# Stoichiometry Of Copper

AP Chemistry/ 2013-14/ A. Collins

## *Introduction:*

Have you ever noticed the multiple uses for copper? The first things that come to mind are probably coins and electrical wires. Why is copper so useful? Copper is widely distributed in Earth's crust. It is commonly found in sulfides, carbonates, and as uncombined, pure metal. It is a relatively soft metal with a reddish color. It is similar in many ways to another metal in Group 1B, silver. It is an excellent conductor of electricity and heat, second only to silver. Like silver, it maintains its integrity through a series of chemical reactions, but it has the advantage of being relatively inexpensive.

In this investigation, you will perform a series of chemical reactions involving copper and copper compounds. Beginning with a sample of copper of known mass, you will perform a series of reactions, eventually recovering the pure copper at the end. You will then analyze your quantitative data to see what percentage of the copper was recovered.

This lab will take two weeks to complete (two lab sessions). You will perform steps 1-8 in week one and steps 9-12 in week two.

## Purpose:

## *Pre-Lab Questions:*

1. What are some properties of copper metal? [Of course, yours will be different than the properties stated above.]
2. How will copper(II)sulfate be prepared in this investigation?
3. In step three, you use an ice bath. Why are you using this bath? What are you trying to prevent?
4. In which step of this investigation is the initial copper recovered?
5. What method will be used to dry the final amount of copper produced?
6. List all of the balanced chemical ***and*** net ionic equations that will take place in this lab. State which reaction family each of these reactions belongs to. Make sure to include phase symbols. You will be given prompts in the procedure.
7. What safety hazards are associated with dissolving copper in nitric acid? What precautions should be taken?
8. In step six you will rinse the solids by decanting. What is the purpose of this?
9. The last two reactions (Step 8 and Step 9) are very interesting. Explain the PURPOSE of these two reactions. These reactions are thought to be "competitive" reactions. Explain what this statement means. Hypothesize some possible complications that could arise from this competition.

## *Materials:*

| | |
|---|---|
| Balance | Watch glass |
| 250 mL beaker | 400 mL beaker |
| Copper wire | Ice, tap water |
| 50 or 100 mL graduated cylinder | 6.0 M NaOH |
| 6.0 M nitric acid ($HNO_3$) | pH paper |
| Hot plate | Stirring rod |
| Beaker tongs | 3.0 M sulfuric acid |
| Evaporating dish | 3.0 M hydrochloric acid |
| Zinc granules | |

## *Safety:*

Wear goggles and apron at all times. Nitric, sulfuric, and hydrochloric acids are corrosive – handle with care. Sodium Hydroxide is caustic, if any of these solutions are spilled, wash with plenty of water and notify teacher. The use of nitric acid (In part A) must be performed in a fume hood. The use of hydrochloric acid in Part B must be performed in a fume hood.

***Procedure:*** Turn the following steps into an illustrated procedure.

Part A: [week one of lab]

1. Put on goggles and apron. Find the mass of the copper wire and record. [We will use approximately 1.250 g. ] Place wire in 250-mL beaker.
2. In the fume hood, slowly add 25 mL of 6.0 M $HNO_3$ to the beaker and cover with watch glass. The reaction produces poisonous gas, DO NOT INHALE. When the copper has completely dissolved, remove the watch glass and allow the reddish-brown colored gas to disappear. Record your observations. Complete your reaction for this step in pre-lab question #6.

3. Put some ice and water into a 400-mL beaker until the beaker is about half full. Place the smaller beaker in the ice bath to keep the reaction mixture cool.
4. Obtain 25 mL of 6.0 M NaOH in a graduated cylinder. Slowly add the NaOH solution to the 250-mL beaker and test the reaction mixture's pH until its pH is 12+. Record your observations. COMPLETE YOUR REACTION FOR THIS STEP IN PRE-LAB QUESTION #6.
5. Add 50 mL water to the mixture. Using a hot plate, ***gently*** heat the mixture to a boil. Stir CONTINUOUSLY while heating for about 5 minutes. CAUTION: Stir continuously; otherwise, the beaker could break or the mixture could foam/spit out. Record observations. COMPLETE YOUR REACTION FOR THIS STEP IN PRE-LAB QUESTION #6. THIS ONE IS TRICKY.
6. Remove the beaker from the hot plate using beaker tongs and allow the solution to cool for about 5 minutes. Turn off the hot plate. Decant (pour off) the liquid from the beaker into the sink with the water running. While stirring, add 50mL of water to the precipitate in the beaker, let it settle, and decant the liquid. Repeat this process once again. It is important that the precipitate remain in the beaker.
7. Slowly add 50 mL of 3.0 M sulfuric acid to the precipitate from step #6 while stirring. Record observations in Data Table 2. If needed, add up to 20 mL more $H_2SO_4$ in 5 mL increments. COMPLETE YOUR REACTION FOR THIS STEP IN PRE-LAB QUESTION #6.
8. In the fume hood, add approximately 5 grams of zinc granules to the solution from Step 7. Cover the beaker and swirl gently until most of the blue color disappears from the solution. Allow this solution to sit until doing part B of the lab. Record your observations. COMPLETE YOUR REACTION FOR THIS STEP IN PRE-LAB QUESTION #6.

*Part B:* [week two of lab] Perform all steps with HCl (aq) in the fume hood.

**Depending on what happens with your product from week one, you will potentially start in different places from other lab groups.**

**A. If the liquid above your copper solid is blue – you will have to add more zinc.**

**B. If you have no blue liquid, but you have a grayish solid mixed in with your copper (zinc) – you will need to start with HCl.**

**C. If you have no blue liquid and you see no dark solid, zinc – proceed directly to the decanting process.**

9. Since there may be excess zinc remaining in the beaker, add 3.0 M hydrochloric acid slowly in small (5 mL) increments until the zinc enters the solution and you cease to see bubbles forming. Rinse the walls of the beaker with approximately 50 mL of distilled water and decant the liquid. COMPLETE YOUR REACTION FOR THIS STEP IN PRE-LAB QUESTION #6.
10. Find the mass of the evaporating dish and record the value. Transfer the solid remaining in the beaker to the evaporating dish. Decant the excess solution one last time from the evaporating dish. Place the evaporating dish in the chemical oven.
11. DO THIS STEP THE NEXT AVAILABLE DAY. Remove the evaporating dish from the chemical oven and let it cool. Find the combined mass of the copper and the evaporating dish and record.
12. Dispose of the recovered copper as directed by your teacher. Clean up your work area and wash your hands before leaving the laboratory.

## *Chemical Safety Data/Physical Data:*

## *Data table:*

## *Observations:*

## *Calculations:*

## *Conclusion:*

## *Error Analysis:*

*A Note About Error Analysis:*

Your goal in this lab was to recover as much of your original copper as possible. There were many places where you could have lost copper. Likewise, there are a number of ways that you could gain mass at the end as well! In your discussion, you need to *very specifically* identify the errors that most likely shaped YOUR final results. PLEASE BE SPECIFIC TO YOUR DATA & OBSEVATIONS. Any well-constructed error argument, should be backed-up with observations from your actual lab. You DO NOT need to quantify errors for this lab! There are too many places for things to go wrong. Just make logical written arguments.

## *Post Lab Questions:*

There are none! Yippee!