Early Booklet E.C.: + 2
Unit 10.B Hwk. Pts.: / 21
Unit 10.B Lab Pts.: / 14
Late, Incomplete, No Work, No Units **Fees**? Y / N

Unit 10 – Stoichiometry

Chapter 11 of your textbook

Learning Targets for Unit 10

1.1 I can describe the types of relationships indicated by a balanced chemical equation.
1.2 I can state the mole ratios from a balanced chemical equation.
1.3 I can list the sequence of steps and solve stoichiometric problems.
1.4 I can identify the limiting reactant and excess reactant in a chemical equation.
1.5 I can calculate the mass of a product when the amounts of more than one reactant are given.
1.6 I can calculate the theoretical yield of a chemical reaction from data.
1.7 I can determine the percent yield for a chemical reaction.

Unit Vocabulary for Unit 10

Stoichiometry			
Mole ratio	Limiting reactant	Excess reactant	Theoretical yield
Actual yield	Percent yield		

Possible 10.1 Pts.: 6
Late, Incomplete, No work, No Units Fee: - 1 - 2 - 3
Final Score: / 6

10.1 Problems – Defining Stoichiometry

Section 11.1 of your textbook.

1. What relationships can be determined from a balanced chemical equation?

Consider the following equation: $4Al_{(s)} + 3O_{2(g)} \rightarrow 2Al_2O_{3(s)}$ Interpret it in terms of:

2. Particles

3. Moles

4. Mass.

Solid silicon dioxide (SiO_2), often called silica, reacts with hydrofluoric acid (HF) solution to produce the gas silicon tetrafluoride (SiF_4) and water.

5. Write the balanced chemical equation for the reaction.

6. List three mole ratios from the previous equation, and explain how you would use one of your ratios in a stoichiometric calculation.

Possible 10.2 Pts.: 4
Late, Incomplete, No work, No Units Fee: - 1 - 2 - 3
Final Score: / 4

10.2 Problems – Stoichiometric Calculations

Section 11.2 of your textbook.

1. What is the first step in all stoichiometric calculations?

2. Ethanol (C_2H_5OH), also known as grain alcohol, can be made from the fermentation of sugar ($C_6H_{12}O_6$). The unbalanced chemical equation is shown below. Balance the chemical reaction and determine the mass of C_2H_5OH produced from 750 g of $C_6H_{12}O_6$.

$$\_\_\_\_\ C_6H_{12}O_6 \rightarrow \_\_\_\_\ C_2H_5OH + \_\_\_\_\ CO_2$$

Rocket Fuel. The exothermic reaction between liquid hydrazine (N_2H_2) and liquid hydrogen peroxide (H_2O_2) is used to fuel rockets. The products are nitrogen gas and water.

3. Write the balanced chemical equation.

4. How many grams of hydrazine are needed to produce 10.0 moles of nitrogen gas?

Possible 10.3 Pts.: 6
Late, Incomplete, No work, No Units Fee: - 1 - 2 - 3
Final Score: / 6

10.3 Problems – Limiting Reactants
Section 11.3 of your textbook.

1. How is a mole ratio used to find the limiting reactant?

2. Iron Production. Iron is obtained commercially by the reaction of hematite (Fe_2O_3) with carbon monoxide. How many grams of iron is produced when 25.0 mol of hematite reacts with 30.0 mol of carbon monoxide? Hint: find limiting reactant first.

$$Fe_2O_{3(s)} + 3CO_{(g)} \rightarrow 2\ Fe_{(s)} + 3CO_{2(g)}$$

3. Lithium reacts spontaneously with bromine to produce lithium bromide. Balance the chemical reaction.

_____ Li + _____ Br_2 → _____ LiBr

If 25.0 grams of lithium and 25.0 grams of bromine are present at the beginning of the reaction, determine:

4. The limiting reactant.

5. The mass of lithium bromide produced.

6. The mass of excess reactant..

Possible 10.4 Pts.: 5
Late, Incomplete, No work, No Units Fee: - 1 - 2 - 3
Final Score: / 5

10.4 Problems – Percent Yield
Section 11.4 of your textbook.

1. What is the difference between actual yield and theoretical yield?

2. (2 Points) Van Arkel Process. Pure zirconium is obtained using the two-step Van Arkle process. In the first step, impure zirconium and iodine are heated to produce zirconium iodide (ZrI_4). In the second step, ZrI_4 is decomposed to produce pure zirconium.

   $$ZrI_{4(s)} \rightarrow Zr_{(s)} + 2I_{2(g)}$$

   Determine the percent yield of zirconium if 45.0 g of ZrI_4 is decomposed and 5.00 g of pure Zr is obtained.

3. (2 Points) Chlorine forms from the reaction of hydrochloric acid with manganese (IV) oxide. The balanced equation is:

   $$4HCl + MnO_2 \rightarrow MnCl_2 + Cl_2 + 2H_2O$$

   After finding the limiting reactant, calculate the theoretical yield and the percent yield of chlorine if 50.0 g of HCl and 86.0 g of MnO_2 react. The actual yield of Cl_2 is 20.0 g.

Chemistry	10.1 Lab: Limiting Reactants				
Name:					Correction Credit: Half
Lab Points:	Missed:	Late, No Units, No Work Fee:	First Score:	Corrections:	Final Score:
14		-1 -2 -3			

Objective:

Experimentally determine how much product is obtained from an amount of limiting reactant, and calculate the theoretical maximum product.

Overview:

In chemical reactions, limiting reactants are consumed first. What remains is the excess reactant and products of the reaction.

In this lab you will predict the amount of copper metal you can make in a reaction of zinc and copper sulfate.

The balanced reaction between zinc and copper (II) sulfate is:

$$Zn_{(s)} + CuSO_{4(aq)} \rightarrow ZnSO_{4(aq)} + Cu_{(s)}$$

Safety:

1. Wear goggles throughout the lab – even when you are finished but others are still working.
2. Tie loose clothing and hair back.
3. Copper (II) sulfate is mildly toxic and corrosive to skin, avoid contact with it.

Materials:

Ring Stand	Spatula	250 mL Beaker
Bunsen Burner	Funnel	Deionized Water
Triple Beam Balance	Filter Paper	Zinc Metal - Zn
Tweezers	Stirring Rod	

Copper (II) Sulfate Pentahydrate

$CuSO_4 \cdot 5\ H_2O$ Molar Mass = 249.69 g/mol

Clean up and Disposal:

1. Pour all waste solutions down the drain.
2. Dispose of filter and copper remnants in the trash.
3. Place used zinc pellets in the receptacle at the front of the room.

Procedure: **Day 1**.

1. Obtain ~ 3 grams of zinc and record the exact mass in the data table.
2. Measure ~ 5 grams of copper (II) sulfate pentahydrate and record the exact mass.
3. In your 250 mL beaker, dissolve the copper (II) sulfate in 75.0 mL deionized water. Add the zinc metal, and record your observations in question 4 as time goes by.
4. Heat the copper and water mixture gently while stirring with the glass rod until the blue color fades to clear (about 10 – 15 minutes).
5. Use the metal spatula and the stirring rod to break the copper flakes off the zinc.
6. Decant as much of the clear solution down the drain as you can, being careful not to drop any copper into the sink!
7. Use the tweezers to remove the remaining zinc pieces from the solution – you can rinse the pieces with water to get all the remaining copper bits off. Put the zinc in the zinc disposal beaker at the front of the room.
8. Decant the water carefully out of your beaker down the drain, then rinse and decant with deionized water three more times to remove dissolved solids.
9. Get a piece of filter paper and **label** it with your group name and period. Measure its exact weight, and record it.
10. Build a funnel assembly, and filter your copper metal. Use the squirt bottles to rinse any residual copper out of the bottom of your beaker and into the funnel. When all the free water has gone through the funnel, pick up your filter with copper and place it in the container at the front of the room for drying.
11. Tidy up your lab area and work on homework or calculations for the rest of class.

Procedure: **Day 2.**

1. Get your filter from the container and record its exact mass.
2. Subtract the empty filter mass from the filter + copper mass and record the copper mass in your data table.
3. You are ready to do the calculations for the lab, so make sure your area is tidy before you leave, and get to work.

Data Table: (5 Points)

Measure masses to the hundredths place.

Limiting Reactant Lab Data Table			
Measured Item:	Mass	Molar Mass	Moles
Zinc			
Copper (II) Sulfate Pentahydrate			
Dry Filter Paper		X	X
Filter Paper and Copper		X	X
Copper			

Calculations and Questions: Answer the following in complete sentences, and show all work for calculations.

1. (2 Points) What was the limiting reactant in this lab, zinc or copper sulfate? What evidence do you cite to support your answer?

2. (3 Points) Use stoichiometry to calculate the mass of copper possible from the exact mass of copper sulfate pentahydrate that you used. Show all your work, and box your answer.

3. (2 Points) What was the percent yield in your experiment? The equation is as follows:

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

   Theoretical Yield = the value from question 2
   Actual Yield = the weighed mass of copper.

4. (2 Points) Describe what happened when you added the zinc metal to the solution of copper sulfate.

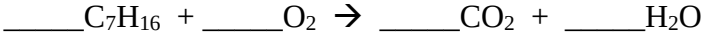
Chemistry	Essential Skill 10.1 - Stoichiometry
Name:	**Period:**
This is practice to prepare you in the short term for a quiz, and for the long term by reinforcing an essential skill needed in chemistry.	

We will go over this in class tomorrow.

1. When solid copper is added to nitric acid, copper (II) nitrate, nitrogen dioxide, and water are produced. List four mole ratios for the reaction.

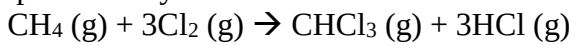
$$Cu_{(s)} + 4\ HNO_3 \rightarrow Cu(NO_3)_2 + 2\ NO_2 + 2\ H_2O$$

2. Carbon dioxide is released into the atmosphere through the combustion of heptane (C_7H_{16}) in gasoline. Balance the reaction (1 point) and calculate the mass of heptane needed to release 5.00 moles of CO_2 (2 points).



$$\_\_\_\_\_C_7H_{16} + \_\_\_\_\_O_2 \rightarrow \_\_\_\_\_CO_2 + \_\_\_\_\_H_2O$$

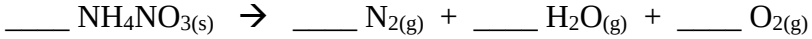
3. Chloroform ($CHCl_3$) is produced by a reaction between methane and chlorine.



$$CH_4\ (g) + 3Cl_2\ (g) \rightarrow CHCl_3\ (g) + 3HCl\ (g)$$

How many grams of CH_4 are needed to produce 50.0 g $CHCl_3$?

4. The decomposition of ammonium nitrate during heating releases nitrogen gas, water vapor, and oxygen gas. Balance this reaction (1 point), and determine how many moles of ammonium nitrate you would need to decompose to produce 158 moles of oxygen gas (2 points).



$$\_\_\_\_\ NH_4NO_{3(s)} \rightarrow \_\_\_\_\ N_{2(g)} + \_\_\_\_\ H_2O_{(g)} + \_\_\_\_\ O_{2(g)}$$

Chemistry	Essential Skill 10.2 - Limiting Reactants
Name:	**Period:**
This is practice to prepare you in the short term for a quiz, and for the long term by reinforcing an essential skill needed in chemistry.	

We will go over this in class tomorrow. Show work for understanding.

One proposed equation for the reaction of sugar with potassium nitrate is:

$$C_6H_{12}O_6 + 4\,KNO_3 \rightarrow 4\,CO_2 + 2\,CO + 6\,H_2O + 2\,K_2O + 2\,N_2$$

1. If you mixed 3.5 moles of sugar and 13.0 moles of potassium nitrate and ignited them, which would be the limiting reactant?

2. If you mixed 1.8 moles of sugar with 7.0 moles of potassium nitrate, which is limiting?

3. If you mixed 13.8 grams of sugar with 25 grams of potassium nitrate, which is limiting and which is in excess?

Points Possible:	**10**
Late/Inc. Fee: -1	**-2 - 3**
Final Score:	**/ 10**

Unit 10 Review – The Moles & Stoichiometry

This serves as test preparation for the Unit 7 Test. Points earned are based on completion, and we will go over any questions you have during the review.

1. **All Play**: What mole ratio would you use to go from copper to silver in the following **skeleton** reaction? Write out any units you use: $Cu + AgNO_3 = Ag + Cu(NO_3)_2$.

2. **All Play:** What is the mass percent of sodium in sodium oxide?

3. If you have 28.0 grams of boron, how many moles is that?

4. **All Play**: How many grams of HCl would be needed to react with 15 grams of zinc, according to the reaction: $2\ HCl + Zn = ZnCl_2 + H_2$?

5. What is the molar mass of calcium chloride?

6. How much mass does two moles of sodium chloride have?

7. **All Play:** What is the molar mass of lead (IV) nitrate?

8. **All Play:** At the start of a reaction there is 8.5 mol X to 11.8 mol Y. Ideally, one would have a ratio of 3 mol X to 4 mol Y. Which is the limiting reactant, X or Y?

9. **All Play:** If a reaction has a % yield of 55%, how many grams of product would you get from 512 g of reactant?

10. **All Play** If 0.0023 moles of copper (II) sulfate are connected to 0.0113 moles of water, what is the formula of the hydrate?