1. ***Balance*** the following chemical equations:

a. ______SiO_2 + 4 HF → ______ SiF_4 + 2 H_2O

b. ______Fe_2O_3 + 3 CO → 2 Fe + 3 CO_2

c. ______K_2O + ______H_2O → 2 KOH

d. ______$SiCl_4$ + 4 H_2O → ______H_4SiO_4 + 4 HCl

2. A binary compound of iron and nitrogen is analyzed, and 1.5634 g of the compound is found to contain 1.3394 g of iron. When a second sample of this compound is treated with water and heated, the nitrogen is driven off as ammonia, leaving a compound that contains 77.73% iron and 22.27% oxygen by mass. Calculate the empirical formulas of the two iron compounds. Write the chemical equation that occurs between the first iron compound and water. Calculate the mass of ammonia produced in the reaction.

$$1.3394\ g\ Fe \times \frac{1\ mol\ Fe}{55.845\ g\ Fe} = 0.023898\ mol\ Fe$$

$$(1.5634\ g\ compound - 1.3394\ g\ Fe) \times \frac{1\ mol\ N}{14.0067\ g\ N} = 0.015992\ mol\ N$$

$\frac{0.015992\ mol\ N}{0.015992\ mol} = 1\ N \times 2 = 2$ $\frac{0.023898\ mol\ Fe}{0.015992\ mol} = 1.49434 \cong 1.5\ Fe \times 2 = 3$

The first compound is Fe_3N_2.

$$77.73\ g\ Fe \times \frac{1\ mol\ Fe}{55.845\ g\ Fe} = 1.39189\ mol\ Fe$$

$$22.27\ g\ O \times \frac{1\ mol\ O}{15.9994\ g\ O} = 1.39193\ mol\ O$$

$\frac{1.13189\ mol\ Fe}{1.13189\ mol} = 1$ $\frac{1.139193\ mol\ O}{1.39189\ mol} = 1.00003 \cong 1$

The second compound is FeO. The chemical equation is:

$$Fe_3N_2 + 3\ H_2O \rightarrow 2\ NH_3 + 3\ FeO$$

The amount of ammonia produced is:

$$1.5634\ g\ Fe_3N_2 \times \frac{1\ mol\ Fe_3N_2}{195.548\ g\ Fe_3N_2} \times \frac{2\ mol\ NH_3}{1\ mol\ Fe_3N_2} \times \frac{17.0305\ g\ NH_3}{1\ mol\ NH_3} = 0.2723\ g\ NH_3$$

3. Calculate the following.

a. The ***number of nitrogen atoms*** in 35.00 g of ammonium azide.

$$35.00 \text{ g } NH_4N_3 \times \frac{1 \text{ mol } NH_4N_3}{60.0586 \text{ g } NH_4N_3} \times \frac{4 \text{ mol N}}{1 \text{ mol } NH_4N_3} \times \frac{6.022141 \times 10^{23} \text{ at N}}{1 \text{ mol N}} = 1.403 \times 10^{24} \text{ at N}$$

b. the number of grams of vanadium(III) oxalate that contains 153.013 g of carbon

$$? \text{ g } V_2(C_2O_4)_3 = 153.013 \text{ g C} \times \frac{1 \text{ mol C}}{12.011 \text{ g C}} \times \frac{1 \text{ mol } V_2(C_2O_4)_3}{6 \text{ mol C}} \times \frac{365.937 \text{ g } V_2(C_2O_4)_3}{1 \text{ mol } V_2(C_2O_4)_3} = 776.97 \text{ g } V_2(C_2O_4)_3$$

c. the number of grams of manganese(V) permanganate that contains the same number of oxygen atoms as in 243.2 g of hydrogen peroxide.

$$? \text{ g } Mn(MnO_4)_5 = 243.2 \text{ g } H_2O_2 \times \frac{1 \text{ mol } H_2O_2}{34.014 \text{ g } H_2O_2} \times \frac{2 \text{ mol O, } H_2O_2}{1 \text{ mol } H_2O_2} \times \frac{6.02214 \times 10^{23} \text{ at O, } H_2O_2}{1 \text{ mol O, } H_2O_2}$$

$$\times \frac{1 \text{ at O, } Mn(MnO_4)_4}{1 \text{ at O, } H_2O_2} \times \frac{1 \text{ mol O, } Mn(MnO_4)_5}{6.02214 \times 10^{23} \text{ at O,} Mn(MnO_4)_5}$$

$$\times \frac{1 \text{ mol } Mn(MnO_4)_5}{20 \text{ mol O,} Mn(MnO_4)_5} \times \frac{649.608 \text{ g } Mn(MnO_4)_5}{1 \text{ mol } Mn(MnO_4)_5} = 464.5 \text{ g } Mn(MnO_4)_5$$

d. the number of molecules of tetrasulfur decoxide that contains 200.0 g of sulfur.

$$? \text{ molc } S_4O_{10} = 200.0 \text{ g S} \times \frac{1 \text{ mol S}}{32.06 \text{ g S}} \times \frac{1 \text{ mol } S_4O_{10}}{4 \text{ mol S}} \times \frac{6.02214 \times 10^{23} \text{ molc } S_4O_{10}}{1 \text{ mol } S_4O_{10}} = 9.392 \times 10^{23} \text{ molc } S_4O_{10}$$

4. 222.222 g of chromium(IV) nitrate reacts with potassium carbonate in a double replacement reaction. Calculate the ***number of grams of solid produced*** if there is a 96.10 % yield.

$$Cr(NO_3)_4 + 2\ K_2CO_3 \rightarrow Cr(CO_3)_2 + 4\ KNO_3$$

$$222.222\ \text{g}\ Cr(NO_3)_4 \times \frac{1\ \text{mol}\ Cr(NO_3)_4}{300.0157\ \text{g}\ Cr(NO_3)_4} \times \frac{1\ \text{mol}\ Cr(CO_3)_2}{1\ \text{mol}\ Cr(NO_3)_4} \times \frac{172.0139\ \text{g}\ Cr(CO_3)_2}{1\ \text{mol}\ Cr(CO_3)_2} \times \frac{96.10\ \text{g}\ Cr(CO_3)_2\ \text{actual}}{100.00\ \text{g}\ Cr(CO_3)_2\ \text{theoretical}}$$

$$= 122.4\ \text{g}\ Cr(CO_3)_2$$

5. Iron(III) nitrate and potassium carbonate solutions react in a double replacement reaction. Write the balanced chemical, ionic and net ionic equations. If 66.6 mL of a 0.666 M solution of iron(III) nitrate is mixed with 66.6 mL of a 0.666 M solution of potassium carbonate what mass of the solid product is produced?

$$2\ Fe(NO_3)_{3\,(aq)} + 3\ K_2CO_{3\,(aq)} \rightarrow Fe_2(CO_3)_{3\,(s)} + 6\ KNO_{3\,(aq)}$$

$$2\ Fe^{3+}{}_{(aq)} + 6\ NO_3^{-}{}_{(aq)} + 6\ K^{+}{}_{(aq)} + 3\ CO_3^{2-}{}_{(aq)} \rightarrow Fe_2(CO_3)_{3\,(s)} + 6\ K^{+}{}_{(aq)} + 6\ NO_3^{-}{}_{(aq)}$$

$$2\ Fe^{3+}{}_{(aq)} + 3\ CO_3^{2-}{}_{(aq)} \rightarrow Fe_2(CO_3)_{3\,(s)}$$

$$?\ \text{g}\ Fe_2(CO_3)_3 = 66.6\ \text{mL}\ Fe(NO_3)_3\ \text{sol'n} \times \frac{0.666\ \text{mol}\ Fe(NO_3)_3}{1000\ \text{mL}\ Fe(NO_3)_3\ \text{sol'n}} \times \frac{1\ \text{mol}\ Fe_2(CO_3)_3}{2\ \text{mol}\ Fe(NO_3)_3} \times \frac{291.714\ \text{g}\ Fe_2(CO_3)_3}{1\ \text{mol}\ Fe_2(CO_3)_3} = 6.47\ \text{g}\ Fe_2(CO_3)_3$$

$$?\ \text{g}\ Fe_2(CO_3)_3 = 66.6\ \text{mL}\ Fe(NO_3)_3\ \text{sol'n} \times \frac{0.666\ \text{mol}\ K_2CO_3}{1000\ \text{mL}\ K_2CO_3\ \text{sol'n}} \times \frac{1\ \text{mol}\ Fe_2(CO_3)_3}{3\ \text{mol}\ K_2CO_3} \times \frac{291.714\ \text{g}\ Fe_2(CO_3)_3}{1\ \text{mol}\ Fe_2(CO_3)_3} = 4.31\ \text{g}\ Fe_2(CO_3)_3$$

4.31 g of the solid product are produced.