Chapter 13.1

65. What is the partial pressure of water vapor in an air sample when the total pressure is 1.00 atm, the partial pressure of nitrogen is 0.79 atm, the partial pressure of oxygen is 0.20 atm, and the partial pressure of all other gases in air is 0.0044 atm?

$$P_{H_2O} = 1.00 \text{ atm} - (0.79 \text{ atm} + 0.20 \text{ atm} + 0.0044 \text{ atm}) = 0.0056 \text{ atm}$$

66. What is the total gas pressure in a sealed flask that contains oxygen at a partial pressure of 0.41 atm and water vapor at a partial pressure of 0.58 atm?

P_{Total}=0.41 atm + 0.58 atm = 0.99 atm

69. The pressure atop the world's highest mountain, Mount Everest, is usually about 33.6 kPa. Convert the pressure to atmospheres. How does the pressure compare with the pressure at sea level?

$$P = 33.6 \text{ kPa} \times \frac{1.00 \text{ atm}}{101.3 \text{ kPa}} = 0.332 \text{ atm}$$

70. The atmospheric pressure in Denver, Colorado, is usually about 84.0 kPa. What is this pressure in atm and torr units?

$$P = 84.0 \text{ kPa} \times \frac{1.00 \text{ atm}}{101.3 \text{ kPa}} = 0.829 \text{ atm}; \; P = 84.0 \text{ kPa} \times \frac{760 \text{ torr}}{101.3 \text{ kPa}} = 630 \text{ torr}$$

Chapter 14

88. Use Boyle's, Charles's, or Gay-Lussac's law to calculate the missing value in each of the following:
    a. $V_1 = 2.0$ L, $P_1 = 0.82$ atm, $V_2 = 1.0$ L, $P_2 = ?$
    b. $V_1 = 250$ mL, $T_1 = ?$, $V_2 = 400$ mL, $T_2 = 298$ K
    c. $V_1 = 0.55$ L, $P_1 = 740$ mm Hg, $V_2 = 0.80$ L, $P_2 = ?$
    d. $T_1 = 25°C$, $P_1 = ?$, $T_2 = 37°C$, $P_2 = 1.0$ atm

a. $$P_1V_1 = P_2V_2;\; P_2 = \frac{(0.82 \text{ atm})(2.0 \text{ L})}{1.0 \text{ L}} = \boxed{1.64 \text{ atm}}$$

b. $$\frac{V_1}{T_1} = \frac{V_2}{T_2};\; T_1 = \frac{(250 \text{ mL})(298 \text{ K})}{400 \text{ mL}} = \boxed{186 \text{ K}}$$

c. $$P_1V_1 = P_2V_2;\; P_2 = \frac{(740 \text{ mm Hg})(0.55 \text{ L})}{0.80 \text{ L}} = \boxed{509 \text{ mm Hg}}$$

d. $$\frac{P_1}{T_1} = \frac{P_2}{T_2};\; P_1 = \frac{(1.0 \text{ atm})(298 \text{ K})}{310 \text{ K}} = \boxed{0.96 \text{ atm}}$$

92. A sample of nitrogen gas is stored in a 500.0-mL flask at 108 kPa and 10.0°C. The gas is transferred to a 750.0-mL flask at 21.0°C. What is the pressure of nitrogen in the second flask?

T_1=10.0°C + 273 = 283 K; T_2=21.0°C + 273 = 294 K

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2};\; P_2 = \frac{P_1V_1T_2}{V_2T_1} = \frac{(108 \text{ kPa})(500.0 \text{ mL})(294 \text{ K})}{(750.0 \text{ mL})(283 \text{ K})} = \boxed{74.8 \text{ kPa}}$$

94. A weather balloon is filled with helium that occupies a volume of 5.00×10^4 L at 0.995 atm and 32.0°C. After it is released, it rises to a location where the pressure is 0.720 atm and the temperature is -12.0°C. What is the volume of the balloon at that new location?

$T_1 = 32.0°C + 273 = 305\ K;\ T_2 = -12.0°C + 273 = 261\ K$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2};\ V_2 = \frac{P_1V_1T_2}{P_2T_1} = \frac{(0.995\ atm)(5.00 \times 10^4\ L)(261\ K)}{(0.720\ atm)(305\ K)} = \boxed{5.91 \times 10^4\ L}$$

95. Propane, C_3H_8, is a gas commonly used as a home fuel for cooking and heating.

a. Calculate the volume that 0.540 mol of propane occupies at STP.

$$?\ L\ C_3H_8 = 0.540\ mol\ C_3H_8 \times \frac{22.4\ L\ C_3H_8}{1\ mol\ C_3H_8} = \boxed{12.1\ L\ C_3H_8}$$

96. Carbon monoxide, CO, is a product of incomplete combustion of fuels. Find the volume that 42 g of carbon monoxide gas occupies at STP.

$$?\ L\ CO = \underbrace{42\ g\ CO \times \frac{1\ mol\ CO}{28.01\ g\ CO}}_{1.499\ mol\ CO} \times \frac{22.4\ L\ CO}{1\ mol\ CO} = \boxed{33.6\ L\ CO}$$

97. The lowest pressure achieved in a laboratory is about 1.0×10^{-15} mm Hg. How many *moles* of gas are present in a 1.00-L sample at that pressure and a temperature of 22.0°C?

$$T = 22.0°C + 273 = 295\ K;\ P = 1.0 \times 10^{-15}\ mm\ Hg \times \frac{1\ atm}{760\ mm\ Hg} = 1.3 \times 10^{-18}\ atm$$

$$PV = nRT \Rightarrow n = \frac{PV}{RT} = \frac{(1.3 \times 10^{-18}\ atm)(1.00\ L)}{(0.08206\ \frac{L \cdot atm}{mol \cdot K})(295\ K)} = \boxed{5.4 \times 10^{-20}\ mol}$$

100. A 2.00-L flask is filled with propane gas (C_3H_8) at 1.00 atm and –15.0°C. What is the mass of the propane in the flask?

$T = -15.0°C + 273 = 258\ K$

$$PV = nRT \Rightarrow n = \frac{PV}{RT} = \frac{(1.00\ atm)(2.00\ L)}{(0.08206\ \frac{L \cdot atm}{mol \cdot K})(258\ K)} = 0.09447\ mol$$

$$?\ g\ C_3H_8 = 0.09447\ mol\ C_3H_8 \times \frac{44.11\ g\ C_3H_8}{1\ mol\ C_3H_8} = 4.166 = \boxed{4.17\ g\ C_3H_8}$$

102. When 3.00 L of propane gas is completely combusted to form water vapor and carbon dioxide at a temperature of 350°C and a pressure of 0.990 atm, what mass of water vapor will result?

$C_3H_8\ (g) + 5\ O_2\ (g) \rightarrow 3\ CO_2\ (g) + 4\ H_2O\ (g)$

Molar Mass H_2O = 2×1.01 g + 16.00 g = 18.02 g; T = 350°C + 273 = 623 K

$$\text{Use } PV = nRT \text{ to solve for } n_{C_3H_8} = \frac{PV}{RT} = \frac{(0.990\ atm)(3.00\ L)}{(0.08206\ \frac{L \cdot atm}{mol \cdot K})(623\ K)} = 0.05809\ mol\ C_3H_8$$

$$?\ g\ H_2O = \underbrace{0.05809\ mol\ C_3H_8 \times \frac{4\ mol\ H_2O}{1\ mol\ C_3H_8}}_{0.2323\ mol\ H_2O} \times \frac{18.02\ gH_2O}{1\ mol\ H_2O} = 4.187 = \boxed{4.19\ g\ H_2O}$$

104. Use the reaction shown below to answer these questions.

$CO (g) + NO (g) \rightarrow N_2 (g) + CO_2 (g)$

a. Balance the equation

b. What is the volume ratio of carbon monoxide to carbon dioxide in the balanced equation?

c. if 42.7 g CO is reacted completely at STP, what volume of N_2 gas will be produced?

a. $2\ CO (g) + 2\ NO (g) \rightarrow N_2 (g) + 2\ CO_2 (g)$

b. $\frac{2\ CO}{2\ CO_2}$ or 1:1

c. $$?\ L\ N_2 = \underbrace{\frac{42.7\ g\ CO}{1} \times \frac{1\ mol\ CO}{28.01\ g\ CO}}_{1.524\ mol\ CO} \times \underbrace{\frac{1\ mol\ N_2}{2\ mol\ CO}}_{0.7622\ mol\ N_2} \times \frac{22.4\ L\ N_2}{1\ mol\ N_2} = \boxed{17.1\ L\ N_2}$$

Additional Problems:

a. What volume will 0.00660 mol of hydrogen gas occupy at 0.907 atm and 25.0 K?

$$PV = nRT \Rightarrow V = \frac{(0.00660\ mol)(0.08206\ \frac{L\cdot atm}{mol\cdot K})(25.0\ K)}{0.907\ atm} = \boxed{0.0149\ L}$$

b. What is the pressure, in kPa, of 3.95 mol of Cl_2 compressed to 850. mL at 15°C?

T=15°C+273=288 K; V = 850. mL × 1 L/1000 mL = 0.850 L

$$PV = nRT \Rightarrow P = \frac{nRT}{V} = \frac{(3.95\ mol)(8.314\ \frac{L\cdot kPa}{mol\cdot K})(288\ K)}{0.850\ L} = 11{,}127 = \boxed{11{,}100\ kPa\ (1.11\times10^4\ kPa)}$$

c. What is the temperature, in °C, of 0.120 mol of an ideal gas in a volume of 250. mL at 500.0 kPa?

$$V = 250.\ mL \times \frac{1\ L}{1000\ mL} = 0.250\ L$$

$$PV = nRT \Rightarrow T = \frac{PV}{nR} = \frac{(500.0\ kPa)(0.250\ L)}{(0.120\ mol)(8.314\ \frac{L\cdot kPa}{mol\cdot K})} = 125\ K - 273 = \boxed{-148°C}$$

d. What is the molar mass of a gas if a 27.9 g sample in a 6.57 L container has a pressure of 1.76 atm at 54°C?

$T = 54°C + 273 = 327\ K$

Solve for n with PV = nRT: $$n = \frac{PV}{RT} = \frac{(1.76\ atm)(6.57\ L)}{(0.08206\ \frac{L\cdot atm}{mol\cdot K})(327\ K)} = 0.4309\ mol$$

$$MM = \frac{27.9\ g}{0.4309\ mol} = 64.74 = \boxed{64.7\ g/mol}$$

The gas could be SO_2 since its molar mass is 64.07 g/mol.

Or use PM = DRT: $$M = \frac{DRT}{P} = \frac{(\frac{27.9\ g}{6.57\ L})(0.08206\ \frac{L\cdot atm}{mol\cdot K})(327\ K)}{1.76\ atm} = 64.74 = \boxed{64.7\ g/mol}$$

e. What volume of CO_2, at STP, can be produced by the combustion of 82.3 L of propane gas, C_3H_8, also at STP, according to the following equation?

$$C_3H_8\ (g) + 5\ O_2\ (g) \rightarrow 3\ CO_2\ (g) + 4\ H_2O\ (g)$$

W & G are at same T & P so we can use the L/L ratio:

$$?\ L\ CO_2 = 82.3\ L\ C_3H_8 \times \frac{3\ L\ CO_2}{1\ L\ C_3H_8} = \boxed{247\ L\ CO_2}$$

f. What mass of $KClO_3$ must be used in order to generate 5.00 L of O_2 at STP according to the following equation?

$$2\ KClO_3\ (s) \rightarrow 2\ KCl\ (s) + 3\ O_2\ (g)$$

$$?\ g\ KClO_3 = \underbrace{5.00\ L\ O_2 \times \frac{1\ mol\ O_2}{22.4\ L\ O_2}}_{0.2232\ mol\ O_2} \times \underbrace{\frac{2\ mol\ KClO_3}{3\ mol\ O_2}}_{0.1488\ mol\ KClO_3} \times \frac{122.55\ g\ KClO_3}{1\ mol\ KClO_3} = \boxed{18.2\ g\ KClO_3}$$

g. What volume of O_2 gas will be collected at 95.6 kPa and 225°C by the decomposition of 15.3 g of barium peroxide, BaO_2?

$$2\ BaO_2\ (s) \rightarrow 2\ BaO\ (s) + O_2\ (g)$$

Find mol O_2 first:

$$?\ mol\ O_2 = \underbrace{15.3\ g\ BaO_2 \times \frac{1\ mol\ BaO_2}{169.33\ g\ BaO_2}}_{0.09035\ mol\ BaO_2} \times \frac{1\ mol\ O_2}{2\ mol\ BaO_2} = 0.04518\ mol\ O_2$$

Next use PV = nRT to find V_{O_2} (T = 225°C + 273 = 498 K):

$$V_{O_2} = \frac{nRT}{P} = \frac{(0.04518\ mol)(8.314\ \frac{L\cdot kPa}{mol\cdot K})(498\ K)}{95.6\ kPa} = 1.956 = \boxed{1.96\ L\ O_2}$$