AP CHEMISTRY

TOPIC 3: GASES, PART B, EXAMPLE PROBLEMS

Day 35:

- Gas Stoichiometry
- Gas Density

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

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

OR

@ STP; P = 1 atm, T = 273 K or **0^0C**

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

2) The density of a gas was measured at 4.97 atm and 96.2 ^{0}C and found to be 0.873 g / L. Calculate the molar mass of this gas.

$$PV = nRT \quad ; \quad n = \frac{m}{M}$$

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$$M = \frac{mRT}{PV} \qquad D = \frac{m}{V}$$

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

3) $HCl_{(g)}$ 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 ^{0}C?

Gas Stoichiometry !!!

$$2\ NaCl\ +\ H_2SO_4\ \rightarrow\ 2\ HCl\ +\ Na_2SO_4$$

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

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

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 ^{0}C and a pressure of 2.27 atm is mixed with excess nitrogen gas under the same conditions?

$$3\ H_2\ +\ N_2\ \rightarrow\ 2\ NH_3$$

$$H_2 \quad ; \quad PV = nRT \quad ; \quad n = \frac{PV}{RT} \ = \ \frac{(2.27\ atm)(mol \cdot K)(30.5\ L)}{(0.0821\ atm \cdot L)(416\ K)} \ = \ 2.03\ mol\ H_2$$

$$NH_3 \quad ; \quad \frac{2.03\ mol\ H_2}{} \times \frac{2\ mol\ NH_3}{3\ mol\ H_2} \ = \ 1.35\ mol\ NH_3$$

$$V = \frac{nRT}{P} \ = \ \frac{(1.35\ mol)(0.0821\ atm \cdot L)(416\ K)}{(2.27\ atm)(mol \cdot K)} \ = \ 20.3\ \ L\ \ NH_3$$