CHEM-1105 GASES-PROBLEM SET

1. A sample of H_2S gas occupies 32.1 L at 50.0°C and 730. mmHg. Calculate the volume of the gas at STP. **(26.1L)**

2. A sealed container containing methane gas at 730. mmHg and 27.0°C is put into a box cooled with "dry ice" (-78°C). What pressure the gas would exert under these conditions? **(475 mmHg)**

3. Calculate the density of $N_2O(g)$

   a) at STP **(1.96g/L)** b) at 729 mmHg and 25.0°C. **(1.73g/L)**

4. If 0.670 g vapor of a compound at 100.°C and 735 torr has a volume of 249 mL, what is the molar mass of the compound? **(85.2g/mol)**

5. A compound containing 21.4 % silicon, 24.4 % sulfur, and 54.2 % chlorine is vaporized. 5.00 g of the vapor is found to occupy 854 mL at STP. Calculate the empirical and molecular formulas of the compound. **($SiSCl_2$)**

6. In 1897 the Swedish explorer Andree tried to reach the North Pole in a balloon. The balloon was filled with hydrogen gas. The hydrogen gas was prepared from iron splints and diluted sulfuric acid. The reaction is

   $$Fe(s) + H_2SO_4(aq) \rightarrow FeSO_4(aq) + H_2(g)$$

   The volume of the balloon was 4800 m^3 and the loss of H_2 gas during filling was estimated at 20. . What mass of iron and 98% (by mass) H_2SO_4 were needed to ensure the complete filling of the balloon at STP. **(1.5×10^7g Fe, 2.6×10^7g 98% H_2SO_4)**

7. A low pressure can be achieved easily with a vacuum pump. Calculate the number of molecules present in 1.00 mL of a gas at 273 K and pressure of 1.00×10^{-6}. **(3.53×10^{10} molecules)**

8. $KClO_3(s)$ decomposes according to the reaction

   $$2\ KClO_3(s) \rightarrow 2KCl(s) + 3\ O_2(g)$$

   A white solid is known to be a mixture of only $KClO_3$ and KCl. 7.0950 g of this solid mixture produced 865.5 mL of $O_2(g)$. The gas

was collected over water at a pressure of 741.5 torr and a temperature of 27.0°C. Calculate the percent of KCl, by mass, in the mixture. **(62.0 % KCl)**

9. Laughing gas, N_2O, one of the first anesthetics used by the dental profession is made by the decomposition of ammonium nitrate.

$$NH_4NO_3(aq) \rightarrow N_2O(g) + 2\ H_2O(l)$$

How many grams of ammonium nitrate must be decomposed to prepare 350 mL of N_2O at STP? **(1.25 g NH_4NO_3)**

10. A 500 mL flask contains $O_2(g)$ at 1 atm. Another flask, 1500 mL, contains $N_2(g)$ at 360 torr. Both the flasks are connected by a tube and stopcock. The stopcock is opened and the gases are mixed. The temperature remains constant. Calculate the partial pressure of each gas and the total pressure. Calculate the mole fraction of $O_2(g)$. **(pp O_2=190 torr, pp N_2= 270, Ptotal = 460 torr, X of O_2=0.413)**

11. Consider the reaction

$$4\ NH_3(g) + 5\ O_2(g) \rightarrow 4\ NO(g) + 6\ H_2O(g)$$

If all the gases are mixed under the same conditions of temperature and pressure, what is the volume of products from the reaction of 2.5 L NH_3 and 10.0 L of O_2? **(6.25 L of products)**

12. A method of removing $CO_2(g)$ from a spacecraft is to allow CO_2 to react with LiOH. What volume of $CO_2(g)$ at 24.8°C and 746 torr can be removed per kilogram of LiOH? **(521 L CO_2)**

$$2\ LiOH(s) + CO_2(g) \rightarrow Li_2CO_3(s) + H_2O(l)$$

13. Air bags are activated when a severe impact causes a steel ball to compress a spring and electrically ignite a detonator cap. This action causes sodium azide, NaN_3, to decompose explosively according to the following reaction:

$$2\ NaN_3(s) \rightarrow 2\ Na(s) + 3\ N_2(g)$$

What mass of $NaN_3(s)$ must be reacted to inflate an air bag to 70.0 L at STP? **(135 g)**