3 OBSERVING A CHEMICAL REACTION

PURPOSE

To learn how qualitative and quantitative observations of a chemical reaction are used to formulate a hypothesis.

Text Reference
Section 2.4

Time Required
15–30 minutes

Objectives
- Record observations for the reaction of copper(II) chloride with aluminum.
- Distinguish between observations and interpretations.
- Classify observations as qualitative or quantitative.

Advance Preparation
Copper(II) chloride dihydrate
You will need approximately 80 g of reagent grade $CuCl•2H_2O$ for 15 student pairs. Reagent grade copper(II) chloride crystals will give a clear, brilliantly colored solution. Technical grade crystals will yield a murky solution. The crystals should be placed in labeled wide-mouthed bottles and made available at each lab station.

Aluminum foil
Cut 20 8 cm × 8 cm squares. Dispense the aluminum foil yourself.

Demonstrate how easily a small beaker can be tipped over by a long thermometer.

BACKGROUND

You and a friend may have very different feelings about a movie you've just seen. You may disagree about whether you liked the movie or about the movie's intended meaning. Although you both have observed the same movie, your interpretations of the movie may differ. Distinguishing between observation and interpretation is very important in chemistry. An *observation* is a statement of fact, based on what you detect by your senses. An *interpretation* is your judgment or opinion about what you have observed. A statement such as "the liquid is clear and colorless" is an observation. It would be an interpretation to say, without further testing, that the clear and colorless liquid is water.

The purpose of this experiment is to help you distinguish observation from interpretation while examining a chemical reaction. Try to make as many observations of the reaction as possible. There are two types of observations. A *quantitative* observation is an observation that involves a measurement; a *qualitative* observation is a general description and does not involve a measurement. "The liquid is hot" is a qualitative observation. "The temperature of the liquid is 95.0°C" is a quantitative observation.

MATERIALS (PER PAIR)

safety goggles
100-mL beaker
plastic spoon
glass stirring rod
thermometer
copper(II) chloride dihydrate, $CuCl_2•2H_2O$ [T] [I]
distilled water
aluminum foil, 8 cm × 8 cm

SAFETY FIRST!

In this lab, the solution you are working with may become quite hot following the addition of aluminum foil. Observe all precautions, especially the ones listed below. If you see a safety icon beside a step in the Procedure, refer to the list below for its meaning.

Caution: Wear safety goggles. (All steps.)

Caution: Copper(II) chloride is an irritant. Avoid skin contact with this chemical. (All steps.)

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Caution: Copper chloride is toxic by ingestion and inhalation. (Step 1.)

Note: Return or dispose of all materials according to the instructions of your teacher. (Step 5.)

PROCEDURE

As you perform the experiment, record your observations in Data Table 1.

1. Obtain and describe a sample of copper(II) chloride dihydrate, $CuCl_2 \cdot 2H_2O$.

2. Fill the 100-mL beaker about one-fourth full with distilled water. Without stirring, add 1 level teaspoonful of the solid to the water. Record your observations of both the solid and the water.

3. Use the glass stirring rod to stir the mixture until the solid is completely dissolved. Record your observations of the solution.

4. Place the thermometer in the copper(II) chloride solution and record the temperature. **CAUTION:** *Observe the mixture from the side; do not look directly down into the beaker.* Place a loosely crumpled ball of aluminum in the solution and record your observations. Stir the mixture occasionally and observe for at least 10 minutes. Record any change in temperature.

5. Follow your teacher's instructions for proper disposal of the materials.

Step 1.
Copper(II) chloride crystals are blue-green, rhombic needles.

Step 2.
Remind students to pay attention to quantities required in Step 2. Too dilute a solution of $CuCl_2$ will react very slowly with Al. If the instructions (one-fourth full and 1 teaspoon) are followed, the reaction proceeds nicely.

Step 4.
Students will observe the blue-green solution of $CuCl_2$ change to clear upon reaction with aluminum foil. A red-brown precipitate forms, heat is released, and H_2 gas is produced.

$3Cu^{2+}(aq) + 4Al(s) + 6H^{+}(aq) \rightarrow 3Cu(s) + 4Al^{3+}(aq) + 3H_2(g)$

Warn students that the beaker may become quite hot in the course of this very reaction. Some spitting of the solution can occur as the gas is produced.

Use the following disposal methods for chemical waste.

Disposal 1: Cu(*s*) precipitate in Step 4.

Disposal 2: The reaction solution in Step 4.

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OBSERVATIONS

DATA TABLE 1: OBSERVATIONS	
System	Observations
dry copper(II) chloride dihydrate	**The crystals are small in size and pale blue to dark blue-green in color. They resemble short needles in shape.**
copper(II) chloride in water	**The crystals on the bottom of the beaker appear green; the solution above becomes pale blue. After a few seconds, the solution just above the crystals becomes a deep green.**
stirred copper(II) chloride in water	**The crystals dissolve readily; the solution becomes blue-green.**
copper(II) chloride solution plus aluminum foil	**The foil is plated with copper and corrodes rapidly. A gas is produced and the solution becomes very warm. A red-brown precipitate drops to the bottom of the beaker.**
initial temperature:	
final temperature:	

ANALYSES AND CONCLUSIONS

1. Check your observations. Cross out any that are interpretations rather than observations.
2. List each of your observations in one of four following sections. Number your observations consecutively. Circle the number of any observation that is quantitative.

   a. observations of the dry solid

   Ask each group to present one observation of the dry solid. Repeat the process with each section, starting with a different group each time.

   b. observations of the wet solid before stirring

   c. observations of the solution before addition of aluminum

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d. observations of the reaction that occurs when the aluminum is added to the solution

3. Would you expect your observations or your interpretations to most closely match those of your classmates? Explain.

Observations should most closely match, because everyone is observing the same changes. Everyone may have a slightly different interpretation of the same events, depending on their previous experiences.

GOING FURTHER

Develop a Hypothesis

Based on the observations you made during this lab, develop a hypothesis about what happened when aluminum metal was added to the solution of copper(II) chloride.

Hypothesis: When aluminum metal is dropped into a solution of copper ions, a chemical reaction occurs. Copper is formed during the reaction. A compound of aluminum forms and dissolves in water.

Design an Experiment

Propose an experiment to test your hypothesis. If resources are available and you have the permission of your teacher, perform the experiment.

Repeat the experiment using a solution of copper(II) chloride and a thin rod of aluminum metal. Then perform similar experiments in which the copper(II) chloride solution is replaced with (a) copper(II) sulfate and (b) copper(II) nitrate.