10.5 APPLICATIONS OF GASES

PRACTICE

(Page 488)

Understanding Concepts

1. $p_1 = 100$ kPa

   $T_1 = 20°C = 293$ K

   $v_1 = 4.0$ kL

   $p_2 = 1.2$ kPa

   $T_2 = -47°C = 226$ K

   $v_{He} = ?$

$$\frac{p_1 v_1}{T_1} = \frac{p_2 v_2}{T_2}$$

$$v_{He} = \frac{T_2 p_1 v_1}{T_1 p_2}$$

$$= \frac{226 \text{ K} \times 100 \text{ kPa} \times 4.0 \text{ kL}}{}$$

$$v_{He} = 2.6 \times 10^2 \text{ kL} = 0.26 \text{ ML}$$

   or

$$v_{He} = 4.0 \text{ kL} \times \frac{100 \text{ kPa}}{1.2 \text{ kPa}} \times \frac{226 \text{ K}}{293 \text{ K}}$$

$$v_{He} = 2.6 \times 10^2 \text{ kL} = 0.26 \text{ ML}$$

   The final volume of the helium balloon is 0.26 ML.

2. The molar masses of water, nitrogen, and oxygen, respectively, are 18.02 g/mol, 28.02 g/mol, and 32.00 g/mol. Since water molecules are obviously much lighter than the other principal gases in air, for equal total pressure and temperature, air of high water vapour partial pressure (high relative humidity) must be less dense than "dry" air.

3. (a) $NH_4NO_{3(s)} \rightarrow N_2O_{(g)} + 2\ H_2O_{(g)}$

   m 1.0 L, 20°C = 293 K, 100 kPa

   80.06 g/mol $R = 8.31$ kPa · L/(mol · K)

$$pv = nRT$$

$$n_{N_2O} = \frac{pv}{RT}$$

$$= \frac{100 \text{ kPa} \times 1.0 \text{ L}}{\frac{8.31 \text{ kPa} \cdot \text{L}}{\text{mol} \cdot \text{K}} \times 293 \text{ K}}$$

$$n_{N_2O} = 0.041 \text{ mol}$$

$$n_{NH_4NO_3} = 0.041 \text{ mol} \times \frac{1}{1}$$

$$n_{NH_4NO_3} = 0.041 \text{ mol}$$

$$m_{NH_4NO_3} = 0.041 \text{ mol} \times \frac{80.06 \text{ g}}{1 \text{ mol}}$$

$$m_{NH_4NO_3} = 3.3 \text{ g}$$

or

$$m_{NH_4NO_3} = 1.0 \cancel{\text{L}}\ \cancel{N_2O} \times \frac{1\ \cancel{\text{mol}}\ \cancel{N_2O} \cdot \cancel{\text{K}}}{8.31\ \cancel{\text{kPa}} \cdot \cancel{\text{L}}\ \cancel{N_2O}} \times \frac{1\ \cancel{\text{mol}}\ \cancel{NH_4NO_3}}{1\ \cancel{\text{mol}}\ \cancel{N_2O}}$$

(continued)

$$\times \frac{100\ \cancel{\text{kPa}}}{293\ \cancel{\text{K}}} \times \frac{80.06 \text{ g } NH_4NO}{1\ \cancel{\text{mol}}\ \cancel{NH_4NO_3}}$$

$$m_{NH_4NO_3} = 3.3 \text{ g}$$

The mass of ammonium nitrate required is 3.3 g.

(b) $p_{N_2O} = (400 - 100) \text{ kPa} = 300 \text{ kPa}$

Making Connections

4. Meteorologists' reports are mostly concerned with air temperature, pressure, and relative humidity (water vapour partial pressure).
5. Human respiration is controlled by the brain, responding to carbon dioxide and oxygen partial pressures — so controlling these during surgery under general anaesthetic is critical.
6. A diver must know about gas pressure and partial pressures, and their effect on gas reaction rates and on solubility.

SECTION 10.5 QUESTIONS

(Page 489)

Making Connections

1. Compressed propane is used as a fuel, compressed air is used to inflate car tires, and methane (natural gas) is used to heat homes.
2. All compressed gases are a physical hazard because of the possibility of "explosion" — that is, container failure. Some compressed aerosol can propellants are toxic if inhaled, and some are flammable — two chemical hazards.
3. (a) Welding — the technology of joining metals while molten — is an area of study that involves knowledge of compressed and dangerous gases.
   (b) Welders use gases for fuel and oxidizers for heating metals, and also inert gases to prevent the occurrence of corrosion during the welding process.

PRACTICE

(Page 490)

Making Connections

7. (a) Welding — the technology of joining metals while molten — is an area of study that involves knowledge and use of compressed and dangerous gases. Welders use gases for fuel and oxidizers for heating metals, and also inert gases to prevent corrosion during the welding process.
   (b) Math and physical science high school courses are required for this career.
   (c) Training beyond high school usually involves a technical college course of study and certification, as well as apprenticeship and on-the-job training.
   (d) Welders are in high demand anywhere industrial construction is being done, and also anywhere metal fabrication maintenance is required — essentially everywhere. Experienced welders may make $50 000 – $150 000 annually, depending on experience and specialization.