Gas Stoichiometry
Chemistry 110

1] Given the equation: 2 NH_3 (g) + 3 Cl_2(g) ---> N_2(g) + 6 HCl(g)

a. How many milliliters of nitrogen can be made from 13 L of chlorine and 10.0 L of ammonia gas at STP?

$$\mathbf{10.0\ L\ NH_3 \times \frac{1\ L\ N_2}{2\ L\ NH_3} = 5.00\ L\ N_2}$$

$$\mathbf{13\ L\ Cl_2 \times \frac{1\ L\ N_2}{3\ L\ Cl_2} = 4.3\ L\ N_2}$$

Answer _____**4.3×10^3 mL N_2**_____

b. How many grams of chlorine must react to produce 16 L of nitrogen gas at 1.2 atm and 23^{O}C?

$$\mathbf{n_{N_2} = \frac{(1.2atm) \times (16L)}{(0.0821\frac{L\text{-}atm}{mol\text{-}K}) \times (273+23)K} = 0.790\ mol\ N_2}$$

$$\mathbf{0.790\ mol\ N_2 \times \frac{3mol\ Cl_2}{1mol\ N_2} \times \frac{70.1g\ Cl_2}{1mol} = 1.66 \times 10^2\ L\ Cl_2}$$

Answer _____

c. How many liters of ammonia gas at 244 torr and 35^{O}C must be used to produce 2.3 kg of HCl gas?

$$\mathbf{2.3\ Kg\ HCl \times \frac{10^3 g}{1Kg} \times \frac{1mol\ HCl}{36.5g} \times \frac{2mol\ NH_3}{6mol\ HCl} = 21\ mol\ NH_3}$$

$$\mathbf{V_{NH_3} = \frac{(21mol\ NH_3) \times (0.0821\frac{L\text{-}atm}{mol\text{-}K}) \times (273 + 35)K}{\frac{244torr}{760torr/1atm}} = 1.7 \times 10^3\ L\ NH_3}$$

Answer _____

2] How many liters of ammonia, measured at STP, must be used to produce of 2.65 grams of calcium hydride 6 Ca(s) + 2 NH_3 (g)--> 3 CaH_2(s) + Ca_3N_2(g)

$$\mathbf{2.65\ g\ CaH_2 \times \frac{1mol\ CaH_2}{42.1g} \times \frac{2mol\ NH_3}{3mol\ CaH_2} \times \frac{22.4L}{1mol} = 0.940\ L\ NH_3}$$

Answer _____

3] What volume of oxygen, measured at 35^O C and 752 mm Hg, is required to "burn" 3.26 grams of calcium .
2 Ca(s) + O_2(g) --> 2 CaO(s)

$$\mathbf{3.26\ g\ Ca \times \frac{1molCa}{40.1g} \times \frac{1mol\ O_2}{2mol\ Ca} = 0.0406\ mol\ O_2}$$

$$\mathbf{V_2 = \frac{(0.0406\ mol\ O_2) \times (0.0821\frac{L\text{-}atm}{mol\text{-}K}) \times (273 + 35)K}{\frac{752mm}{760mm/1atm}} = 1.04\ L\ O_2}$$

Answer _____

4] How many mLs of 0.0246 M $AgNO_3$ required to precipitate as silver chromate all the chromate ion in a solution containing 2.10 g sodium chromate

Sodium chromate + Silver nitrate --> Silver chromate (solid) + Sodium nitrate

$$\mathbf{Na_2CrO_4 + 2\ AgNO_3 \rightarrow Ag_2CrO_4 + 2\ NaNO_3}$$

$$\mathbf{2.10\ g\ Na_2CrO_4 \times \frac{1mol\ Na_2CrO_4}{161.8g} \times \frac{2mol\ AgNO_3}{1mol\ Na_2CrO_4} \times \frac{1000ml\ AgNO_3}{0.0246mol} = 1.05 \times 10^3\ ml}$$

Answer _____

5] How many mls of 0.50M nitric acid are required to release 3.44 liters of hydrogen gas at 1.33 atm and 45^{o}C.

2HNO_3 + Zn ---> $Zn(NO_3)_2$ + H_2

$$n_{H_2} = \frac{(1.33atm) \times (3.44L)}{(0.0821\frac{L\text{-}atm}{mol\text{-}K}) \times (273 + 45)K} = 0.175 \text{ mol } H_2$$

$$0.175 \text{ mol } H_2 \times \frac{2 \text{mol } HNO_3}{1 \text{mol } H_2} \times \frac{1000 mL}{0.50 \text{mol } HNO_3} = 7.0 \times 10^2 \text{ ml } HNO_3$$

Answer _____

6] What is the molarity of a 5.00 L sodium hydroxide solution that would completely react with 2.00 L of carbon dioxide gas measured at STP..

2NaOH + CO_2 --> Na_2CO_3 + H_2O

Find the **Molarity** of the sodium hydroxide solution

$$2.00 \text{ L } CO_2 \times \frac{1 \text{mol } CO_2}{22.4L} \times \frac{2 \text{mol NaOH}}{1 \text{mol } CO_2} = 0.179 \text{ mol NaOH}$$

$$M_{NaOH} = \frac{0.179 \text{mol NaOH}}{5.00L \text{ soln}} = 0.0357 \text{ M}$$

Answer _____

7] How many liters of dry hydrogen gas, measured at 796 torr and 25^{o}C, will be released by the decomposition of 255 milliliters of H_2O(g) at 1.33 atm and 25^{o}C?

Write the balanced equation $2H_2O \text{ ---> } 2H_2 + O_2$

$$n_{H_2O} = \frac{(1.33atm) \times (0.255L)}{(0.0821\frac{L\text{-}atm}{mol\text{-}K}) \times (298K)} = 0.0139 \text{ mol } H_2O$$

$$0.0139 \text{ mol } H_2O \times \frac{2 \text{mol } H_2}{2 \text{ mol } H_2O} = 0.0139 \text{ mol } H_2$$

$$V_{H_2} = \frac{(0.0139 \text{ mol } H_2) \times (0.0821\frac{L\text{-}atm}{mol\text{-}K}) \times (298K)}{\frac{796torr}{760torr/1atm}} = 0.325 \text{ L } H_2$$

Answer _____

8] For the following reaction: 2CO(g) + O_2(g) ---> 2CO_2(g)

1.5 mol of CO and 2.0 mol of oxygen react in a closed 10 L vessel.

a. How many moles of CO,O_2 and CO_2 are present at the end of the reaction

$$1.5 \text{ mol CO} \times \frac{2 \text{mol } CO_2}{2 \text{mol CO}} = 1.5 \text{ mol } CO_2 \quad \text{<----amount made}$$

$$2.0 \text{ mol } O_2 \times \frac{2 \text{mol } CO_2}{1 \text{mol } O_2} = 4.0 \text{ mol } CO_2$$

$$1.5 \text{ mol CO} \times \frac{1 \text{mol } O_2}{2 \text{mol CO}} = 0.75 \text{ mol } O_2 \text{ used}$$

$$2.0 \text{ mol } O_2 - 0.75 \text{ mol } O_2 \text{ used} = 1.25 \text{ mol} = 1.3 \text{ mol remaining}$$

Answer: Moles CO_____**0**_____Moles O_2_____**1.3**_____Moles CO_2____**1.5**_____

b. What will be the total pressure in the flask at 273K?

Total moles of gas = 1.3 mol + 1.5 mol = 2.8 mol

$$P = \frac{(2.8mol) \times (0.0821\frac{L\text{-}atm}{mol\text{-}K}) \times (273K)}{10 \text{ L}} = 6.3 \text{ atm or } 4.8 \times 10^3 \text{ torr}$$