An Iron-Copper Reaction

# Introduction

Balancing chemical reactions is an important learning objective for General Chemistry. We employ different principles to do that, including the assignment of ionic charges, and later in the course, oxidation numbers. But ultimately, chemistry is an experimental science and theories of ionic charge or oxidation state are confirmed by experimental data. The purpose of this experiment is to determine the coefficients of a balanced reaction from experimental data.

The reaction under consideration is a single displacement between copper and iron

Fe(s) + Cu(aq) → Fe(aq) + Cu(s)

We know that atoms must be conserved, so whatever the coefficient is for the iron atom on the reactant side, it must also be the coefficient for the iron atom on the product side. The same would be true for the copper atom.

We happen to know that the two common charge states for iron are Fe2+ and Fe3+. The two common charge states for the copper ion are Cu1+ and Cu2+. Therefore, based on the theory of ion charges and conservation of charge, there are four possible combinations of coefficients for the reaction between iron and copper. In this experiment, we will discover which is the correct set for these reactants and reaction conditions.

# Materials and Methods

100-mL beaker

Hot plate

Iron powder

Copper sulfate solution – marine pollutant

Funnel and filter paper

# Procedure

1. Weigh a sample of iron powder around 1.0 gram to the closest 0.001 gram and record the mass on the Report Sheet. Also weight a circle of filter paper to the closest 0.001 gram and record its mass on the Report Sheet.
2. Obtain approximately 40 mL of copper solution in a 100 mL beaker and add the iron powder to the solution. Warm the solution on a hot plate set to medium-high until water vapor begins to condense on the sides of the beaker (about 60 Celsius) but it is not necessary to boil it. Continue heating for at least five more minutes to complete the reaction then remove the beaker from the hot plate and turn off the heat. If a stirring hot plate is used, the stirring function can be turned on to help the dissolution because iron powder is magnetic.
3. Fold a piece of filter paper into a flute and place it in a funnel set on top of a 150-mL beaker. Hold the top edge of the paper against the funnel and begin pouring the solution through the filter paper. As it gets wet, the paper will adhere to the sides of the funnel and won’t need to be held anymore. Try to pour about half of the clear solution into the filter paper before swirling and adding the remaining solution into the funnel.
4. Use a wash bottle and the beaker set at an angle and pointing down to wash any remaining copper into the funnel.
5. When the solution has drained, remove the paper carefully and open it back into a circle. Place the filter paper with the copper sample on a WARM hot plate. As the paper dries, it may become discolored. It may be necessary to turn the hot plate on to a low setting. The copper is dry when water vapor is no longer emanating from the sample. DO NOT char the filter paper.
6. Find the mass of the copper and filter paper to the closest 0.001 gram. Use the measured values to complete the calculations on the Report Sheet.

# Data and Results

1. Convert the mass of iron powder into moles of iron.
2. Subtract the mass of filter paper plus copper from the mass of filter paper to find the mass of copper.
3. Convert the mass of copper to moles of copper.
4. Record the ratio of moles Fe:moles Cu on the Report Sheet.
5. Divide by the smaller of the two values. On the next line of the Report Sheet, it should be either 1.00:x.xx or x.xx:1.00, where x.xx is the numerical value after the division.
6. Use the previous ratio to determine the simplest whole number ratio.
7. Use the whole number ratio to fill in the coefficients on the Repot Sheet for this reaction between iron and copper.

# Clean Up

Discard the solution and copper in the labeled container; discard the filter paper in the trash.