

AP CHEMISTRY

TOPIC 3: GASES, PART B, EXAMPLE PROBLEMS

Day 35:

- Gas Stoichiometry
- Gas Density

1) Calculate the volume occupied by 2.5 moles of an ideal gas at STP.

$$PV = nRT \quad ; \quad V = \frac{nRT}{P} = \frac{(2.5 \text{ mol})(0.0821 \text{ atm}\cdot\text{L})(273 \text{ K})}{(1 \text{ atm})(\text{mol}\cdot\text{K})} = 56 \text{ L}$$

OR

@ STP; P = 1 atm, T = 273 K or 0°C

$$\frac{2.5 \text{ mol}}{1 \text{ mol}} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = 56 \text{ L}$$

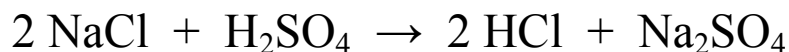
2) The density of a gas was measured at 4.97 atm and 96.2 °C and found to be 0.873 g / L. Calculate the molar mass of this gas.

$$PV = nRT \quad ; \quad n = \frac{m}{M}$$
$$PV = \frac{m}{M} RT$$
$$PV = \frac{m}{M} RT$$
$$M = \frac{mRT}{PV} \quad D = \frac{m}{V}$$

$$M = \left(\frac{m}{V} \right) \frac{RT}{P} = \left(\frac{0.873 \text{ g}}{\text{L}} \right) \left(\frac{(0.0821 \text{ atm}\cdot\text{L})(369.2 \text{ K})}{(\text{mol}\cdot\text{K})(4.97 \text{ atm})} \right) = 5.32 \frac{\text{g}}{\text{mol}}$$

- 3) $\text{HCl}_{(g)}$ can be prepared by reacting NaCl with H_2SO_4 . What mass solid NaCl is required to prepare enough HCl to fill a 340. mL cylinder to a pressure of 151 atm at 20.0°C ?

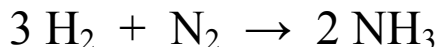
Gas Stoichiometry !!!



$$PV = nRT \quad ; \quad n = \frac{PV}{RT} = \frac{(151 \text{ atm})(\text{mol} \cdot \text{K})(0.340 \text{ L})}{(0.0821 \text{ atm} \cdot \text{L})(293 \text{ K})} = 2.13 \text{ mol HCl}$$

$$\frac{2.13 \text{ mol HCl}}{2 \text{ mol HCl}} \times \frac{2 \text{ mol NaCl}}{2 \text{ mol HCl}} \times \frac{58.44 \text{ g}}{1 \text{ mol NaCl}} = 124 \text{ g NaCl}$$

- 4) Ammonia, NH_3 , is generated by mixing hydrogen gas with nitrogen gas. What volume of ammonia can be generated if 30.5 liters of hydrogen at 143.0°C and a pressure of 2.27 atm is mixed with excess nitrogen gas under the same conditions?



$$\text{H}_2 \quad ; \quad PV = nRT \quad ; \quad n = \frac{PV}{RT} = \frac{(2.27 \text{ atm})(\text{mol} \cdot \text{K})(30.5 \text{ L})}{(0.0821 \text{ atm} \cdot \text{L})(416 \text{ K})} = 2.03 \text{ mol H}_2$$

$$\text{NH}_3 \quad ; \quad \frac{2.03 \text{ mol H}_2}{3 \text{ mol H}_2} \times \frac{2 \text{ mol NH}_3}{3 \text{ mol H}_2} = 1.35 \text{ mol NH}_3$$

$$V = \frac{nRT}{P} = \frac{(1.35 \text{ mol})(0.0821 \text{ atm} \cdot \text{L})(416 \text{ K})}{(2.27 \text{ atm})(\text{mol} \cdot \text{K})} = 20.3 \text{ L NH}_3$$