WKS
Ideal Gas Law

NAME Answer Key
Period _____ **Date** _____

1. A student collects 425 mL of oxygen at a temperature of 24°C and a pressure of 0.899 atm. How many moles of O_2 did she collect?

   $T = 24°C + 273 = 297\ K; V = 425\ mL \times 1\ L/1000\ mL = 0.425\ L$

   $$n = \frac{PV}{RT};\ n = \frac{(0.899\ \cancel{atm})(0.425\ \cancel{L})}{\left(0.0821 \frac{\cancel{L} \cdot \cancel{atm}}{mol \cdot \cancel{K}}\right)(297\ \cancel{K})} = \boxed{0.0157\ mol}$$

2. What is the volume of 1.5 moles of an ideal gas at 25°C and a pressure of 0.915 kPa?

   $T = 25°C + 273 = 298\ K$

   $$V = \frac{nRT}{P};\ V = \frac{(1.5\ \cancel{mol})\left(8.314 \frac{L \cdot kPa}{\cancel{mol} \cdot K}\right)(298\ \cancel{K})}{(0.915\ \cancel{kPa})} = \boxed{4060\ L}$$

3. What pressure, in atm, will 1,360 g of N_2O gas exert on its cylinder with volume of 25.0 L if stored in a shed whose temperature reaches 59°C in the summer?

   $T = 59°C + 273 = 332\ K;\ n = 1360\ g\ N_2O \times 1\ mol/44.02\ g = 30.90\ mol\ N_2O$

   $$P = \frac{nRT}{V};\ P = \frac{(30.90\ \cancel{mol})\left(0.0821 \frac{\cancel{L} \cdot atm}{\cancel{mol} \cdot \cancel{K}}\right)(332\ \cancel{K})}{(25.0\ \cancel{L})} = \boxed{33.7\ atm}$$

4. A tank with a volume of 658 mL contains 1.50 g of Ne gas at a pressure of 450 kPa. What is the temperature of the gas, in °C?

   $V = 658\ mL \times 1\ L/1000\ mL = 0.658\ L;\ n = 1.50\ g\ Ne \times 1\ mol/20.18\ g = 0.0743\ mol\ Ne;$

   $$T = \frac{PV}{nR};\ T = \frac{(450\ \cancel{kPa})(0.658\ \cancel{L})}{(0.0743\ \cancel{mol})\left(8.314 \frac{\cancel{L} \cdot kPa}{\cancel{mol} \cdot K}\right)} = 479\ K;\ T = 479\ K - 273 = \boxed{206°C}$$

5. What mass of boron trifluoride gas will occupy a volume of 18.5 L at a temperature of 78.0°C and a pressure of 925 mmHg?

   $T = 78.0°C + 273 = 351\ K;\ P = 925\ mmHg \times 1\ atm / 760\ mmHg = 1.22\ atm$

   $$n = \frac{PV}{RT};\ P = \frac{(1.22\ \cancel{atm})(18.5\ \cancel{L})}{\left(0.0821 \frac{\cancel{L} \cdot atm}{mol \cdot \cancel{K}}\right)(351\ \cancel{K})} = 0.781\ mol;\ \text{mass } BF_3 = 0.781\ mol \times 67.81\ g/1\ mol = \boxed{53.0\ g\ BF_3}$$

6. What is the molar mass of 12.18 grams of a gas that has a volume of 2.75 L at 714 torr and 125°C?

   $$T = 125.0°C + 273 = 398\ K;\ P = 714\ \cancel{torr} \times \frac{1\ atm}{760\ \cancel{torr}} = 0.939\ atm$$

   $$PV = nRT \rightarrow n = \frac{PV}{RT};\ n = \frac{(0.939\ \cancel{atm})(2.75\ \cancel{L})}{\left(0.0821\ \frac{\cancel{L} \cdot atm}{mol \cdot \cancel{K}}\right)(398\ \cancel{K})} = 0.0790\ mol$$

   $$\text{Molar Mass} = \frac{\text{mass of gas}}{\text{moles of gas}} = \frac{12.18\ g}{0.0790\ mol} = \boxed{154\ g/mol}$$

[Over]

7. What is the molar mass of a sample of gas that has a density of 1.09 g/L at 1.02 atm pressure and 25.0°C? [Hint: set V = 1.00 L]

$T = 25.0°C + 273 = 298\ K$; assume V = 1.00 L, so mass = 1.09 g

$$PV = nRT \rightarrow n = \frac{PV}{RT};\ n = \frac{(1.02\ \cancel{atm})(1.00\ \cancel{L})}{\left(0.0821\ \frac{\cancel{L}\cdot\cancel{atm}}{mol\cdot\cancel{K}}\right)(298\ \cancel{K})} = 0.0417\ mol$$

$$\text{Molar Mass} = \frac{\text{mass of gas}}{\text{moles of gas}} = \frac{1.09\ g}{0.0417\ mol} = \boxed{26.1\ g/mol}$$

8. A sample of propane (C_3H_8) has a density of 0.925 g/L at 1.55 atm. What is its temperature? [You can assume either 1 mol or 1 L, then calculate the other first.]

$MM = 3\times 12.01\ g + 8\times 1.008\ g = 44.09\ g/mol$

Assume 1 mol & determine volume:

$$V = 1\ mol \times \frac{44.09\ g}{1\ mol} \times \frac{1\ L}{0.925\ g} = 47.66\ L$$

$$PV = nRT \text{ so } T = \frac{PV}{nR} = \frac{(1.55\ atm)(47.66\ L)}{(1\ mol)\left(0.0821\ \frac{L\cdot atm}{mol\cdot K}\right)} = \boxed{900.\ K}$$

Assume 1 L and determine # mol

$$n = 1\ L \times \frac{0.925\ g}{1\ L} \times \frac{1\ mol}{44.09\ g} = 0.02098\ mol$$

$$T = \frac{PV}{nR} = \frac{(1.55\ atm)(1\ L)}{(0.02098\ mol)\left(0.0821\ \frac{L\cdot atm}{mol\cdot K}\right)} = \boxed{900.\ K}$$

STOICHIOMETRY + PV= nRT:

9. Ammonia (NH_3) is made by the Haber process. This process involves reacting N_2 gas with H_2 gas at high temperatures and pressures to produce ammonia. If 10.0 kg of N_2 gas is reacted with excess H_2 gas at 550.°C and 250. atm, what volume of ammonia is produced?

$$N_2\ (g) + 3\ H_2\ (g) \rightarrow 2\ NH_3\ (g)$$

$$?\ mol\ NH_3 = 10.0\ \cancel{kg\ N_2} \times \frac{1000\ \cancel{g}}{1\ \cancel{kg}} \times \frac{1\ \cancel{mol\ N_2}}{28.02\ \cancel{g\ N_2}} \times \frac{2\ mol\ NH_3}{1\ mol\ \cancel{N_2}} = 714\ mol\ NH_3$$

$$V_{NH_3} = \frac{nRT}{P} = \frac{(714\ \cancel{mol}\ NH_3)\left(0.0821\ \frac{L\cdot atm}{\cancel{mol}\cdot K}\right)(823\ \cancel{K})}{250.\ \cancel{atm}} = \boxed{193\ L}$$

10. Acetylene gas (C_2H_2) can be produced by reacting calcium carbide (CaC_2) with water as shown here:

$$\underset{\text{Calcium carbide}}{CaC_2\ (s)} + 2\ H_2O\ (l) \rightarrow \underset{\text{acetylene gas}}{C_2H_2\ (g)} + Ca(OH)_2\ (aq)$$

If 3.25 g of CaC_2 is reacted with excess water, what volume of acetylene gas will be produced if it is collected over water at 17°C and the pressure is 0.974 atm. (This pressure is the total pressure of the acetylene gas mixed with water vapor.) **HINT:** First, determine the partial pressure of just the acetylene gas. Second, determine the moles of acetylene gas produced. Third, plug values into PV = nRT

$$P_{C_2H_2} = 0.974\ atm - 14.5\ mm\ Hg \times 1\ atm/760\ mm\ Hg = 0.955\ atm$$

$$?\ mol\ C_2H_2 = 3.25\ \cancel{g\ CaC_2} \times \frac{1\ \cancel{mol\ CaC_2}}{64.10\ \cancel{g\ CaC_2}} \times \frac{1\ mol\ C_2H_2}{1\ \cancel{mol\ CaC_2}} = 0.0507\ mol\ C_2H_2$$

$$V = \frac{nRT}{P} = \frac{(0.0507\ \cancel{mol})\left(0.0821\ \frac{L\cdot atm}{\cancel{mol}\cdot K}\right)(290.\ \cancel{K})}{0.955\ \cancel{atm}} = \boxed{1.26\ L\ C_2H_2}$$