DATE: NAME: CLASS:

CHAPTER 8 HANDOUT	Investigation 8.B: Determining the Percentage Yield of a Chemical Reaction	BLM 8.2.2

The percentage yield of a reaction is determined by numerous factors: the nature of the reaction itself, the conditions under which the reaction was carried out, the purity of the reactants, and the skill of the experimenter.

In this investigation, you will determine the percentage yield of the following chemical reaction:

$$Fe(s) + CuCl_2(aq) \rightarrow FeCl_2(aq) + Cu(s)$$

You will use steel wool as your source of iron.

Question

What is the percentage yield of the reaction of iron and copper(II) chloride when steel wool and copper(II) chloride dihydrate are used as reactants?

Predictions

While waiting for the filtration in Procedure Step 7, calculate the predicted yield. Assume the steel wool is 100% iron. Assume the iron reacts completely with a solution containing excess $CuCl_2(aq)$. Then predict the percentage yield and actual yield, giving reasons for your predictions.

Safety Precautions

Hydrochloric acid is corrosive. If either $CuCl_2(aq)$ or $HCl(aq)$ spill on your skin, wash immediately with plenty of cold water and inform your teacher. When you have completed the Investigation, wash your hands.

Materials

- distilled water
- 5.00 g copper chloride dihydrate, $CuCl_2 \cdot 2H_2O(s)$
- 20 mL 1 mol/L hydrochloric acid, $HCl(aq)$
- 250 mL beaker
- stirring rod
- electronic balance
- 1.00 g to 1.20 g rust-free, clean steel wool
- Erlenmeyer flask
- plastic funnel
- retort stand
- wash bottle
- ring clamp
- filter paper
- watch glass
- drying oven (if available)

Investigation 8.B: Determining the Percentage Yield of a Chemical Reaction (continued)

Procedure

1. Place about 50 mL of distilled water in a 250 mL beaker. Add 5.00 g of $CuCl_2 \cdot 2H_2O(s)$ to the water. Stir to dissolve.

2. Determine the mass of your sample of steel wool. Record the mass in the table on the following page.

Observations

Mass of filter paper	
Mass of steel wool	
Mass of filter paper and solid product	

3. Add the steel wool to the solution in the beaker. Allow the mixture to sit until the reaction is complete. The reaction could take up to 20 minutes.

4. While the reaction is proceeding, set up your filtration apparatus as you did for Investigation 7.B.

Be sure to determine the mass of your piece of filter paper before folding and wetting it. Record the mass of the filter paper in your table.

5. When you believe that the reaction is complete, carefully decant most of the liquid in the beaker through the filter paper. Pouring the liquid down a stirring rod helps avoid losing any solid.

6. Pour the remaining liquid and solid through the filter paper. While you are waiting for the filtration to be completed, calculate the predicted yield (see Predictions).

7. Rinse the beaker and stirring rod several times with small quantities of water. Pour the rinse water through the filter paper. Ensure there is no solid product remaining in the beaker or on the stirring rod.

8. Rinse the filter paper and solid with about 10 mL of 1 mol/L HCl(aq). Then rinse the solid with water to remove the acid.

9. After all the liquid has drained from the funnel, carefully remove your paper and place it on a labeled watch glass. Be careful not to lose any solid product.

10. Place the watch glass in a drying oven overnight. If no drying oven is available, allow the solid to dry in a safe place for several days. Dispose of the material in the flask as your teacher directs.

11. Determine the mass of the dried filter paper and product. Dispose of the filter paper and product as your teacher directs.

Analysis

1. Based on the amount of iron that you used, prove that the 5.00 g of $CuCl_2 \cdot 2H_2O(s)$ was the excess reactant.

Investigation 8.B: Determining the Percentage Yield of a Chemical Reaction (continued)

2. Suggest sources of error for this reaction.

3. How might you attain an improved percentage yield if you performed this reaction again? Consider materials and technique.

Conclusion

4. Calculate the percentage yield for this reaction. How does the percentage yield compare with the percentage yield you predicted?

Extension

5. Consider the precision and accuracy of your results.
(a) How precise was your determination of the maximum percentage yield of the reaction of iron with copper(II) chloride? Explain your answer.

Investigation 8.B: Determining the Percentage Yield of a Chemical Reaction (continued)

(b) Suggest how you could have improved the precision of your determination.

(c) How accurate was your determination of the maximum percentage yield of the reaction of iron with copper(II) chloride? Explain your answer and list factors that affected the accuracy of your determination.

(d) Suggest how you could have improved the accuracy of your determination.