

EXPERIMENT

Copper Chemistry and Percent Recovery



OBJECTIVES

- To observe the chemical properties of copper in a series of reactions.
- To use several techniques in recovering copper from solution.

INTRODUCTION

In previous laboratory experiments we were able to take advantage of the physical properties of a substance for identification (Experiment 2) or for separation (Experiment 3). The identification and separation of a substance can also be performed when taking advantage of its unique chemical properties.

In this experiment we will cycle copper through a series of chemical reactions by taking advantage of its chemical properties. Copper is a soft metal with a characteristic color that we often call “copper-colored”, a bright orange-brown color. Copper is relatively inert chemically; it does not readily air oxidize (react with oxygen in air) and is not attacked by simple mineral acids such as sulfuric or hydrochloric acid.

TECHNIQUES

TECHNIQUE 9a, page 17. Heating liquids, test tube

TECHNIQUE 9c, page 17. Heating liquids, beaker

TECHNIQUE 18, page 29. Centrifuge technique

EXPERIMENTAL PROCEDURE

A. Copper Metal to Copper(II) Nitrate

Obtain a copper wool sample of unknown mass, less than 0.05 g, from your laboratory instructor and record its number. Roll and place the copper wool into a previously weighed (± 0.001 g, Technique 19b), 75-mm test tube. Using a dropper bottle or 10-mL graduated cylinder carefully add conc HNO_3 (CAUTION: *conc HNO_3 is very corrosive. Do not allow it to touch the skin - if it does, wash immediately with excess water. Your skin will turn yellow, a way to check your technique!*) until the Cu has completely reacted, but no more than 10 drops. Do not inhale the evolved NO_2 gas. What color is the gas? After the copper wool has completely dissolved, show the solution to your laboratory instructor for approval and save for Part B.

B. Copper(II) Nitrate to Copper(II) Hydroxide

Add approximately 20 drops of 6 M NaOH (CAUTION: *wash with water immediately if in contact with skin*) to the solution from Part A to form insoluble $\text{Cu}(\text{OH})_2$. Shake the test tube continuously while slowly adding the first 10 drops, then add the rest. Centrifuge (Technique 18) the solution for 30 seconds. Test for completeness of precipitation by adding 2-3 more drops of 6 M NaOH. If additional precipitate forms, add 4-5 more drops and centrifuge again. Repeat for completeness of precipitation until the test is negative. The solution should appear colorless and the precipitate should be light blue. Obtain your laboratory instructor's approval and save for Part C.

C. Copper(II) Hydroxide to Copper(II) Oxide

Decant (pour off) the supernatant (the liquid in the test tube) from the $\text{Cu}(\text{OH})_2$ precipitate. Carefully heat the test tube over a *cool* flame (Technique 9a) until the precipitate changes color. Obtain your instructor's approval and save for Part D.

D. Copper(II) Oxide to Copper(II) Sulfate

Add 20 drops (1 mL) of 6 M H_2SO_4 (CAUTION: *do not let it touch the skin!*) until the CuO dissolves. Slight heating may be necessary (Technique 9a). The solution's sky blue appearance is evidence of the presence of CuSO_4 . Obtain your instructor's approval and save for Part E.

E. Copper(II) Sulfate to Copper Metal

1. Dilute the solution from Part D with distilled (or de-ionized) water until the test tube is half-full. Using fine steel wool, polish about 5 cm of Mg ribbon. Cut or tear the ribbon into 1-cm lengths and add, one at a time, to the solution until the solution is colorless. Describe what is happening - what is coating the ribbon? What is the gas? If a white, milky precipitate forms (due to $\text{Mg}(\text{OH})_2$, called magnesium hydroxide) add several drops of 6 M H_2SO_4 . Break up the red-brown coating with a stirring rod. Centrifuge the mixture after breaking up the copper metal *and* after the addition of several pieces of magnesium.
2. Continue to add Mg ribbon until the solution becomes colorless. Add drops of 6 M H_2SO_4 to dissolve the excess magnesium. Centrifuge, decant, and discard the supernatant. Wash the red-brown copper with three 1-mL portions of distilled (or de-ionized) water; centrifuge, decant, and discard each washing.
3. Gently dry the copper in the test tube over a "cool" flame. Allow to cool and weigh (± 0.001 g) the test tube and copper. Repeat the heating and weighing until a reproducibility of less than 3% is obtained. Record the mass of Cu in the unknown.

REPORT SHEET-EXPERIMENT 5
THE CHEMISTRY OF COPPER

Date _____ Lab. Sec _____ Name _____ Desk No. _____

Unknown No. _____

1. Mass of 75-mm test tube (g) _____
2. Mass of 75-mm test tube + Cu wool (g) _____
3. Mass of Cu wool (g) _____

Synthesis of	Observation	Instructor Approval	Balanced Equation
A. $\text{Cu}(\text{NO}_3)_2$			
B. $\text{Cu}(\text{OH})_2$			
C. CuO			
D. CuSO_4			

E. Copper(II) Sulfate to Copper Metal

1. Observation
2. Write the equation for the appearance of the Cu metal on the Mg ribbon.
3. Write the equation for the evolution of the hydrogen gas.

4. Mass of 75-mm test tube + recovered Cu (g)

1st weighing _____
 2nd weighing _____
 3rd weighing _____
5. Mass of recovered Cu, expt'l (g) _____
6. Mass of original Cu sample (g) _____