Ch. 13.1 & 14 Extra Review Problems Answer Key

1. Pressure
   What is the height of a column of Hg that would be supported by a pressure of 110.8 kPa?
   Note that this is essentially asking what the pressure would be in mmHg (on a barometer):

$$?\ \text{mm Hg} = 110.8\ \text{kPa} \times \frac{760\ \text{mm Hg}}{101.3\ \text{kPa}} = \boxed{831.3\ \text{mm Hg}}$$

2. Partial Pressure
   If the total pressure of a gas mixture (N_2, O_2 & He) is 1.23 atm, and the pressure of N_2 is 0.34 atm and O_2 is 0.77 atm, what is the pressure of He?

$$P_{He} = 1.23\ \text{atm} - (0.34\ \text{atm} + 0.77\ \text{atm})$$
$$= \boxed{0.12\ \text{atm}}$$

3. Boyle's Law
   A sample of neon gas occupies a volume of 2.8 L at 1.8 atm. What will its volume be at 1.2 atm?

$$P_1V_1 = P_2V_2; (1.8\ \text{atm})(2.8\ \text{L}) = (1.2\ \text{atm})V_2;\ V_2 = \frac{(1.8\ \text{atm})(2.8\ \text{L})}{1.2\ \text{atm}} = \boxed{4.2\ \text{L}}$$

4. Charles's Law
   A balloon full of air has a volume of 2.75 L at 18.0°C. What is its volume at 45.0°C?

$T_1 = 18.0°C + 273 = 291\ \text{K};\ T_2 = 45.0°C + 273 = 318\ \text{K}$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}; \frac{2.75\ \text{L}}{291\ \text{K}} = \frac{V_2}{318\ \text{K}};\ V_2 = \frac{(2.75\ \text{L})(318\ \text{K})}{291\ \text{K}} = \boxed{3.01\ \text{L}}$$

5. Gay-Lussac's Law
   A cylinder of He gas has a pressure of 4.40 atm at 25.0°C. At what temperature, in °C, will it reach a pressure of 6.50 atm?

$T_1 = 25.0°C + 273 = 298\ \text{K}$

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}; \frac{4.40\ \text{atm}}{298\text{K}} = \frac{6.50\ \text{atm}}{T_2};\ T_2 = \frac{(298\ \text{K})(6.50\ \text{atm})}{4.40\ \text{atm}} = 440\ \text{K} - 273 = 167°C$$

6. Combined Gas Law
   A sample of H_2 gas has a volume of 65.0 mL at 0.992 atm and 16.0°C. What is its volume at 0.984 atm and 25.0°C?

$T_1 = 16.0°C + 273 = 289\ \text{K};\ T_2 = 25.0°C + 273 = 298\ \text{K};$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}; \frac{(0.992\ \text{atm})(65.0\ \text{mL})}{289\ \text{K}} = \frac{(0.984\ \text{atm})V_2}{298\ \text{K}};\ V_2 = \frac{(0.992\ \text{atm})(65.0\ \text{mL})(298\ \text{K})}{(0.984\ \text{atm})(289\ \text{K})} = \boxed{67.6\ \text{mL}}$$

7. Avogadro's Principle
   What is the volume of 45.8 g of Kr at STP?

$$?\ \text{L Kr} = \underbrace{45.8\ \text{g Kr} \times \frac{1\ \text{mol Kr}}{83.8\ \text{g Kr}}}_{0.547\ \text{mol Kr}} \times \frac{22.4\ \text{L}}{1\ \text{mol}} = \boxed{12.2\ \text{L Kr}}$$

8. Ideal Gas Law
   What is the pressure, in kPa, of 5.00 mol CO in a 20.0 L cylinder at 0.00°C?

$$T = 0.00°C + 273 = 273\ \text{K};\ P = \frac{nRT}{V} = \frac{(5.00\ \text{mol})\left(0.0821 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}}\right)(273\ \text{K})}{20.0\ \text{L}} = 5.60\ \text{atm};$$

$$P = 5.60\ \text{atm} \times \frac{101.3\ \text{kPa}}{1\ \text{atm}} = \boxed{568\ \text{kPa}}$$

9. Molar Mass Calculations

What is the molar mass of a gas if 6.45 g of the gas in a 20.0 L cylinder has a pressure of 0.241 atm at 0.00°C?

$$n = \frac{PV}{RT} = \frac{(0.241\text{ atm})(20.0\text{ L})}{\left(0.0821\frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}}\right)(273\text{ K})} = 0.215\text{ mol};\ MM = \frac{6.45\text{ g}}{0.215\text{ mol}} = \boxed{30.0\text{ g/mol}}$$ -OR-

$$PM = DRT;\ M = \frac{DRT}{P} = \frac{\left(\frac{6.45\text{ g}}{20.0\text{ L}}\right)\left(0.0821\frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}}\right)(273\text{ K})}{0.241\text{ atm}} = \boxed{30.0\text{ g/mol}}$$

10. Volume-Volume Calculations

$$4\ NH_3(g) + 3\ O_2(g) \rightarrow 2N_2(g) + 6H_2O\ (\ell)$$

If 1.78 L of O_2 reacts, what volume of nitrogen can be produced at the same T & P?

$$?\text{ L } N_2 = 1.78\text{ L of } O_2 \times \frac{2\ N_2}{3\ O_2} = \boxed{1.19\text{ L } N_2}$$

11. Mass-Volume Calculations

$$2As_2S_3(g) + 9O_2(g) \rightarrow 2As_2O_3(g) + 6SO_2\ (g)$$

If 89.5 g of As_2S_3 reacts with excess O_2, what volume of SO_2 can be produced at STP?

$$MM\ As_2S_3 = 2(74.92\text{ g}) + 3(32.07\text{ g}) = 246.05\text{ g}$$

$$?\text{ L } SO_2 = 89.5\text{ g } As_2S_3 \times \frac{1\text{ mol } As_2S_3}{246.05\text{ g } As_2S_3} \times \frac{6\text{ mol } SO_2}{2\text{ mol } As_2S_3} \times \frac{22.4\text{ L } SO_2}{1\text{ mol } SO_2} = \boxed{24.4\text{ L } SO_2}$$