Student Name: _____ Pd. ____ Date: _____

Partner(s) Name: _____

Investigation 5

Evidence for Chemical Change

Have you ever made a volcano using baking soda and white vinegar? The foam and gas you see bubbling out of the crater is evidence that a chemical change has occurred. Maybe you've even cracked the glass tube inside a glow stick on Halloween? The light that emanates from the liquid inside is evidence that a chemical change has occurred.

Chemical changes do not have to be as flashy as an erupting model volcano or a chemiluminescent glow stick. Nature is saturated with processes that involve chemical changes – from the simple interaction of oxygen with steel to form rust to the elegant biochemical reactions that drive life on Earth.

In this laboratory, you will get an opportunity to carry out some simple reactions and make predictions and observations about some of the evidence that chemical changes have occurred. You will also have the opportunity to infer whether or not new substances have been formed, and you will describe these changes by writing the equations that describe these changes.

MASTERY INDICATORS

Chemical Reactions	Teamwork	Literacy (Writing)	Laboratory Technique	Safety

SAFETY

When using a Bunsen burner, confine long hair and loose clothing. Do not heat damaged glassware. Lab equipment that has been heated remains hot for some time after the heat source is removed. Use hot mitts or tongs when handling equipment, even if you believe it might no longer be hot.

Copper(II) nitrate is an eye irritant and is harmful if inhaled or ingested. Prolonged exposure to skin can cause dermatitis. Keep your hands clear of your face and always wash them thoroughly after handling $Cu(NO_3)_2$.

Sodium hydroxide and hydrochloric acid are corrosive and can cause severe burns to skin, eyes, and mucus membranes, and could damage clothing.

Always wear gloves, goggles, and aprons when handling these materials.

When using a stirring rod, always rinse the rod with tap water and dry it before placing it on the lab bench.

BACKGROUND

The simplest way to determine if a chemical change has occurred is to observe that the properties of the products are different from those of the reactants. Then, with very little preparation, the products can become reactants in yet another reaction.

In this reaction, you will observe a sequence of changes that occur when a solution of copper(II) nitrate is treated with a series of reactants. Each of the reactions in the sequence will take place in the same test tube, and you will observe the system after each step to determine what changes, if any, have occurred. In addition, you will have the opportunity to see how heat is related to chemical reactions.

The concentrations of the solutions used in this lab are expressed in **molarity (M)**. Molarity is a measure of moles of solute (the substance being dissolved) divided by the total volume of the solution in liters (the solvent – the substance doing the dissolving – is usually water). Although you will not explicitly be required to make computations involving molarity, it is important to be aware of how concentration is expressed for this investigation.

copper(II) nitrate

PRE-LAB ACTIVITY

1. Determine the chemical formulas and molar masses for the three compounds used in this lab.

MATERIALS

The following materials are necessary for this investigation:

- 1.0 *M* cupric nitrate
- 1.0 *M* hydrochloric acid
- 1.0 *M* sodium hydroxide
- Aluminum wire, ~12 cm
- Copper wire
- 2-400 mL beaker
- Bunsen burner/striker
- Glass stirring rod
- Ring stand
- Iron ring
- Ruler
- Test tube
- Test tube rack
- Test tube clamp
- Wire gauze

PROCEDURE

Many steps of the procedure correspond to a part of the "**DATA**" section below. These steps are marked with an asterisk "*****". For each of those steps, record your observations in the appropriate section.

1. Fill a 400 ml beaker about 2/3 of the way with ice, and then top it off with tap water (also to no more than 2/3 full). This will be the ice bath you use in step 8.
2. Set up a Bunsen burner and ring stand configuration for heating a beaker.
3. Fill a 400 mL beaker about 2/3 of the way with tap water and set it on your ring stand.
4. Light the burner and bring the water to a boil. This will be the water bath you use in step 7. Continue with the steps below while you wait for the water to boil.
5. ***** Place a test tube in a test tube rack. Add 5.0 mL of 1.0 *M* copper(II) nitrate to the test tube. Write down any physical properties of the copper(II) nitrate solution you observe.
6. ***** Add 5 mL of 1.0 *M* sodium hydroxide solution to your test tube. Touch the bottom of the test tube to determine if heat has been released by the reaction.
7. ***** Using a test tube clamp, place the test tube carefully into your boiling water bath. Allow it to heat for at least 5 minutes. *Do not stir the materials in the test tube during this phase.*
8. Remove the test tube from the water bath and turn off the Bunsen burner. Cool the test tube for at least 5 minutes in the ice bath you prepared in step 1
9. ***** Return your test tube to the test tube rack, and add 5 mL of 1.0 *M* hydrochloric acid. Stir the solution well with a stirring rod.
10. ***** Place a 12 cm length of aluminum wire into your test tube. Leave the wire in place until no further reaction is observed. Touch the bottom of the test tube to check for a temperature change. ***Note:*** *Two reactions are occurring simultaneously in this step.*
11. ***** Carefully remove the aluminum wire from the test tube. Compare the copper deposited on the wire to a sample of copper wire obtained from your instructor.

DATA

Step 5
List any physical properties you observe.

_____

_____

_____

Step 6
List any evidence that a chemical change has occurred.

_____

_____

_____

Step 7
List any evidence that a chemical change has occurred.

_____

_____

_____

Step 9
List any evidence that a chemical change has occurred. Explain why you think it is important that the test tube be thoroughly cooled prior to this step?

_____

_____

_____

Step 10
List any evidence that a chemical change has occurred. Try to determine the two reactions occurring in this step.

_____

_____

_____

Step 11
What similarities or differences do you notice? Can you account for them?

_____

_____

_____

POST-LAB ANALYSIS

Answer the following questions in complete, grammatically correct sentences (when appropriate). When calculations are required, show all of your work.

1. Five chemical reactions occur in this laboratory.
    a. Write balanced equations for each of the 4 reactions.
    b. Identify each reactant and product as an element or compound.
    c. Identify if each reactant or product is aqueous or insoluble.

2. Cite 1 example each of an exothermic and endothermic reaction from this lab. Explain which observations support your choices.

3. In the last step of this experiment, in what form is the aluminum chloride? Suggest a means of recovering it.

4. List 4 specific observations from this lab that indicate when a chemical change has occurred.

CLEANUP AND DISPOSAL

Liquid waste and unused reagents should be emptied into the container designated by your instructor. Aluminum wire samples and copper deposits can be disposed of in the trash after being rinsed thoroughly with water. Copper wire samples should be returned to your instructor for reuse.

All glassware should be thoroughly cleaned, dried, and returned to the storage cabinets. Be sure to wash your hands before leaving the lab.

ONGOING LEARNING

Copper is a relatively expensive metal that has thousands of commercial and industrial uses. It has several unique characteristics, most notably that it is the second best metal conductor of electricity (behind silver, Ag) and that it is one of few metals that has a natural color other than grey or silver.

1. Using the internet as a resource, explain at least two reasons why copper is used more readily than silver for conducting electricity.

2. The chemical conversion of one product into another useful product is the basis for recycling. Explain how some of the reactions you observed in this experiment could be useful in recycling copper (or other metals). Include in your discussion some of the advantages and disadvantages of recycling metals in this way.