

# Iron-Copper Chloride Reaction

Adapted from Davis, J et al. "Experiment #4". Laboratory Manual for Chemistry Experiments and Principles. Lexington: Heath, 1982

## Safety and Cautions

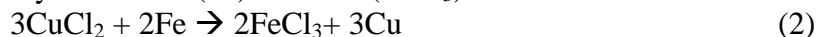
1. You must wear safety goggles *at all times* during the lab.
2. We are using balances today. If heavy weights are placed on them they will be permanently damaged. Do not place anything other than the beaker and nails on the balances. Make certain to use a weigh boat so that you do not place anything directly on the balance.
3. We will be using copper(II) chloride (a solid powder) in this lab. If you inadvertently get some on your hands, *first* wipe them with a dry paper towel, then wash them well for 2 minutes. Copper(II) chloride can irritate the skin if not removed.

## Introduction

In this experiment you will let iron (Fe) nails react with a copper chloride ( $\text{CuCl}_2$ ) solution. Some of the iron will be replaced by the copper (Cu) in the solution. After observing the results of this chemical reaction, you will determine the mass of iron which reacted and the mass of copper formed. These data will then be presented in a more useful form, i.e., the ratio of moles of iron used to moles of copper formed. This will allow us to determine which of two reactions occurred. In the first reaction the product is iron(II) chloride ( $\text{FeCl}_2$ ):



Alternately it may be the iron(III) chloride ( $\text{FeCl}_3$ ) forms which results in the reaction:



We know that one mole of iron does not have the same mass as one mole of copper! So we will need to calculate the number of moles of iron consumed and the number of moles of copper produced in order to solve our mystery! Fill in the following information:

If the first reaction occurs, \_\_\_\_\_ moles of Fe will be used for every one mole of copper produced, which gives a mole ration of \_\_\_\_\_ mols Fe: 1 mol Cu.

If the second reaction occurs, \_\_\_\_\_ moles of Fe will be used for every \_\_\_\_\_ moles of copper produced, which gives a mole ratio \_\_\_\_\_ of mols Fe: 1 mol Cu.

As you do the experiment, record your observations and data accurately and neatly in the data table provided. This experiment will be done in three parts, the first two on block day, then we will finish Thursday after our samples dry.

## Materials Needed

250ml or 400ml Beaker  
100ml Graduated Cylinder  
Watch glass  
Iron (two clean nails)  
Copper chloride powder  
Stirring rod  
1 paper towel

scoopula  
tongs  
wash bottle  
waste container (beaker)  
Weigh boat  
Balance  
Sharpie

# ***Iron-Copper Chloride Reaction***

## ***Procedure***

### **Day 1: Part I**

1. Use a permanent marker to label an empty, clean, dry 250 ml or 400ml beaker with the name of you and your lab partners (do not write on the white areas). Also label the watch glass with your names.
2. Identify your waste beaker. If you do not have one, label a second large beaker with "WASTE LAB 1".
3. Choose one lab member to mass the beaker and record this information in the data table.
4. Have a different lab member measure 50ml of distilled water into a graduated cylinder.
5. AFTER FINDING THE MASS OF THE BEAKER, add the 50 ml of distilled water to the beaker.
6. A third lab member should then add two heaping scoops of the  $\text{CuCl}_2$  to the beaker and mix the solution until it fully dissolves with a glass stir rod. Set the scoop and the stir rod on a paper towel on your lab table so as to not contaminate the surface. All members should record their observations about this solution.
7. Now a lab member should mass two clean iron nails (DON'T forget to use a weigh boat!). Record observations of the nails (Color, texture, etc)
8. Carefully add two nails to the beaker. Make certain that all members of the group have the data you need. We will now need to wait about 40 minutes for the reaction to take place. Ask the teacher to check your work and then you may go sit down.

### ***Data Table: Day 1 Part 1***

<b>Item</b>	<b>Measurement or Observation</b>
Mass of the empty, dry beaker	
Observations about the $\text{CuCl}_2$ solution	
Mass of the two iron nails used	
Observations of the two iron nails	

## ***Iron-Copper Chloride Reaction***

### **Day 1: Part II**

1. Make two new sets of observations in the table below.
2. Pick up the nails, one at a time, with a pair of tongs. Using the stirring rod, scrape as much of the reddish-brown material from the nails into the beaker. Using a *very small amount of water* from a wash bottle, wash all the reddish-brown material from the nails into the reaction beaker. **Do not rinse into the waste container.**
3. Put the nails aside to dry on the labeled watch glass.
4. Carefully decant the solution from the reddish-brown material remaining in the beaker. *Decant* means to pour off the liquid leaving the solid behind. The liquid should go into the waste beaker.
5. Wash the remaining solid with about 25 ml of distilled water and decant into the waste beaker again. Repeat the washing and decanting 2 or 3 times. *Lose as little of the solid as possible.*
6. After the final washing, the solid must be dried. Place the watch glass *with the nails*, next to your beaker on a paper with your names on it at the end of the lab station.
7. Follow all directions to clean the lab. BEFORE putting away the tools and glassware, get approval from your teacher.

### ***Data Table: Day 1 Part II***

<b>Item</b>	<b>Observations</b>
Observations about the $\text{CuCl}_2$ solution	
Observations of the two iron nails	

### **Day 2**

1. One member should mass the beaker and the solid. The other member(s) should mass the nails (Remember to use a weigh boat!). Record the measurements in the table below.
2. Dispose of solids and clean glassware as instructed.

### ***Data Table: Day 2***

<b>Item</b>	<b>Measurement or Observation</b>
Mass of the beaker and solid	
Mass of the two iron nails used	

## ***Iron-Copper Chloride Reaction***

Processing the Data: SHOW ALL CALCULATIONS

1. Determine the mass of iron (Fe) lost by the nails (The initial mass of the nails minus the final mass of the nails).
2. Determine the moles of the iron consumed from the mass loss that you calculated in step 1. Use the periodic table to find the average molar mass of iron.
3. Determine the mass of the copper produced (The final weight of the beaker and product minus the weight of the clean dry beaker).
4. Determine the number of moles of copper (Cu) produced from the mass in step 3. Use the periodic table to find the average molar mass of copper
5. Determine the mole ratio: Divide the number of moles of iron by the number of moles of copper. This ratio is \_\_\_\_\_ moles of Fe:1 mole of Cu.
6. What evidence did you observe that would suggest some of the copper was left in the solution?

### **Conclusions:**

1. Based on the mole ratio of Fe reacted to moles of Cu produced, which product or products do you think formed? Why?
2. What are three sources of error in this experiment? What is one thing you could do to reduce or eliminate each source of error?
3. What suggestions would you have in improving this lab? (think of at least one)