Chapter 1. Answers to selected Integrative and Advanced Exercises

69. **(D)** volume needed $= 18{,}000 \text{ gal} \times \frac{4 \text{ qt}}{1 \text{ gal}} \times \frac{0.9464 \text{ L}}{1 \text{ qt}} \times \frac{1000 \text{ mL}}{1 \text{ L}} \times \frac{1.00 \text{ g}}{1 \text{ mL}} \times \frac{1 \text{ g Cl}}{10^6 \text{ g water}}$

$$\times \frac{100 \text{ g soln}}{7 \text{ g Cl}} \times \frac{1 \text{ mL soln}}{1.10 \text{ g soln}} \times \frac{1 \text{ L soln}}{1000 \text{ mL soln}} = 0.9 \text{ L soln}$$

71. **(D)** *Conversion pathway approach:*

$$\text{NaCl mass} = 330{,}000{,}000 \text{ mi}^3 \times \left(\frac{5280 \text{ ft}}{1 \text{ mi}} \times \frac{12 \text{ in.}}{1 \text{ ft}} \times \frac{2.54 \text{ cm}}{1 \text{ in.}}\right)^3 \times \frac{1 \text{ mL}}{1 \text{ cm}^3} \times \frac{1.03 \text{ g}}{1 \text{ mL}}$$

$$\times \frac{3.5 \text{ g sodium chloride}}{100.0 \text{ g sea water}} \times \frac{1 \text{ lb}}{453.6 \text{ g}} \times \frac{1 \text{ ton}}{2000 \text{ lb}} = 5.5 \times 10^{16} \text{ tons}$$

Stepwise approach:

$$330{,}000{,}000 \text{ mi}^3 \times \left(\frac{5280 \text{ ft}}{1 \text{ mi}}\right)^3 = 4.9 \times 10^{19} \text{ ft}^3$$

$$4.9 \times 10^{19} \text{ ft}^3 \times \left(\frac{12 \text{ in.}}{1 \text{ ft}}\right)^3 = 8.4 \times 10^{22} \text{ in.}^3$$

$$8.4 \times 10^{22} \text{ in.}^3 \times \left(\frac{2.54 \text{ cm}}{1 \text{ in.}}\right)^3 = 1.4 \times 10^{24} \text{ cm}^3$$

$$1.4 \times 10^{24} \text{ cm}^3 \times \frac{1 \text{ mL}}{1 \text{ cm}^3} \times \frac{1.03 \text{ g}}{1 \text{ mL}} = 1.4 \times 10^{24} \text{ g}$$

$$1.4 \times 10^{24} \text{ g} \times \frac{3.5 \text{ g sodium chloride}}{100.0 \text{ g sea water}} = 4.9 \times 10^{22} \text{ g NaCl}$$

$$4.9 \times 10^{22} \text{ g NaCl} \times \frac{1 \text{ lb}}{453.6 \text{ g}} = 1.1 \times 10^{20} \text{ lb}$$

$$1.1 \times 10^{20} \text{ lb} \times \frac{1 \text{ ton}}{2000 \text{ lb}} = 5.4 \times 10^{16} \text{ tons}$$

The answers for the stepwise and conversion pathway approaches differ slightly due to a cumulative rounding error that is present in the stepwise approach.

73. **(M)**

$$V_{seawater} = 1.00 \times 10^5 \text{ ton Mg} \times \frac{2000 \text{ lb Mg}}{1 \text{ ton Mg}} \times \frac{453.6 \text{ g Mg}}{1 \text{ lb Mg}} \times \frac{1000 \text{ g seawater}}{1.4 \text{ g Mg}} \times \frac{0.001 \text{ L}}{1.025 \text{ g seawater}}$$

$$\times \frac{1 \text{ m}^3}{1000 \text{ L}} = 6 \times 10^7 \text{ m}^3 \text{ seawater}$$

74. **(D) (a)** dustfall $= \frac{10 \text{ ton}}{1 \text{ mi}^2 \bullet 1 \text{ mo}} \times \left(\frac{1 \text{ mi}}{5280 \text{ ft}} \times \frac{1 \text{ ft}}{12 \text{ in.}} \times \frac{39.37 \text{ in.}}{1 \text{ m}}\right)^2 \times \frac{2000 \text{ lb}}{1 \text{ ton}} \times \frac{454 \text{ g}}{1 \text{ lb}} \times \frac{1000 \text{ mg}}{1 \text{ g}}$

$$= \frac{3.5\times10^{3}\ \text{mg}}{1\text{m}^{2}\bullet 1\text{mo}}\times\frac{1\ \text{month}}{30\ \text{d}}\times\frac{1\ \text{d}}{24\ \text{h}}=\frac{5\ \text{mg}}{1\text{m}^{2}\ \bullet\ 1\text{h}}$$

(b) This problem is solved by the conversion factor method, starting with the volume that deposits on each square meter, 1 mm deep.

$$\frac{(1.0\ \text{mm}\times 1\ \text{m}^{2})}{1\ \text{m}^{2}}\times\frac{1\ \text{cm}}{10\ \text{mm}}\times\left(\frac{100\ \text{cm}}{1\ \text{m}}\right)^{2}\times\frac{2\ \text{g}}{1\ \text{cm}^{3}}\times\frac{1000\ \text{mg}}{1\ \text{g}}\times\frac{1\ \text{m}^{2}\bullet\text{h}}{4.9\ \text{mg}}$$

$= 4.1\times10^{5}\ \text{h} = 5\times10^{1}\ \text{y}$ It would take about half a century to accumulate a depth of 1 mm.

77. **(M)** We will use the density of diatomaceous earth, and its mass in the cylinder, to find the volume occupied by the diatomaceous earth.

$$\text{diatomaceous earth volume} = 8.0\ \text{g}\times\frac{1\,\text{cm}^{3}}{2.2\ \text{g}} = 3.6\,\text{cm}^{3}$$

The added water volume will occupy the remaining volume in the graduated cylinder.

$\text{water volume} = 100.0\ \text{mL} - 3.6\ \text{mL} = 96.4\ \text{mL}$

81. **(M)**

$$\text{Water used (in kg/week)} = 1.8\times10^{6}\text{people}\times\left(\frac{750\ \text{L}}{1\ \text{day}}\right)\times\left(\frac{7\ \text{day}}{1\ \text{week}}\right)\times\frac{1\ \text{kg}}{1\ \text{L}} = 9.45\times10^{9}\,\text{kg water/week}$$

Given: Sodium hypochlorite is NaClO

$$\text{mass of NaClO} = 9.45\times10^{9}\,\text{kg water}\left(\frac{1\ \text{kg chlorine}}{1\times10^{6}\ \text{kg water}}\right)\times\left(\frac{100\ \text{kg NaClO}}{47.62\ \text{kg chlorine}}\right)$$

$$= 1.98\times10^{4}\,\text{kg sodium hypochlorite}$$

82. **(M)** $$\frac{1.77\ \text{lb}}{1\ \text{L}}\times\frac{1\ \text{kg}}{2.2046\ \text{lb}} = 0.803\ \text{kg L}^{-1}$$

22,300 kg of fuel are required, hence:

$$22{,}300\ \text{kg fuel}\times\frac{1\ \text{L}}{0.803\ \text{kg}} = 2.78\times10^{4}\ \text{L of fuel}$$

(Note, the plane had 7682 L of fuel left in the tank.)

Hence, the volume of fuel that should have been added = $2.78\times10^{4}\ \text{L} - 0.7682\ \text{L} = 2.01\times10^{4}\ \text{L}$

87. **(M)** First, calculate the mass of wine: 4.72 kg – 1.70 kg = 3.02 kg

Then, calculate the mass of ethanol in the bottle:

$$3.02\ \text{kg wine}\times\frac{1000\ \text{g wine}}{1\ \text{kg wine}}\times\frac{11.5\ \text{g ethanol}}{100\ \text{g wine}} = 347.3\ \text{g ethanol}$$

Then, use the above amount to determine how much ethanol is in 250 mL of wine:

$$250.0 \text{ mL ethanol} \times \frac{1 \text{ L ethanol}}{1000 \text{ mL ethanol}} \times \frac{347.3 \text{ g ethanol}}{3.00 \text{ L bottle}} = 28.9 \text{ g ethanol}$$

88. **(M)** First, determine the total volume of tungsten:

$$\text{vol W} = \text{m/D} = \frac{0.0429 \text{ g W}}{19.3 \text{ g/cm}^3} \times \frac{(10 \text{ mm})^3}{1 \text{ cm}^3} = 2.22 \text{ mm}^3 \text{ W}$$

The wire can be viewed as a cylinder. Therefore:
vol cylinder = $A \times h = \pi(D/2)^2 \times h = \pi(D/2)^2 \times (0.200 \text{ m} \times 1000 \text{ mm/1 m}) = 2.22 \text{ mm}^3$
Solving for D, we obtain: $D = 0.119$ mm

89. **(M)** First, determine the amount of alcohol that will cause a BAC of 0.10%:

$$\text{mass of ethanol} = \frac{0.100 \text{ g ethanol}}{100 \text{ mL of blood}} \times 5400 \text{ mL blood} = 5.4 \text{ g ethanol}$$

This person's body metabolizes alcohol at a rate of 10.0 g/h. Therefore, in 3 hours, this person metabolizes 30.0 g of alcohol. For this individual to have a BAC of 0.10% after 3 hours, he must consume 30.0 + 5.4 = 35.4 g of ethanol.

Now, calculate how many glasses of wine are needed for a total intake of 35.4 g of ethanol:

$$35.4 \text{ g ethanol} \times \frac{100 \text{ g wine}}{11.5 \text{ g eth.}} \times \frac{1 \text{ mL wine}}{1.01 \text{ g wine}} \times \frac{1 \text{ glass wine}}{145 \text{ mL wine}} = 2.1 \text{ glasses of wine}$$