Cu Later Lab: What's in a Chemical Formula?

Purpose: In this experiment you will observe chemical changes involving copper compounds, write formulas to describe the substances produced, and determine the masses of the copper compounds made in each step.

CAUTION: This experiment involves using strong acids and bases. Wear goggles and aprons. Avoid all skin contact with the chemicals. Neutralize any acid spills with baking soda and use vinegar for sodium hydroxide spills. Wash your hands immediately if there is skin contact. Vapors produced during these reactions can be irritating to the eyes and lungs. Avoid inhaling the vapors generated.

Procedure & Analysis: Record all observations of chemical changes that occur.

1. Use a milligram balance to measure out a 0.3-0.5 gram sample of copper metal turnings in a 250 mL beaker. Record the exact mass of your sample. Mass of copper metal = _____ g Cu

2. **Under the fume hood**, add 4 mL of concentrated nitric acid to the copper in the beaker to form copper (II) nitrate. Cover the beaker with your watch glass until the bubbling subsides. Swirl the flask occasionally, to make sure all of the copper has dissolved. Then add 50 mL of distilled water to the beaker to dilute any excess acid. The chemical reaction is shown below. Write the chemical formulas for each substance.

   copper + nitric acid ---> copper (II) nitrate + nitrogen dioxide + water

   Calculate the mass of copper (II) nitrate that will form based on the mass ratio shown below derived from the Law of Definite Composition.

   $$\text{x g copper (II) nitrate} = \text{\_\_\_\_\_ g copper used} \times \frac{\text{(molar mass copper (II) nitrate)}}{\text{(g copper per mole of compound)}}$$

3. In a second beaker, dissolves 15-20 pellets (~2 g) of sodium hydroxide in 100 mL of distilled water. Add the sodium hydroxide to the beaker with the copper (II) nitrate to make a royal blue-colored precipitate of copper (II) hydroxide. If the precipitate is green (or no precipitate forms), and a few more pellets of sodium hydroxide. Write the chemical formulas for each substance based on the chemical reaction shown below.

   copper (II) nitrate + sodium hydroxide ---> copper (II) hydroxide + sodium nitrate

   Calculate the mass of copper (II) hydroxide that will form based on the mass of the copper (II) nitrate produced in the previous step. (Note that 1 mole of copper (II) hydroxide is formed for every 1 mole of copper (II) nitrate that reacts, therefore.....)

   $$\text{x g copper (II) hydroxide} = \text{\_\_\_ g copper (II) nitrate} \times \frac{\text{(molar mass copper (II) hydroxide)}}{\text{(molar mass copper (II) nitrate)}}$$

4. Heat the contents of the beaker with a Bunsen burner until the solution just begins to boil. The copper (II) hydroxide decomposes to form copper (II) oxide. Allow the solid to settle, then decant off as much of the liquid as possible. Write the chemical formulas for each substance shown below.

heat

copper (II) hydroxide ---------> copper (II) oxide + water

Calculate the mass of copper (II) oxide that will form based on the mass of the copper (II) hydroxide produced in the previous step.

x g copper (II) oxide =

5. Add just enough (10-15 mL) of 3M sulfuric acid to the copper (II) oxide to produce copper (II) sulfate. Write the chemical formulas for each substance below.

copper (II) oxide + sulfuric acid ---------> copper (II) sulfate + water

Calculate the mass of copper (II) sulfate that will form based on the mass of the copper (II) oxide produced in the previous step.

x g copper (II) sulfate =

6. Under the fume hood, add 1.5 g of powdered zinc to the copper (II) sulfate to produce copper metal. Write the chemical formulas for each substance below.

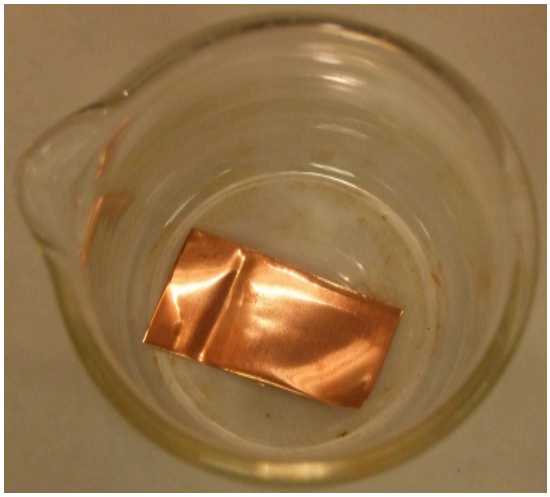
copper (II) sulfate + zinc ---------> copper + zinc sulfate

Calculate the mass of copper metal that will form based on the mass of the copper(II) sulfate produced in the previous step.

x g copper =

7. Add 5 mL of 6 M hydrochloric acid to dissolve any excess zinc. When the bubbling stops, decant the solution. Rinse with 5 mL of distilled water and decant again.

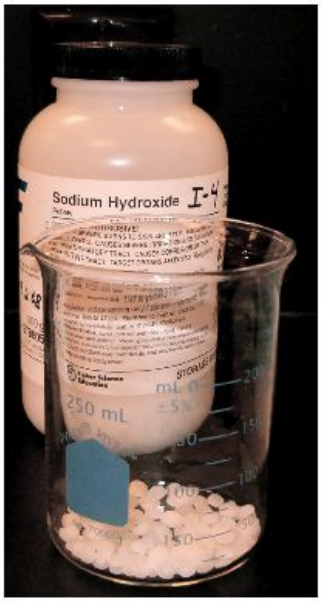
8. Use a pencil to label a piece of filter paper with your initials, then mass the paper. Use a wash bottle to transfer the copper metal into the filter paper placed in a funnel. Rinse the copper in the filter paper with 5 mL of acetone. Open the paper on your watch glass and dry in an oven set at 110ºC or under a heat lamp. Mass the copper metal after the paper has completely dried. Using the calculated mass of copper in Step 6 as the accepted value, determine your percent error.

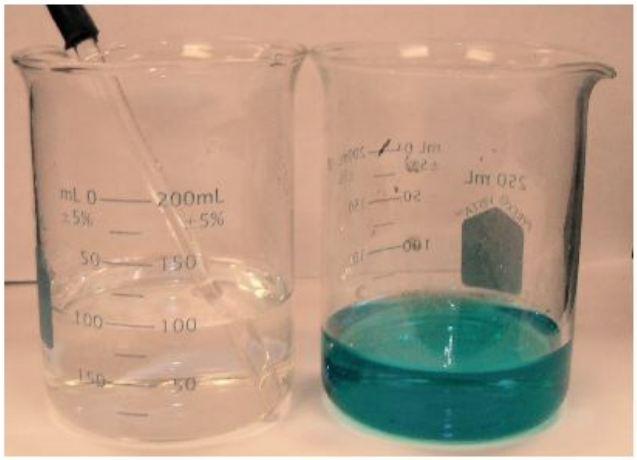


Mass of beaker = 74.89 g
Mass of beaker + copper = 75.41 g

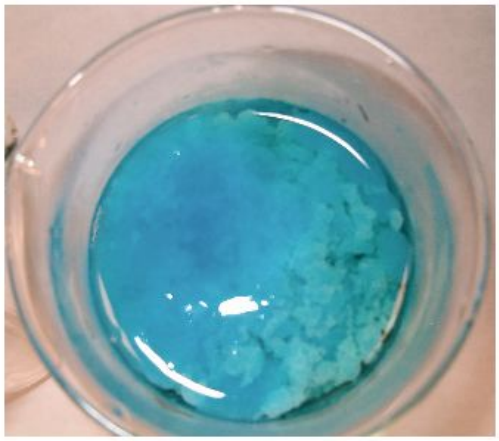
copper + nitric acid reaction

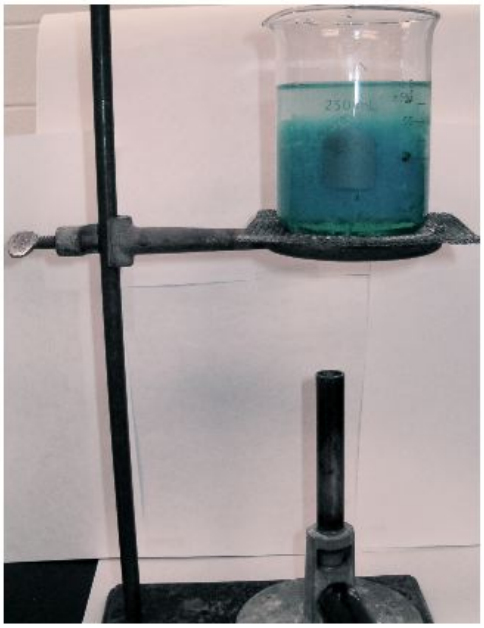
About 2 g of sodium hydroxide is dissolved in distilled water to mix with the copper (II) nitrate solution



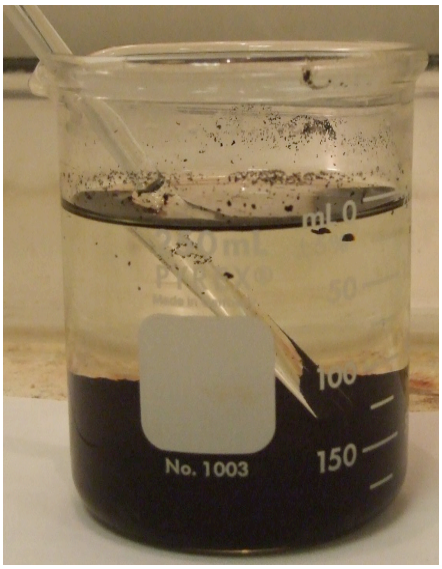


The gelatinous copper (II) hydroxide is heated to boiling with a Bunsen burner.



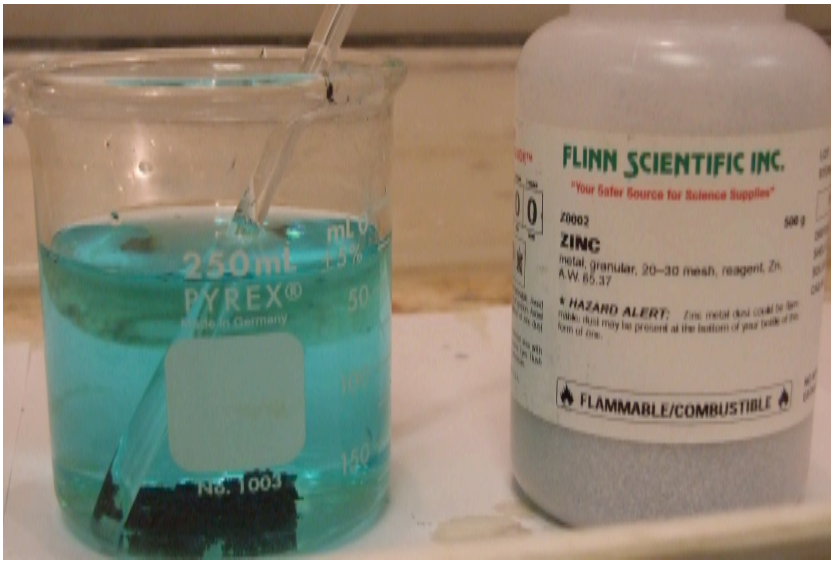


The blue precipitate turns into black copper (II) oxide when heated to the boiling point.

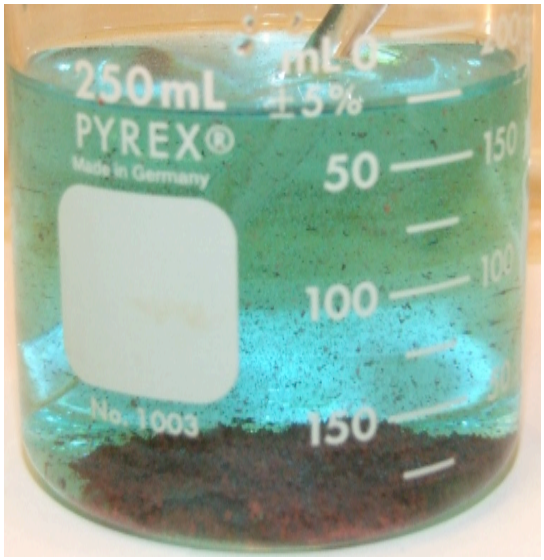


copper (II) oxide formed by heating copper (II) hydroxide

copper (II) oxide + sulfuric acid



copper (II) sulfate + zinc



removed copper