Chapter 8.3 and 8.4 Class Notes on Theoretical Yield, Percent Yield, Limiting reagent and excess reagent

ONLY REVIEW QUESTIONS 1 and 2 FOR EXAM 3

Theoretical Yield: The amount of product you would obtain if the reaction went to completion
Actual Yield: The amount of product actually obtained
Percent Yield = (actual yield/ theoretical yield) * 100
Limiting Reagent: The reagent that limits the production of the desired product

1) Using the following equation: $2\ NaOH + H_2SO_4 \rightarrow 2\ H_2O + Na_2SO_4$

A. What is the percent yield if 325 grams of sodium sulfate is formed if you start with 200.0 grams of sodium hydroxide and you have an excess of sulfuric acid?

Old School style: Your limiting reagent is NaOH because sulfuric acid is in excess

$$\frac{200\ g\ NaOH}{} \times \frac{1\ mole\ NaOH}{40\ g\ NaOH} \times \frac{1\ mole\ Na_2SO_4}{2\ mole\ NaOH} \times \frac{142\ g\ Na_2SO_4}{1\ mole\ Na_2SO_4} = 355\ g\ NaOH\ (theoretical\ yield)$$

$$\%\ yield = \frac{325\ g}{355} \times 100 = 91.5\%$$

B. How many grams of sodium hydroxide would you need to start with if you have the percent yield from part A and you wanted to obtain the theoretical yield found in part A

$\frac{91.5}{100} = \frac{355}{X}$ X= 388 g and now work backwards from the product to the reactant

$$\frac{388\ g\ Na_2SO_4}{} \times \frac{1\ mole\ Na_2SO_4}{142\ g\ Na_2SO_4} \times \frac{2\ mole\ NaOH}{1\ mole\ Na_2SO_4} \times \frac{40\ g\ NaOH}{1\ mole\ NaOH} = 218.6\ g\ NaOH$$

2) Using the following equation: $\mathbf{CuCl_2 + 2\ NaNO_3 \rightarrow Cu(NO_3)_2 + 2\ NaCl}$

WORK THE TABLE FIRST AND THEN ANSWER THE QUESTIONS

A. If 15 grams of copper (II) chloride react with 20 grams of sodium nitrate, how much sodium chloride can be formed? **12.87 g NaCl**

B. What is the limiting reagent for the reaction? _____**$CuCl_2$**_____

C. How much of the non-limiting reagent is left over in this reaction? **1.7 g $NaNO_3$**

D. If 11.3 grams of sodium chloride are formed, what is the percent yield of this reaction?

$$\%\ yield = \frac{11.3}{12.87} \times 100 = 87.8\%$$

	$CuCl_2$	+ 2 $NaNO_3$	→	$Cu(NO_3)_2$	+ 2 NaCl
MM	134.5 g/mol	85 g/mol		187.5g/ mol	58.5 g/mol
Amount	15 g	20 g			
Moles Gram/ MM	0.11	0.24			
Moles/rxn (divide moles by SC)	0.11	0.12			
React (Least Mol/ Rxn)	- 0.11	-0.11		+ 0.11	+0.11
Final Mole/ Rxn	0	0.01		0.11	0.11
Final Moles (SC x final mol/ rxn)	0	0.02		0.11	0.22
Final Amt (final moles x MM)	0	1.7 g		20.63 g	12.87 g

3) Using the following equation: **$2\ FePO_4 + 3\ Na_2SO_4 \rightarrow Fe_2(SO_4)_3 + 2\ Na_3PO_4$**

WORK THE TABLE FIRST AND THEN ANSWER THE QUESTIONS

A. If 25 grams of iron (III) phosphate reacts with 250 mL of 5.00 M sodium sulfate, how many grams of iron (III) sulfate could be made?

33.18g

B. If a 65.0% yield is obtained, how many grams of sodium phosphate were made?

$$\frac{65}{100} = \frac{X}{27.22} \qquad X = 17.69\ g$$

C. What is the concentration of all reagents and products in solution?

0 M $FePO_4$; 4 M Na_2SO_4; 0.332 M $Fe_2(SO_4)_3$ and 0.664 M Na_3PO_4

	$2\ FePO_4$	**$+ 3\ Na_2SO_4$**	**→**	**$Fe_2(SO_4)_3$**	**$+ 2\ Na_3PO_4$**
Molarity or MM	**150.85 g/mol**	**5.0 M**		**399.7 g/mol**	**164 g/ mol**
Amount	**25 g**	**250 mL**			
Moles Gram/ MM or Molarity x L	**0.166 mol**	**1.25 mol**			
Moles/rxn (divide moles by SC)	**0.083**	**0.417**			
React (Least Mol/ Rxn)	**- 0.083**	**-0.083**		**+0.083**	**+0.083**
Final Mole/ Rxn	**0**	**0.334**		**0.083**	**0.083**
Final Moles (SC x final mol/ rxn)	**0**	**1**		**0.083**	**0.166**
Final Amt (final moles x MM) or Concentration (final mols/ total volume)	**0g** **0 M**	**142 g** **4 M**		**33.18g** **0.332 M**	**27.22g** **0.664 M**

4) Using the equation: **$Ca(OH)_{2(s)} + 2\ HCl_{(aq)} \rightarrow CaCl_{2(aq)} + 2\ H_2O_{(l)}$**

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

$$5\ g\ Ca(OH)_2 \times \frac{1\ mole\ Ca(OH)_2}{74.1\ g\ Ca(OH)_2} \times \frac{2\ mole\ HCl}{1\ mole\ Ca(OH)_2} \times \frac{1\ L\ HCl}{0.1\ mole\ HCl} = 1.35\ L\ HCl$$

B. If 15.0 grams of calcium hydroxide is combined with 75.0 mL of 0.500 M HCl, how many grams of calcium chloride would be formed?

2.11 grams $CaCl_2$

C. How many grams of the excess reagent will be left over after the reaction is complete?

13.4 g $Ca(OH)_2$

	$Ca(OH)_{2(s)}$	+ 2 $HCl_{(aq)}$	→	$CaCl_{2(aq)}$	+ 2 $H_2O_{(l)}$
Molarity or MM	**74.1 g/mol**	**0.5 M**		**111.1 g/mol**	**18 g/ mol**
Amount	**15 g**	**0.075 L**			
Moles Gram/ MM or Molarity x L	**0.20 mol**	**0.0375 mol**			
Moles/rxn (divide moles by SC)	**0.2**	**0.019**			
React (Least Mol/ Rxn)	**- 0.019**	**-0.019**		**+0.019**	**+0.019**
Final Mole/ Rxn	**0.181**	**0**		**0.019**	**0.019**
Final Moles (SC x final mol/ rxn)	**0.181**	**0**		**0.019**	**0.038**
Final Amt (final moles x MM) or Concentration (final mols/ total volume)	**13.4 g** **2.41 M**	**0 g** **0 M**		**2.11 g** **0.25 M**	**0.684 g** **0 M or 0.5 M**