CHEM 1105 **PROBLEM SET 2**

1. Chlorine can be produced by the reaction

$$MnO_2(s) + 4HCl(aq) \rightarrow MnCl_2(aq) + 2H_2O(l) + Cl_2(g)$$

   (a) The reaction of 50.0 g of impure MnO_2 with an excess of HCl gave 32.1 g of Cl_2. Assuming the reaction went in 100% yield, calculate the percentage purity of the MnO_2.

   (b) Calculate the theoretical yield of chlorine from the reaction of 25.0 g of 88.5% MnO_2 with 1.50 litres of 0.635 *M* HCl.

2. Ammonia reacts with oxygen as follows:

$$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$$

   If the percentage yield in this reaction is 86.5%, how many grams of NH_3 are needed to form 13.7 g of H_2O?

3. Sulphuric acid, H_2SO_4, may be prepared from FeS_2 by the following sequence of reactions:

$$4FeS_2(s) + 11O_2(g) \rightarrow 2Fe_2O_3(s) + 8SO_2(g)$$
$$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$$
$$SO_3(g) + H_2O(l) \rightarrow H_2SO_4(l)$$

   What mass of FeS_2 is required to prepare 1.00 litre of $H_2SO_4(l)$? The density of $H_2SO_4(l)$ is 1.85 g/mL.

4. When 1.11 g of vanadium is dissolved in HCl, 0.066 g of H_2 is produced. Calculate the value of $\boldsymbol{x}$ for the compound $VCl_{\boldsymbol{x}}$ produced according to the equation

$$V + \boldsymbol{x}HCl \rightarrow VCl_{\boldsymbol{x}} + 0.5\boldsymbol{x}H_2$$

5. Calculate the number of grams of SF_4 that can be made from 4.00 g of SCl_2 and 2.00 g of NaF by the following reaction:

$$3SCl_2 + 4NaF \rightarrow SF_4 + S_2Cl_2 + 4NaCl$$

   How many grams of the reactant in excess are left over?

6. A certain compound was found to be 29.95% C, 3.137% H and 66.91% Cl by mass. Calculate the empirical formula of the compound. The molecular weight was found to be 320±5. Calculate the molecular formula and the accurate molecular weight.

7. When 24.0 mL of 0.100 *M* NaOH was reacted with 20.0 mL of H_2SO_4 of unknown molarity, the final solution was 0.0375 *M* in H_2SO_4. Calculate the molarity of the original H_2SO_4 solution. The equation for the reaction is given below.

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O.$$

8. A 40.0% HNO_3 solution (by mass) has a density of 1.25 g/mL. Calculate the molarity of the solution.

9. A 32.0% (by mass) solution of KBr is 3.44 *M*. Calculate the density of the solution (in g/mL).

10. Calculate the theoretical yield of B_2H_6 from the reaction of 25.0 g of 85.0% $NaBH_4$ with 54.0 g of BF_3. The reaction is:

$$3NaBH_4 + 4BF_3 \rightarrow 2B_2H_6 + 3NaBF_4$$

11. Calculate the percent purity of a sample of KO_2 if 3.30 g of the sample gave 655 mL of O_2 at STP by the reaction below. The volume of 1 mole of O_2 at STP is 22.4 L.

$$4KO_2(s) + 2H_2O(g) + 4CO_2(g) \rightarrow 4KHCO_3(s) + 3O_2(g)$$