EXPERIMENT 7:
THE LIMITING REACTANT

PURPOSE

To find the ratio of moles of a reactant to moles of a product of a chemical reaction.

To relate this ratio to the coefficients of these substances in the balanced equation for the reaction.

BACKGROUND

Chemical reactions are represented by balanced chemical equations. Proper interpretation of an equation provides a great deal of information about the reaction it represents and about the substances involved in the reaction. For example, the coefficients in a balanced equation indicate the number of moles of each substance. Thus, the ratio of moles of a substance to moles of any other substance in the reaction can be determined at a glance.

In this experiment, iron metal will be added to an aqueous solution of copper(II) sulfate. A single replacement reaction will take place, the products being iron(II) sulfate and copper metal. The balanced equation for the reaction is

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

The limiting reactant is the reactant that gets used up completely in a reaction. It determines the maximum amount of product that can be produced. As the equation shows, the number of moles of copper produced should be equal to the number of moles of the limiting reactant used, since all the mole ratios are 1 to 1.

MATERIALS

Ring stand	Filter paper	Distilled water	Stirring rod
Pipestem triangle	Balance	Copper(II) sulfate	100 mL beakers
Wire screen	Weigh cups	Iron filings	250 mL beakers
Bunsen burner			

PROCEDURE

1. Record the balance number you are using. Measure and record the mass of a 100-mL beaker.

2. Measure about 8.0 grams of copper sulfate crystals and place them in the 100-mL beaker. Record the actual mass of the crystals.

3. Measure 50.0 mL of water in a graduated cylinder and add it to the crystals in the beaker.

While one partner continues with steps 4 and 5, the other partner should carry out the instructions in step 6. There should be no more than 1 minute between step 6 and step 7.

4. Set up the ring stand with the ring and wire mesh. Heat the mixture in the beaker to just ***below*** boiling. DO NOT ALLOW THE LIQUID TO BOIL.

5. Continue heating and stir the mixture until the crystals are completely dissolved. Turn off the gas and remove the burner.

6. Obtain 1.2 to 1.5 grams of iron filings. Use a measuring cup to weigh the iron. Record the mass.

7. Add the iron filings, *small amounts at a time*, to the hot copper sulfate solution. Stir continuously. After all of the iron has been added and the mixture stirred, allow the beaker to sit for 10 minutes while the reaction proceeds. Record your observations.

8. Record the mass of a filter paper with you initials written on it. Set up a filtration apparatus by placing your piece of filter paper into a funnel and placing the funnel on top of an Erlenmeyer flask. Decant the liquid into the filter paper slowly. Try not to allow any solid to get on the filter paper.

9. With de-ionized water, rinse your solid in the beaker. Let the solid settle and decant the liquid. Repeat the washing twice more. The last time, guide all of the solid into the filter paper.

10. ~~Place the filter paper in the 100 mL beaker. Place the beaker in a **warm** oven to dry. (Don't burn your product!)~~

11. After it is cool, record the ~~mass of the beaker~~, filter paper and solid. The period may not be long enough ~~for the beaker to cool. You may have to come back during the next day.~~ for the filtration process. You will need to set it up and let it drip. I will lay them out so they are dry tomorrow. You can measure your filter paper and solid then.

Name _____ Date _____

PRE-LAB QUESTIONS

1. Define the terms "limiting reactant" and "single replacement reaction."

2. Why is it important to record the number of the balance that you use in the laboratory and only use that balance?

3. How could using dirty or wet glassware sabotage your results?

4. Are your results ruined if you accidentally use 8.7 grams of copper(II) sulfate instead of 8.0 grams? Why or why not?

Name _____ Date _____

LIMITING REACTANT

1. ~~Mass of empty 100 mL beaker~~ _____
2. Mass of copper(II) sulfate _____
3. Mass of iron filings _____
4. Substance collected _____
5. Mass of collected substance ~~and 100 mL beaker~~ _____

CALCULATIONS AND POST-LAB QUESTIONS

(Show all work, answer questions in complete sentences for full credit).

1. Moles of copper(II) sulfate in solution based on your measurement

2. Moles of iron added to the solution based on your measurement

3. Moles of substance produced (Theoretical yield)

4. Moles of iron metal that reacted (Find your limiting reactant)

5. Moles of copper(II) sulfate that reacted (Find your limiting reactant)

6. Which reactant was the limiting reactant? Why?

7. Which reactant was in excess? Why? How many moles of excess reactant were left over?

8. What is your percent yield?

ERROR ANALYSIS

1. List the possible causes for errors in this experiment and their effect on your results.

2. Explain any discrepancies in the number of moles of iron initially added and the calculated number of moles of iron that reacted.