

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 O₂ did she collect?

$$T = 24^{\circ}\text{C} + 273 = 297 \text{ K}; V = 425 \text{ mL} \times 1 \text{ L}/1000 \text{ mL} = 0.425 \text{ L}$$

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

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

$$T = 25^{\circ}\text{C} + 273 = 298 \text{ K}$$

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

3. What pressure, in atm, will 1,360 g of N₂O gas exert on its cylinder with volume of 25.0 L if stored in a shed whose temperature reaches 59°C in the summer?

$$T = 59^{\circ}\text{C} + 273 = 332 \text{ K}; n = 1360 \text{ g N}_2\text{O} \times 1 \text{ mol}/44.02 \text{ g} = 30.90 \text{ mol N}_2\text{O}$$

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

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?

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

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

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?

$$T = 78.0^{\circ}\text{C} + 273 = 351 \text{ K}; P = 925 \text{ mmHg} \times 1 \text{ atm} / 760 \text{ mmHg} = 1.22 \text{ atm}$$

$$n = \frac{PV}{RT}; n = \frac{(1.22 \cancel{\text{atm}})(18.5 \cancel{\text{L}})}{(0.0821 \frac{\cancel{\text{L}} \cdot \text{atm}}{\text{mol} \cdot \cancel{\text{K}}})(351 \cancel{\text{K}})} = 0.781 \text{ mol}; \text{mass BF}_3 = 0.781 \text{ mol} \times 67.81 \text{ g} / 1 \text{ mol} = \boxed{53.0 \text{ g BF}_3}$$

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?

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

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

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

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]

$$T = 25.0^\circ\text{C} + 273 = 298 \text{ K}; \text{ assume } V = 1.00 \text{ L, so mass} = 1.09 \text{ g}$$

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

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

8. A sample of propane (C₃H₈) 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.]

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

Assume 1 mol & determine volume:

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

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

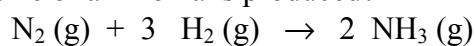
Assume 1 L and determine # mol

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

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

STOICHIOMETRY + PV = nRT:

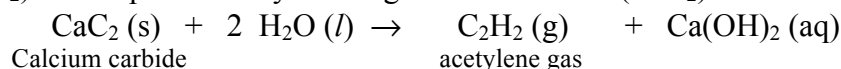
9. Ammonia (NH₃) is made by the Haber process. This process involves reacting N₂ gas with H₂ gas at high temperatures and pressures to produce ammonia. If 10.0 kg of N₂ gas is reacted with excess H₂ gas at 550. °C and 250. atm, what volume of ammonia is produced?



$$? \text{ mol NH}_3 = 10.0 \text{ kg N}_2 \times \frac{1000 \text{ g}}{1 \text{ kg}} \times \frac{1 \text{ mol N}_2}{28.02 \text{ g N}_2} \times \frac{2 \text{ mol NH}_3}{1 \text{ mol N}_2} = 714 \text{ mol NH}_3$$

$$V_{\text{NH}_3} = \frac{nRT}{P} = \frac{(714 \text{ mol NH}_3)(0.0821 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}})(823 \text{ K})}{250. \text{ atm}} = \boxed{193 \text{ L}}$$

10. Acetylene gas (C₂H₂) can be produced by reacting calcium carbide (CaC₂) with water as shown here:



If 3.25 g of CaC₂ 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

$$P_{\text{C}_2\text{H}_2} = 0.974 \text{ atm} - 14.5 \text{ mm Hg} \times 1 \text{ atm}/760 \text{ mm Hg} = 0.955 \text{ atm}$$

$$? \text{ mol C}_2\text{H}_2 = 3.25 \text{ g CaC}_2 \times \frac{1 \text{ mol CaC}_2}{64.10 \text{ g CaC}_2} \times \frac{1 \text{ mol C}_2\text{H}_2}{1 \text{ mol CaC}_2} = 0.0507 \text{ mol C}_2\text{H}_2$$

$$V = \frac{nRT}{P} = \frac{(0.0507 \text{ mol})(0.0821 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}})(290. \text{ K})}{0.955 \text{ atm}} = \boxed{1.26 \text{ L C}_2\text{H}_2}$$