Name: KEY Block: ______

Chemistry 11

Stoichiometry Worksheet #1

Directions: Answer in the space provided. Be sure to show ALL your work. Please highlight your answer for each question. Watch for sig figs...and enemy fighters ;)

1. How many moles of $H_2O_{(g)}$ are produced when 9.6 mol of $O_{2\,(g)}$ react according to the equation:

$$2H_{2\,(g)} + O_{2\,(g)} \rightarrow 2H_2O_{(g)}$$ (ASSume an excess of H_2.)

9.6mol   mol=?

$$9.6\text{mol } O_2 \times \frac{2\text{mol } H_2O}{1\text{mol } O_2} = 19.2\text{ mol } H_2O$$

19mol H_2O

2. Consider the equation:

$$3\,I_{2\,(g)} + 6\,F_{2\,(g)} \rightarrow 2\,IF_{5\,(g)} + I_4F_{2\,(g)}$$

a. How many moles of $I_4F_{2\,(g)}$ are produced by 5.4 mol of $F_{2\,(g)}$? ASSume an excess of I_2.

$$5.4\text{ mol } F_2 \times \frac{1\text{mol } I_4F_2}{6\text{ mol } F_2} = 0.90\text{ mol } I_4F_2$$

b. How many moles of $F_{2\,(g)}$ are required to produce 4.5 mol of $IF_{5\,(g)}$? ASSume an excess of I_2.

$3I_2 + 6F_2 \rightarrow 2IF_5 + I_4F_2$

$$4.5\text{ mol } IF_5 \times \frac{6\text{mol } F_2}{2\text{ mol } IF_5} = 13.5\text{mol } F_2$$

13 mol F_2

c. How many moles of $I_{2\,(g)}$ are required to react with exactly 7.6 mol of $F_{2\,(g)}$?

$$7.6\text{mol } F_2 \times \frac{3\text{ mol } I_2}{6\text{ mol } F_2} = 3.8\text{mol } I_2$$

3.8mol I_2

3. Consider the equation:

$$1\,Fe_{(s)} + 1\,CuSO_{4\,(aq)} \rightarrow 1\,FeSO_{4\,(aq)} + 1\,Cu_{(s)}$$

a. If 14.3 g of Iron (II) sulphate is produced, how many grams of Iron are required? ASSume an excess of $CuSO_4$.

$$14.3\text{g } FeSO_4 \times \frac{1\text{ mol } FeSO_4}{151.9\text{g } FeSO_4} \times \frac{1\text{mol Fe}}{1\text{mol } FeSO_4} \times \frac{55.0\text{g Fe}}{1\text{mol Fe}} = 5.18\text{g Fe}$$

5.18g Fe

Name: KEY Block: ______________

4. What mass (in kg) of CO_2 is produced by burning 556 moles of glucose ($C_6H_{12}O_6$) in air? What mass of oxygen is required?

$$1\,C_6H_{12}O_{6\,(s)} + 6\,O_{2\,(g)} \longrightarrow 6\,CO_{2\,(g)} + 6\,H_2O_{(l)}$$

556 mol → kg=?

$$556\text{ mol } C_6H_{12}O_6 \times \frac{3\text{ mol } CO_2}{1\text{ mol } C_6H_{12}O_6} \times \frac{44.0\text{ g } CO_2}{1\text{ mol } CO_2} \times \frac{1\text{ kg}}{1000\text{ g}} = \boxed{73.4\text{ kg } CO_2}$$

5. When 66.80 g of benzene, C_6H_6, is added to excess oxygen and ignited, carbon dioxide and water are produced.

$$2\,C_6H_{6\,(s)} + 15\,O_{2\,(g)} \longrightarrow 6\,CO_{2\,(g)} + 3\,H_2O_{(l)}$$

a. What mass of $CO_{2\,(g)}$ is produced?

$$66.80\text{ g } C_6H_6 \times \frac{1\text{ mol } C_6H_6}{78.0\text{ g } C_6H_6} \times \frac{12\text{ mol } CO_2}{2\text{ mol } C_6H_6} \times \frac{44.0\text{ g } CO_2}{1\text{ mol } CO_2} = \boxed{226\text{ g } CO_2}$$

b. What mass of $H_2O_{(l)}$ is produced?

$$2\,C_6H_{6\,(s)} + 15\,O_{2\,(g)} \longrightarrow 6\,CO_{2\,(g)} + 3\,H_2O_{(l)}$$

$$66.80\text{ g } C_6H_6 \times \frac{1\text{ mol } C_6H_6}{78.0\text{ g } C_6H_6} \times \frac{6\text{ mol } H_2O}{2\text{ mol } C_6H_6} \times \frac{18.0\text{ g } H_2O}{1\text{ mol } H_2O} = \boxed{46.2\text{ g } H_2O}$$

6. What is the mass of NaCl that will decompose to yield 355 g of Cl_2?

$$2\,NaCl_{(s)} \longrightarrow 2\,Na_{(s)} + 1\,Cl_{2\,(g)}$$

$$355\text{ g } Cl_2 \times \frac{1\text{ mol } Cl_2}{70.0\text{ g } Cl_2} \times \frac{2\text{ mol } NaCl}{1\text{ mol } Cl_2} \times \frac{58.2\text{ g } NaCl}{1\text{ mol } NaCl} = \boxed{585\text{ g } NaCl}$$

Name: KEY Block: ____________

7. For the neutralization of calcium hydroxide and sulphuric acid,

$$1\,H_2SO_{4\,(aq)} + 1\,Ca(OH)_{2(aq)} \Longrightarrow 1\,CaSO_{4(s)} + 2\,H_2O_{(l)}$$

1. How many grams of calcium hydroxide will react with 29.4 g of sulphuric acid?

$$29.4\text{ g } H_2SO_4 \times \frac{1\text{ mol } H_2SO_4}{98.1\text{ g } H_2SO_4} \times \frac{1\text{ mol } Ca(OH)_2}{1\text{ mol } H_2SO_4} \times \frac{74.1\text{ g } Ca(OH)_2}{1\text{ mol } Ca(OH)_2} = \boxed{22.2\text{ g } Ca(OH)_2}$$

2. What mass of $CaSO_4$ will be produced?

$$29.4\text{ g } H_2SO_4 \times \frac{1\text{ mol } H_2SO_4}{98.1\text{ g } H_2SO_4} \times \frac{1\text{ mol } CaSO_4}{1\text{ mol } H_2SO_4} \times \frac{136.2\text{ g } CaSO_4}{1\text{ mol } CaSO_4} = \boxed{40.8\text{ g } CaSO_4}$$

8. How is chemistry 11 going so far? What do you like? What's not so good?

9. Pick three (3) students in the class, and write something POSITIVE about them:

1.

2.

3.

Name: KEY Block: ______

Chemistry 11

Stoichiometry Worksheet #2

Directions: Answer in the space provided. Be sure to show ALL your work. Please highlight your answer for each question. Watch for sig figs...and Darth Vader ;)

1. Consider the reaction:

$$4\ NH_{3\,(g)} + 5\ O_{2\,(g)} \rightarrow 6\ H_2O_{(g)} + 4\ NO_{(g)}$$

a. What mass of $NO_{(g)}$ is produced when 2.00 mol of $NH_{3\,(g)}$ are reacted with an excess of $O_{2\,(g)}$?

$$2.00\text{ mol } NH_3 \times \frac{4\text{ mol } NO}{4\text{ mol } NH_3} \times \frac{30.0\text{ g } NO}{1\text{ mol } NO} = \boxed{60.0\text{ g } NO}$$

b. What mass of $H_2O_{(g)}$ is produced when 4.00 mol of $O_{2\,(g)}$ are reacted with an excess of $NH_{3\,(g)}$?

$$4.00\text{ mol } O_2 \times \frac{6\text{ mol } H_2O}{5\text{ mol } O_2} \times \frac{18.0\text{ g } H_2O}{1\text{ mol } H_2O} = \boxed{86.4\text{ g } H_2O}$$

c. What volume of $NH_{3\,(g)}$ at STP is required to react with 3.00 mol of $O_{2\,(g)}$?

$$3.00\text{ mol } O_2 \times \frac{4\text{ mol } NH_3}{5\text{ mol } O_2} \times \frac{22.4\text{ L } NH_3}{1\text{ mol } NH_3} = \boxed{53.8\text{ L of } NH_3}$$

d. What volume of $NH_{3\,(g)}$ at STP is required to produce 0.750 mol of $H_2O_{(g)}$?

$$0.750\text{ mol } H_2O \times \frac{4\text{ mol } NH_3}{6\text{ mol } H_2O} \times \frac{22.4\text{ L } NH_3}{1\text{ mol } NH_3} = \boxed{11.2\text{ L of } NH_3}$$

2. Pentane, $C_5H_{12(l)}$, burns according to the reaction:

$$C_5H_{12\,(l)} + 8\ O_{2\,(g)} \rightarrow 5\ CO_{2\,(g)} + 6\ H_2O_{(l)}$$

a. What mass of H_2O is produced when 100.0 g of C_5H_{12} is burned? Assume an excess of O_2.

$$100.0\text{ g } C_5H_{12} \times \frac{1\text{ mol } C_5H_{12}}{72.0\text{ g } C_5H_{12}} \times \frac{6\text{ mol } H_2O}{1\text{ mol } C_5H_{12}} \times \frac{18.0\text{ g } H_2O}{1\text{ mol } H_2O} = \boxed{150.\text{ g } H_2O}$$

b. What mass of C_5H_{12} is required to produce 90.0 L of CO_2 at STP? Assume an excess of O_2.

$$90.0\text{ L of } CO_2 \times \frac{1\text{ mol } CO_2}{22.4\text{ L } CO_2} \times \frac{1\text{ mol } C_5H_{12}}{5\text{ mol } CO_2} \times \frac{72.0\text{ g } C_5H_{12}}{1\text{ mol } C_5H_{12}} = \boxed{57.9\text{ g } C_5H_{12}}$$

Name: KEY Block: ____________

$C_5H_{12\,(l)} + 8\,O_{2\,(g)} \rightarrow 5\,CO_{2\,(g)} + 6\,H_2O_{\,(l)}$

c. What volume of O_2 at STP is required to produce 70.0 g of CO_2? Assume an excess of C_5H_{12}.

$$70.0\text{g } CO_2 \times \frac{1\text{ mol } CO_2}{44.0\text{g } CO_2} \times \frac{8\text{ mol } O_2}{5\text{ mol } CO_2} \times \frac{22.4\text{L of } O_2}{1\text{ mol } O_2} = \boxed{57.0\text{L of } O_2}$$

3. How many litres of hydrogen gas will be produced by 5.72 g of zinc in the single replacement reaction of zinc and hydrochloric acid at STP?

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2$$

$$5.72\text{g Zn} \times \frac{1\text{ mol Zn}}{65.4\text{g Zn}} \times \frac{1\text{ mol } H_2}{1\text{ mol Zn}} \times \frac{22.4\text{L of } H_2}{1\text{ mol } H_2} = \boxed{1.96\text{ L of } H_2}$$

4. Calculate the number of grams of nitrogen gas required to make 1.22 L of ammonia at STP. Assume an excess of H_2.

$N_{2\,(g)} + 3\,H_{2\,(g)} \rightarrow 2\,NH_{3\,(g)}$

$$1.22\text{L of } NH_3 \times \frac{1\text{ mol } NH_3}{22.4\text{L of } NH_3} \times \frac{1\text{ mol } N_2}{2\text{ mol } NH_3} \times \frac{28.0\text{g } N_2}{1\text{ mol } N_2} = \boxed{0.762\text{g } N_2}$$

5. Tetraethyl lead, $Pb(C_2H_5)_{4(l)}$, is an "anti-knock" ingredient, which was added to some gasoline's. Tetraethyl lead burns according to the equation:

$2\,Pb(C_2H_5)_{4\,(l)} + 27\,O_{2\,(g)} \rightarrow 2\,PbO_{\,(s)} + 16\,CO_{2\,(g)} + 20\,H_2O_{\,(l)}$

a. What volume of $O_{2\,(g)}$ at STP is consumed when 100.0 g of $PbO_{(s)}$ are formed?

$$100.0\text{g PbO} \times \frac{1\text{ mol PbO}}{223.2\text{g PbO}} \times \frac{27\text{ mol } O_2}{2\text{ mol PbO}} \times \frac{22.4\text{L of } O_2}{1\text{ mol } O_2} = \boxed{135\text{L of } O_2}$$

b. How many molecules of CO_2 are formed when 1.00×10^{-6} g of tetraethyl lead is burned? Assume an excess of O_2.

$$1.00\times10^{-6}\text{g } Pb(C_2H_5)_4 \times \frac{1\text{ mol}}{323.2\text{g}} \times \frac{16\text{ mol } CO_2}{2\text{ mol } Pb(C_2H_5)_4} \times \frac{6.02\times10^{23}\text{ molecules } CO_2}{1\text{ mol } CO_2}$$

$$\boxed{1.49\times10^{16}\text{ molecules } CO_2}$$

Name: KEY Block: ______________

$$2\ Pb(C_2H_5)_{4\ (l)} + 27\ O_{2\ (g)} \rightarrow 2\ PbO_{\ (s)} + 16\ CO_{2\ (g)} + 20\ H_2O_{\ (l)}$$

c. What volume of $O_{2(g)}$ at STP, in milliliters, is required to react with 1.00×10^{15} molecules of tetraethyl lead?

$$1.00 \times 10^{15} \text{ molecules } Pb(C_2H_5)_4 \times \frac{1 \text{ mol } Pb(C_2H_5)_4}{6.02 \times 10^{23}\ Pb(C_2H_5)_4} \times \frac{27 \text{ mol } O_2}{2 \text{ mol } Pb(C_2H_5)_4} \times \frac{22.4\ L\ O_2}{1 \text{ mol } O_2} = \boxed{5.02 \times 10^{-7}\ L \text{ of } O_2}$$

6. How many grams of Silver chloride can be produced from 34.0 g of Silver nitrate? ASSume an excess of NaCl.

$$AgNO_{3\ (aq)} + NaCl_{\ (aq)} \Longrightarrow AgCl_{\ (s)} + NaNO_{3\ (aq)}$$

$$34.0 g\ AgNO_3 \times \frac{1 \text{ mol } AgNO_3}{169.9 g\ AgNO_3} \times \frac{1 \text{ mol } AgCl}{1 \text{ mol } AgNO_3} \times \frac{143.4 g\ AgCl}{1 \text{ mol } AgCl} = \boxed{28.7 g\ AgCl}$$

7. How many grams of Copper (I) sulphide could be produced from 19.8 g of Copper (I) chloride reacting with an excess of Hydrogen Sulphide gas?

$$2CuCl_{\ (s)} + H_2S_{\ (g)} \Longrightarrow Cu_2S_{\ (s)} + 2HCl_{\ (aq)}$$

$$19.8 g\ CuCl \times \frac{1 \text{ mol } CuCl}{99.0 g\ CuCl} \times \frac{1 \text{ mol } Cu_2S}{2 \text{ mol } CuCl} \times \frac{159.1 g\ Cu_2S}{1 \text{ mol } Cu_2S} = \boxed{15.9 g\ Cu_2S}$$

8. Chlorine gas reacts with sodium metal to produce sodium chloride. What mass of Chlorine will be needed to react with 12.30 g of Sodium?

$$Cl_2 + 2\ Na \rightarrow 2NaCl$$

$$12.30 g\ Na \times \frac{1 \text{ mol } Na}{23.0 g\ Na} \times \frac{1 \text{ mol } Cl_2}{2 \text{ mol } Na} \times \frac{71.0 g\ Cl_2}{1 \text{ mol } Cl_2} = \boxed{19.0 g\ Cl_2}$$

Name: KEY Block: ____________

9. Calcium phosphate and water react to form Calcium hydroxide and Phosphoric acid. How many grams of Calcium phosphate will be needed if 72.0 g of water react?

$$Ca_3(PO_4)_2 + 6H_2O \rightarrow 3Ca(OH)_2 + 2H_3PO_4$$

$$72.0\,g\,H_2O \times \frac{1\,mol\,H_2O}{18.0\,g\,H_2O} \times \frac{1\,mol\,Ca_3(PO_4)_2}{6\,mol\,H_2O} \times \frac{310.3\,g\,Ca_3(PO_4)_2}{1\,mol\,Ca_3(PO_4)_2} = \boxed{207\,g\,Ca_3(PO_4)_2}$$

10. What mass of PbO is obtained by heating 100.0 g of $PbCO_3$ according to the following equation:

$$PbCO_{3\,(s)} \longrightarrow PbO_{(s)} + CO_{2\,(g)}$$

$$100.0\,g\,PbCO_3 \times \frac{1\,mol\,PbCO_3}{267.2\,g\,PbCO_3} \times \frac{1\,mol\,PbO}{1\,mol\,PbCO_3} \times \frac{223.2\,g\,PbO}{1\,mol\,PbO} = \boxed{83.5\,g\,PbO}$$

11. How much zinc is required to produce 10.00 g of ZnCl2 according to the following equation:

$$Zn_{(s)} + 2HCl_{(aq)} \longrightarrow ZnCl_{2\,(aq)} + H_{2\,(g)}$$

$$10.0\,g\,ZnCl_2 \times \frac{1\,mol\,ZnCl_2}{136.4\,g\,ZnCl_2} \times \frac{1\,mol\,Zn}{1\,mol\,ZnCl_2} \times \frac{65.4\,g\,Zn}{1\,mol\,Zn} = \boxed{4.79\,g\,Zn}$$

12. Pentane burns according to the reaction:

$$C_5H_{12\,(l)} + 8\,O_{2\,(g)} \longrightarrow 5\,CO_{2\,(g)} + 6\,H_2O_{(g)}$$

a. What volume in ml of $CO_{2\,(g)}$ at S.T.P is produced when 100.0 g of $C_5H_{12\,(l)}$ is burned? (Assume an excess of O_2).

$$100.0\,g\,C_5H_{12} \times \frac{1\,mol\,C_5H_{12}}{72.0\,g\,C_5H_{12}} \times \frac{5\,mol\,CO_2}{1\,mol\,C_5H_{12}} \times \frac{22.4\,L}{1\,mol\,CO_2} = 156\,L\,of\,CO_2 = \boxed{156{,}000\,mL\,of\,CO_2}$$

b. How many molecules of $C_5H_{12\,(l)}$ would burn if only 50.0 g of $O_{2\,(g)}$ is available?

$$50.0\,g\,O_2 \times \frac{1\,mol\,O_2}{32.0\,g\,O_2} \times \frac{1\,mol\,C_5H_{12}}{8\,mol\,O_2} \times \frac{6.02\times10^{23}\,molecules\,C_5H_{12}}{1\,mol\,C_5H_{12}} = \boxed{1.18\times10^{23}\,molecules\,of\,C_5H_{12}}$$

Name: KEY Block: ____________

13. The net reaction for photosynthesis is water and carbon dioxide combining to form oxygen gas and glucose ($C_6H_{12}O_6$). How many grams of carbon dioxide must a plant take in through its leaves to make 60.0 g of glucose? (Balanced? ☺...ASSume an excess of water)

$$6H_2O + 6CO_2 \longrightarrow 1C_6H_{12}O_6 + 9O_2$$

$$60.0\,g\ C_6H_{12}O_6 \times \frac{1\ mol\ C_6H_{12}O_6}{180.0\,g\ C_6H_{12}O_6} \times \frac{6\ mol\ CO_2}{1\ mol\ C_6H_{12}O_6} \times \frac{44.0\,g\ CO_2}{1\ mol\ CO_2} = \boxed{88.0\,g\ CO_2}$$

14. Animals require glucose for energy which is released in a combustion reaction. Balanced?

$$1C_6H_{12}O_6 + 9O_2 \longrightarrow 6H_2O + 6CO_2$$

a. What mass of O_2 is required to burn 75.0 g of glucose?

$$75.0\,g\ C_6H_{12}O_6 \times \frac{1\ mol\ C_6H_{12}O_6}{180.0\,g\ C_6H_{12}O_6} \times \frac{9\ mol\ O_2}{1\ mol\ C_6H_{12}O_6} \times \frac{32.0\,g\ O_2}{1\ mol\ O_2} = \boxed{120.\ g\ O_2}$$

b. What mass of water will be produced?

$$75.0\,g\ C_6H_{12}O_6 \times \frac{1\ mol\ C_6H_{12}O_6}{180.0\,g\ C_6H_{12}O_6} \times \frac{6\ mol\ H_2O}{1\ mol\ C_6H_{12}O_6} \times \frac{18.0\,g\ H_2O}{1\ mol\ H_2O} = \boxed{45.0\,g\ H_2O}$$

c. What volume, in ml's, of $CO_{2\,(g)}$ will be produced at S.T.P?

$$75.0\,g\ C_6H_{12}O_6 \times \frac{1\ mol\ C_6H_{12}O_6}{180.0\,g\ C_6H_{12}O_6} \times \frac{6\ mol\ CO_2}{1\ mol\ C_6H_{12}O_6} \times \frac{22.4\ L\ CO_2}{1\ mol\ CO_2} \times \frac{1000\ mL}{1\ L}$$

$$= \boxed{56{,}000\ mL\ of\ CO_2}$$

Name: KEY Block: ______________

15. How many litres of 0.100 M HCl would be required to react completely with 5.00 grams of calcium hydroxide?

$$Ca(OH)_{2\,(s)} + 2\ HCl_{(aq)} \rightarrow CaCl_{2\,(aq)} + 2\ H_2O_{(l)}$$

$$5.00\,g\ Ca(OH)_2 \times \frac{1\,mol\ Ca(OH)_2}{74.1\,g\ Ca(OH)_2} \times \frac{2\,mol\ HCl}{1\,mol\ Ca(OH)_2} \times \frac{1\,L\ of\ HCl}{0.100\,mol\ HCl} = \boxed{1.35\,L\ of\ HCl}$$

For the following questions, please use this reaction:

$$Ca(OH)_{2(s)} + 2\ HCl_{(aq)} \rightarrow CaCl_{2(aq)} + 2\ H_2O_{(l)}$$

16. How many liters of 0.100 M HCl would be required to react completely with 5.00 grams of calcium hydroxide?

$$Ca(OH)_{2(s)} + 2\ HCl_{(aq)} \rightarrow CaCl_{2(aq)} + 2\ H_2O_{(l)}$$

$$5.00\,g\ Ca(OH)_2 \times \frac{1\,mol\ Ca(OH)_2}{74.1\,g\ Ca(OH)_2} \times \frac{2\,mol\ HCl}{1\,mol\ Ca(OH)_2} \times \frac{1\,L\ of\ HCl}{0.100\,mol\ HCl} = \boxed{1.35\,L\ of\ HCl}$$

17. How many grams of calcium hydroxide are needed to react with 69.50 ml of 0.350 M hydrochloric acid? = 0.06950 L

$$Ca(OH)_{2(s)} + 2\ HCl_{(aq)} \rightarrow CaCl_{2(aq)} + 2\ H_2O_{(l)}$$

$$0.06950\,L\ HCl \times \frac{0.350\,mol\ HCl}{1\,L\ HCl} \times \frac{1\,mol\ Ca(OH)_2}{2\,mol\ HCl} \times \frac{74.1\,g\ Ca(OH)_2}{1\,mol\ Ca(OH)_2} = \boxed{0.901\,g\ Ca(OH)_2}$$

18. If 350.0 ml's of 0.250 M Calcium chloride were produced, what mass of Calcium hydroxide was required? (Assume an excess of HCl)

$$Ca(OH)_{2(s)} + 2\ HCl_{(aq)} \rightarrow CaCl_{2(aq)} + 2\ H_2O_{(l)}$$

$$0.3500\,L\ CaCl_2 \times \frac{0.250\,mol\ CaCl_2}{1\,L\ CaCl_2} \times \frac{1\,mol\ Ca(OH)_2}{1\,mol\ CaCl_2} \times \frac{74.1\,g\ Ca(OH)_2}{1\,mol\ Ca(OH)_2} = \boxed{6.48\,g\ Ca(OH)_2}$$

=

Name: KEY Period: ____________

Chemistry 11

Stoichiometry Worksheet #3

Directions: Answer in the space provided. Be sure to show ALL your work. Please highlight your answer for each question. Watch for sig figs...and Aliens ;)

1. Given the following equation:

$$Al_2(SO_3)_3 + 6\ NaOH \Longrightarrow 3\ Na_2SO_3 + 2\ Al(OH)_3$$

a. If 10.0 g of $Al_2(SO_3)_3$ is reacted with 10.0 g of NaOH, determine the limiting reagent

$$10.0\,g\ Al_2(SO_3)_3 \times \frac{1\,mol\ Al_2(SO_3)_3}{294.3\,g\ Al_2(SO_3)_3} \times \frac{3\,mol\ Na_2SO_3}{1\,mol\ Al_2(SO_3)_3} = \boxed{0.102\,mol\ Na_2SO_3}$$

(Limiting Reagent)

$$10.0\,g\ NaOH \times \frac{1\,mol\ NaOH}{40.0\,g\ NaOH} \times \frac{3\,mol\ Na_2SO_3}{6\,mol\ NaOH} = \boxed{0.125\,mol\ Na_2SO_3}$$

(EXCESS Reagent)

b. Determine the number of grams of Na_2SO_3 produced

$$0.102\,mol\ Na_2SO_3 \times \frac{126.1\,g\ Na_2SO_3}{1\,mol\ Na_2SO_3} = \boxed{12.9\,g\ Na_2SO_3}$$

c. Determine the number of grams of excess reagent left over in the reaction

$$10.0\,g\ Al_2(SO_3)_3 \times \frac{1\,mol\ Al_2(SO_3)_3}{294.3\,g\ Al_2(SO_3)_3} \times \frac{6\,mol\ NaOH}{1\,mol\ Al_2(SO_3)_3} \times \frac{40.0\,g\ NaOH}{1\,mol\ NaOH} = \boxed{8.16\,g\ NaOH}$$

$$\therefore \boxed{10.0\,g - 8.16\,g = 1.8\,g\ NaOH\ excess}$$

d. Calculate how many grams of $Al(OH)_3$ are produced

$$10.0\,g\ Al_2(SO_3)_3 \times \frac{1\,mol\ Al_2(SO_3)_3}{294.3\,g\ Al_2(SO_3)_3} \times \frac{2\,mol\ Al(OH)_3}{1\,mol\ Al_2(SO_3)_3} \times \frac{78.0\,g\ Al(OH)_3}{1\,mol\ Al(OH)_3} = \boxed{5.30\,g\ Al(OH)_3}$$

Name: KEY Period: ______

2. Given the following equation:

$$4\ Al_2O_3 + 9\ Fe \longrightarrow 3\ Fe_3O_4 + 8\ Al$$

a. If 25.4 g of Al_2O_3 is reacted with 10.2 g of Fe, determine the limiting reagent

$$25.4\,g\ Al_2O_3 \times \frac{1\,mol\ Al_2O_3}{102.0\,g\ Al_2O_3} \times \frac{8\,mol\ Al}{4\,mol\ Al_2O_3} = \boxed{0.498\,mol\ Al}$$

(Excess Reagent)

$$10.2\,g\ Fe \times \frac{1\,mol\ Fe}{55.8\,g\ Fe} \times \frac{8\,mol\ Al}{9\,mol\ Fe} = \boxed{0.162\,mol\ Al}$$

(Limiting Reagent)

b. Determine the mass, in grams, of Al produced

$$0.162\,mol\ Al \times \frac{27.0\,g}{1\,mol} = \boxed{4.37\,g\ Al}$$

c. Determine the number of grams of Fe_3O_4 produced

$$10.2\,g\ Fe \times \frac{1\,mol\ Fe}{55.8\,g\ Fe} \times \frac{3\,mol\ Fe_3O_4}{9\,mol\ Fe} \times \frac{231.4\,g\ Fe_3O_4}{1\,mol\ Fe_3O_4} = \boxed{14.1\,g\ Fe_3O_4}$$

d. Determine the number of grams of excess reagent left over in the reaction

$$10.2\,g\ Fe \times \frac{1\,mol\ Fe}{55.8\,g\ Fe} \times \frac{4\,mol\ Al_2O_3}{9\,mol\ Fe} \times \frac{102.0\,g\ Al_2O_3}{1\,mol\ Al_2O_3} = 8.29\,g\ Al_2O_3$$

Excess Reagent left = 25.4g − 8.29g

$$= \boxed{17.1\,g\ Al_2O_3}$$

Name: KEY Period: ____________

3. Given the following reaction:

$$1\ C_3H_8 + 5O_2 \Longrightarrow 3CO_2 + 4H_2O$$

If you start with 14.8 g of C_3H_8 and 3.44 g of O_2,

a. Determine the limiting reagent

$$14.8g\ C_3H_8 \times \frac{1\ mol\ C_3H_8}{44.0g\ C_3H_8} \times \frac{3\ mol\ CO_2}{1\ mol\ C_3H_8} = \boxed{1.01\ mol\ CO_2}$$

(Excess Reagent)

$$3.44g\ O_2 \times \frac{1\ mol\ O_2}{32.0g\ O_2} \times \frac{3\ mol\ CO_2}{5\ mol\ O_2} = \boxed{0.0645\ mol\ CO_2}$$

(Limiting Reagent)

b. Determine the grams of carbon dioxide produced

$$0.0645\ mol\ CO_2 \times \frac{44.0\ g\ CO_2}{1\ mol\ CO_2} = \boxed{2.84\ g\ CO_2}$$

c. Determine the grams of H_2O produced

$$3.44g\ O_2 \times \frac{1\ mol\ O_2}{32.0g\ O_2} \times \frac{4\ mol\ H_2O}{5\ mol\ O_2} \times \frac{18.0g\ H_2O}{1\ mol\ H_2O} = \boxed{1.55g\ H_2O}$$

d. Determine the number of grams of excess reagent left

$$3.44g\ O_2 \times \frac{1\ mol\ O_2}{32.0g\ O_2} \times \frac{1\ mol\ C_3H_8}{5\ mol\ O_2} \times \frac{44.0g\ C_3H_8}{1\ mol\ C_3H_8} = 0.946g\ C_3H_8$$

Excess C_3H_8 = 14.8g − 0.946g

= 13.9 g C_3H_8 excess

Name: KEY Period: ______________

4. Write the balanced equation for the reaction of lead (II) nitrate with sodium iodide to form sodium nitrate and lead (II) iodide

$$Pb(NO_3)_2 + 2NaI \rightarrow 2NaNO_3 + PbI_2$$

a. If you start with 25.0 grams of lead (II) nitrate and 15.0 grams of sodium iodide, what is the limiting reagent?

$$25.0\,g\,Pb(NO_3)_2 \times \frac{1\,mol\,Pb(NO_3)_2}{331.2\,g\,Pb(NO_3)_2} \times \frac{1\,mol\,PbI_2}{1\,mol\,Pb(NO_3)_2} = \boxed{0.0755\,mol\,Pb(NO_3)_2}$$

(EXCESS Reagent)

$$15.0\,g\,NaI \times \frac{1\,mol\,NaI}{149.9\,g\,NaI} \times \frac{1\,mol\,Pb(NO_3)_2}{2\,mol\,NaI} = \boxed{0.0500\,mol\,Pb(NO_3)_2}$$

(LIMITING Reagent)

b. How much excess reactant will be left over from the reaction

$$15.0\,g\,NaI \times \frac{1\,mol\,NaI}{149.9\,g\,NaI} \times \frac{1\,mol\,Pb(NO_3)_2}{2\,mol\,NaI} \times \frac{331.2\,g\,Pb(NO_3)_2}{1\,mol\,Pb(NO_3)_2} = \boxed{16.6\,g\,Pb(NO_3)_2}$$

Excess Reactant = 25.0 g − 16.6 g = $\boxed{8.4\,g\,Pb(NO_3)_2\ \text{excess}}$

5. When a sample of malachite ore containing 215.0 g of malachite, ($Cu_2(OH)_2CO_3$) was heated, the products were copper (II) oxide, carbon dioxide and water.

$$Cu_2(OH)_2CO_3 \Longrightarrow CO_2 + 2\,CuO + H_2O$$

a. What is the theoretical yield of CuO in grams?

$$215.0\,g\,Cu_2(OH)_2CO_3 \times \frac{1\,mol\,Cu_2(OH)_2CO_3}{221.0\,g\,Cu_2(OH)_2CO_3} \times \frac{2\,mol\,CuO}{1\,mol\,Cu_2(OH)_2CO_3} \times \frac{79.5\,g\,CuO}{1\,mol\,CuO} = \boxed{155\,g\,CuO}$$

b. If the reaction had an 84.0% yield, how many grams of CuO actually formed?

$$\%\,Yield = \frac{AY}{TY} \times 100\%$$

$$84\% = \frac{AY}{155\,g} \times 100\%$$

$\boxed{\text{Actual Yield} = 130\,g\,CuO}$

Name: KEY Period: ______

6. Given the following equation:

1 K_2PtCl_4 + 2 NH_3 ⟹ 1 $Pt(NH_3)_2Cl_2$ + 2 KCl

a. Balance the equation.

Balanced above shown.

b. Determine the theoretical yield of KCl if you start with 34.5 grams of NH_3. (ASSume an excess of K_2PtCl_4).

$$34.5\,g\ NH_3 \times \frac{1\ mol\ NH_3}{17.0\,g\ NH_3} \times \frac{2\ mol\ KCl}{2\ mol\ NH_3} \times \frac{74.6\,g\ KCl}{1\ mol\ KCl} = 151\,g\ KCl$$

c. Starting with 34.5 g of NH_3, you isolated 76.4 g of KCl. What is the percent yield?

$$\%\ yield = \frac{AY}{TY} \times 100\% = \frac{76.4\,g}{151\,g} \times 100\%$$

$$\%\ yield = \frac{76.4\,g}{151\,g} \times 100\% = 50.6\%\ yield\ KCl$$

7. Given the following equation:

H_3PO_4 + 3 KOH ------> K_3PO_4 + 3 H_2O

If 49.0 g of H_3PO_4 is reacted with excess KOH, determine the percent yield of K_3PO_4 if you isolate 49.0 g of K_3PO_4.

$$49.0\,g\ H_3PO_4 \times \frac{1\ mol\ H_3PO_4}{98.0\,g\ H_3PO_4} \times \frac{1\ mol\ K_3PO_4}{1\ mol\ H_3PO_4} \times \frac{212.3\,g\ K_3PO_4}{1\ mol\ K_3PO_4} = 106.2\,g\ K_3PO_4$$

$$\%\ yield = \frac{AY}{TY} \times 100\% = \frac{49.0\,g\ K_3PO_4}{106.2\,g\ K_3PO_4} \times 100\%$$

$$\%\ yield = 46.1\%\ yield\ K_3PO_4$$

Name: KEY Period: ____________

8. Consider the following reaction:

$$C_3H_8 + 5\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$$

a. If I start with 5.00 grams of C_3H_8, what is my theoretical yield of water? (ASSume an excess of O_2)

$$5.00\text{g } C_3H_8 \times \frac{1\text{ mol } C_3H_8}{44.0\text{g } C_3H_8} \times \frac{4\text{ mol } H_2O}{1\text{ mol } H_2O} \times \frac{18.0\text{g } H_2O}{1\text{ mol } H_2O} = \boxed{8.18\text{g } H_2O}$$

b. I got a percent yield of 75.0%. How many grams of water did I make?

$$\%\text{ Yield} = \frac{\text{Actual Yield}}{\text{Theoretical Yield}} \times 100\%$$

$$75\% = \frac{AY}{8.18\text{g } H_2O} \times 100\% \rightarrow \boxed{AY = 6.14\text{g } H_2O}$$

9. Consider the following reaction:

$$LiOH + KCl \rightarrow LiCl + KOH$$

a. What is the theoretical yield of lithium chloride if 20.0 grams of lithium hydroxide are reacted? (Assume an excess of KCl)

$$20.0\text{g LiOH} \times \frac{1\text{ mol LiOH}}{23.9\text{ g LiOH}} \times \frac{1\text{ mol LiCl}}{1\text{ mol LiOH}} \times \frac{42.4\text{g LiCl}}{1\text{ mol LiCl}} = \boxed{35.5\text{g LiCl}}$$

b. 6.00 grams of lithium chloride were actually produced. What is the percent yield?

$$\%\text{ Yield} = \frac{AY}{TY} \times 100\%$$

$$= \frac{6.00\text{g}}{35.5\text{g}} \times 100\% = \boxed{16.9\%\text{ yield LiCl}}$$

Name: KEY

Period: ____________

Chemistry 11

Stoichiometry Worksheet - Unit Review

Directions: Answer in the space provided. Have fun ☺

1. When 85.1 g of zinc are reacted with 125.65 g hydrochloric acid, HCl, to produce zinc chloride, $ZnCl_2$, and hydrogen gas, H_2, which reactant will be in excess and by how much? Calculate the number of grams of H_2.

$$Zn + 2\,HCl \longrightarrow ZnCl_2 + H_2$$

85.1 g Zn (LIMITING Reagent) $\times \frac{1\text{ mol Zn}}{65.4\text{ g Zn}} \times \frac{1\text{ mol }H_2}{1\text{ mol Zn}} = $ **1.30 mol H_2** $\times \frac{2.00\text{ g}}{1\text{ mol }H_2} = $ **2.60 g H_2 produced.**

125.65 g HCl (EXCESS Reagent) $\times \frac{1\text{ mol HCl}}{36.5\text{ g HCl}} \times \frac{1\text{ mol }H_2}{2\text{ mol HCl}} = $ **1.72 mol H_2**

Excess Reactant Amount $= 1.30\text{ mol }H_2 \times \frac{2\text{ mol HCl}}{1\text{ mol }H_2} \times \frac{36.5\text{ g HCl}}{1\text{ mol HCl}} = 94.9\text{ g HCl}$

Excess HCl $= 125.65\text{ g} - 94.9\text{ g} = $ **30.75 g HCl excess**

2. If 10.45 g of aluminium are reacted with 66.55 g of copper (II) sulphate, $CuSO_4$, then aluminium sulphate, $Al_2(SO_4)_3$, and copper are formed. Which reactant is in excess? By how much? Calculate the mass of each product.

$$2\,Al + 3\,CuSO_4 \longrightarrow Al_2(SO_4)_3 + 3\,Cu$$

10.45 g Al (EXCESS Reagent) $\times \frac{1\text{ mol Al}}{27.0\text{ g Al}} \times \frac{1\text{ mol }Al_2(SO_4)_3}{2\text{ mol Al}} = $ **0.194 mol $Al_2(SO_4)_3$**

66.55 g $CuSO_4$ (Limiting Reagent) $\times \frac{1\text{ mol }CuSO_4}{159.6\text{ g }CuSO_4} \times \frac{1\text{ mol }Al_2(SO_4)_3}{3\text{ mol }CuSO_4} = $ **0.139 mol $Al_2(SO_4)_3$**

Amount of PRODUCTS FORMED

$0.139\text{ mol }Al_2(SO_4)_3 \times \frac{342.3\text{ g }Al_2(SO_4)_3}{1\text{ mol }Al_2(SO_4)_3} = $ **47.6 g $Al_2(SO_4)_3$**

$0.139\text{ mol }Al_2(SO_4)_3 \times \frac{3\text{ mol Cu}}{1\text{ mol }Al_2(SO_4)_3} \times \frac{63.5\text{ g Cu}}{1\text{ mol Cu}} = $ **26.5 g Cu**

Excess Reactant Amount $= 0.139\text{ mol }Al_2(SO_4)_3 \times \frac{2\text{ mol Al}}{1\text{ mol }Al_2(SO_4)_3} \times \frac{27.0\text{ g Al}}{1\text{ mol Al}} = $ **7.51 g Al**

∴ Excess Al $= 10.45\text{ g} - 7.51\text{ g} = $ **2.94 g Al excess**

Name: KEY　　　　　　　　　　　　　　　　Period: ________

3. Large amounts of uranium metals are produced by reacting uranium (IV) chloride with magnesium metal to produce magnesium chloride and uranium metal.

$$UCl_4 + 2\,Mg \longrightarrow 2\,MgCl_2 + U$$

a. How many grams of magnesium are required to completely react 155 g of uranium (IV) chloride?

$$155\,g\ UCl_4 \times \frac{1\,mol\ UCl_4}{380.0\,g\ UCl_4} \times \frac{2\,mol\ Mg}{1\,mol\ UCl_4} \times \frac{24.3\,g\ Mg}{1\,mol\ Mg} = \boxed{19.8\,g\ Mg}$$

b. How many grams of uranium metal will be produced?

$$155\,g\ UCl_4 \times \frac{1\,mol\ UCl_4}{380.0\,g\ UCl_4} \times \frac{1\,mol\ U}{1\,mol\ UCl_4} \times \frac{238.0\,g\ U}{1\,mol\ U} = \boxed{97.0\,g\ U}$$

4. The methyl alcohol, CH_3OH, used in alcohol burners combines with oxygen gas to form carbon dioxide and water. How many ml's of oxygen gas at S.T.P are required to burn 34.2 g of methyl alcohol?

$$2\,CH_3OH + 3\,O_2 \longrightarrow 2\,CO_2 + 4\,H_2O$$

$$34.2\,g\ CH_3OH \times \frac{1\,mol\ CH_3OH}{32.0\,g\ CH_3OH} \times \frac{3\,mol\ O_2}{3\,mol\ CH_3OH} \times \frac{22.4\,L\ of\ O_2}{1\,mol\ O_2} = \boxed{23.9\,L\ of\ O_2}$$

23900ml O2

5. What volume of 0.60M copper (II) sulphate will react with 45 ml of 1.50 M sodium hydroxide to form copper (II) hydroxide and sodium sulphate?

$$CuSO_4 + 2\,NaOH \longrightarrow Cu(OH)_2 + Na_2SO_4$$

$$\frac{1.50\,mol}{1\,L}\ NaOH \times 0.045\,L \times \frac{1\,mol\ Cu(OH)_2}{2\,mol\ NaOH} \times \frac{1\,L\ Cu(OH)_2}{0.60\,mol\ Cu(OH)_2} = \boxed{0.0563\,L\ Cu(OH)_2}$$

Name: KEY Period: ________

6. Caustic Soda (NaOH) is prepared commercially by passing an electric current through a concentrated solution of salt in water:

$$2\ NaCl + 2H_2O \longrightarrow 2\ NaOH + H_2 + Cl_2$$

a. What is the theoretical yield of caustic soda if 100.0 kg of sodium chloride is electrolysed?

$$100.0\ kg\ NaCl \times \frac{1000\ g}{1\ kg} \times \frac{1\ mol\ NaCl}{58.5\ g\ NaCl} \times \frac{2\ mol\ NaOH}{2\ mol\ NaCl} \times \frac{40.0\ g\ NaOH}{1\ mol\ NaOH} =$$

66 500 g or 68.5 Kg NaOH

b. What is the percent yield if the electrolysis produces 55.0 kg of caustic soda?

$$\%\ yield = \frac{55.0\ kg}{68.5\ kg} \times 100\% = \boxed{80.3\%\ yield\ NaOH}$$

7. Freon-12 (CCl_2F_2) is a gas used as a refrigerant. It is prepared by the reaction:

$$3\ CCl_4 + 2\ SbF_3 \longrightarrow 3\ CCl_2F_2 + 2\ SbCl_3$$

If the % yield is 72.0, how many grams of antimony triflouride (SbF_3) will be produced if 25.0 g of Freon-12 is reacted with excess carbon tetrachloride?

$$TY = 25.0\ g\ CCl_2F_2 \times \frac{1\ mol\ CCl_2F_2}{121.0\ g\ CCl_2F_2} \times \frac{2\ mol\ SbF_3}{3\ mol\ CCl_2F_2} \times \frac{178.8\ g\ SbF_3}{1\ mol\ SbF_3} = 24.6\ g\ SbF$$

$$\%\ yield = \frac{AY}{TY} \times 100\%$$

$$\boxed{AY = \frac{72\ (24.6\ g)}{100} = 17.7\ g\ SbF_3}$$

8. What volume, in ml's, of 0.550 M Nickel (II) nitrate, will react with 85.0 ml of 0.250 M potassium carbonate to form nickel (I) carbonate and potassium nitrate,

$$Ni(NO_3)_2 + K_2CO_3 \longrightarrow NiCO_3 + 2\ KNO_3$$

$$\frac{0.250\ mol}{1\ L}\ K_2CO_3 \times 0.0850\ L \times \frac{1\ mol\ Ni(NO_3)_2}{1\ mol\ K_2CO_3} \times \frac{1\ L}{0.550\ mol\ Ni(NO_3)_2}$$

$$= 0.0386\ L = \boxed{38.6\ mL\ of\ Ni(NO_3)_2}$$

Name: KEY Period: ________

9. 5.45 g of potassium chlorate is decomposed and forms potassium chloride and 1.95 g of oxygen gas.

$$2\ KClO_3 \longrightarrow 2\ KCl + 3\ O_2$$

a. Calculate the theoretical yield of oxygen.

$$5.45\ g\ KClO_3 \times \frac{1\ mol\ KClO_3}{122.6\ g\ KClO_3} \times \frac{3\ mol\ O_2}{2\ mol\ KClO_3} \times \frac{32.0\ g\ O_2}{1\ mol\ O_2} = \boxed{2.13\ g\ O_2}$$

b. Calculate the % yield of oxygen.

$$\%\text{-yield} = \frac{1.95\ g}{2.13\ g} \times 100\% = \boxed{92\%\ \text{yield of}\ O_2}$$

10. If 15.50 g of lead (II) nitrate, $Pb(NO_3)_2$, are reacted with 3.81 g of sodium chloride, NaCl, then sodium nitrate, $NaNO_3$, and lead (II) chloride, $PbCl_2$, are formed.

$$Pb(NO_3)_2 + 2NaCl \longrightarrow 2NaNO_3 + PbCl_2$$

a. Which reactant will be in excess?

$$15.50\ g\ Pb(NO_3)_2 \times \frac{1\ mol\ Pb(NO_3)_2}{331.2\ g\ Pb(NO_3)_2} \times \frac{2\ mol\ NaNO_3}{1\ mol\ Pb(NO_3)_2} = \boxed{0.0936\ mol\ NaNO_3}$$

(Excess Reagent)

$$3.81\ g\ NaCl \times \frac{1\ mol\ NaCl}{58.5\ g\ NaCl} \times \frac{2\ mol\ NaNO_3}{2\ mol\ NaCl} = \boxed{0.0651\ mol\ NaNO_3}$$

(Limiting Reagent)

b. Calculate the mass of the excess reactant.

$$0.0651\ mol\ NaNO_3 \times \frac{1\ mol\ Pb(NO_3)_2}{2\ mol\ NaNO_3} \times \frac{331.2\ g\ Pb(NO_3)_2}{1\ mol\ Pb(NO_3)_2} = 10.79\ g\ Pb(NO_3)_2$$

$$\text{Excess Reactant} = 15.50\ g - 10.79\ g = \boxed{4.71\ g\ Pb(NO_3)_2\ \text{excess}}$$

c. Calculate the mass of lead (II) chloride produced.

$$0.0651\ mol\ NaNO_3 \times \frac{1\ mol\ PbCl_2}{2\ mol\ NaNO_3} \times \frac{278.2\ g\ PbCl_2}{1\ mol\ PbCl_2} = \boxed{9.06\ g\ PbCl_2}$$