Name: KEY Date: _____

1. Calculate the molar mass in grams of each of the following:

a. Na

22.99 g/mol

b. Br_2

159.8 g/mol

c. $CaCl_2$

110.98 g/mol

d. C_2H_5OH

46.08 g/mol

2. Calculate the number of moles of atoms in:

a. 23 g of sodium 1 mol Na

$\frac{23\text{g}}{22.99\text{g}} \left| \frac{1\text{ mol}}{} \right.$

b. 64 g of sulfur 2 mol S

$\frac{64\text{g S}}{32.07\text{g}} \left| \frac{1\text{ mol S}}{} \right.$

c. 7 grams of iron 0.13 mol Fe

$\frac{7\text{g Fe}}{55.85\text{g Fe}} \left| \frac{1\text{ mol Fe}}{} \right.$

d. 20 g krypton .24 mol K

$\frac{20\text{g K}}{83.8\text{g K}} \left| \frac{1\text{ mol K}}{} \right.$

3. State the number of moles in:

a. 58.5 g sodium chloride 1 mol NaCl

$\frac{58.5\text{g NaCl}}{58.44\text{g}} \left| \frac{1\text{ mol NaCl}}{} \right.$

b. 50 g of $CaCO_3$ .50 mol $CaCO_3$

$\frac{50\text{g}}{100.09\text{g}} \left| \frac{1\text{ mol CaCO}_3}{} \right.$

c. 499 g of $CuSO_4$ 3.13 mol

$\frac{499\text{g CuSO}_4}{159.62\text{g}} \left| \frac{1\text{ mol CuSO}_4}{} \right.$

d. 303g of Potassium Nitrate 3 mol KNO_3

$\frac{303\text{g KNO}_3}{101.11\text{g}} \left| \frac{1\text{ mol}}{} \right.$

4. Given Avogadro's Number 6×10^{23}, calculate the number of atoms in:

a. 48 g of Magnesium

$$48\text{ g Mg} \left| \frac{1\text{ mol Mg}}{24.31\text{ g}} \right| \frac{6.02 \times 10^{23}}{1\text{ mol}}$$

1.19×10^{24} atoms Mg

b. 336 g of iron

$$336\text{ g Fe} \left| \frac{1\text{ mol}}{55.85\text{ g}} \right| \frac{6.02 \times 10^{23}}{1\text{ mol}}$$

3.62×10^{24} atoms Fe

5. Calculate the mass of the following samples:

a. 5 mol sodium chloride

$$5\text{ mol NaCl} \left| \frac{58.44\text{ g NaCl}}{1\text{ mol}} \right.$$

292.2 g NaCl

b. 50 mol of $CaCO_3$

$$50\text{ mol} \left| \frac{100.09\text{ g } CaCO_3}{1\text{ mol}} \right.$$

5004.5 g $CaCO_3$

c. 43 mol of $CuSO_4$

$$43\text{ mol} \left| \frac{159.62\text{ g}}{1\text{ mol } CuSO_4} \right.$$

6863.66 g $CuSO_4$

d. 3.03×10^{-3} mol of Potassium Nitrate

$$3.03 \times 10^{-3}\text{ mol} \left| \frac{101.11\text{ g}}{1\text{ mol}} \right.$$

.306 g KNO_3

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

1. How many moles of hydrogen are needed to react completely with two moles of nitrogen?

$$2\text{ mol } N_2 \left| \frac{3\text{ mol } H_2}{1\text{ mol } N_2} \right.$$

6 mol H_2

2. How many grams of hydrogen are necessary to react completely with 50g of nitrogen, and how much ammonia will be produced?

$$50\text{ g } N_2 \left| \frac{1\text{ mol}}{28.02\text{ g } N_2} \right.$$

$$1.78\text{ mol } N_2 \left| \frac{3\text{ mol } H_2}{1\text{ mol } N_2} \right.$$

$$5.34\text{ mol } H_2 \left| \frac{2.02\text{ g}}{1\text{ mol } H_2} \right.$$

$$1.78\text{ mol } N_2 \left| \frac{2\text{ mol } NH_3}{1\text{ mol } N_2} \right.$$

$$3.56\text{ mol } NH_3 \left| \frac{17.04\text{ g } NH_3}{1\text{ mol } NH_3} \right.$$

$$10.79\text{ g } H_2 \left| \frac{}{60.66\text{ g } NH_3} \right.$$

Limiting Reactants Practice

1. Forty grams of magnesium is reacted with an excess of oxygen. How much oxygen is used in the reaction? $2Mg + O_2 \rightarrow 2MgO$

$$\frac{40\text{ g Mg}}{1}\left|\frac{1\text{ mol Mg}}{24.31\text{ g Mg}}\right. \qquad \frac{1.65\text{ mol Mg}}{1}\left|\frac{1\text{ mol }O_2}{2\text{ mol Mg}}\right.$$

$$\frac{.825\text{ mol }O_2}{1}\left|\frac{32\text{ g }O_2}{1\text{ mol }O_2}\right.$$

26.4 g O_2

2. In a container, 100 grams of iron is combined with 100 grams of oxygen to form iron (II) oxide.
   a. How much iron (II) oxide is produced? $2Fe + O_2 \rightarrow 2FeO$

$$\frac{100\text{ g Fe}}{1}\left|\frac{1\text{ mol Fe}}{55.85\text{ g Fe}}\right. \qquad \frac{1.79\text{ mol Fe}}{1}\left|\frac{2\text{ mol FeO}}{2\text{ mol Fe}}\right.$$

1.79 mol FeO

$$\frac{100\text{ g }O_2}{1}\left|\frac{1\text{ mol }O_2}{32\text{ g }O_2}\right. \qquad \frac{3.13\text{ mol }O_2}{1}\left|\frac{2\text{ mol FeO}}{1\text{ mol }O_2}\right.$$

6.26 mol FeO

   b. Which element is the limiting reactant? Fe

   c. How much of the excess reactant does not react?

$$\frac{1.79\text{ mol Fe}}{1}\left|\frac{1\text{ mol }O_2}{2\text{ mol Fe}}\right. \qquad \frac{.895\text{ mol }O_2}{1}\left|\frac{32\text{ g }O_2}{1\text{ mol }O_2}\right. : 28.64\text{g used}$$

100 - 28.64

71.36 g O_2 unreacted

3. Seventy grams of silver are allowed to react with 50 grams of bromine to form silver bromide, a compound found in eyeglass lenses.
   a. How much silver bromide is produced? $2Ag + Br_2 \rightarrow 2AgBr$

$70\ g\ Ag \mid 1\ mol\ Ag \,/\, 107.87\ g\ Ag$ $\quad .649\ mol\ Ag \mid 2\ mol\ AgBr \,/\, 2\ mol\ Ag$ $\quad .649\ mol\ AgBr$

$50\ g\ Br_2 \mid 1\ mol\ Br_2 \,/\, 159.8\ g\ Br_2$ $\quad .313\ mol\ Br_2 \mid 2\ mol\ AgBr \,/\, 1\ mol\ Br_2$ $\quad$ **.626 mol AgBr**

$.313\ mol\ Br_2 \mid 2\ mol\ Ag \,/\, 1\ mol\ Br_2$ $\quad .626\ mol\ Ag\ used \mid 107.87\ g\ Ag \,/\, 1\ mol\ Ag$ $\quad 67.53\ g$ used

   b. Which element is the limiting reactant? Br_2

   c. How much of the excess reactant does not react?

$70 - 67.53\ g$ $\quad$ **2.47 g Ag not reacted**

4. In a container, 30 grams of potassium is combined with 25 grams of nitrogen and potassium nitride is formed.
   a. How much potassium nitride is formed? $6K + N_2 \rightarrow 2K_3N$

$30\ g\ K \mid 1\ mol\ K \,/\, 39.1\ g\ K$ $\quad .767\ mol\ K \mid 2\ mol\ K_3N \,/\, 6\ mol\ K$ $\quad$ **.511 mol K_3N**

$25\ g\ N_2 \mid 1\ mol\ N_2 \,/\, 28.02\ g$ $\quad .892\ mol\ N_2 \mid 2\ mol\ K_3N \,/\, 1\ mol\ N_2$ $\quad 1.784\ mol\ K_3N$

   b. What is the limiting reactant? K

   c. How much of the excess reactant remains?

$.767\ mol\ K \mid 1\ mol\ N_2 \,/\, 6\ mol\ K$ $\quad .128\ mol\ N_2 \mid 28.02\ g \,/\, 1\ mol\ N_2$ $\quad 3.59\ g\ N_2$ used

$25\ g - 3.59\ g =$ **21.41 g N_2 unreacted**

Predicting Products Practice

Complete the following word equations and then write a balanced molecular equation.
Identify the reaction type to the left of the arrow. If no reaction is to take place write NR after the yield arrow.

SR 1. Lead + mercury (II) sulfate →

$$Pb + 2HgSO_4 \longrightarrow Pb(SO_4)_2 + 2Hg$$

DR 2. Copper (II) sulfate + lead (II) nitrate →

$$CuSO_{4(aq)} + Pb(NO_3)_{2(aq)} \rightarrow PbSO_{4(s)} + Cu(NO_3)_{2(a}$$

DR 3. Lead (II) nitrate + potassium iodide →

$$Pb(NO_3)_{2(aq)} + 2KI_{(aq)} \rightarrow 2KNO_{3(aq)} + PbI_{2(s)}$$

SR 4. Sodium + magnesium phosphate →

$$6Na + Mg_3(PO_4)_2 \rightarrow 2Na_3PO_4 + 3Mg$$

SR 5. Zinc chlorate + magnesium →

$$Zn(ClO_3)_2 + Mg \longrightarrow Mg(ClO_3)_2 + Zn$$

DR 6. Barium chloride + sulfuric acid →

$$BaCl_{2(aq)} + H_2SO_{4(aq)} \rightarrow 2HCl_{(aq)} + BaSO_{4(s)}$$

DR 7. Barium chloride + nitric acid →

$$BaCl_{2(aq)} + HNO_{3(aq)} \longrightarrow NR$$

SR 8. Zinc + magnesium hypochlorite →

$$Zn + Mg(ClO)_2 \rightarrow NR$$

DR 9. Calcium chloride + silver nitrate →

$$CaCl_{2(aq)} + 2AgNO_{3(aq)} \rightarrow 2AgCl_{(s)} + Ca(NO_3)_{2(aq)}$$

SR 10. Gold (III) nitrate + silver →

$$Au(NO_3)_3 + 3Ag \rightarrow 3AgNO_3 + Au$$

Name _____ Date _____ Period _____

Stoichiometry Ws # 2: Stoichiometric Conversions

1. Copper I oxide solid is produced in a combination reaction with solid copper and oxygen gas
   a. Write a balanced chemical equation for this reaction.

$4Cu + O_2 \rightarrow 2Cu_2O$

   b. How many moles of copper are needed to produce 13 moles of copper I oxide?

$$13 \text{ mol } Cu_2O \left| \frac{4 \text{ mol } Cu}{2 \text{ mol } Cu_2O} \right.$$

26 mol Cu

   c. How many moles of copper I oxide would be produced if only .25 moles of oxygen were available?

$$.25 \text{ mol } O_2 \left| \frac{2 \text{ mol } Cu_2O}{1 \text{ mol } O_2} \right.$$

.5 mol Cu_2O

   d. You produced 11.7 grams of copper I oxide. How many grams of oxygen did you need?

$$11.7 \text{ g } Cu_2O \left| \frac{1 \text{ mol } Cu_2O}{143.1 \text{ g } Cu_2O} \right. \quad .082 \text{ mol} \left| \frac{1 \text{ mol } O_2}{2 \text{ mol } Cu_2O} \right. \quad .041 \text{ mol } O_2 \left| \frac{32 \text{ g}}{1 \text{ mol } O_2} \right.$$

1.31 g O

2. Iron III oxide will decompose in the presence of hydrogen gas and heat to produce free iron and water.
   a. Write a balanced equation for the reaction.

$Fe_2O_3 + 3H_2 \xrightarrow{\text{Heat}} 2Fe + 3H_2O$

   b. What mass of iron is produced when 450.0 grams of iron III oxide decomposes?

$$450 \text{ g } Fe_2O_3 \left| \frac{1 \text{ mol } Fe_2O_3}{159.7 \text{ g}} \right. \quad 2.82 \text{ mol } Fe_2O_3 \left| \frac{2 \text{ mol Fe}}{1 \text{ mol } Fe_2O_3} \right. \quad 5.64 \text{ mol Fe} \left| \frac{55.85 \text{ g}}{1 \text{ mol Fe}} \right.$$

314.99 g Fe

   c. How many moles of hydrogen gas are needed to produce 90.0 grams of iron?

$$90 \text{ g Fe} \left| \frac{1 \text{ mol Fe}}{55.85 \text{ g Fe}} \right. \quad 1.61 \text{ mol Fe} \left| \frac{3 \text{ mol } H_2}{2 \text{ mol Fe}} \right.$$

2.42 mol H_2

   d. How many grams of water will be produced when .01 moles of iron III oxide decomposes?

$$.01 \text{ mol } Fe_2O_3 \left| \frac{3 \text{ mol } H_2O}{1 \text{ mol } Fe_2O_3} \right. \quad .03 \text{ mol } H_2O \left| \frac{18.02 \text{ g } H_2O}{1 \text{ mol } H_2O} \right.$$

.541 g H_2O

3. Solid calcium combines with oxygen gas to form solid calcium oxide.
   a. Write a balanced equation for the reaction.

$2Ca + O_2 \rightarrow 2CaO$

   b. How many moles of calcium oxide would be produced if only .33 moles of oxygen were available?

$$.33 \text{ mol } O_2 \left| \frac{2 \text{ mol CaO}}{1 \text{ mol } O_2} \right.$$

.66 mol CaO

   c. If 4.5 grams of oxygen were used, how many grams of calcium are needed for the reaction to go to completion?

$$4.5 \text{ g } O_2 \left| \frac{1 \text{ mol } O_2}{32 \text{ g } O_2} \right. \quad .141 \text{ mol } O_2 \left| \frac{2 \text{ mol Ca}}{1 \text{ mol } O_2} \right. \quad .282 \text{ mol Ca} \left| \frac{40.08 \text{ g}}{1 \text{ mol Ca}} \right.$$

11.30 g Ca

4. The combustion of butane gas is used in many hand held lighters
   a. Write a balanced chemical equation for the reaction.

$$2\,C_4H_{10} + 13\,O_2 \longrightarrow 8\,CO_2 + 10\,H_2O$$

   b. How many moles of oxygen are required to burn 4.8 moles of butane completely?

$$4.8\text{ mol } C_4H_{10} \left| \frac{13\text{ mol } O_2}{2\text{ mol } C_4H_{10}} \right.$$

31.2 mol O_2

   c. How many grams of CO_2 are produced when 88g of O_2 react with an excess of butane?

$$88\text{ g } O_2 \left| \frac{1\text{ mol } O_2}{32\text{ g } O_2} \right. \quad 2.75\text{ mol } O_2 \left| \frac{8\text{ mol } CO_2}{13\text{ mol } O_2} \right. \quad 1.69\text{ mol } CO_2 \left| \frac{44.01\text{ g } CO_2}{1\text{ mol } CO_2} \right.$$

74.38 g CO_2

6 Sodium Chloride can be split into its elements by electrolosis.
   a. Write a balanced chemical equation for this reaction.

$$2\,NaCl \longrightarrow 2\,Na + Cl_2$$

   b. How many moles of chlorine gas are produced when 40.0g of salt is split by electrolosis?

$$40\text{ g NaCl} \left| \frac{1\text{ mol NaCl}}{58.44\text{ g NaCl}} \right. \quad .684\text{ mol NaCl} \left| \frac{1\text{ mol } Cl_2}{2\text{ mol NaCl}} \right.$$

.342 mol Cl_2

   c. How many moles of sodium is produced when 5 moles of NaCl is split?

$$5\text{ mol NaCl} \left| \frac{2\text{ mol Na}}{2\text{ mol NaCl}} \right.$$

5mol Na

7. The complete combustion of liquid ethanol, C_2H_5OH, is used in alcohol burners.
   a. Write a balanced chemical equation for this reaction.

$$C_2H_5OH + 3\,O_2 \longrightarrow 2\,CO_2 + 3\,H_2O$$

   b. How many grams of water are produced in the complete combustion of 100.0 grams of ethanol?

$$100\text{g } C_2H_5OH \left| \frac{1\text{ mol } C_2H_5OH}{46.08\text{ g } C_2H_5OH} \right. \quad 2.17\text{ mol } C_2H_5OH \left| \frac{3\text{mol } H_2O}{1\text{ mol } C_2H_5OH} \right. \quad 6.51\text{ mol } H_2O \left| \frac{18.02}{1\text{mol}} \right.$$

117.31 g H_2O

   c. In the complete combustion of ethanol, how many moles of oxygen are necessary to produce 18 moles of carbon dioxide?

$$18\text{ mol } CO_2 \left| \frac{3\text{ mol } O_2}{2\text{ mol } CO_2} \right.$$

27 mol O_2

   d. In the complete combustion of ethanol, how many grams of carbon dioxide are produced when 1.2 moles of water is produced?

$$1.2\text{ mol } H_2O \left| \frac{2\text{ mol } CO_2}{3\text{ mol } H_2O} \right. \quad 0.8\text{ mol } CO_2 \left| \frac{44.01\text{ g } CO_2}{1\text{ mol } CO_2} \right.$$

35.21 g CO_2

8. Aqueous solutions of barium nitrate and ammonium carbonate react in a double replacement reaction.
   a. Predict the products and write the balanced equation for the reaction.

$$Ba(NO_3)_2(aq) + (NH_4)_2CO_3(aq) \longrightarrow BaCO_3(s) + 2\,NH_4NO_3(aq)$$

   b. How many moles of ammonium nitrate will be produced form 110.0 grams of ammonium carbonate?

$$110\text{ g } (NH_4)_2CO_3 \left| \frac{1\text{mol } (NH_4)_2CO_3}{96.11\text{ g } (NH_4)_2CO_3} \right. \quad 1.14\text{ mol } (NH_4)_2CO_3 \left| \frac{2\text{ mol } NH_4NO_3}{1\text{ mol } (NH_4)_2CO_3} \right.$$

2.28 mol NH_4NO_3

   c. How many moles of barium carbonate would be produced from 6 moles of ammonium carbonate?

$$6\text{mol } (NH_4)_2CO_3 \left| \frac{1\text{ mol } BaCO_3}{1\text{ mol } (NH_4)_2CO_3} \right.$$

6 mol $BaCO_3$

   d. How many grams of barium nitrate are needed to react with 220.0 grams of ammonium carbonate?

$$220\text{ g } (NH_4)_2CO_3 \left| \frac{1\text{ mol } (NH_4)_2CO_3}{96.11\text{ g } (NH_4)_2CO_3} \right. \quad 2.29\text{ mol } (NH_4)_2CO_3 \left| \frac{1\text{ mol } BaCO_3}{1\text{ mol } (NH_4)_2CO_3} \right.$$

$$2.29\text{ mol } BaCO_3 \left| \frac{197.34\text{ g } BaCO_3}{} \right.$$

451.91 g $BaCO_3$