Evaluation

(f) If some of the magnesium oxide had escaped from the crucible, the mass of the product left in the crucible would be less than the Prediction. The mass of magnesium would not be affected, however. Therefore, the percentage composition of magnesium would be too high.

(g) If the other component of air is nitrogen, the percentage composition of magnesium would be higher than the Prediction. Nitrogen has a lower molar mass than oxygen. Also, the formula of magnesium nitride, Mg_3N_2, means that the ratio of magnesium to nitrogen is 1 : 0.67 versus 1:1 for magnesium oxide. Therefore, the mass of product would be less for the same mass of magnesium and the percentage composition would be higher than the predicted value.

(h) Magnesium metal, like many metals, oxidizes in air to form an oxide layer. The oxide layer needs to be removed to more accurately determine the mass of pure magnesium.

(i) The best modification would be to cause the magnesium to react inside a container of pure oxygen. This method would require a substantial modification to the materials and procedure, however.

(j) The Prediction is inconclusive because the certainty of the experimental answer is only one significant digit. The accuracy of the balance is probably one or two hundredths of a gram. Therefore, the answer can vary widely. The law of definite proportions remains valid until it is tested with an improved experiment.

Synthesis

(k) Some of the educational requirements to become a gemologist include courses such as Diamonds, Diamond Grading, Coloured Stones, Coloured Stone Grading, and Gem Identification. A Math and Science background, liberal arts education, and the knowledge of foreign languages are also useful assets. Gemologists work with many different instruments, including a gem microscope, which is more powerful than an average microscope, a refractrometer to measure the refractive index of gems, and a balance beam to measure specific gravity.

2.5 QUANTITATIVE ANALYSIS: CONCENTRATION OF SOLUTIONS

PRACTICE

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Understanding Concepts

1. $v_{\text{ethanol}} = 4.1\text{L}$

$v_{\text{solution}} = 55\,\text{L}$

$c_{\text{solution}} = ?$

$$c_{\text{solution}} = \frac{v_{\text{ethanol}}}{v_{\text{solution}}} \times 100\%$$

$$= \frac{4.1\,\text{L}}{55\ \text{L}} \times 100\%$$

$$c_{\text{solution}} = 7.5\%\ \ \text{V/V}$$

The ethanol concentration of a typical gasohol mixture is 7.5% V/V.

2. $m_{\text{ZnCl}_2} = 16\ \text{g}$

$v_{\text{solution}} = 500\ \text{mL}$

$c_{\text{solution}} = ?$

$$c_{\text{solution}} = \frac{m_{\text{ZnCl}_2}}{v_{\text{solution}}} \times 100\%$$

$$= \frac{16\ \text{g}}{500\ \text{mL}} \times 100\%$$

$$c_{\text{solution}} = 3.2\%\,\text{W/V}$$

The concentration of the zinc chloride in solder flux solution is 3.2% W/V.

3. $m_{C_6H_{12}O_6} = 27.5 \text{ g}$

$v_{\text{solution}} = 550 \text{ mL}$

$c_{\text{solution}} = ?$

$$c_{\text{solution}} = \frac{m_{C_6H_{12}O_6}}{v_{\text{solution}}} \times 100\%$$

$$= \frac{27.5 \text{ g}}{550 \text{ mL}} \times 100\%$$

$$c_{\text{solution}} = 5.0\% \text{ W/V}$$

The concentration of glucose in the IV solution is 5.0% W/V.

PRACTICE

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4. $m_{\text{NaOCl}} = 5.25 \text{ g NaOCl}$

$M_{\text{NaOCl}} = 74.44 \text{ g/mol NaOCl}$

$v_{\text{NaOCl}} = 100.0 \cancel{\text{mL}} \times \frac{1 \text{ L}}{1000 \cancel{\text{mL}}}$

$v_{\text{NaOCl}} = 0.1000 \text{ L}$

$c_{\text{NaOCl}} = ?$

$$n_{\text{NaOCl}} = 5.25 \cancel{\text{g NaOCl}} \times \frac{1 \text{ mol NaOCl}}{74.44 \cancel{\text{g NaOCl}}}$$

$$n_{\text{NaOCl}} = 0.0705 \text{ mol NaOCl}$$

$$c_{\text{NaOCl}} = \frac{n_{\text{NaOCl}}}{v_{\text{NaOCl}}}$$

$$= \frac{0.0705 \text{ mol NaOCl}}{0.100 \text{ L}}$$

$$c_{\text{NaOCl}} = 0.705 \text{ mol/L NaOCl}$$

The molar concentration of the sodium hypochlorite solution is 0.705 mol/L.

5. $m_{\text{NaCl}} = 235 \text{ g NaCl}$

$M_{\text{NaCl}} = 58.44 \text{ g/mol NaCl}$

$v_{\text{NaCl}} = 3.00 \text{ L}$

$c_{\text{NaCl}} = ?$

$$n_{\text{NaCl}} = 235 \cancel{\text{g NaCl}} \times \frac{1 \text{ mol NaCl}}{58.44 \cancel{\text{g NaCl}}}$$

$$n_{\text{NaCl}} = 4.02 \text{ mol NaCl}$$

$$c_{\text{NaCl}} = \frac{n_{\text{NaCl}}}{v_{\text{NaCl}}}$$

$$= \frac{4.02 \text{ mol NaCl}}{3.00 \text{ L}}$$

$$c_{\text{NaCl}} = 1.34 \text{ mol/L NaCl}$$

The molar concentration of the salt solution is 1.34 mol/L.

6. $m_{HCl} = 7.66 \text{ g HCl}$

$M_{HCl} = 36.46 \text{ g/mol HCl}$

$v_{HCl} = 1.50 \text{ L}$

$c_{HCl} = ?$

$$n_{HCl} = 7.66 \cancel{\text{ g HCl}} \times \frac{1 \text{ mol HCl}}{36.46 \cancel{\text{ g HCl}}}$$

$$n_{HCl} = 0.210 \text{ mol HCl}$$

$$c_{HCl} = \frac{n_{HCl}}{v_{HCl}} = \frac{0.210 \text{ mol HCl}}{1.50 \text{ L}}$$

$$c_{HCl} = 0.140 \text{ mol/L HCl}$$

The molar concentration of the hydrochloric acid stock solution is 0.140 mol/L.

7. $m_{K_2Cr_2O_7} = 102.9 \text{ g}$

$M_{K_2Cr_2O_7} = 294.20 \text{ g/mol } K_2Cr_2O_7$

$v_{K_2Cr_2O_7} = 1.75 \text{ L}$

$c_{K_2Cr_2O_7} = ?$

$$n_{K_2Cr_2O_7} = 102.9 \cancel{\text{ g } K_2Cr_2O_7} \times \frac{1 \text{ mol } K_2Cr_2O_7}{294.20 \cancel{\text{ g } K_2Cr_2O_7}}$$

$$n_{K_2Cr_2O_7} = 0.3498 \text{ mol } K_2Cr_2O_7$$

$$c_{K_2Cr_2O_7} = \frac{n_{K_2Cr_2O_7}}{v_{K_2Cr_2O_7}} = \frac{0.3498 \text{ mol } K_2Cr_2O_7}{1.75 \text{ L}}$$

$$c_{K_2Cr_2O_7} = 0.200 \text{ mol } K_2Cr_2O_7$$

The molar concentration of the potassium dichromate solution is 0.200 mol/L.

PRACTICE

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Understanding Concepts

8. $v_{AgNO_3} = 50.0 \cancel{\text{ mL}} \times \dfrac{1 \text{ L}}{1000 \cancel{\text{ mL}}}$

$v_{AgNO_3} = 5.00 \times 10^{-2} \text{ L}$

$c_{AgNO_3} = 0.570 \text{ mol/L}$

$n_{AgNO_3} = ?$

$$c_{AgNO_3} = \frac{n_{AgNO_3}}{v_{AgNO_3}}$$

$$n_{AgNO_3} = c_{AgNO_3} v_{AgNO_3} = \frac{0.570 \text{ mol } AgNO_3}{\cancel{\text{L}}} \times 5.00 \times 10^{-2} \cancel{\text{ L}}$$

$$n_{AgNO_3} = 0.0285 \text{ mol } AgNO_3$$

There is 0.0285 mol silver nitrate in the solution.

9. $c_{HCl} = 12.4 \text{ mol/L}$

$v_{HCl} = 1.50 \text{ L}$

$n_{HCl} = ?$

$$c_{HCl} = \frac{n_{HCl}}{v_{HCl}}$$

$$n_{HCl} = c_{HCl}v_{HCl}$$

$$= \frac{12.4 \text{ mol HCl}}{\cancel{\text{L}}} \times 1.50 \cancel{\text{L}}$$

$$n_{HCl} = 18.6 \text{ mol HCl}$$

There is 18.6 mol hydrochloric acid in 1.50 L of the solution.

10. $v_{hemoglobin} = 25.0 \cancel{\text{mL}} \times \frac{1 \text{ L}}{1000 \cancel{\text{mL}}}$

$v_{hemoglobin} = 2.50 \times 10^{-2} \text{L}$

$c_{hemoglobin} = 1.90 \times 10^{-3} \text{mol/L}$

$n_{hemoglobin} = ?$

$$c_{hemoglobin} = \frac{n_{hemoglobin}}{v_{hemoglobin}}$$

$$n_{hemoglobin} = c_{hemoglobin}v_{hemoglobin}$$

$$= \frac{1.90 \times 10^{-3} \text{mol hemoglobin}}{\cancel{\text{L}}} \times 2.50 \times 10^{-2} \cancel{\text{L}}$$

$$n_{hemoglobin} = 4.75 \times 10^{-5} \text{mol hemoglobin}$$

There is 4.75×10^{-5} mol hemoglobin in the solution.

11. $v_{KOH} = 35.8 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}}$

$v_{KOH} = 3.58 \times 10^{-2} \text{ L}$

$c_{KOH} = 1.76 \times 10^{-2} \text{ mol/L}$

$n_{KOH} = ?$

$$c_{KOH} = \frac{n_{KOH}}{v_{KOH}}$$

$$n_{KOH} = c_{KOH}v_{KOH}$$

$$= \frac{1.76 \times 10^{-2} \text{mol KOH}}{\cancel{\text{L}}} \times 3.58 \times 10^{-2} \cancel{\text{L}}$$

$$n_{KOH} = 6.30 \times 10^{-4} \text{mol KOH}$$

The technician added 6.30×10^{-4} mol potassium hydroxide to the mixture.

PRACTICE

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Understanding Concepts

12. $c_{MgCl_2} = 0.055 \text{ mol/L}$

$n_{MgCl_2} = 4.1 \text{ mol } MgCl_2$

$v_{MgCl_2} = ?$

$$c_{MgCl_2} = \frac{n_{MgCl_2}}{v_{MgCl_2}}$$

$$v_{MgCl_2} = \frac{n_{MgCl_2}}{c_{MgCl_2}}$$

$$= \frac{4.1 \text{ mol } MgCl_2}{0.055 \text{ mol/L}}$$

$$v_{MgCl_2} = 75 \text{ L}$$

Therefore, 75 L of magnesium chloride solution contains 4.1 mol magnesium chloride.

13. $c_{HCl} = 7.6 \text{ mol/L}$

$n_{HCl} = 0.050 \text{ mol HCl}$

$v_{HCl} = ?$

$$c_{HCl} = \frac{n_{HCl}}{v_{HCl}}$$

$$v_{HCl} = \frac{n_{HCl}}{c_{HCl}}$$

$$= \frac{0.050 \text{ mol HCl}}{7.6 \text{ mol/L}}$$

$$v_{HCl} = 0.0066 \text{ L}$$

Therefore, 6.6 mL (0.0066 L) of hydrochloric acid solution must be poured into the flask.

14. $n_{FeCl_3} = 1.25 \text{ mol } FeCl_3$

$c_{FeCl_3} = 6.00 \text{ mol/L}$

$v_{FeCl_3} = ?$

$$c_{FeCl_3} = \frac{n_{FeCl_3}}{v_{FeCl_3}}$$

$$v_{FeCl_3} = \frac{n_{FeCl_3}}{c_{FeCl_3}}$$

$$= \frac{1.25 \text{ mol } FeCl_3}{6.00 \text{ mol/L}}$$

$$v_{FeCl_3} = 0.208 \text{ L}$$

Therefore, 208 mL (0.208 L) of stock solution must be poured into the flask.

15. $c_{Na_2Cr_2O_7} = 0.0020 \text{ mol/L}$

$n_{Na_2Cr_2O_7} = 5.0 \text{ mol } Na_2Cr_2O_7$

$v_{Na_2Cr_2O_7} = ?$

$$c_{Na_2Cr_2O_7} = \frac{n_{Na_2Cr_2O_7}}{v_{Na_2Cr_2O_7}}$$

$$v_{Na_2Cr_2O_7} = \frac{n_{Na_2Cr_2O_7}}{c_{Na_2Cr_2O_7}}$$

$$= \frac{5.0 \text{ mol } Na_2Cr_2O_7}{0.0020 \text{ mol/L}}$$

$$v_{Na_2Cr_2O_7} = 2500 \text{ L}$$

A volume of 2500 L of the sodium dichromate solution contains 5.0 mol sodium dichromate.

PRACTICE

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Understanding Concepts

16. $m_{CH_2O} = 3.2 \text{ mg } CH_2O$

$v_{CH_2O} = 500 \text{ L}$

$c_{CH_2O} = ?$

$1 \text{ ppm} = 1 \text{ mg/L}$

$$c_{CH_2O} = \frac{m_{CH_2O}}{v_{CH_2O}}$$

$$= \frac{3.2 \text{ mg}}{500 \text{ L}}$$

$$c_{CH_2O} = 6.4 \times 10^{-3} \text{mg/L}$$

The concentration of formaldehyde in the 200-L sample is 6.4×10^{-3} ppm.

17. $m_{Cu} = 3.0 \times 10^{-5} \text{gCu}$

$v_{Cu} = 1.0 \text{ L}$

$c_{Cu} = ?$

$1 \text{ ppm} = 1 \text{ mg/L}$

$$M_{Cu} = 3.0 \times 10^{-5} \cancel{\text{g Cu}} \times \frac{1000 \text{ mg Cu}}{1 \cancel{\text{g Cu}}}$$

$$M_{Cu} = 3.0 \times 10^{-2} \text{mg Cu}$$

$$c_{Cu} = \frac{m_{Cu}}{v_{Cu}}$$

$$= \frac{3.0 \times 10^{-2} \text{mg}}{1.0 \text{ L}}$$

$$= 3.0 \times 10^{-2} \text{mg/L}$$

$$c_{Cu} = 0.030 \text{ ppm}$$

The concentration of copper in the drinking water is 0.030 ppm.

18. $m_{CO_2} = 1.8 \text{ mg}$

$v_{CO_2} = 350 \text{ mL}$

$c_{CO_2} = ?$

$1 \text{ ppm} = 1 \text{ mg/L}$

$$v_{CO_2} = 350 \ \cancel{\text{mL}} \times \frac{1 \text{ L}}{1000 \ \cancel{\text{mL}}}$$

$$v_{CO_2} = 0.035 \text{ L}$$

$$c_{CO_2} = \frac{m_{CO_2}}{v_{CO_2}}$$

$$= \frac{1.8 \text{ mg}}{0.35 \text{ L}}$$

$$= 5.1 \text{ mg/L}$$

$$c_{CO_2} = 5.1 \text{ ppm}$$

The concentration of dissolved carbon dioxide in the pond water is 5.1 ppm.

PRACTICE

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Understanding Concepts

19. $c_i = 15\%\ \text{W/V}$

$v_i = 240\ \text{mL}$

$v_f = 300.0\ \text{mL}$

$c_f = ?$

$$c_i v_i = c_f v_f$$

$$c_f = \frac{c_i v_i}{v_f}$$

$$= \frac{(15\%)(240\ \cancel{\text{mL}})}{300.0\ \cancel{\text{mL}}}$$

$$c_f = 12\%\ \text{W/V}$$

The final concentration of the glucose solution is 12% W/V.

20. $c_i = 16.0\ \text{mol/L}$

$c_f = 0.100\ \text{mol/L}$

$v_f = 500.0\ \text{mL}$

$v_i = ?$

$$c_i v_i = c_f v_f$$

$$v_i = \frac{c_f v_f}{c_i}$$

$$= \frac{(0.100\ \cancel{\text{mol/L}})(500.0\ \text{mL})}{16.0\ \cancel{\text{mol/L}}}$$

$$v_i = 3.13\ \text{mL}$$

Therefore, 3.13 mL of sulfuric acid is needed to make the sulfuric acid solution.

21. $c_i = 14.8\ \text{mol/L}$

$c_f = 1.00\ \text{mol/L}$

$v_f = 100.0\ \text{mL}$

$v_i = ?$

$$c_i v_i = c_f v_f$$

$$v_i = \frac{c_f v_f}{c_i}$$

$$= \frac{(1.00\ \cancel{\text{mol/L}})(100.0\ \text{mL})}{14.8\ \cancel{\text{mol/L}}}$$

$$v_i = 6.76\ \text{mL}$$

Therefore, 6.76 mL of 14.8-mol/L ammonia solution is needed to form 100 mL of 1.00-mol/L ammonia solution.

22. $c_i = 0.400\ \text{mol/L}$

$v_i = 125\ \text{mL}$

$v_f = 500.0\ \text{mL}$

$c_f = ?$

$$c_i v_i = c_f v_f$$

$$c_f = \frac{c_i v_i}{v_f}$$

$$= \frac{(0.400 \text{ mol/L})(125 \cancel{\text{mL}})}{500.0 \cancel{\text{mL}}}$$

$$c_f = 0.100 \text{ mol/L}$$

The final concentration of the barium chloride solution is 0.1 mol/L.

SECTION 2.5 QUESTIONS

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Understanding Concepts

1. $$v_{\text{solution}} = 500 \cancel{\text{bottles}} \times \frac{250 \text{ mL}}{1 \cancel{\text{bottle}}}$$

$$v_{\text{solution}} = 1.2 \times 10^5 \text{ mL}$$

$$c_{\text{solution}} = 6.0\% \text{ W/V}$$

$$m_{H_2O_2} = ?$$

$$c_{\text{solution}} = \frac{m_{H_2O_2}}{v_{\text{solution}}} \times 100\%$$

$$m_{H_2O_2} = \frac{c_{\text{solution}} v_{\text{solution}}}{100\%}$$

$$= \frac{(6.0 \text{ g}/\cancel{\text{mL}}\ \%)(1.2 \times 10^5 \cancel{\text{mL}})}{100\%}$$

$$m_{H_2O_2} = 7200 \text{ g} H_2O_2$$

Therefore, 7200 g of hydrogen peroxide is required.

2. $$v_{F^-} = 250 \cancel{\text{mL}} \times \frac{1 \text{ L}}{1000 \cancel{\text{mL}}}$$

$$v_{F^-} = 0.25 \text{ L}$$

$$c_{F^-} = 1.5 \text{ ppm or } 1.5 \text{ mg/L}$$

$$m_{F^-} = ?$$

$$1 \text{ ppm} = 1 \text{ mg/L}$$

$$c_{F^-} = \frac{m_{F^-}}{v_{F^-}}$$

$$m_{F^-} = c_{F^-} v_{F^-}$$

$$= (1.5 \text{ mg}/\cancel{\text{L}})(0.25 \cancel{\text{L}})$$

$$m_{F^-} = 0.38 \text{ mg}$$

The maximum mass of fluorine in the glass of water is 0.38 mg.

3. $$v_{C_{12}H_{22}O_{11}} = 50.0 \cancel{\text{mL}} \times \frac{1 \text{ L}}{1000 \cancel{\text{mL}}}$$

$$v_{C_{12}H_{22}O_{11}} = 0.050 \text{ L}$$

$$c_{C_{12}H_{22}O_{11}} = 0.50 \text{ mol/L}$$

$$m_{C_{12}H_{22}O_{11}} = ?$$

$$M_{C_{12}H_{22}O_{11}} = 12(12.01\text{ g/mol}) + 22(1.01\text{ g/mol}) + 11(16.00\text{ g/mol})$$
$$M_{C_{12}H_{22}O_{11}} = 342.34\text{ g/mol}$$
$$1\text{ mol } C_{12}H_{22}O_{11} = 342.34\text{ g } C_{12}H_{22}O_{11}$$
$$c_{C_{12}H_{22}O_{11}} = \frac{n_{C_{12}H_{22}O_{11}}}{v_{C_{12}H_{22}O_{11}}}$$
$$n_{C_{12}H_{22}O_{11}} = \left(c_{C_{12}H_{22}O_{11}}\right)\left(v_{C_{12}H_{22}O_{11}}\right)$$
$$= \left(\frac{0.50\text{ mol } C_{12}H_{22}O_{11}}{\cancel{\text{L}}}\right)(0.050\ \cancel{\text{L}})$$
$$n_{C_{12}H_{22}O_{11}} = 0.025\text{ mol } C_{12}H_{22}O_{11}$$
$$m_{C_{12}H_{22}O_{11}} = 0.025\ \cancel{\text{mol } C_{12}H_{22}O_{11}} \times \frac{342.34\text{ g } C_{12}H_{22}O_{11}}{1\ \cancel{\text{mol } C_{12}H_{22}O_{11}}}$$
$$m_{C_{12}H_{22}O_{11}} = 8.6\text{ g } C_{12}H_{22}O_{11}$$

Therefore, 8.6 g of sucrose is in the sucrose solution.

4. $m_{H_3PO_4} = 40.2\text{ g}$

$$v_{H_3PO_4} = 250\ \cancel{\text{mL}} \times \frac{1\text{ L}}{1000\ \cancel{\text{mL}}}$$
$$v_{H_3PO_4} = 0.25\text{ L}$$
$$c_{H_3PO_4} = ?$$
$$M_{H_3PO_4} = 3(1.01\text{ g/mol}) + (30.97\text{ g/mol}) + 4(16.00\text{ g/mol})$$
$$M_{H_3PO_4} = 98.00\text{ g/mol}$$
$$n_{H_3PO_4} = 40.2\ \cancel{\text{g } H_3PO_4} \times \frac{1\text{ mol } H_3PO_4}{98.00\ \cancel{\text{g } H_3PO_4}}$$
$$n_{H_3PO_4} = 0.4100\text{ mol } H_3PO_4$$
$$c_{H_3PO_4} = \frac{n_{H_3PO_4}}{v_{H_3PO_4}}$$
$$= \frac{0.4100\text{ mol } H_3PO_4}{0.25\text{ L}}$$
$$c_{H_3PO_4} = 1.64\text{ mol/L}$$

The molar concentration of the phosphoric acid solution is 1.64 mol/L.

5. (a) $c_i = 1.50\text{ mol/L}$

$$v_i = 45.5\text{ mL}$$
$$v_f = 200.0\text{ mL}$$
$$c_f = ?$$
$$c_i v_i = c_f v_f$$
$$c_f = \frac{c_i v_i}{v_f}$$
$$= \frac{(1.50\text{ mol/L})(45.5\ \cancel{\text{mL}})}{200.0\ \cancel{\text{mL}}}$$
$$c_f = 0.341\text{ mol/L}$$

The concentration of the dilute sodium sulfate solution is 0.341 mol/L.

(b) $c_i = 3.50 \text{ mol/L}$

$c_f = 2.50 \text{ mol/L}$

$v_i = 50.0 \text{ mL}$

$v_f = ?$

$c_i v_i = c_f v_f$

$$v_f = \frac{c_i v_i}{c_f}$$

$$= \frac{(3.50 \cancel{\text{mol/L}})(50.0 \text{ mL})}{2.50 \cancel{\text{mol/L}}}$$

$v_f = 70.0 \text{ mL}$

The final volume of the diluted nitric acid solution is 70.0 mL.

Applying Inquiry Skills

6. (a) $c_i = 0.25 \text{ mol/L}$

$c_f = 0.010 \text{ mol/L}$

$v_f = 250 \text{ mL}$

$v_i = ?$

$c_i v_i = c_f v_f$

$$v_i = \frac{c_f v_f}{v_i}$$

$$= \frac{(0.010 \cancel{\text{mol/L}})(250 \text{ mL})}{0.25 \cancel{\text{mol/L}}}$$

$v_i = 10 \text{ mL}$

Therefore, 10 mL of the sodium carbonate stock solution is needed to prepare the diluted solution.

(b) Step 1. Place 10.0 mL of sodium carbonate stock solution, $Na_2CO_{3(aq)}$, into a clean, dry 250-mL volumetric flask.
Step 2. Add enough distilled water to bring the volume to the 250-mL mark on the volumetric flask.
Step 3. Place the stopper on the volumetric flask and invert several times to mix.

Making Connections

7. LD_{50} is a test that measures the concentration of a substance that kills 50% of the animals tested. The LD_{50} value is obtained by administering increasing concentrations of a test product until half of the test animals die within 14 days of a single administration. Test animals are usually mice, rats, rabbits, or hamsters. A substance with an LD_{50} between 1 to 50 ppm is considered highly toxic, and a substance with an LD_{50} between 500 to 5000 ppm is considered slightly toxic.
8. Concentrations must be clearly communicated to health care workers to avoid errors when dispensing or administering medications to patients. Concentration units commonly used in the health care field include percentage concentrations in W/V and V/V, mg/100 mL, mg/dL, mol/L, μmol/L, and ppm.

2.6 TECH CONNECT: THE SPECTROPHOTOMETER

CAREER CONNECTION: CHEMICAL LABORATORY TECHNICIAN

(i) Student answers will vary. Educational requirements for admission to a chemical laboratory technician program at Seneca College of Applied Arts and Technology are:
Ontario Secondary School Diploma with a majority of senior credits at the College Preparation (C), University Preparation (U) or University/College Preparation (M) level
Grade 12 English: ENG4 (C) or ENG4 (U)
Grade 11 Biology (C)