Name: Key

Honors Chemistry Worksheet: Calculations Involving a Limiting Reactant

- ✓ ***If an equation is not given write a balanced equation.***
- ✓ ***Identify the limiting reactant in each problem.***

1. For the reaction of $2Na_{(s)} + Cl_{2(g)} \rightarrow 2\ NaCl_{(s)}$, 12.0 grams of sodium reacts with 5.00 grams of chlorine. What mass of sodium chloride could be produced?

$$12.0\text{g Na} \left| \frac{1\text{mol Na}}{22.99\text{g Na}} \right| \frac{2\text{NaCl}}{2\text{Na}} \left| \frac{58.45\text{g NaCl}}{1\text{mol NaCl}} \right| = 30.5\text{ g NaCl}$$

~~$12.0\text{g Na} \left| \frac{1\text{mol Na}}{22.99\text{g Na}} \right| \frac{2\text{NaCl}}{2\text{Na}}$~~

$$5.00\text{g Cl}_2 \left| \frac{1\text{mol Cl}_2}{72\text{g Cl}_2} \right| \frac{2\text{NaCl}}{1\text{Cl}_2} \left| \frac{58.45\text{g NaCl}}{1\text{mol NaCl}} \right| = \boxed{8.11\text{ g NaCl}}$$

2. In the combustion of ethane, C_2H_6, all reactants and products are gases at STP. Determine the volume of CO_2 gas that is produced when 300.0 liters of ethane is reacted with 900.0 liters of oxygen. (*Can you see the direct solution to this problem? Remember what coefficients represent!*)

$2C_2H_6 + 7O_2 \longrightarrow 4CO_2 + 6H_2O$

$$300\text{L } C_2H_6 \left| \frac{1\text{mol } C_2H_6}{22.4\text{L}} \right| \frac{4\ CO_2}{2\ C_2H_6} \left| \frac{22.4\text{L}}{1\text{mol } CO_2} \right| = 600\text{ L } CO_2$$

$$900.0\text{L } O_2 \left| \frac{1\text{mol } O_2}{22.4\text{L } O_2} \right| \frac{4CO_2}{7O_2} \left| \frac{22.4\text{L}}{1\text{mol } O_2} \right| = \boxed{514.3\text{L } CO_2}$$

* Because volume to volume so ÷22.4 then ×22.4 can just do mole ratio

3. What mass of sodium sulfate is produced when 12.37 grams of sodium hydroxide is reacted with a 200.0 ml of a solution that is 5.0% sulfuric acid by mass? $2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$

$$12.37\text{g NaOH} \left| \frac{1\text{mol NaOH}}{40\text{g NaOH}} \right| \frac{1\ Na_2SO_4}{2\text{NaOH}} \left| \frac{142.04\text{g } Na_2SO_4}{1\text{mol } Na_2SO_4} \right| = 21.96\text{g } Na_2SO_4$$

$.05 \times 200 = 10$

$$10\text{g } H_2SO_4 \left| \frac{1\text{mol } H_2SO_4}{98\ H_2SO_4} \right| \frac{1\ Na_2SO_4}{1\ H_2SO_4} \left| \frac{142.04\text{g } Na_2SO_4}{1\text{mol } Na_2SO_4} \right| = \boxed{14.49\text{g } Na_2SO_4}$$

4. Given: $2\ AgNO_{3(aq)} + NiCl_{2(aq)} \rightarrow 2AgCl_{(s)} + Ni(NO_3)_{2(aq)}$. Answer the following:

   a.) What mass of silver chloride is produced when 0.847 grams of silver nitrate is reacted with 0.650 grams of nickel(II) chloride?

$$.847\text{g } AgNO_3 \left| \frac{1\text{mol } AgNO_3}{169.87\text{g } AgNO_3} \right| \frac{2\ AgCl}{2\ AgNO_3} \left| \frac{143.32\text{g } AgCl}{1\text{mol } AgCl} \right| = \boxed{.715\text{g } AgCl}$$

$$.650\text{g } NiCl_2 \left| \frac{1\text{mol } NiCl_2}{169.87\text{g } NiCl} \right| \frac{2\ AgCl}{1\ NiCl_2} \left| \frac{143.32\text{g } AgCl}{1\text{mol } AgCl} \right| = 1.10\text{g } AgCl$$

   b.) If 0.683 grams of silver chloride is actually produced what is the percent yield.

$$.683 / .715 = 95.5\%$$

   c.) What mass of excess reactant remains?

$$.847\text{g } AgNO_3 \left| \frac{1\text{mol } AgNO_3}{169.87\text{g } AgNO_3} \right| \frac{1\ NiCl_2}{2\ AgNO_3} \left| \frac{129.6\text{g } NiCl_2}{1\text{mol } NiCl} \right| = .323\text{g } NiCl_2 \text{ used}$$

$.650\text{g} - .323\text{g} = \boxed{.327\text{g } NiCl_2 \text{ excess}}$

5. Given: $CO_2(g) + NaCl_{(aq)} + NH_{3(aq)} + H_2O_{(l)} \rightarrow NaHCO_{3(aq)} + NH_4Cl_{(aq)}$. Determine the amount of grams of sodium bicarbonate that could be produced when 1.50 liter of carbon dioxide gas at STP is reacted with 6.11 grams NaCl, 2.70 grams of ammonia and 250.0 grams of water.

$6.11\text{g NaCl} \left| \frac{1\text{mol NaCl}}{58\text{g NaCl}} \right| \frac{1\text{NaHCO}_3}{1\text{NaCl}} \left| \frac{84.0\text{g NaHCO}_3}{1\text{mol NaHCO}_3} \right| = 8.85\text{g NaHCO}_3$

$2.70\text{g NH}_3 \left| \frac{1\text{mol NH}_3}{17\text{g NH}_3} \right| \frac{1\text{NaHCO}_3}{1\text{NH}_3} \left| \frac{84.0\text{g NaHCO}_3}{1\text{mol NaHCO}_3} \right| = 13.3$

$1.50\text{L CO}_2 \left| \frac{1\text{mol CO}_2}{22.4\text{L}} \right| \frac{1\text{NaHCO}_3}{1\text{CO}_2} \left| \frac{84.0\text{g NaHCO}_3}{1\text{mol NaHCO}_3} \right| = \boxed{5.63\text{g NaHCO}_3}$

$250.0\text{g H}_2\text{O} \left| \frac{1\text{mol H}_2\text{O}}{18\text{g H}_2\text{O}} \right| \frac{1\text{NaHCO}_3}{1\text{H}_2\text{O}} \left| \frac{84.0\text{g NaHCO}_3}{1\text{mol NaHCO}_3} \right| = 1166$

6. Given: $Zn_{(s)} + 2NaOH_{(aq)} + 2H_2O_{(l)} \rightarrow Na_2Zn(OH)_{4(aq)} + H_{2(g)}$. What volume of hydrogen gas at STP is produced when 3.17 grams of Zn is combined with 5.00 grams of NaOH with excess water.

$3.17\text{g Zn} \left| \frac{1\text{mol Zn}}{65.38\text{g Zn}} \right| \frac{1\text{H}_2}{1\text{Zn}} \left| \frac{22.4\text{L H}_2}{1\text{mol H}_2} \right| = 1.09\text{L H}_2$

$5.00\text{g NaOH} \left| \frac{1\text{mol NaOH}}{58\text{g NaOH}} \right| \frac{1\text{H}_2}{2\text{NaOH}} \left| \frac{22.4\text{L H}_2}{1\text{mol H}_2} \right| = \boxed{.966\text{L H}_2}$

7. Given: $2CuSO_{4(aq)} + 4KI_{(aq)} \rightarrow 2CuI_{(s)} + I_{2(s)} + 2K_2SO_{4(aq)}$. Answer the following:

a.) What mass of iodine is produced when 6.76 grams of copper(II) sulfate is reacted with 9.82 grams of potassium iodide?

$6.76\text{g CuSO}_4 \left| \frac{1\text{mol CuSO}_4}{159.61\text{g CuSO}_4} \right| \frac{1\text{I}_2}{2\text{CuSO}_4} \left| \frac{253.8\text{g I}_2}{1\text{mol I}_2} \right| = 5.37$

$9.82\text{g KI} \left| \frac{1\text{mol KI}}{166.0\text{g KI}} \right| \frac{1\text{I}_2}{4\text{KI}} \left| \frac{253.8\text{g I}_2}{1\text{mol I}_2} \right| = \boxed{3.75\text{g I}_2}$

b.) If 0.3.31 grams of iodine is actually produced what is the percent yield.

$3.31 / 3.75 \times 100 = \boxed{88.3\%}$

c.) What mass of excess reactant remains?

$9.82\text{g KI} \left| \frac{1\text{mol KI}}{166.0\text{g KI}} \right| \frac{2\text{CuSO}_4}{4\text{KI}} \left| \frac{159.6\text{g CuSO}_4}{1\text{mol CuSO}_4} \right| = 4.72$

$6.72\text{g} - 4.72 = \boxed{2\text{g CuSO}_4 \text{ excess}}$

8. What mass of lead(II) iodide is formed from the reaction of 0.357 grams of lead(II) acetate and 0.104 grams of potassium iodide? $Pb(C_2H_3O_2)_2 + 2KI \rightarrow PbI_2 + 2KC_2H_3O_2$

$.357\text{g Pb}(C_2H_3O_2)_2 \left| \frac{1\text{mol Pb}(C_2H_3O_2)_2}{325.3\text{g Pb}(C_2H_3O_2)_2} \right| \frac{1\text{PbI}_2}{1\text{Pb}(C_2H_3O_2)_2} \left| \frac{461\text{g PbI}_2}{1\text{mol PbI}_2} \right| = .506\text{g PbI}_2$

$.104\text{g KI} \left| \frac{1\text{mol KI}}{166.\text{g KI}} \right| \frac{1\text{PbI}_2}{2\text{KI}} \left| \frac{461\text{g PbI}_2}{1\text{PbI}_2} \right| = \boxed{.144\text{g PbI}_2}$

9. A 15.32 gram sample of brass (an alloy of copper and zinc) that is 77.0% Cu by mass is reacted with 720. ml of a solution of sulfuric acid that is 14.0% H_2SO_4 by mass. What mass of $CuSO_4$ would be produced?

Reaction is: $Cu_{(s)} + 2H_2SO_{4(aq)} \rightarrow CuSO_{4(aq)} + SO_{2(g)} + 2H_2O_{(l)}$

$.77 \times 15.32 = 11.80\text{g Cu} \left| \frac{1\text{mol Cu}}{63.55\text{g Cu}} \right| \frac{1\text{CuSO}_4}{1\text{Cu}} \left| \frac{159.61\text{g CuSO}_4}{1\text{mol CuSO}_4} \right| = 29.64$

$.14 \times 720\text{mL} = 100.8\text{g H}_2\text{SO}_4 \left| \frac{1\text{mol H}_2\text{SO}_4}{98\text{g H}_2\text{SO}_4} \right| \frac{1\text{CuSO}_4}{2\text{H}_2\text{SO}_4} \left| \frac{159.61\text{g CuSO}_4}{1\text{mol CuSO}_4} \right| = \boxed{82.09\text{g CuSO}_4}$