Stoichiometry Homework 3

**Balancing equations**

16)  Write the equation that expresses in acceptable chemical shorthand the following statement: “Iron can be made to react with molecular oxygen (O2) to give iron oxide with the formula Fe2O3”

17)  Balance the following reactions:

a.     Ca(OH)2 + HCl  CaCl2 + H2O

b.     AgNO3 + CaCl2  Ca(NO3)2 +AgCl

c.       Fe2O3 + C  Fe + CO3

d.     NaHCO3 + H2SO4  Na2SO4 + H2O + CO2

e.      C4H10 + O2  CO2 +H2O

f.       Mg(OH)2 + HBr  MgBr2 + H2O

g.     Al2O3 + H2SO4  Al2(SO4)3 + H2O

h.      KHCO3 + H3PO4  K2HPO4 + H2O + CO2

i.        C9H10O + O2  CO2 + H2O

**Stoichiometry**

18)  Chlorine is used by textile manufacturers to bleach cloth.  Excess chlorine is destroyed by its reaction with sodium thiosulfate, Na2S2O3:

Na2S2O3(aq) + 4Cl2(g) + 5H2O(aq)  2NaHSO4(aq) + 8HCl(aq)

a.     How many moles of Na2S2O3 are needed to react with 0.12mol of Cl2?

b.     How many moles of HCl can form from 0.12mol of Cl2?

c.       How many moles of H2O are required for the reaction of 0.12mol of Cl2?

d.     How many moles of H2O react if 0.24mol HCl is formed?

19)  The incandescent white of a fireworks display is caused by the reaction of phosphorous with O2 to give P4O10.

a.     Write the balanced chemical equation for the reaction.

b.     How many grams of O2 are needed to combine with 6.85g of P?

c.       How many grams of P4O10 can be made from 8.00g of O2?

d.     How many grams of P are needed to make 7.46g P4O10?

20)  In *dilute* nitric acid, HNO3, copper metal dissolves according to the following equation:

3Cu(s) + 8HNO3(aq)  3Cu(NO3)2(aq) + 2NO(g) + 4H2O(aq)

            How many grams of HNO3 are needed to dissolve 11.45g of Cu?

**Limiting Reactant, Theoretical and percent yield**

21)  The reaction of powdered aluminum and iron(II)oxide,

2Al(s) + Fe2O3(s)  Al2O3(s) + 2Fe(l)

produces so much heat the iron that forms is molten.  Because of this, railroads use the reaction to provide molten steel to weld steel rails together when laying track.  Suppose that in one batch of reactants 4.20mol Al was mixed with 1.75mol Fe2O3.

a.     Which reactant, if either, was the limiting reactant?

b.     Calculate the mass of iron (in grams) that can be formed from this mixture of reactants.

22)  Silver nitrate, AgNO3, reacts with iron(III) chloride, FeCl3, to give silver chloride, AgCl, and iron(III) nitrate, Fe(NO3)3.  A solution containing 18.0g AgNO3 was mixed with a solution containing 32.4g FeCl3.  How many grams of which reactant *remains* after the reaction is over?

23)  Barium sulfate, BaSO4, is made by the following reaction:

Ba(NO3)2(aq) + Na2SO4(aq)  BaSO4(s) + 2NaNO3(aq)

An experiment was begun with 75.00g of Ba(NO3)2 and an excess of Na2SO4.  After collecting and drying the product, 63.45g BaSO4 was obtained.  Calculate the theoretical yield and percent yield of BaSO4.

24)  Aluminum sulfate can be made by the following reaction:

2AlCl3(aq) + 3H2SO4(aq)  Al2(SO4)3(aq) + 6HCl(aq)

It is quite soluble in water, so to isolate it the solution has to be evaporated to dryness.  This drives off the volatile HCl, but the residual solid has to be treated to a little over 200C to drive off all the water.  In one experiment, 25.0g of AlCl3 was mixed with 30.0g H2SO4.  Eventually, 28.46g of pure Al2(SO4)3 was isolated.  Calculate the percent yield.

**Answers**

16)  4Fe + 3O2  2Fe2O3

17)

a.     Ca(OH)2 + 2HCl  CaCl2 + 2H2O

b.     2AgNO3 + CaCl2  Ca(NO3)2 + 2AgCl

c.       2Fe2O3 + 3C  4Fe + 3CO3

d.     2NaHCO3 + H2SO4  Na2SO4 + 2H2O + 2CO2

e.      2C4H10 + 13O2  8CO2 + 10H2O

f.       Mg(OH)2 + 2HBr  MgBr2 + 2H2O

g.     Al2O3 + 3H2SO4  Al2(SO4)3 + 3H2O

h.      2KHCO3 + H3PO4  K2HPO4 + 2H2O + 2CO2

i.        C9H10O + 14O2  9CO2 + 10H2O

18)  a. 0.030mol Na2S2O3            b. 0.24mol HCl            c. 0.15mol H2O

 d. 0.15mol H2O

19)  a. 4P + 5O2  P4O10            b. 8.85g O2            c. 14.2g P4O10               d. 3.26g P

20)  30.31g HNO3

21)  a. limiting reactant is Fe2O3            b. 195g Fe is formed

22)  26.7g of FeCl3 are left over

23)  theoretical yield = 66.98g BaSO4, % yield = 94.73%

24)  % yield = 88.74%