Stoichiometry worksheet #2

1. Consider the following equation:

$$3\ Ag + 4\ HNO_3 \rightarrow 3\ AgNO_3 + NO + 2\ H_2O$$

What mass of nitric acid, HNO_3, is necessary to obtain n 6 moles of water?

Given: $6\ mol\ H_2O \times \frac{4\ mol\ HNO_3}{2\ mol\ H_2O}$ (ratio) $\times \frac{63.02\ g\ HNO_3}{1\ mol\ HNO_3}$ (m m) $= 800\ g\ HNO_3$

2. Using the equation below, answer the following questions.

$$2\ H_2 + O_2 \rightarrow 2\ H_2O$$

a- If 4.0 moles of H_2 gas are reacted, how many grams of water would be produced?

Given: $4.0\ mol\ H_2 \times \frac{2\ mol\ H_2O}{2\ mol\ H_2}$ (ratio) $\times \frac{18.02\ g\ H_2O}{1\ mol\ H_2O}$ (m m) $= 72\ g\ H_2O$

b- If 2.45×10^2 molecules of oxygen gas are available, how many moles of H_2 would react with it?

Given: $2.45 \times 10^2\ molec\ O_2 \times \frac{1\ mol\ O_2}{(6.02 \times 10^{23}\ molec\ O_2)}$ (m m) $\times \frac{2\ mol\ H_2}{1\ mol\ O_2}$ (R) $= 8.14 \times 10^{-22}\ mol\ H_2$

3. a- Balance the equation below:

$$2\ Al + 3\ F_2 \rightarrow 2\ AlF_3$$

b- How many moles of aluminum react with 4.5 moles of fluorine?

Given: $4.5\ mol\ F \times \frac{2\ mol\ Al}{3\ mol\ F}$ (K) $= 3.0\ mol\ Al$

c- If 42 g of aluminum fluoride, AlF_3 are produced, what mass of aluminum is reacted with aluminum fluoride?

Given: $42\ g\ AlF_3 \times \frac{1\ mol\ AlF_3}{83.98\ g\ AlF_3}$ (m m) $\times \frac{2\ mol\ Al}{2\ mol\ AlF_3}$ (ratio) $\times \frac{26.98\ g\ Al}{1\ mol\ Al}$ (m m) $= 13\ g\ Al$

d- How many moles of fluorine will take part in the above reaction to produce 33.6 g of aluminum fluoride?

Given

$$33.6\,g\,AlF_3 \times \frac{1\,mol\,AlF_3}{83.98\,g\,AlF_3} \times \frac{3\,mol\,F_2}{2\,mol\,AlF_3} = 0.600\,mol\,F_2$$

(m m)

4. a- Write a balanced equation for the combustion of methane gas (CH_4) to form carbon dioxide (CO_2) and water vapour (H_2O).

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

b- If 124.5 g of CO_2 is produced, how many moles of CH_4 must have been reacted?

Given

$$124.5\,g\,CO_2 \times \frac{1\,mol\,CO_2}{44.01\,g\,CO_2} \times \frac{1\,mol\,CH_4}{1\,mol\,CO_2} = 2.829\,mol\,CH_4$$

(m m)

5. a- Write a balanced equation for the reaction of nitrogen gas (N_2) and hydrogen gas (H_2) to produce ammonia gas (NH_3).

$$N_2 + 3H_2 \rightarrow 2NH_3$$

b-If 212.5 g of ammonia gas is produced, how many molecules of hydrogen gas must have reacted with the nitrogen?

Given

$$212.5\,g\,NH_3 \times \frac{1\,mol\,NH_3}{17.04\,g\,NH_3} \times \frac{3\,mol\,H_2}{2\,mol\,NH_3} \times \frac{6.02 \times 10^{23}}{1\,mol\,H_2} = 1.126 \times 10^{25}\ molec\ H_2$$

6. Solid copper can be prepared from copper oxide by reacting with ammonia, according to the following unbalanced equation:

$$3\,CuO + 2NH_3 \rightarrow N_2 + 3Cu + 3H_2O$$

How many moles of ammonia(NH_3) are needed to obtain 9.0 moles of copper (Cu)?

$$9.0\,mol\,Cu \times \frac{2\,mol\,NH_3}{3\,mol\,Cu} = 6.0\,mol\,NH_3$$

7. Iron (Fe) and carbon monoxide (CO) are produced when iron oxide (Fe_2O_3) reacts with carbon (C). Write a balanced equation for this reaction.

$$Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$$

You would like to produce 50 mol if iron, what mass of iron oxide is required?

$$50\,mol\,Fe \times \frac{1\,mol\,Fe_2O_3}{2\,mol\,Fe} \times \frac{159.7\,g\,Fe_2O_3}{1\,mol\,Fe_2O_3} = 4000\,g\,Fe_2O_3$$

8. 300 mL of NaI whose concentration is 3 mol/L are reacted with $Pb(NO_3)_2$ in order to obtain the precipitate PbI_2 . Calculate the moles of PbI_2 obtained.

$$\frac{3\,mol}{L} = \frac{x}{.3L} = .9\,mol$$

$$2\,NaI + Pb(NO_3)_2 \rightarrow PBI_2 + 2\,Na(NO_3)$$

$$.9\,mol\,NaI \times \frac{1\,mol\,PbI_2}{2\,mol\,NaI} = .5\,mol\,PbI_2$$

9. When a solution of aluminum hydroxide, $Al(OH)_3$, reacts with a solution of sulfuric acid, H_2SO_4, the result is a salt, aluminum sulphate, $Al_2(SO_4)_3$ and water, H_2O. The reaction is seen by the following unbalanced equation:

$$2\,Al(OH)_3 + 3\,H_2SO_4 \rightarrow Al_2(SO_4)_3 + 6\,H_2O$$

What mass of aluminum hydroxide is required to produce 100.0 g of aluminum sulphate?

$$100.0\,g\,Al_2(SO_4)_3 \times \frac{1\,mol\,Al_2(SO_4)_3}{342.17\,g\,Al_2(SO_4)_3} \times \frac{2\,mol\,Al(OH)_3}{1\,mol\,Al_2(SO_4)_3} \times \frac{78.01\,g\,Al(OH)_3}{1\,mol\,Al(OH)_3} = 45.6\,g\,Al(OH)_3$$

10. Use the equation below to solve questions a and b.

$$2\,HCl + Mg(OH)_2 \rightarrow MgCl_2 + 2\,H_2O$$

a- If 650 g of water was produced, how many molecules of magnesium hydroxide $Mg(OH)_2$ must have reacted?

$$650\,g\,H_2O \times \frac{1\,mol\,H_2O}{18.02\,g\,H_2O} \times \frac{1\,mol\,Mg(OH)_2}{2\,mol\,H_2O} \times \frac{6.02\times10^{23}\,molec\,Mg(OH)_2}{1\,mol\,Mg(OH)_2} = 1.1\times10^{25}\,molec\,Mg(OH)_2$$

b- If 5.3×10^9 molecules of water are available, how many moles of HCl react with it?

G M

$5.3 \times 10^9 \text{ molec } H_2O \times \frac{1 \text{ mol } H_2O}{(6.02 \times 10^{23}) \text{ molec } H_2O} \times \frac{2 \text{ mol HCl}}{2 \text{ mol } H_2O} = 8.8 \times 10^{-15} \text{ mol HCl}$

11. Use the equation below to answer questions a and b.

$$Cu + 2\,AgNO_3 \rightarrow Cu(NO_3)_2 + 2\,Ag$$

a- If 4.33×10^7 molecules of Ag are available, how many moles of silver nitrate $AgNO_3$ would react with it? m m R

G

$4.33 \times 10^7 \text{ molec Ag} \times \frac{1 \text{ mol Ag}}{(6.02 \times 10^{23}) \text{ molec Ag}} \times \frac{2 \text{ mol } AgNO_3}{2 \text{ mol Ag}} = 7.19 \times 10^{-17} \text{ mol } AgNO_3$

b- If 450.0 g of copper nitrate $Cu(NO_3)_2$ was produced, how many Ag atoms must have reacted with the copper nitrate?

G

$450.0 \text{ g } Cu(NO_3)_2 \times \frac{1 \text{ mol } Cu(NO_3)_2}{187.55 \text{ g } Cu(NO_3)_2} \times \frac{2 \text{ mol Ag}}{1 \text{ mol } Cu(NO_3)_2} \times \frac{6.02 \times 10^{23}}{1 \text{ mol Ag}} = \text{Ag}$

2.890×10^{24} atoms Ag

12. 85mL of $BaCl_2$ is used to produce $BaCrO_4$. If 9.81g of $BaCrO_4$ is made, what is the concentration of the $BaCl_2$ used? The following equation represents the reaction:

$$K_2CrO_{4\,(aq)} + BaCl_{2(aq)} \rightarrow BaCrO_{4(s)} + 2KCl_{(aq)}$$

G m m R

$9.81 \text{ g } BaCrO_4 \times \frac{1 \text{ mol } BaCrO_4}{253.33 \text{ g } BaCrO_4} \times \frac{1 \text{ mol } BaCl_2}{1 \text{ mol } BaCrO_4} = \frac{0.038724\ldots}{.085} = 0.46 \frac{\text{mol}}{\text{L}}$

13. How many L of a 7.0M solution of HCl are needed to react with 9.85g of CO_2? The equation that represents the reaction follows.

$$NaHCO_3 + HCl \rightarrow NaCl + H_2O + CO_2$$

0.032 L

G m m

$9.85 \text{ g } CO_2 \times \frac{1 \text{ mol } CO_2}{44.01 \text{ g } CO_2} \times \frac{1 \text{ mol HCl}}{1 \text{ mol } CO_2} = 0.2238\ldots \quad \frac{7.0 \text{ mol}}{\text{L}} = \frac{0.2238\ldots}{x}$

14. Kim neutralizes 250 mL of HCL at a concentration of 4.5mol/L using $Ca(OH)_2$ according to the following equation: $2HCl + Ca(OH)_2 \rightarrow CaCl_2 + 2\,H_2O$ What is the mass of the $CaCl_2$ that will be left in the beaker?

$\frac{4.5 \text{ mol}}{\text{L}} = \frac{x}{.25}$

Given 0.125 mol HCl

R n m

$0.125 \text{ mol HCl} \times \frac{1 \text{ mol } CaCl_2}{2 \text{ mol HCl}} \times \frac{110.97 \text{ g } CaCl_2}{1 \text{ mol } CaCl_2} = 6.9 \text{ g } CaCl_2$