Stoichiometry Review #1

1. Lithium Carbonate is decomposed. How many grams of ~~oxygen~~ CO_2 will result from the reaction of 34.55 g of lithium carbonate?

2. Hydrochloric acid is added to magnesium hydroxide. What mass of magnesium hydroxide is required to react with 0.75 moles of hydrochloric acid?

3. Barium Nitrate reacts with sodium. If 3.2 g of barium nitrate and 5.3 g of sodium are used, how many grams of Ba will result?

4. Ammonium Chloride is added to cobalt (III) oxide. When the reaction is performed in lab, the experimenter places 110.25 g of cobalt (III) oxide in the reaction vessel. When the reaction is complete, 98.22 g of ammonium oxide result. What is the percent yield of the reaction?

5. Calcium Hydroxide is reacted with iron (III) cyanide. If 2.05 g of calcium hydroxide and 4.65 g of iron (II) cyanide are used, what is the limiting reactant? How many moles of each product are formed? How many grams of excess reagent remain?

Stoich Review #1

1. $Li_2CO_3 \rightarrow Li_2O + CO_2$

34.5 g g ?

$$34.5\text{ g } Li_2CO_3 \left(\frac{1\text{ mol } Li_2CO_3}{73.8\text{ g } Li_2CO_3}\right)\left(\frac{1\text{ mol } CO_2}{1\text{ mol } Li_2CO_3}\right)\left(\frac{44.0\text{ g } CO_2}{1\text{ mol } CO_2}\right) = 20.60\text{ g } CO_2$$

$2\,HCl + Mg(OH)_2 \rightarrow MgCl_2 + 2\,HOH$

0.75 mol ? g

$$0.75\text{ mol HCl}\left(\frac{1\text{ mol } Mg(OH)_2}{2\text{ mol HCl}}\right)\left(\frac{58.3\text{ g}}{1\text{ mol } Mg(OH)_2}\right) = 22\text{ g } Mg(OH)_2$$

3. $Ba(NO_3)_2 + 2Na \rightarrow 2NaNO_3 + Ba$

3.2 g 5.3 g ? g

$$3.2\text{ g } Ba(NO_3)_2\left(\frac{1\text{ mol } Ba(NO_3)_2}{261.3\text{ g } Ba(NO_3)_2}\right)\left(\frac{1\text{ mol Ba}}{1\text{ mol } Ba(NO_3)_2}\right)\left(\frac{137.3\text{ g Ba}}{1\text{ mol Ba}}\right) = 1.7\text{ g Ba}$$

LR

$$5.3\text{ g Na}\left(\frac{1\text{ mol Na}}{23\text{ g Na}}\right)\left(\frac{1\text{ mol Ba}}{2\text{ mol Na}}\right)\left(\frac{137.3\text{ g Ba}}{1\text{ mol Ba}}\right) = 15\text{ g Ba}$$

$4.6\,NH_4Cl + Co_2O_3 \rightarrow 2\,CoCl_3 + 3\,(NH_4)_2O$

110.25 g 98.22 g (actual)

$$110.25\text{ g } Co_2O_3\left(\frac{1\text{ mol } Co_2O_3}{166.0\text{ g}}\right)\left(\frac{3\text{ mol } (NH_4)_2O}{1\text{ mol } Co_2O_3}\right)\left(\frac{52.0\text{ g } (NH_4)_2O}{1\text{ mol } (NH_4)_2O}\right) = 103.61\text{ g } (NH_4)_2O$$

$$\%\text{ yield} = \frac{98.22\text{ g}}{103.61\text{ g}} \times 100 = 94.8\%$$

5. $3Ca(OH)_2 + 2Fe(CN)_3 \rightarrow 2Fe(OH)_3 + 3Ca(CN)_2$

2.05 g 4.65 g mol? mol?

LR → $\frac{2.05\text{ g } Ca(OH)_2}{1}\left(\frac{1\text{ mol } Ca(OH)_2}{74.1\text{ g } Ca(OH)_2}\right)\left(\frac{2\text{ mol } Fe(OH)_3}{3\text{ mol } Ca(OH)_2}\right) = 0.0184\text{ mol } Fe(OH)_3$

$4.65\text{ g } Fe(CN)_3\left(\frac{1\text{ mol } Fe(CN)_3}{133.8\text{ g } Fe(CN)_3}\right)\left(\frac{2\text{ mol } Fe(OH)_3}{2\text{ mol } Fe(CN)_3}\right) = 0.0348\text{ mol } Fe(OH)_3$

$2.05\text{ g } Ca(OH)_2\left(\frac{1\text{ mol } Ca(OH)_2}{74.1\text{ g } Ca(OH)_2}\right)\left(\frac{3\text{ mol } Ca(CN)_2}{3\text{ mol } Ca(OH)_2}\right) = 0.0277\text{ mol } Ca(CN)_2$

$2.05\text{ g } Ca(OH)_2\left(\frac{1\text{ mol } Ca(OH)_2}{74.1\text{ g } Ca(OH)_2}\right)\left(\frac{2\text{ mol } Fe(CN)_3}{3\text{ mol } Ca(OH)_2}\right)\left(\frac{133.8\text{ g}}{1\text{ mol } Fe(CN)_3}\right) = 2.47\text{ g}$

Excess ⇒ $4.65 - 2.47 = 2.18\text{ g } Fe(CN)_3$ in excess

Stoichiometry Review #2

1. Managnese (V) oxide reacts with lithium carbonate. If 5.3 g of manganese (V) oxide and 8.4 g of lithium carbonate are used, how many grams of lithium oxide will be produced?

2. Chlorine gas is added to calcium bromide. How many grams of calcium bromide are needed to react with 14.55 g of chlorine gas?

3. 34.80 kg of magnesium carbonate are decomposed. If 16.44 kg of carbon dioxide are produced in this reaction, what is the percent yield of the reaction?

4. Hydrogen and oxygen gas react to form water. If 3.8 moles of hydrogen and 5.2 moles of oxygen are used, how many grams of water will be produced? How much of the excess reagent remains?

5. Cobalt (III) chloride is added to iron (II) nitrate. How many moles of each product will be produced from the reaction of 60.88 g of cobalt (III) chloride (assuming there is an abundant supply of iron (II) nitrate)?

1. $Mn_2O_5 + 5Li_2CO_3 \rightarrow Mn_2(CO_3)_5 + 5Li_2O$

5.3 g 8.4 g g?

$5.3\,g\ Mn_2O_5\left(\frac{1\,mol\,Mn_2O_5}{190\,g}\right)\left(\frac{5\,mol}{1\,mol}\right)\left(\frac{30\,g\,Li_2O}{1\,mol}\right) = 4.2\,g\ Li_2O$

$8.4\,g\ Li_2CO_3\left(\frac{1\,mol}{74\,g}\right)\left(\frac{5\,mol}{5\,mol}\right)\left(\frac{30\,g}{1\,mol}\right) = 3.4\,g\ Li_2O$

2. $Cl_2 + CaBr_2 \rightarrow Br_2 + CaCl_2$

14.55 g g?

$14.55\,g\ Cl_2\left(\frac{1\,mol\,Cl_2}{71\,g\,Cl_2}\right)\left(\frac{1\,mol}{1\,mol}\right)\left(\frac{200\,g}{1\,mol}\right) = 40.99\,g\ CaBr_2$

3. $MgCO_3 \rightarrow MgO + CO_2$

34.80 kg

$34.80\,kg\left(\frac{1000\,g}{1\,kg}\right)\left(\frac{1\,mol\,MgCO_3}{84\,g}\right)\left(\frac{1\,mol\,CO_2}{1\,mol\,MgCO_3}\right)\left(\frac{44\,g\,CO_2}{1\,mol}\right)\left(\frac{1\,kg}{1000\,g}\right) = 18.23\,kg$

$\%\ yield = \frac{16.44}{18.23} \times 100 = 90.18\%$

$4.2H_2 + O_2 \rightarrow 2H_2O$

$3.8\,mol\,H_2\left(\frac{2\,mol}{2\,mol}\right)\left(\frac{18\,g}{1\,mol}\right) = 68\,g\ H_2O$

$5.2\,mol\,O_2\left(\frac{2\,mol\,H_2O}{1\,mol\,O_2}\right)\left(\frac{18\,g}{1\,mol\,H_2O}\right) = 187\,g$

$3.8\,mol\,H_2\left(\frac{1\,mol\,O_2}{2\,mol\,H_2}\right) = 1.9\,mol\ used$

$5.2 - 1.9 = 3.3\,mol\,O_2\ excess$

$105.6\,g\ O_2$

$110\,g\ O_2$

$5.2 CoCl_3 + 3 Fe(NO_3)_2 \rightarrow 2 Co(NO_3)_3 + 3 FeCl_2$

60.88g mol? mol?

$60.88\,g\ CoCl_3 \left(\frac{1\,mol}{165.5\,g}\right)\left(\frac{2\ mol\ Co(NO_3)_3}{2\ mol\ CoCl_3}\right) = 0.3679\ mol\ Co(NO_3)_3$

$60.88\,g\ CoCl_3 \left(\frac{3\ mol\ FeCl_2}{2\ mol\ CoCl_3}\right) = 0.5518\ mol\ FeCl_2$

STOICHIOMETRY - LAST REVIEW!!!

1. Sulfuric acid reacts with magnesium hydroxide through double replacement. If 30.0 g of sulfuric acid and 25.0 g of magnesium hydroxide react, what is the limiting reactant?

2. Magnesium chloride is decomposed into its comprising elements. If 4.50 moles of magnesium chloride are heated, how many grams of magnesium are produced?

3. Aluminum is added to hydrochloric acid. What mass of hydrochloric acid is required to completely react with 3.46×10^8g of aluminum?

4. Examine the following reaction:
   $3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$
   If 26.0 g of iron produce ~~112.5~~ 31.4 g of Fe_3O_4, what is the percent yield of the reaction?

5. Hydrochloric acid is neutralized by sodium hydroxide. If 4.50 g of hydrochloric acid is added to 5.25 g of sodium hydroxide, how many grams of sodium chloride are produced? How many grams of excess reactant remain?

1. $H_2SO_4 + Mg(OH)_2 \rightarrow MgSO_4 + 2HOH$
   36.0g 25.0g
   $36.0\text{g } H_2SO_4 \left(\frac{1\text{mol } H_2SO_4}{98.0\text{g}}\right)\left(\frac{2\text{mol HOH}}{1\text{mol } H_2SO_4}\right)\left(\frac{18.0\text{g HOH}}{1\text{mol HOH}}\right) = 11.0\text{g HOH}$ (LR = H_2SO_4)
   $25.0\text{g } Mg(OH)_2 \left(\frac{1\text{mol } Mg(OH)_2}{58.3\text{g}}\right)\left(\frac{2\text{mol HOH}}{1\text{mol } Mg(OH)_2}\right)\left(\frac{18.0\text{g HOH}}{1\text{mol HOH}}\right) = 15.4\text{g HOH}$

2. $MgCl_2 \rightarrow Mg + Cl_2$
   4.50 mol g?
   $4.50\text{mol } MgCl_2 \left(\frac{1\text{mol Mg}}{1\text{mol } MgCl_2}\right)\left(\frac{24.3\text{g Mg}}{1\text{mol Mg}}\right) = 109\text{g Mg}$

3. $2Al + 6HCl \rightarrow 2AlCl_3 + 3H_2$
   3.46×10^8g g?
   $3.46 \times 10^8\text{g Al}\left(\frac{1\text{mol Al}}{27.0\text{g Al}}\right)\left(\frac{6\text{mol HCl}}{2\text{mol Al}}\right)\left(\frac{36.5\text{g HCl}}{1\text{mol HCl}}\right) = 1.40 \times 10^9\text{g HCl}$

4. $3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$
   26.0g 31.4g
   $26.0\text{g Fe}\left(\frac{1\text{mol Fe}}{55.8\text{g Fe}}\right)\left(\frac{1\text{mol } Fe_3O_4}{3\text{mol Fe}}\right)\left(\frac{231.4\text{g } Fe_3O_4}{1\text{mol } Fe_3O_4}\right) = 35.9\text{g } Fe_3O_4$ $\%\text{ yield} = \frac{31.4\text{g}}{35.9\text{g}} \times 100 = 87.5\%$

5. $HCl + NaOH \rightarrow NaCl + HOH$
   4.50g 5.25g g?
   $4.50\text{g HCl}\left(\frac{1\text{mol HCl}}{36.5\text{g HCl}}\right)\left(\frac{1\text{mol NaCl}}{1\text{mol HCl}}\right)\left(\frac{58.5\text{g NaCl}}{1\text{mol NaCl}}\right) = 7.21\text{g NaCl}$ LR = HCl
   $5.25\text{g NaOH}\left(\frac{1\text{mol NaOH}}{40.0\text{g NaOH}}\right)\left(\frac{1\text{mol NaCl}}{1\text{mol NaOH}}\right)\left(\frac{58.5\text{g NaCl}}{1\text{mol NaCl}}\right) = 7.68\text{g NaCl}$
   $4.50\text{g HCl}\left(\frac{1\text{mol HCl}}{36.5\text{g HCl}}\right)\left(\frac{1\text{mol NaOH}}{1\text{mol HCl}}\right)\left(\frac{40.0\text{g NaOH}}{1\text{mol NaOH}}\right) = 4.93\text{g NaOH}$
   $5.25\text{g} - 4.93\text{g} = 0.32\text{g}$ in excess

Honors Chemistry Stoichiometry Review

Show all of the work in the solution of the following problems.

1. How many grams of hydrogen are formed from the reaction of 12.5 grams of potassium with 10.0 grams of water?

2. The decomposition of 125.0 grams of potassium chlorate produced 35 grams of oxygen. What is the percent yield of oxygen?

3. Marble is 95.0% calcium carbonate. When calcium carbonate reacts with hydrochloric acid, carbon dioxide gas and water are produced, rather than carbonic acid. How many grams of marble are needed to make 100.0 grams of carbon dioxide?

4. Burning coal in a power plant produces sulfur dioxide gas, a severe air pollutant, because the coal, which is mostly carbon, contains some amount of sulfur. When the coal is burned, the sulfur reacts with some of the oxygen in the air. What mass of sulfur dioxide is formed for each metric ton of coal burned, if the coal is 1.50% sulfur?

5. Brass is an alloy, or mixture, of copper and zinc. When 150 grams of a certain type of brass were reacted with HCl, 180 grams of zinc chloride were recovered, while the copper was left unreacted. What is the percent of copper in the brass?

6. 5.35 grams of 20.0% sodium phosphate solution are mixed with 3.68 grams of 35.0% barium nitrate solution. How many grams of barium phosphate precipitate are formed?

Honors Chemistry Stoichiometry Review

Limiting Reactant Problem

1. $2K + 2H_2O \rightarrow 2KOH + H_2$

12.5 g 10.0 g g?

$12.5\,g\,K\left(\frac{1\,mol\,K}{39.10\,g\,K}\right)\left(\frac{1\,mol\,H_2}{2\,mol\,K}\right)\left(\frac{2.02\,g\,H_2}{1\,mol\,H_2}\right) = 0.323\,g\,H_2$

$10.0\,g\,H_2O\left(\frac{1\,mol\,H_2O}{18.02\,g\,H_2O}\right)\left(\frac{1\,mol\,H_2}{2\,mol\,H_2O}\right)\left(\frac{2.02\,g\,H_2}{1\,mol\,H_2}\right) = 0.560\,g\,H_2$

Percent Yield Problem

2. $2KClO_3 \rightarrow 2KCl + 3O_2$

125.0 g 35 g

$125.0\,g\,KClO_3\left(\frac{1\,mol\,KClO_3}{122.55\,g\,KClO_3}\right)\left(\frac{3\,mol\,O_2}{2\,mol\,KClO_3}\right)\left(\frac{32.00\,g\,O_2}{1\,mol\,O_2}\right) = 48.96\,g\,O_2$

$\%\,Yield = \frac{Ay}{Ty} \times 100 = \frac{35\,g\,O_2}{48.96\,g\,O_2} \times 100 = 71\%\,O_2$

Basic Stoich. Problem + Challenge

3. $CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$

Marble
95.0% $CaCO_3$
g Marble ?

100.0 g CO_2

$100.0\,g\,CO_2\left(\frac{1\,mol\,CO_2}{44.01\,g\,CO_2}\right)\left(\frac{1\,mol\,CaCO_3}{1\,mol\,CO_2}\right)\left(\frac{100.09\,g\,CaCO_3}{1\,mol\,CaCO_3}\right)\left(\frac{100\,g\,Marble}{95.0\,g\,CaCO_3}\right) = 239.4\,g\,Marble$

Basic Stoich. Problem + Challenge

4. Coal
1.50% Sulfur $S + O_2 \rightarrow SO_2$
g?

1 metric ton = 1,000 kg

$1.00\,metric\,ton\,coal\left(\frac{1{,}000\,kg}{1\,metric\,ton}\right)\left(\frac{1000\,g\,Coal}{1\,kg\,Coal}\right)\left(\frac{1.50\,g\,S}{100\,g\,Coal}\right)\left(\frac{1\,mol\,S}{32.10\,g\,S}\right)\left(\frac{1\,mol\,SO_2}{1\,mol\,S}\right)\left(\frac{64.10\,g}{1\,mol\,SO_2}\right)$

$= 3.00 \times 10^4\,g\,SO_2$

5. Brass = Cu + Zn

$$\underset{150\,g}{\text{Brass}} + HCl \longrightarrow \underset{180\,g}{ZnCl_2}$$

Basic Stoich Problem + Challenge

Only the Zn in the Brass reacted ...

Therefore, the reaction is:

$$Zn + 2HCl \rightarrow \underset{180\,g}{ZnCl_2} + H_2$$

The amount of Zn needs to be found to solve for percent.

$$180\,g\,ZnCl_2\left(\frac{1\,mol\,ZnCl_2}{136.29\,g\,ZnCl_2}\right)\left(\frac{1\,mol\,Zn}{1\,mol\,ZnCl_2}\right)\left(\frac{65.39\,g\,Zn}{1\,mol\,Zn}\right) = 86\,g\,Zn$$

$$\%\,Zn = \frac{g\,Zn}{g\,Brass} \times 100 = \frac{86\,g\,Zn}{150\,g\,Brass} \times 100 = 57\%\,Zn$$

∴ Cu is 43% in Brass

6. $2Na_3PO_{4(aq)} + 3Ba(NO_3)_{2(aq)} \longrightarrow \underset{g?}{Ba_3(PO_4)_{2(s)}} + 6NaNO_{3(aq)}$

5.35 g, 20.0% Soln. — 3.68 g, 35.0% Soln.

$$5.35\,g\,Na_3PO_4\,Solution\left(\frac{20.0\,g\,Na_3PO_4}{100\,g\,Soln.}\right)\left(\frac{1\,mol\,Na_3PO_4}{163.97\,g\,Na_3PO_4}\right)\left(\frac{1\,mol\,Ba_3(PO_4)_2}{2\,mol\,Na_3PO_4}\right)\left(\frac{601.93\,g\,Ba_3(PO_4)_2}{1\,mol\,Ba_3(PO_4)_2}\right) = 1.96\,g\,Ba_3(PO_4)_2$$

$$3.68\,g\,Ba(NO_3)_2\,Solution\left(\frac{35.0\,g\,Ba(NO_3)_2}{100\,g\,Solution}\right)\left(\frac{1\,mol\,Ba(NO_3)_2}{261.30\,g\,Ba(NO_3)_2}\right)\left(\frac{1\,mol\,Ba_3(PO_4)_2}{3\,mol\,Ba(NO_3)_2}\right)\left(\frac{601.93\,g\,Ba_3(PO_4)_2}{1\,mol\,Ba_3(PO_4)_2}\right) = 0.989\,g\,Ba_3(PO_4)_2$$