 hp)(746 W/hp) = 150 W

$I = \dfrac{P}{V} = \dfrac{15 \text{ J/s}}{120 \text{ J/C}} = 1.3 \text{ A}$

Three 100 W bulbs: 3 × 100 W = 300 W

$I = \dfrac{P}{V} = \dfrac{300 \text{ J/s}}{120 \text{ J/C}} = 2.5 \text{ A}$

Iron: $I = \dfrac{P}{V} = \dfrac{600 \text{ J/s}}{120 \text{ J/C}} = 5.0 \text{ A}$

The sum of the currents is 8.0 A + 1.3 A + 2.5 A + 5.0 A = 16.8 A, so the total current is greater than 15.0 amp and the circuit breaker will trip.

6.11 **a.** $V_p = 1{,}200 \text{ V}$

$N_p = 1 \text{ loop}$

$N_s = 200 \text{ loops}$

$V_s = ?$

$$\frac{V_p}{N_p} = \frac{V_s}{N_s} \quad \therefore V_s = \frac{V_p N_s}{N_p}$$

$$= \frac{(1{,}200 \text{ V})(200 \text{ loops})}{1 \text{ loop}}$$

$$= \boxed{240{,}000 \text{ V}}$$

b. $I_p = 40 \text{ A}$

$I_s = ?$

$$V_p I_p = V_s I_s \quad \therefore I_s = \frac{V_p I_p}{V_s}$$

$$= \frac{1{,}200 \text{ V} \times 40 \text{ A}}{240{,}000 \text{ V}}$$

$$= \frac{1{,}200 \text{ V} \times 40}{240{,}000} \frac{\cancel{\text{V}}\cdot\text{A}}{\cancel{\text{V}}}$$

$$= \boxed{0.2 \text{ A}}$$

6.12 **a.** $V_s = 12 \text{ V}$

$I_s = 0.5 \text{ A}$

$V_p = 120 \text{ V}$

$\dfrac{N_p}{N_s} = ?$

$$\frac{V_p}{N_p} = \frac{V_s}{N_s} \quad \therefore \frac{N_p}{N_s} = \frac{V_p}{V_s}$$

$$= \frac{120 \cancel{\text{V}}}{12 \cancel{\text{V}}} = \frac{10}{1}$$

or

$\boxed{\text{10 primary to 1 secondary}}$

b. $I_p = ?$

$$V_p I_p = V_s I_s \quad \therefore I_p = \frac{V_s I_s}{V_p}$$

$$I_p = \frac{(12 \text{ V})(0.5 \text{ A})}{120 \text{ V}}$$

$$= \frac{12 \times 0.5}{120} \frac{\cancel{\text{V}}\cdot\text{A}}{\cancel{\text{V}}}$$

$$= \boxed{0.05 \text{ A}}$$

c. $P_s = ?$

$$P_s = I_s V_s$$

$$= (0.5 \text{ A})(12 \text{ V})$$

$$= 0.5 \times 12 \frac{\cancel{\text{C}}}{\text{s}} \times \frac{\text{J}}{\cancel{\text{C}}}$$

$$= 6 \frac{\text{J}}{\text{s}}$$

$$= \boxed{6 \text{ W}}$$

CHAPTER 7

7.1 The relationship between the speed of light in a transparent material (v), the speed of light in a vacuum ($c = 3.00 \times 10^8$ m/s), and the index of refraction (n) is $n = c/v$. According to table 7.1, the index of refraction for water is $n = 1.33$ and for ice is $n = 1.31$.

a. $c = 3.00 \times 10^8$ m/s
$n = 1.33$
$v = ?$

$$n = \frac{c}{v} \quad \therefore v = \frac{c}{n} = \frac{3.00 \times 10^8 \text{ m/s}}{1.33} = \boxed{2.26 \times 10^8 \text{ m/s}}$$

b. $c = 3.00 \times 10^8$ m/s
$n = 1.31$
$v = ?$

$$v = \frac{3.00 \times 10^8 \text{ m/s}}{1.31} = \boxed{2.29 \times 10^8 \text{ m/s}}$$

7.2 $d = 1.50 \times 10^8$ km
$= 1.50 \times 10^{11}$ m
$c = 3.00 \times 10^8$ m/s
$t = ?$

$$v = \frac{d}{t} \quad \therefore t = \frac{d}{v} = \frac{1.50 \times 10^{11} \text{ m}}{3.00 \times 10^8 \frac{\text{m}}{\text{s}}} = \frac{1.50 \times 10^{11}}{3.00 \times 10^8} \text{m} \times \frac{\text{s}}{\text{m}} = 5.00 \times 10^2 \frac{\cancel{\text{m}}\cdot\text{s}}{\cancel{\text{m}}}$$

$$= \frac{5.00 \times 10^2 \text{ s}}{60.0 \frac{\text{s}}{\text{min}}} = \frac{5.00 \times 10^2}{60.0} \cancel{\text{s}} \times \frac{\text{min}}{\cancel{\text{s}}} = \boxed{8.33 \text{ min}}$$

7.3 $d = 6.00 \times 10^9$ km
$= 6.00 \times 10^{12}$ m
$c = 3.00 \times 10^8$ m/s
$t = ?$

$$v = \frac{d}{t} \quad \therefore t = \frac{d}{v} = \frac{6.00 \times 10^{12} \text{ m}}{3.00 \times 10^8 \frac{\text{m}}{\text{s}}} = \frac{6.00 \times 10^{12}}{3.00 \times 10^8} \cancel{\text{m}} \times \frac{\text{s}}{\cancel{\text{m}}} = 2.00 \times 10^4 \text{ s}$$

$$= \frac{2.00 \times 10^4 \text{ s}}{3{,}600 \frac{\text{s}}{\text{h}}} = \frac{2.00 \times 10^4}{3.600 \times 10^3} \cancel{\text{s}} \times \frac{\text{h}}{\cancel{\text{s}}} = \boxed{5.56 \text{ h}}$$

7.4 From equation 7.1, note that both angles are measured from the normal and that the angle of incidence (θ_i) equals the angle of reflection (θ_r), or

$$\theta_i = \theta_r \quad \therefore \boxed{\theta_i = 10°}$$

7.5 $v = 2.20 \times 10^8$ m/s
$c = 3.00 \times 10^8$ m/s
$n = ?$

$$n = \frac{c}{v} = \frac{3.00 \times 10^8 \frac{\text{m}}{\text{s}}}{2.20 \times 10^8 \frac{\text{m}}{\text{s}}} = 1.36$$

According to table 7.1, the substance with an index of refraction of 1.36 is $\boxed{\text{ethyl alcohol.}}$

7.6 **a.** From equation 7.3:

$\lambda = 6.00 \times 10^{-7}$ m
$c = 3.00 \times 10^8$ m/s
$f = ?$

$$c = \lambda f \quad \therefore f = \frac{c}{\lambda} = \frac{3.00 \times 10^8 \frac{\text{m}}{\text{s}}}{6.00 \times 10^{-7} \text{ m}} = \frac{3.00 \times 10^8}{6.00 \times 10^{-7}} \frac{\cancel{\text{m}}}{\text{s}} \times \frac{1}{\cancel{\text{m}}} = 5.00 \times 10^{14} \frac{1}{\text{s}} = \boxed{5.00 \times 10^{14} \text{ Hz}}$$

b. From equation 7.4:

$f = 5.00 \times 10^{14}$ Hz
$h = 6.63 \times 10^{-34}$ J·s
$E = ?$

$$E = hf = (6.63 \times 10^{-34} \text{ J·s})\left(5.00 \times 10^{14} \frac{1}{\text{s}}\right) = (6.63 \times 10^{-34})(5.00 \times 10^{14}) \text{ J·}\cancel{\text{s}} \times \frac{1}{\cancel{\text{s}}} = \boxed{3.32 \times 10^{-19} \text{ J}}$$

7.7 First, you can find the energy of one photon of the peak intensity wavelength (5.60×10^{-7} m) by using equation 7.3 to find the frequency, then equation 7.4 to find the energy:

Step 1:

$$c = \lambda f \quad \therefore f = \frac{c}{\lambda} = \frac{3.00 \times 10^8 \frac{\text{m}}{\text{s}}}{5.60 \times 10^{-7} \text{ m}} = 5.36 \times 10^{14} \text{ Hz}$$

Step 2:

$$E = hf = (6.63 \times 10^{-34} \text{ J·s})(5.36 \times 10^{14} \text{ Hz}) = 3.55 \times 10^{-19} \text{ J}$$

Step 3: Since one photon carries an energy of 3.55×10^{-19} J and the overall intensity is 1,000.0 W, each square meter must receive an average of

$$\frac{1{,}000.0\ \frac{J}{s}}{3.55 \times 10^{-19}\ \frac{J}{photon}}$$

$$\frac{1.000 \times 10^{3}}{3.55 \times 10^{-19}} \frac{\cancel{J}}{s} \times \frac{photon}{\cancel{J}}$$

$$\boxed{2.82 \times 10^{21}\ \frac{photon}{s}}$$

7.8 a.

$f = 4.90 \times 10^{14}$ Hz

$c = 3.00 \times 10^{8}$ m/s

$\lambda = ?$

$$c = \lambda f \quad \therefore \lambda = \frac{c}{f}$$

$$= \frac{3.00 \times 10^{8}\ \frac{m}{s}}{4.90 \times 10^{14}\ \frac{1}{s}}$$

$$= \frac{3.00 \times 10^{8}}{4.90 \times 10^{14}} \frac{m}{\cancel{s}} \times \frac{\cancel{s}}{1}$$

$$= \boxed{6.12 \times 10^{-7}\ m}$$

b. According to table 7.2, this is the frequency and wavelength of orange light.

7.9

$f = 5.00 \times 10^{20}$ Hz

$h = 6.63 \times 10^{-34}$ J·s

$E = ?$

$$E = hf$$

$$= (6.63 \times 10^{-34}\ J{\cdot}s)\left(5.00 \times 10^{20}\ \frac{1}{s}\right)$$

$$= (6.63 \times 10^{-34})(5.00 \times 10^{20})\ J{\cdot}\cancel{s} \times \frac{1}{\cancel{s}}$$

$$= \boxed{3.32 \times 10^{-13}\ J}$$

7.10

$\lambda = 1.00$ mm

$= 0.001$ m

$f = ?$

$c = 3.00 \times 10^{8}$ m/s

$h = 6.63 \times 10^{-34}$ J·s

$E = ?$

Step 1: $c = \lambda f \quad \therefore f = \frac{c}{\lambda}$

$$= \frac{3.00 \times 10^{8}\ \frac{m}{s}}{1.00 \times 10^{-3}\ m}$$

$$= \frac{3.00 \times 10^{8}}{1.00 \times 10^{-3}} \frac{\cancel{m}}{s} \times \frac{1}{\cancel{m}}$$

$$= 3.00 \times 10^{11}\ Hz$$

Step 2: $E = hf$

$$= (6.63 \times 10^{-34}\ J{\cdot}s)\left(3.00 \times 10^{11}\ \frac{1}{s}\right)$$

$$= (6.63 \times 10^{-34})(3.00 \times 10^{11})\ J{\cdot}\cancel{s} \times \frac{1}{\cancel{s}}$$

$$= \boxed{1.99 \times 10^{-22}\ J}$$

CHAPTER 8

8.1 **a.** cobalt-60: 27 protons, 33 neutrons
b. potassium-40: 19 protons, 21 neutrons
c. neon-24: 10 protons, 14 neutrons
d. lead-208: 82 protons, 126 neutrons

8.2 **a.** ${}^{60}_{27}Co$
b. ${}^{40}_{19}K$
c. ${}^{24}_{10}Ne$
d. ${}^{204}_{82}Pb$

8.3 **a.** cobalt-60: Radioactive because odd numbers of protons (27) and odd numbers of neutrons (33) are usually unstable.
b. potassium-40: Radioactive, again having an odd number of protons (19) and an odd number of neutrons (21).
c. neon-24: Stable, because even numbers of protons and neutrons are usually stable.
d. lead-208: Stable, because even numbers of protons and neutrons, *and* because 82 is a particularly stable number of nucleons.

8.4 **a.** ${}^{56}_{26}Fe \longrightarrow {}^{0}_{-1}e + {}^{56}_{27}Co$
b. ${}^{7}_{4}Be \longrightarrow {}^{0}_{-1}e + {}^{7}_{5}B$
c. ${}^{64}_{29}Cu \longrightarrow {}^{0}_{-1}e + {}^{64}_{30}Zn$
d. ${}^{24}_{11}Na \longrightarrow {}^{0}_{-1}e + {}^{24}_{12}Mg$
e. ${}^{214}_{82}Pb \longrightarrow {}^{0}_{-1}e + {}^{214}_{83}Bi$
f. ${}^{32}_{15}P \longrightarrow {}^{0}_{-1}e + {}^{32}_{16}S$

8.5 **a.** ${}^{235}_{92}U \longrightarrow {}^{4}_{2}He + {}^{231}_{90}Th$
b. ${}^{226}_{88}Ra \longrightarrow {}^{4}_{2}He + {}^{222}_{86}Rn$
c. ${}^{239}_{94}Pu \longrightarrow {}^{4}_{2}He + {}^{235}_{92}U$
d. ${}^{214}_{83}Bi \longrightarrow {}^{4}_{2}He + {}^{210}_{81}Tl$
e. ${}^{230}_{90}Th \longrightarrow {}^{4}_{2}He + {}^{226}_{88}Ra$
f. ${}^{210}_{84}Po \longrightarrow {}^{4}_{2}He + {}^{206}_{82}Pb$

8.6 Thirty-two days is four half-lives. After the first half-life (8 days), 1/2 oz will remain. After the second half-life (8 + 8, or 16 days), 1/4 oz will remain. After the third half-life (8 + 8 + 8, or 24 days), 1/8 oz will remain. After the fourth half-life (8 + 8 + 8 + 8, or 32 days), 1/16 oz will remain, or 6.3×10^{-2} oz.

8.7 The Fe-56 nucleus has a mass of 55.9206 u, but the individual masses of the nucleons are

26 protons × 1.00728 u = 26.1893 u

30 neutrons × 1.00867 u = 30.2601 u

= 56.4494 u

The mass defect is thus

$$\begin{array}{r} 56.4494\ u \\ -55.9206\ u \\ \hline 0.5288\ u \end{array}$$

The atomic mass unit (u) is equal to the mass of a mole (g), therefore 0.5288 u = 0.5288 g. The mass defect is equivalent to the binding energy according to $E = mc^2$. For a molar mass of Fe-56, the mass defect is

$$E = (5.29 \times 10^{-4}\ \text{kg})\left(3.00 \times 10^{8}\ \frac{\text{m}}{\text{s}}\right)^2$$
$$= (5.29 \times 10^{-4}\ \text{kg})\left(9.00 \times 10^{16}\ \frac{\text{m}^2}{\text{s}^2}\right)$$
$$= 4.76 \times 10^{13}\ \frac{\text{kg}\cdot\text{m}^2}{\text{s}^2}$$
$$= 4.76 \times 10^{13}\ \text{J}$$

For a single nucleus,

$$\frac{4.76 \times 10^{13}\ \text{J}}{6.02 \times 10^{23}\ \text{nuclei}} = 7.90 \times 10^{-11}\ \text{J/nuclei}$$

CHAPTER 9

9.1 Change the conversion factor into a conversion ratio and use this ratio to determine the distance in light-years:

$$1\ \text{ly} = 9.5 \times 10^{12}\ \text{km}$$
$$d = 2.4 \times 10^{14}\ \text{km}$$
$$d = ?\ \text{ly}$$

Conversion factor

$$1\ \text{ly} = 9.5 \times 10^{12}\ \text{km}$$

Divide the factor by what you want to convert from:

$$\frac{1\ \text{ly}}{9.5 \times 10^{12}\ \text{km}} = \frac{9.5 \times 10^{12}\ \cancel{\text{km}}}{9.5 \times 10^{12}\ \cancel{\text{km}}}$$
$$= \frac{1}{9.5 \times 10^{12}}\ \frac{\text{ly}}{\text{km}}$$
$$= 1.1 \times 10^{-13}\ \frac{\text{ly}}{\text{km}}$$

Resulting conversion ratio:

$$d = 2.4 \times 10^{14}\ \cancel{\text{km}}\left(1.1 \times 10^{-13}\ \frac{\text{ly}}{\cancel{\text{km}}}\right)$$
$$= \boxed{2.6 \times 10^{1}\ \text{ly}}$$

This problem has made use of data obtained from the High Energy Astrophysics Science Archive Research Center (HEASARC), provided by NASA's Goddard Space Flight Center. http://heasarc.gsfc.nasa.gov/

9.2 Determine the number of magnitude differences and multiply the brightness change factor by itself for each change in magnitude.

$m_1 = -1.6$ magnitude difference $= m_1 - m_2$
$m_2 = +3.4$ $= -1.6 - 3.4$
$B_{change} = ?$ $= -5$ magnitudes

$$B_{change} = (2.51)(2.51)(2.51)(2.51)(2.51)$$
$$= 99.6$$
$$\approx \boxed{100}$$

The negative magnitude difference means the first star is approximately 100 times brighter than the second star.

9.3 Determine the number of magnitude differences, and multiply the brightness change factor by itself for each change in magnitude.

$m_{Venus} = -4.6$ magnitude difference $= m_{Venus} - m_{Moon}$
$m_{Moon} = -12.7$ $= -4.6 - (-12.7)$
$B_{change} = ?$ $= +8.1$ magnitudes
$\approx +8$ magnitudes

$$B_{change} = (2.51)(2.51)(2.51)(2.51)(2.51)(2.51)(2.51)(2.51)$$
$$= \boxed{1{,}575}$$

The positive magnitude difference means Venus is 1,575 times dimmer than a full Moon. This problem has made use of data obtained from the National Space Science Data Center (NSSDC), provided by NASA's Lunar and Planetary Science Planetary Fact Sheets. http://nssdc.gsfc.nasa.gov/planetary/planetfact.html

9.4 $M = 2$
$T = ?$

$$T = \frac{1}{M^{2.5}} = \frac{1}{2^{2.5}} = \frac{1}{5.6} = 0.2\ \text{solar lifetimes}$$

9.5 $1\ M_{solar} = 1 \times 10^{57}$ atoms/star
$10\ M_{solar} = 1 \times 10^{58}$ atoms/star

$$\frac{4.19 \times 10^{60}\ \text{atoms}}{1 \times 10^{58}\ \text{atoms/star}} = 419\ \text{stars}$$

9.6 5,000 K (see graph)

9.7 $\lambda_{peak} = 6{,}550$ angstroms
$T = ?$

$$T = \frac{2.897 \times 10^{7}\ \text{K}\cdot\text{angstrom}}{\lambda_{peak}}$$
$$= \frac{2.897 \times 10^{7}\ \text{K}\cdot\text{angstrom}}{6{,}550\ \text{angstroms}}$$
$$= \frac{2.897 \times 10^{7}}{6{,}550}\ \frac{\text{K}\cdot\cancel{\text{angstrom}}}{\cancel{\text{angstrom}}}$$
$$= \boxed{4.42 \times 10^{3}\ \text{K}}$$

9.8 Determine the temperature of the star and then refer to table 9.2 to determine its type.

$\lambda_{peak} = 6{,}050$ angstroms
$T = ?$

$$T = \frac{2.897 \times 10^{7}\ \text{K}\cdot\text{angstrom}}{\lambda_{peak}}$$
$$= \frac{2.897 \times 10^{7}\ \text{K}\cdot\text{angstrom}}{6{,}050\ \text{angstroms}}$$
$$= \frac{2.897 \times 10^{7}}{6{,}050}\ \frac{\text{K}\cdot\cancel{\text{angstrom}}}{\cancel{\text{angstrom}}}$$
$$= 4.79 \times 10^{3}\ \text{K}$$
$$= \boxed{4{,}790\ \text{K}}$$

Referring to table 9.2, this would be a type K star that is orange-red.

9.9

$T = 7{,}000$ K

$\lambda_{peak} = ?$

$$T = \frac{2.897 \times 10^7 \text{ K·angstrom}}{\lambda_{peak}}$$

$$\frac{\lambda_{peak}}{1} \times \frac{1}{\cancel{T}} \times \cancel{T} = \frac{2.897 \times 10^7 \text{ K·angstrom}}{\cancel{\lambda_{peak}}} \times \frac{\cancel{\lambda_{peak}}}{1} \times \frac{1}{T}$$

$$\lambda_{peak} = \frac{2.897 \times 10^7 \text{ K·angstrom}}{T}$$

$$= \frac{2.897 \times 10^7 \text{ K·angstrom}}{7{,}000 \text{ K}}$$

$$= \frac{2.897 \times 10^7}{7{,}000} \frac{\cancel{\text{K}}\text{·angstrom}}{\cancel{\text{K}}}$$

$$= \boxed{4.14 \times 10^3 \text{ angstroms}}$$

9.10 Determine the change in the radius of the expanding cloud over the time period from 1999 to 2008; then use the result to solve for speed.

$d_{1999} = 8.8 \times 10^{12}$ km

$d_{2008} = 1.4 \times 10^{13}$ km

$\Delta_{radius} = ?$

$$\Delta_{radius} = \frac{d_{2008} - d_{1999}}{2}$$

$$= \frac{1.4 \times 10^{13} \text{ km} - 8.8 \times 10^{12} \text{ km}}{2}$$

$$= \frac{5.2 \times 10^{12}}{2} \text{ km}$$

$$= 2.6 \times 10^{12} \text{ km}$$

Then divide the change in radius by the elapsed time to determine the speed of the gases in the expanding cloud.

$\Delta_{radius} = 2.6 \times 10^{12}$ km

$t = 9$ yr

$v = ?$

$$v = \frac{\Delta_{radius}}{t}$$

$$= \frac{2.6 \times 10^{12} \text{ km}}{9 \text{ yr}}$$

$$= \frac{2.6 \times 10^{12}}{9} \frac{\text{km}}{\text{yr}}$$

$$= \boxed{2.9 \times 10^{11} \frac{\text{km}}{\text{yr}}}$$

9.11 Use the equation provided in the question to solve for the speed at which the galaxies are moving apart from each other.

$$H_0 = \frac{20 \frac{\text{km}}{\text{s}}}{\text{Mly}}$$

$d = 2$ Mly

$v = ?$

$$v = H_0 d$$

$$= \frac{20 \frac{\text{km}}{\text{s}}}{\text{Mly}} 2 \text{ Mly}$$

$$= (20)(2)\frac{\frac{\text{km}}{\text{s}}}{\cancel{\text{Mly}}} \times \frac{\cancel{\text{Mly}}}{1}$$

$$= \boxed{40 \frac{\text{km}}{\text{s}}}$$

CHAPTER 10

10.1 Rotational velocity can be determined by using equation 2.1 in chapter 2. Use the circumference for distance and the length of a sidereal day converted to the appropriate units for time.

$d = 3.072 \times 10^4$ km

$t = 23$ h 56 min 4 s

$v = ?$

$$v = \frac{d}{t}$$

Convert time to hours.

$$t = 23 \text{ h} + 56 \text{ min}\left(\frac{1 \text{ h}}{60 \text{ min}}\right) + 4 \text{ s}\left(\frac{1 \text{ h}}{60 \text{ min}}\right)\left(\frac{1 \text{ min}}{60 \text{ s}}\right)$$

$$= 23 \text{ h} + \frac{56}{60} \cancel{\text{min}}\left(\frac{\text{h}}{\cancel{\text{min}}}\right) + \frac{4}{60^2} \cancel{\text{s}}\left(\frac{\text{h}}{\cancel{\text{min}}}\right)\left(\frac{\cancel{\text{min}}}{\cancel{\text{s}}}\right)$$

$$= 23 \text{ h} + 0.9333 \text{ h} + 0.0011 \text{ h}$$

$$= 23.9344 \text{ h}$$

$$v = \frac{3.072 \times 10^4 \text{ km}}{23.9344 \text{ h}}$$

$$= \boxed{1.284 \times 10^3 \frac{\text{km}}{\text{h}}}$$

10.2 Rotational velocity can be determined by using equation 2.1 in chapter 2. Use the circumference for distance and the length of a sidereal day converted to the appropriate units for time.

$d = 1.928 \times 10^4$ km

$t = 23$ h 56 min 4 s

$v = ?$

$$v = \frac{d}{t}$$

Convert time to minutes.

$$t = 23 \text{ h}\left(\frac{60 \text{ min}}{1 \text{ h}}\right) + 56 \text{ min} + 4 \text{ s}\left(\frac{1 \text{ min}}{60 \text{ s}}\right)$$

$$= (23)(60) \cancel{\text{h}}\left(\frac{\text{min}}{\cancel{\text{h}}}\right) + 56 \text{ min} + \frac{4}{60} \cancel{\text{s}}\left(\frac{\text{min}}{\cancel{\text{s}}}\right)$$

$$= 1{,}380 \text{ min} + 56 \text{ min} + 0.067 \text{ min}$$

$$= 1.436067 \times 10^3 \text{ min}$$

$$v = \frac{1.928 \times 10^4 \text{ km}}{1.436067 \times 10^3 \text{ min}}$$

$$= \boxed{1.343 \times 10^1 \frac{\text{km}}{\text{min}}}$$

10.3 $t = 18$ years

1 year = 12.381 Moon cycles

$M = ?$

$$M = 18 \cancel{\text{yrs}} \times \frac{12.381 \text{ Moons}}{1 \cancel{\text{yr}}}$$

$$= \boxed{222 \text{ Moon cycles}}$$

10.4 Use the length of a year in mean solar days and sidereal days from example 10.1 and multiply by the age.

$$\text{age} = 25\ \text{yr}$$
$$1\ \text{yr} = 365.24220\ \text{msd}$$
$$1\ \text{yr} = 366.243\ \text{day}_{\text{sidereal}}$$
$$\text{age}_{\text{days}} = ?$$

$$\text{age}_{\text{days}} = \text{age(year length)}$$

$$\text{mean solar days} = 25\ \text{yr}\left(365.24220\ \frac{\text{msd}}{\text{yr}}\right) = 25(365.24220)\ \cancel{\text{yr}}\left(\frac{\text{msd}}{\cancel{\text{yr}}}\right) = \boxed{9{,}131\ \text{msd}}$$

$$\text{sidereal days} = 25\ \text{yr}\left(366.243\ \frac{\text{day}_{\text{sidereal}}}{\text{yr}}\right) = 25(366.243)\ \cancel{\text{yr}}\left(\frac{\text{day}_{\text{sidereal}}}{\cancel{\text{yr}}}\right) = \boxed{9{,}156\ \text{day}_{\text{sidereal}}}$$

10.5 Use the equation of time adjustment from figure 10.22.

apparent local solar time = 2:00 P.M.

mean solar time = ?

mean solar time = apparent local solar time + equation of time

= 2:00 P.M. + (–5 min)

= $\boxed{\text{1:55 P.M.}}$

10.6 Add the flight time to the departure time, then adjust the time by the time zone difference shown on figure 10.23. Using 24-hour time simplifies the calculation:

departure time = 11:45 A.M.

flight duration = 5.5 h

arrival time = ?

arrival time = departure time + flight duration + time zone change

Convert flight duration to hours and minutes.

$$5.5\ \text{h} = 5\ \text{h} + 0.5\ \text{h} = 5\ \text{h} + 0.5\ \text{h}\left(\frac{60\ \text{min}}{\text{h}}\right) = 5\ \text{h} + 0.5(60)\ \cancel{\text{h}}\left(\frac{\text{min}}{\cancel{\text{h}}}\right) = 5\ \text{h} + 30\ \text{min}$$

arrival time = 11:45 A.M. + (5 h + 30 min) + (–3 h)

= (11 + 5 – 3) h + (45 + 30) min

= 13 h + 75 min

= 13 h + 1 h + 15 min

= 14 h + 15 min

= $\boxed{\text{14:15 or 2:15 P.M.}}$

10.7 $t_{\text{total}} = 2.42\ \text{s}$

$$t_{\text{one-way}} = \frac{2.42\ \text{s}}{2} = 1.21\ \text{s}$$
$$v = 3 \times 10^5\ \text{km/s}$$
$$d = ?$$

$$d = vt = \left(3 \times 10^5\ \frac{\text{km}}{\cancel{\text{s}}}\right)(1.21\ \cancel{\text{s}}) = \boxed{248{,}000\ \text{km}}$$

CHAPTER 11

11.1 $d = 6.7 \times 10^6\ \text{m}$

$v = 2.85 \times 10^{-2}\ \text{m/yr}$

$t = ?$

$$d = vt$$
$$t = \frac{d}{v}$$
$$t = \frac{6.7 \times 10^6\ \cancel{\text{m}}}{2.85 \times 10^{-2}\ \cancel{\text{m}}/\text{yr}} = \boxed{2.35 \times 10^8\ \text{yr}}$$

11.2 Calculate the future position from the velocity, and state the position relative to its current position.

$v = 45\ \frac{\text{mm}}{\text{yr}}$

$t = 20 \times 10^6\ \text{yr}$

$d = ?$

$$v = \frac{d}{t} \quad \therefore\ d = vt$$

Convert velocity from $\frac{\text{mm}}{\text{yr}}$ to $\frac{\text{km}}{\text{yr}}$

$$45\ \frac{\cancel{\text{mm}}}{\text{yr}}\left(\frac{\text{km}}{1 \times 10^6\ \cancel{\text{mm}}}\right)$$
$$4.5 \times 10^{-5}\ \frac{\text{km}}{\text{yr}}$$

$$d = 4.5 \times 10^{-5}\ \frac{\text{km}}{\cancel{\text{yr}}}(20 \times 10^6\ \cancel{\text{yr}}) = \boxed{9.0 \times 10^2\ \text{km northwest of its current position}}$$

11.3 In the equation shown in example 11.1, use the density of water in place of the mantle density and the density and thickness of the ice block in place of the crust.

$$z_{\text{ice}} = 5\ \text{cm}$$
$$\rho_{\text{water}} = 1.0\ \frac{\text{g}}{\text{cm}^3}$$
$$\rho_{\text{ice}} = 0.92\ \frac{\text{g}}{\text{cm}^3}$$
$$h_{\text{ice}} = ?$$

$$h_{\text{ice}} = z_{\text{ice}} - z_{\text{ice}}\left(\frac{\rho_{\text{ice}}}{\rho_{\text{water}}}\right)$$
$$= 5\ \text{cm} - 5\ \text{cm}\left(\frac{0.92\ \frac{\text{g}}{\text{cm}^3}}{1.0\ \frac{\text{g}}{\text{cm}^3}}\right)$$
$$= 5 - 5\left(\frac{0.92}{1.0}\right)\text{cm}\ \frac{\cancel{\frac{\text{g}}{\text{cm}^3}}}{\cancel{\frac{\text{g}}{\text{cm}^3}}}$$
$$= 5 - 5(0.92)\ \text{cm}$$
$$= 5 - 4.6\ \text{cm}$$
$$= \boxed{0.4\ \text{cm}}$$

11.4 Since the position at which crust floats is a function of the relative densities of crust and mantle, the specific gravity of the wood can be calculated from the ratio of the density of crust and mantle by using a proportion equation.

Case 1: Continental Crust

$\rho_{oil} = 0.91 \frac{g}{cm^3}$

$\rho_{mantle} = 3.3 \frac{g}{cm^3}$

$\rho_{crust} = 2.7 \frac{g}{cm^3}$

$\rho_{wood} = ?$

$$\frac{\rho_{crust}}{\rho_{mantle}} = \frac{\rho_{wood}}{\rho_{water}}$$

$$\rho_{water}\left(\frac{\rho_{crust}}{\rho_{mantle}}\right) = \left(\frac{\rho_{wood}}{\cancel{\rho_{water}}}\right)\cancel{\rho_{water}}$$

$$\rho_{wood} = \rho_{water}\left(\frac{\rho_{crust}}{\rho_{mantle}}\right)$$

$$= 0.91 \frac{g}{cm^3}\left(\frac{2.7 \frac{g}{cm^3}}{3.3 \frac{g}{cm^3}}\right)$$

$$= 0.91\left(\frac{2.7}{3.3}\right)\frac{g}{cm^3}\left(\frac{\cancel{\frac{g}{cm^3}}}{\cancel{\frac{g}{cm^3}}}\right)$$

$$= \boxed{0.74 \frac{g}{cm^3}}$$

Case 2: Oceanic Crust

$\rho_{water} = 0.91 \frac{g}{cm^3}$

$\rho_{mantle} = 3.3 \frac{g}{cm^3}$

$\rho_{crust} = 3.0 \frac{g}{cm^3}$

$\rho_{wood} = ?$

$$\rho_{wood} = \rho_{water}\left(\frac{\rho_{crust}}{\rho_{mantle}}\right)$$

$$= 0.91 \frac{g}{cm^3}\left(\frac{3.0 \frac{g}{cm^3}}{3.3 \frac{g}{cm^3}}\right)$$

$$= 0.91\left(\frac{3.0}{3.3}\right)\frac{g}{cm^3}\left(\frac{\cancel{\frac{g}{cm^3}}}{\cancel{\frac{g}{cm^3}}}\right)$$

$$= \boxed{0.83 \frac{g}{cm^3}}$$

CHAPTER 12

12.1 Determine the number of magnitude differences and multiply the energy change factor by itself for each change in magnitude.

Richter magnitude$_1$ = 4.0
Richter magnitude$_2$ = 9.1
energy difference = ?

magnitude difference = Richter magnitude$_2$ − Richter magnitude$_1$
= 9.1 − 4.0
= 5 magnitudes

energy difference = (30)(30)(30)(30)(30)
= $\boxed{2.4 \times 10^7}$

The positive magnitude difference means the atomic bomb blast has approximately 2.4×10^7 times less energy than a devastating earthquake of 9.1 magnitude.

12.2 Determine the number of magnitude differences, and multiply the ground movement change factor by itself for each change in magnitude.

Richter magnitude$_1$ = 3.5
Richter magnitude$_2$ = 6.5
surface wave difference = ?

magnitude difference = Richter magnitude$_2$ − Richter magnitude$_1$
= 6.5 − 3.5
= 3 magnitudes

surface wave difference = (10)(10)(10)
= $\boxed{1 \times 10^3}$

The positive magnitude difference means the devastating earthquake has 1×10^3 times more ground motion than an earthquake that is felt but causes no damage.

12.3 Subtract the P-wave arrival time from the S-wave arrival time to obtain the difference in arrival times.

Station A	Station B	Station C	Station D	Station E
06:05:29	06:06:18	06:06:35	06:07:24	06:06:00
06:05:19	06:05:50	06:06:01	06:06:32	06:05:39
00:00:10	00:00:28	00:00:34	00:00:52	00:00:21

Based on the difference in P-wave and S-wave arrival times, station D was farthest from the earthquake.

12.4 $v = 725 \frac{km}{h}$ $\quad v = \frac{d}{t} \quad \therefore\ t = \frac{d}{v}$

$d = 10{,}650$ km

$t = ?$

$$= \frac{10{,}650\ km}{725 \frac{km}{h}}$$

$$= \frac{10{,}650}{725}\frac{\cancel{km}}{\frac{\cancel{km}}{h}}$$

$$= \boxed{14.7\ h}$$

12.5 If rocks hit the ground at 350 m/s, the height from which they fell is

$$h = v^2/2g = (350\ m/s)^2/(2 \times 9.8\ m/s^2) = 6{,}250\ m$$

12.6 The velocity of the volcanic materials can be determined as a free-fall motion problem in which the volcanic materials would return to the surface with the same velocity as they were ejected during the eruption. Hence, the velocity of the volcanic materials can be determined from the equations for free fall presented in chapter 2.

$d = 1.1 \times 10^4$ m

$a = 9.8 \frac{m}{s^2}$

$v = ?$

$v_f = at$ and $d = \frac{1}{2}at^2$

Rearrange $v_f = at$ to solve for t.

$$\frac{1}{a} v_f = \cancel{a}t \frac{1}{\cancel{a}}$$

$$\frac{v_f}{a} = t$$

Substitute this relationship for time in $d = \frac{1}{2} at^2$.

$$d = \frac{1}{2} a \left(\frac{v_f}{a}\right)^2$$

$$d = \frac{1}{2} \cancel{a} \frac{v_f^2}{a^{\cancel{2}}}$$

$$(2a)d = \frac{1}{2} \frac{v_f^2}{\cancel{a}} (\cancel{2a})$$

$$v_f^2 = 2ad$$

$$v_f = \sqrt{2ad}$$

$$= \sqrt{2\left(9.8 \frac{\text{m}}{\text{s}^2}\right) 1.1 \times 10^4 \text{ m}}$$

$$= \sqrt{2(9.8)(1.1 \times 10^4) \frac{\text{m}}{\text{s}^2} \text{m}}$$

$$= \sqrt{2.2 \times 10^5 \frac{\text{m}^2}{\text{s}^2}}$$

$$= 4.7 \times 10^2 \frac{\text{m}}{\text{s}}$$

$$= 4.7 \times 10^2 \frac{\cancel{\text{m}}}{\cancel{\text{s}}} \left(\frac{1 \text{ km}}{1{,}000 \cancel{\text{m}}}\right)\left(\frac{60 \cancel{\text{s}}}{1 \cancel{\text{min}}}\right)\left(\frac{60 \cancel{\text{min}}}{1 \text{ h}}\right)$$

$$= \boxed{1.7 \times 10^3 \frac{\text{km}}{\text{h}}}$$

12.7 The position at which crust floats in the mantle can be calculated from the thickness of the crust and the relative densities of crust and mantle by using the formula provided in the question. Determine the height of the continental crust above the mantle for average crustal thickness and for the case following crustal thickening, then subtract the difference.

Case 1: Average Crust Thickness

$z_{crust} = 35.0$ km

$\rho_{mantle} = 3.3 \frac{\text{g}}{\text{cm}^3}$

$\rho_{crust} = 2.7 \frac{\text{g}}{\text{cm}^3}$

$h = ?$

$$h = z_{crust} - z_{crust}\left(\frac{\rho_{crust}}{\rho_{mantle}}\right)$$

$$= 35.0 \text{ km} - 35.0 \text{ km}\left(\frac{2.7 \frac{\text{g}}{\text{cm}^3}}{3.3 \frac{\text{g}}{\text{cm}^3}}\right)$$

$$= 35.0 - 35.0\left(\frac{2.7}{3.3}\right) \text{km} \frac{\frac{\cancel{\text{g}}}{\cancel{\text{cm}^3}}}{\frac{\cancel{\text{g}}}{\cancel{\text{cm}^3}}}$$

$$= 35.0 - 35.0(0.82) \text{ km}$$

$$= 35.0 - 28.7 \text{ km}$$

$$= \boxed{6.3 \text{ km}}$$

Case 2: Thickened Crust

$z_{crust} = 70.0$ km

$\rho_{mantle} = 3.3 \frac{\text{g}}{\text{cm}^3}$

$\rho_{crust} = 2.7 \frac{\text{g}}{\text{cm}^3}$

$h = ?$

$$h = z_{crust} - z_{crust}\left(\frac{\rho_{crust}}{\rho_{mantle}}\right)$$

$$= 70.0 \text{ km} - 70.0 \text{ km}\left(\frac{2.7 \frac{\text{g}}{\text{cm}^3}}{3.3 \frac{\text{g}}{\text{cm}^3}}\right)$$

$$= 70.0 - 70.0\left(\frac{2.7}{3.3}\right) \text{km} \frac{\frac{\cancel{\text{g}}}{\cancel{\text{cm}^3}}}{\frac{\cancel{\text{g}}}{\cancel{\text{cm}^3}}}$$

$$= 70.0 - 70.0(0.82) \text{ km}$$

$$= 70.0 - 57.4 \text{ km}$$

$$= 12.6 \text{ km}$$

$$\text{change} = \text{case 2} - \text{case 1}$$

$$= 12.6 \text{ km} - 6.3 \text{ km}$$

$$= \boxed{6.3 \text{ km}}$$

Crustal thickening increased elevation by 6.3 km.

CHAPTER 13

13.1 Determine the conversion ratio (CR) based on the ratio of the diameter of Earth to the diameter of a beach ball:

$D_{ball} = 9.15 \times 10^1$ cm

$D_{Earth} = 1.2756 \times 10^4$ km

$CR = ?$

$$CR = \frac{D_{ball}}{D_{Earth}}$$

Convert the diameter of Earth to centimeters:

$$1.2756 \times 10^4 \cancel{\text{km}}\left(\frac{1 \times 10^5 \text{ cm}}{\cancel{\text{km}}}\right)$$

$$1.2756 \times 10^9 \text{ cm}$$

$$CR = \frac{9.15 \times 10^1 \text{ cm}}{1.2756 \times 10^9 \text{ cm}}$$

$$= \frac{9.15 \times 10^1}{1.2756 \times 10^9} \frac{\cancel{\text{cm}}}{\cancel{\text{cm}}}$$

$$= 7.17 \times 10^{-8} \text{ m}$$

Determine the thickness (z) of the layer by multiplying the thickness of 50 percent of the mass of Earth's atmosphere (see figure 13.3) by the conversion ratio.

$Z_{atmosphere} = 5.6$ km

$CR = 7.17 \times 10^{-8}$

$Z_{layer} = ?$

$$Z_{layer} = CR\,(Z_{Earth})$$

Convert the thickness of the atmosphere to centimeters:

$$5.6\ \cancel{km}\left(\frac{1\times10^5\ cm}{\cancel{km}}\right)$$

$$5.6\times10^5\ cm$$

$$Z_{layer} = 7.17\times10^{-8}(5.6\times10^5\ cm)$$

$$= \boxed{4.0\times10^{-2}\ cm}$$

13.2 Determine the conversion ratio (*CR*) based on the ratio of the thickness of the sheet of plastic to the thickness of 99 percent of the mass of Earth's atmosphere:

$$z_{plastic\ sheet} = 1.0\ mm$$

$$Z_{Earth} = 3.2\times10^1\ km$$

$$CR = ?$$

$$CR = \frac{z_{plastic\ sheet}}{z_{Earth}}$$

Convert the thickness of Earth's atmosphere to centimeters:

$$3.2\times10^1\ \cancel{km}\left(\frac{1\times10^5\ cm}{\cancel{km}}\right)$$

$$3.2\times10^6\ cm$$

Convert the thickness of the plastic sheet to centimeters:

$$1.0\ \cancel{mm}\left(\frac{1\times10^{-1}\ cm}{\cancel{mm}}\right)$$

$$1.0\times10^{-1}\ cm$$

$$CR = \frac{1.0\times10^{-1}\ cm}{3.2\times10^5\ cm}$$

$$= \frac{1.0\times10^{-1}}{3.2\times10^6}\ \frac{\cancel{cm}}{\cancel{cm}}$$

$$= 3.1\times10^{-8}$$

Determine the diameter of the ball by multiplying the diameter of Earth by the conversion ratio.

$$D_{Earth} = 1.2756\times10^4\ km$$

$$CR = 3.1\times10^{-8}$$

$$D_{ball} = ?$$

$$D_{ball} = CR(D_{Earth})$$

Convert the diameter of Earth to centimeters:

$$1.2756\times10^4\ \cancel{km}\left(\frac{1\times10^5\ cm}{1\ \cancel{km}}\right)$$

$$1.2756\times10^9\ cm$$

$$D_{ball} = 3.1\times10^{-8}(1.2756\times10^9\ cm)$$

$$= \boxed{3.9\times10^1\ cm}$$

13.3 Rearrange the equation to solve for volume at sea level pressure.

$$P_1 = 2.5\ \frac{N}{m^2}$$

$$V_1 = 1.0\ m^3$$

$$P_2 = 10.0\ \frac{N}{m^2}$$

$$V_2 = ?$$

$$P_1V_1 = P_2V_2 \quad \therefore \quad V_2 = \frac{P_1V_1}{P_2}$$

$$V_2 = \frac{\left(2.5\ \frac{N}{cm^2}\right)(1.0\ m^3)}{\left(10.0\ \frac{N}{m^2}\right)}$$

$$= \frac{(2.5)(1.0)}{(10.0)}\ \frac{\left(\frac{\cancel{N}}{\cancel{m^2}}\right)(m^3)}{\left(\frac{\cancel{N}}{\cancel{m^2}}\right)}$$

$$= \boxed{0.25\ m^3}$$

13.4 Rearrange the equation to solve for pressure when the volume is 450.0 cm^3.

$$P_1 = 1{,}013\ hPa$$

$$V_1 = 250.0\ cm^3$$

$$V_2 = 450.0\ cm^3$$

$$P_2 = ?$$

$$P_1V_1 = P_2V_2 \quad \therefore \quad P_2 = \frac{P_1V_1}{V_2}$$

$$P_2 = \frac{(1{,}013\ hPa)(250.0\ cm^3)}{(450.0\ cm^3)}$$

$$= \frac{(1{,}013)(250.0)}{(450.0)}\ \frac{(hPa)(\cancel{cm^3})}{(\cancel{cm^3})}$$

$$= \boxed{563\ hPa}$$

13.5 Use the equation provided in the "Humidity" section of the text.

$$\text{absolute humidity} = 4.0\ \frac{g}{m^3}$$

$$T = 0°C$$

$$\text{relative humidity} = ?$$

$$\text{relative humidity} = \frac{\text{absolute humidity}}{\text{maximum absolute humidity at temperature}} \times 100\%$$

$$= \frac{4.0\ \frac{\cancel{g}}{\cancel{m^3}}}{5.0\ \frac{\cancel{g}}{\cancel{m^3}}} \times 100\%$$

$$= \boxed{80\%}$$

CHAPTER 14

14.1

$$\text{precipitation} = 254\ mm$$

$$\text{potential evapotranspiration} = 1{,}800\ mm$$

$$\text{net water budget} = ?$$

$$\text{net water budget} = \text{precipitation} - \text{potential evapotranspiration}$$

$$= 254\ mm - 1{,}800\ mm$$

$$= \boxed{-1{,}546\ mm}$$

$$\boxed{\text{The net water budget is negative so there is a water deficit.}}$$

14.2

$$\text{precipitation} = 1{,}143 \text{ mm}$$
$$\text{potential evapotranspiration} = 508 \text{ mm}$$
$$\text{net water budget} = ?$$
$$\text{net water budget} = \text{precipitation} - \text{potential evapotranspiration}$$
$$= 1{,}143 \text{ mm} - 508 \text{ mm}$$
$$= \boxed{635 \text{ mm}}$$

The net water budget is positive so there is a water surplus.

14.3

$Q_s = 737$ mm

$A = 1{,}157$ km^2

Volume = ?

$$Volume = Q_G A$$

Convert mm to m:

$$737 \cancel{\text{mm}} \left(\frac{1 \text{ m}}{1 \times 10^3 \cancel{\text{mm}}}\right)$$
$$7.37 \times 10^{-1} \text{ m}$$

Convert km^2 to m^2.

$$1{,}157 \cancel{\text{km}^2} \left(\frac{1 \text{ m}^2}{1 \times 10^{-6} \cancel{\text{km}^2}}\right)$$
$$1.157 \times 10^9 \text{ m}^2$$
$$Volume = 7.37 \times 10^{-1} \text{ m}(1.157 \times 10^9 \text{ m}^2)$$
$$= \boxed{8.53 \times 10^8 \text{ m}^3}$$

14.4

$t = 12$ h

$d = 14.7$ km

$v = ?$

$$v = \frac{d}{t} = \frac{14.7 \text{ km}}{12 \text{ h}} = \boxed{1.2 \frac{\text{km}}{\text{h}}}$$

14.5

$t = 429$ days

$d = 229$ m

$v = ?$

$$v = \frac{d}{t} = \frac{229 \text{ m}}{429 \text{ days}} = \boxed{5.34 \times 10^{-1} \frac{\text{m}}{\text{day}}}$$

14.6

$$A = 2.5 \times 10^4 \text{ m}^2$$
$$z = 3.5 \text{ m}$$
$$\text{m}_{\text{seawater}} = ?$$

$$V = Az \quad \text{and} \quad \rho = \frac{m}{V}$$
$$\therefore \quad \rho = \frac{m}{Az}$$

Rearrange this expression to solve for mass.

$$\text{m}_{\text{seawater}} = \rho Az$$

Convert $\frac{\text{g}}{\text{cm}^3}$ to $\frac{\text{kg}}{\text{m}^3}$.

$$1.03 \frac{\cancel{\text{g}}}{\cancel{\text{cm}^3}} \left(\frac{1 \times 10^6 \cancel{\text{cm}^3}}{1 \text{ m}^3}\right)\left(\frac{1 \text{ kg}}{1 \times 10^3 \cancel{\text{g}}}\right)$$
$$\boxed{1.03 \times 10^3 \frac{\text{kg}}{\text{m}^3}}$$

$$\text{m}_{\text{seawater}} = 1.03 \times 10^3 \frac{\text{kg}}{\text{m}^3}(2.4 \times 10^4 \text{ m}^2)(3.5 \text{ m})$$
$$= 1.03 \times 10^3(2.4 \times 10^4)(3.5) \frac{\text{kg}}{\cancel{\text{m}^3}}(\cancel{\text{m}^2})(3.5 \cancel{\text{m}})$$
$$= 7.4 \times 10^7 \text{ kg}$$

The mass of salt is the mass of the seawater times the salinity.

$\text{m}_{\text{seawater}} = 7.4 \times 10^7$ kg

salinity = 0.036

$\text{m}_{\text{salt}} = ?$

$$\text{m}_{\text{salt}} = \text{m}_{\text{seawater}}(\text{salinity}) = 7.4 \times 10^7 \text{ kg}(0.036) = \boxed{2.7 \times 10^6 \text{ kg}}$$

14.7

$\lambda = 9.5$ m

wave base = ?

$$\text{wave base} = \frac{1}{2}\lambda = \frac{1}{2}(9.5 \text{ m}) = 4.8 \text{ m}$$

slope = $6.8 \frac{\text{cm}}{\text{m}}$

$\Delta Y = 4.8$ m

$\Delta X = ?$

$$\text{slope} = \frac{\Delta Y}{\Delta X} \quad \therefore \ \Delta X = \frac{\Delta Y}{\text{slope}}$$

Convert $\frac{\text{cm}}{\text{m}}$ to $\frac{\text{m}}{\text{m}}$:

$$6.8 \frac{\cancel{\text{cm}}}{\cancel{\text{m}}}\left(\frac{1 \cancel{\text{m}}}{1 \times 10^2 \cancel{\text{cm}}}\right)$$
$$6.8 \times 10^{-2}$$
$$\Delta X = \frac{4.8 \text{ m}}{6.8 \times 10^{-2}} = \boxed{7.1 \times 10^1 \text{ m}}$$

slope = $6.8 \frac{\text{cm}}{\text{m}}$

$\Delta X = 24$ m

$\Delta Y = ?$

$$\text{slope} = \frac{\Delta Y}{\Delta X} \quad \therefore \ \Delta Y = \Delta X \text{ slope}$$

Convert $\frac{\text{cm}}{\text{m}}$ to $\frac{\text{m}}{\text{m}}$:

$$6.8 \frac{\cancel{\text{cm}}}{\cancel{\text{m}}}\left(\frac{1 \cancel{\text{m}}}{1 \times 10^2 \cancel{\text{cm}}}\right)$$
$$6.8 \times 10^{-2}$$
$$\Delta Y = 24 \text{ m}(6.8 \times 10^{-2}) = 1.6 \text{ cm}$$

water depth = 1.6 cm

water height = ?

$$\text{water depth} = 1.33(\text{wave height}) \quad \therefore \ \text{wave height} = \frac{\text{water depth}}{1.33} = \frac{1.6 \text{ m}}{1.33} = \boxed{1.2 \text{ m}}$$

14.8

$d = 87$ m

$t = 0.5$ h

$v = ?$

$$v = \frac{d}{t} = \frac{8.7 \text{ m}}{0.5 \text{ h}} = \boxed{174 \frac{\text{m}}{\text{h}}}$$

CHAPTER 15

15.1 Energy is related to the frequency and Planck's constant in equation 15.1,

$$E = hf$$

For $n = 6$, $E_H = 6.05 \times 10^{-20}$ J

For $n = 2$, $E_L = 5.44 \times 10^{-19}$ J

$$E = ?\ \text{J}$$

$$E = E_H - E_L$$
$$= (-6.05 \times 10^{-20}\ \text{J}) - (-5.44 \times 10^{-19}\ \text{J})$$
$$= \boxed{4.84 \times 10^{-19}\ \text{J}}$$

15.2 For $n = 6$, $E_H = -6.05 \times 10^{-20}$ J

For $n = 2$, $E_L = -5.44 \times 10^{-19}$ J

$h = 6.63 \times 10^{-34}$ J·s

$f = ?$

$$hf = E_H - E_L \therefore f = \frac{E_H - E_L}{h}$$
$$= \frac{(-6.05 \times 10^{-20}\ \text{J}) - (-5.44 \times 10^{-19}\ \text{J})}{6.63 \times 10^{-34}\ \text{J·s}}$$
$$= \frac{4.84 \times 10^{-19}}{6.63 \times 10^{-34}} \frac{\cancel{\text{J}}}{\cancel{\text{J}}\text{·s}}$$
$$= 7.29 \times 10^{14} \frac{1}{\text{s}}$$
$$= \boxed{7.29 \times 10^{14}\ \text{Hz (violet)}}$$

15.3 $(n = 1) = -13.6$ eV

Since the energy of the electron is -13.6 eV, it will require 13.6 eV (or 2.17×10^{-18} J) to remove the electron.

15.4

$q/m = -1.76 \times 10^{11}$ C/kg

$q = -1.60 \times 10^{-19}$ C

$m = ?$

$$\text{mass} = \frac{\text{charge}}{\text{charge/mass}}$$
$$= \frac{-1.60 \times 10^{-19}\ \text{C}}{-1.76 \times 10^{11}\ \dfrac{\text{C}}{\text{kg}}}$$
$$= \frac{-1.60 \times 10^{-19}}{-1.76 \times 10^{11}} \cancel{\text{C}} \times \frac{\text{kg}}{\cancel{\text{C}}}$$
$$= \boxed{9.09 \times 10^{-31}\ \text{kg}}$$

CHAPTER 16

16.1 Recall that the number of outer energy level electrons is the same as the family number for the representative elements:

a. Li: 1
b. N: 5
c. F: 7
d. Cl: 7
e. Ra: 2
f. Be: 2

16.2 The same information that was used in question 1 can be used to draw the dot notation:

(a) ·B·̇ (b) :B̤̈r· (c) Ca: (d) K· (e) ·Ö: (f) ·S̤̈·

16.3 The charge is found by identifying how many electrons are lost or gained in achieving the noble gas structure:

a. Boron 3+
b. Bromine 1–
c. Calcium 2+
d. Potassium 1+
e. Oxygen 2–
f. Nitrogen 3–

16.4 The name of some common polyatomic ions are in box table 16.2. Using this table as a reference, the names are

a. hydroxide
b. sulfite
c. hypochlorite
d. nitrate
e. carbonate
f. perchlorate

16.5 The Roman numeral tells you the charge on the variable charge elements. The charges for the polyatomic ions are found in box table 16.2. The charges for metallic elements can be found in tables 16.2 and 16.3. Using these resources and the crossover technique, the formulas are as follows:

a. $Fe(OH)_3$
b. $Pb_3(PO_4)_2$
c. $ZnCO_3$
d. NH_4NO_3
e. $KHCO_3$
f. K_2SO_3

16.6 Box table 16.3 has information about the meaning of prefixes and stem names used in naming covalent compounds. (a), for example, asks for the formula of carbon tetrachloride. Carbon has no prefixes, so there is one carbon atom, and it comes first in the formula because it comes first in the name. The *tetra*-prefix means four, so there are four chlorine atoms. The name ends in *-ide*, so you know there are only two elements in the compound. The symbols can be obtained from the list of elements on the inside back cover of this text. Using all this information from the name, you can think out the formula for carbon tetrachloride. The same process is used for the other compounds and formulas:

a. CCl_4
b. H_2O
c. MnO_2
d. SO_3
e. N_2O_5
f. As_2S_5

16.7 Again using information from box table 16.3, this question requires you to reverse the thinking procedure you learned in question 6.

a. carbon monoxide
b. carbon dioxide
c. carbon disulfide
d. dinitrogen monoxide
e. tetraphosphorus trisulfide
f. dinitrogen trioxide

16.8 **a.** $2\ SO_2 + O_2 \longrightarrow 2\ SO_3$
b. $4\ P + 5\ O_2 \longrightarrow 2\ P_2O_5$
c. $2\ Al + 6\ HCl \longrightarrow 2\ AlCl_3 + 3\ H_2$
d. $2\ NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2\ H_2O$
e. $Fe_2O_3 + 3\ CO \longrightarrow 2\ Fe + 3\ CO_2$
f. $3\ Mg(OH)_2 + 2\ H_3PO_4 \longrightarrow Mg_3(PO_4)_2 + 6\ H_2O$

16.9 **a.** General form of XY + AZ ⟶ XZ + AY with precipitate formed: Ion exchange reaction.
b. General form of X + Y ⟶ XY: Combination reaction.
c. General form of XY ⟶ X + Y + . . . : Decomposition reaction.
d. General form of X + Y ⟶ XY: Combination reaction.
e. General form of XY + A ⟶ AY + X: Replacement reaction.
f. General form of X + Y ⟶ XY: Combination reaction.

16.10 **a.** $C_5H_{12}(g) + 8\ O_2(g) \longrightarrow 5\ CO_2(g) + 6\ H_2O(g)$
b. $HCl(aq) + NaOH(aq) \longrightarrow NaCl(aq) + H_2O(l)$
c. $2\ Al(s) + Fe_2O_3(s) \longrightarrow Al_2O_3(s) + 2\ Fe(l)$
d. $Fe(s) + CuSO_4(aq) \longrightarrow FeSO_4(aq) + Cu(s)$
e. $MgCl_2(aq) + Fe(NO_3)_2(aq) \longrightarrow$ No reaction (all possible compounds are soluble and no gas or water was formed)
f. $C_6H_{10}O_5(s) + 6\ O_2(g) \longrightarrow 6\ CO_2(g) + 5\ H_2O(g)$

CHAPTER 17

17.1 $\rho = \dfrac{m}{V} \quad \therefore V = \dfrac{m}{\rho}$

$\rho_{0°} = 0.99987\ g/cm^3$
$m = 1.0000\ g$
$V = ?$

$$V = \frac{m}{\rho} = \frac{1.0000\ g}{0.99987 \frac{g}{cm^3}} = \frac{1.0000}{0.99987}\ \frac{g}{g/cm^3} = \boxed{1.0001\ cm^3}$$

17.2 If room temperature is 20°C, then following the solubility line on figure 17.6 shows KNO_3 has solubility at about 34 g solute per 100 g water.

17.3 According to the graph on figure 17.6, the line for $NaNO_3$ increases 10 g solute per 100 g water for each 10°C.

17.4 102.08°C − 100°C = 2.08°C

$$2.08°C \times \frac{29.2\ g}{0.521°C} = \boxed{117\ g}$$

CHAPTER 18

18.1 $CCl_2F_2 = 12.0 + 2(35.5) + 2(19.0) = \boxed{121\ \text{units}}$

18.2 Heptane contains the maximum number of hydrogen atoms so it is saturated.

CHAPTER 19

19.1 $= 3.3 \times 10^{-15}\ m^3 \times \left(\dfrac{1\ \text{atom}}{6.2 \times 10^{-31}\ m^3}\right)$

$\boxed{= 5.4 \times 10^{15}\ \text{atoms}}$

19.2 $\left(\dfrac{2}{3}\right)(81.6\ kg) \times \left(\dfrac{1\ \text{atom}}{2.66 \times 10^{-26}\ kg}\right)$

$\boxed{= 2.0 \times 10^{27}\ \text{oxygen atoms}}$

19.3 time $= 24\ \text{hours} \times \dfrac{3{,}600\ \text{sec}}{1\ \text{hr}} = 8.64 \times 10^4\ s$

rate $= 2 \times 10^{-17}$ watts $= 2 \times 10^{-17}$ J/s

then,

$= (2 \times 10^{-17}\ J/s) \times \left(\dfrac{8.64 \times 10^4\ s}{1\ \text{day}}\right)$

$\boxed{= 2 \times 10^{-12}\ \dfrac{\text{Joules}}{\text{day}}}$

19.4 $1.0 \times 10^{-4}\ m \times \left(\dfrac{1\ \text{cell}}{8.0 \times 10^{-6}\ m}\right)$

$\boxed{= 12.5\ \text{cells}}$

CHAPTER 20

20.1 $t = 60.0$ min
rate $= 2^{t-0.5t}$

number $= 2^{(60-(0.5*60))}$ bacteria
number $= 2^{(30)}$ bacteria
number $= \boxed{1.1 \times 10^9\ \text{bacteria}}$

20.2 If the number of bacteria after 60 minutes is $3^{(60-30)}$ or $3^{30} = 2.0 \times 10^{14}$, then, 2.0×10^{14} bacteria $\times (1.3 \times 10^{-10}\ m^3/_{1\ \text{bacteria}})$
$= \boxed{2.7 \times 10^4\ m^3}$

20.3 Growth rate $= \{(Pop_{new} - Pop_{old})/Pop_{old}\} \times 100/t_{years}$
$= \{(1.311 \times 10^9 - 1.053 \times 10^9)/1.053 \times 10^9\} \times 100/15$
$= \boxed{1.63\%}$

20.4 Growth rate $= \{(Pop_{new} - Pop_{old})/Pop_{old}\} \times 100/t_{years}$
$= \{(2.08 \times 10^8 - 1.76 \times 10^8)/1.76 \times 10^8\} \times 100/15$
$= \boxed{1.21\%}$

CHAPTER 21

21.1 $V_{sp} = 1\ \mu m^3$
$d_{atom} = 0.1\ nm = 1 \times 10^{-4}\ \mu m$

$V_{atom} = \dfrac{4}{3}\pi r^3_{atom}$
$= \dfrac{4}{3}\pi\ (5 \times 10^{-5} \mu m)^3$
$= 5.2 \times 10^{-13}\ \mu m^3$

$r_{atom} = \dfrac{d_{atom}}{2}$
$r_{atom} = \dfrac{1 \times 10^{-4}\ \mu m}{2}$
$= 5 \times 10^{-5}\ \mu m$

$\#_{atoms} = \dfrac{Volume_{s.p.}}{Volume_{atom}}$
$= \dfrac{1\ \mu m^3}{5.2 \times 10^{-13}\ \mu m^3}$
$\boxed{= 1.9 \times 10^{12}\ \text{atoms}}$

21.2 $\dfrac{\text{Volume}_{\text{s.p.}}}{\text{Volume}_{\text{bact.}}}$

$\dfrac{1\ \mu m^3}{0.1\ \mu m^3}$

$\boxed{10}$

21.3 $\text{plants}_{\text{fungi}} = \text{plants}_{\text{total}} \times 90\%$

$= 300{,}000 \text{ plants} \times 0.9$

$\boxed{= 270{,}000 \text{ plants}}$

21.4 unidentified species = expected species − identified species

$= 30{,}000{,}000 \text{ species} - 900{,}000 \text{ species}$

$= 29{,}100{,}000 \text{ species}$

$$\%\text{unidentified} = \frac{\text{unidentified species}}{\text{estimated species}} \times 100$$

$$= \frac{29{,}100{,}000 \text{ species}}{30{,}000{,}000 \text{ species}} \times 100$$

$= \boxed{97\%}$

CHAPTER 22

22.1 % thymine = 32%

% cytosine must equal the % thymine $\boxed{32\%}$

22.2 Beginning bacteria = 1 million

bacteria 1 min = 2 million

bacteria 2 min = 4 million

bacteria 3 min = 8 million

4 min = 16 million

$\boxed{5 \text{ min} = 32 \text{ million}}$

22.3 mutant bacteria = total bacteria × rate of mutation

$$= 32 \text{ million bacteria} \times \frac{1 \text{ mutant}}{1 \text{ million bacteria}}$$

$\boxed{= 32}$

22.4 Of carriers = population × % of carriers

$= 38.9 \text{ million} \times 47\%$

$\boxed{= 18 \text{ million}}$