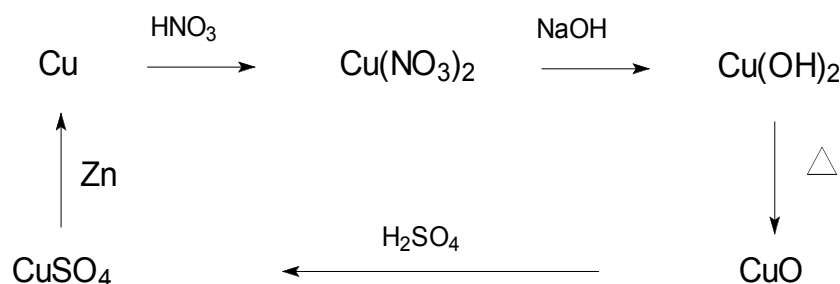


The Copper Cycle

The Law of Conservation of Mass is one of the fundamental laws of chemistry. It states that mass is neither gained nor lost in a chemical change. For example, if 207 g of lead combines with 32 g of sulfur in a chemical reaction, then 239 g of product (lead sulfide) should be made.

In today's experiment you will take a known weight of copper through a series of five chemical changes and end up with copper again.



Since no copper is added or removed between the initial and final steps, and because each reaction goes to completion, you should theoretically be able to recover the same amount of copper you started with. Today's experiment will also allow you to review such concepts as reaction types, predicting products of reactions, balancing equations, and stoichiometry.

PROCEDURE:

a) Remove the tarnish from a thin piece of copper wire (about 0.5 g) by swirling it in about 5 mL of 6M HCl (caution!) in a small beaker. Rinse the wire with 50 mL of water twice to the beaker. Dry and weigh the wire to the nearest centigram (0.01 g).

b) **In the fume hood**, add the wire to a 250 mL beaker containing about 4 mL of concentrated nitric acid (16M HNO₃), **CAUTION!** [Two droppers-full from the Beral (plastic) pipet attached to the side of the HNO₃ is ~ 4 mL.] Swirl the mixture until the copper dissolves completely. *Slight* heating (in the hood) may be required to complete the reaction; do not add more acid. **Record your observations** on your data page. The balanced equation is as follows:



Add 100 mL deionized water. Return to your bench.

c) Add, with stirring, 30 mL of 3.0 M NaOH solution to your copper solution. **Record observations.** What is the identity of the copper-containing precipitate formed? (The other product of reaction stays dissolved in the water.) Write the balanced equation for the reaction, given the fact that it is a double replacement.

d) Heat the mixture, with stirring, just to the boiling point on a hot plate. “Bumping”(local formation of gas bubbles which can eject material from the beaker) may occur if stirring is not maintained). **Record observations**. Write a balanced equation for the reaction of the copper-containing product from Part (c) above, given the facts that it is a decomposition reaction and one of the products is water.

e) When the reaction is complete (all of the blue color in the solution is gone), remove the beaker from the heat and vacuum filter the mixture. A spray from your wash bottle containing deionized water is useful in this transfer. Wash the filter cake with 50 mL of deionized water. (What is the purpose of the washing?) Discard the liquid in the filter flask – in the sink is OK.

f) Use your metal scoopula to transfer the black solid and filter paper to a 250 mL beaker. (It's OK to use the spray from your wash bottle again to help with the transfer.) Add 15 mL of 6.0 M H_2SO_4 (caution!), with stirring to dissolve the black solid. (The filter paper will probably start to break apart, but that is OK.) Heat the mixture gently, if necessary. **Record observations**. Write a balanced equation for the reaction given the fact that it is a double replacement.

g) Clean your filter funnel and flask and then re-filter your mixture to remove the filter paper residue (this time you are saving the liquid that passes through the filter). Rinse your beaker with a small amount of de-ionized water from your wash bottle and transfer the rinse into the filter funnel. Transfer the filtered solution to a clean 250 mL beaker, using a little water from the wash bottle to complete the transfer.

h) Put water in a different 250 or 400mL beaker to heat on a hot plate to boil. This will be used later in step (j).

i) Weigh out 1.0 g of zinc metal. **In the fume hood**, add the zinc all at once to the copper solution resulting from part g), stirring until the solution is colorless and all bubbling has ceased. (If bubbles are still being formed, warm the reaction mixture on a hot plate until gas evolution ceases.) At this point there should be no silvery pieces of Zn remaining. **Record observations**. Write the balanced equations for the two reactions occurring. They are both single replacements.

j) Decant (carefully pour) the liquid from the copper into a separate beaker. Wash the copper with about 5 mL of de-ionized water and discard the wash water. Transfer the copper to a dry watch glass. Wash the copper with about 5 mL of methanol (flammable, poison). (Methanol evaporates faster than water and allows us to get a dry weight of copper recovered.) Discard the methanol in the waste beaker. Repeat the methanol wash and discard the waste in the waste bottle. To dry the copper, place the watch glass containing the copper over the previously prepared beaker of boiling water. The steam from the boiling water will heat the bottom of the glass and drive off the methanol. Use your stirring rod and move the copper pieces around to aid the evaporation. Remove the watch glass from the steam and allow it to cool. Weigh the copper on a piece of weighing paper. Calculate the % copper recovered. (Show your setup.)

The Copper Cycle

Name _____

Lab Partner: _____

Step a. Mass of copper _____

Step b. Observations when HNO_3 is added:

Step c. Observations when NaOH is added:

Balanced equation for step c:

What is the name of the precipitate formed in step c? _____

Step d. Observations when heated:

Balanced equation for step d:

Step e. Purpose of Washing (What is being removed from the Cu-containing product?):

Step f. Observations when H_2SO_4 is added:

Balanced equation for step f:

Step i. Observations when Zn is added:

Balanced equation (Zn + copper compound)

Balanced equation (Zn + H₂SO₄)

What were the bubbles? _____

Step j. Purpose of methanol wash (What is being removed from the Cu?):

Mass of Cu recovered _____

% Cu recovered _____ (show calculation!)

QUESTIONS:

1. Give two specific reasons why a student might have a percent yield could be higher than 100%. (Do not say "Human Error". Be specific what the error of the human (you) was!)
2. Give two specific reasons why a student's percent yield could be lower than 100%.
3. What caused the darkening of the copper during drying?
4. Which reaction steps throughout the procedure (a-i) involve redox reactions?