

# Moles of Iron and Copper

The mole is a convenient unit for analyzing chemical reactions. The mole is equal to  $6.02 \times 10^{23}$  particles, or Avogadro's number of particles. More importantly, however, the mass of a mole of any compound or element is the mass in grams that corresponds to the molecular formula, or atomic mass. Simply stated, the atomic mass of copper is 63.5 u, which means that the mass of one mole of copper atoms is 63.5 g. Likewise, the molecular mass of water is 18.0 u, and the mass of one mole of water molecules is 18.0 g.

The mole is the common language in chemical reactions. In this experiment, you will observe the reaction of iron nails with a solution of copper(II) chloride and determine the number of moles involved in the reaction.

Iron and copper, along with gold, silver, lead, and antimony, were known in very early times. Iron and copper occur naturally in the earth's crust as oxides or sulfides. Chemical analysis and calculation of ore content is vital to the mining industry. Today an ore containing 3–4% copper is considered high-grade, while iron producers are little interested in ores containing less than 20–30% iron.

## OBJECTIVES

1. to determine the number of moles of copper produced in the reaction of iron and copper(II) chloride
2. to determine the number of moles of iron used up in the reaction of iron and copper(II) chloride
3. to determine the ratio of moles of iron to moles of copper
4. to determine the number of atoms and formula units involved in the reaction.

## MATERIALS

### Apparatus

beakers (250 mL)	safety goggles
wash bottle	lab apron
stirring rod	plastic gloves
crucible tongs	sandpaper or
centigram balance	emery cloth
drying oven	face shield

### Reagents

copper(II) chloride  
2 iron nails  
(approx. 5 cm)  
1M hydrochloric acid  
distilled water

## PROCEDURE

1. Find the mass of a clean, empty, dry 250 mL beaker. Record the mass to the nearest 0.01 g.
2. Add approximately 8 g of copper(II) chloride crystals to the beaker. Find the mass and record it in your notebook.
3. Add 50 mL of distilled water to the beaker. Swirl the beaker around to dissolve all of the copper(II) chloride crystals.
4. Obtain two clean, dry nails. If the nails are not clean, use a piece of sandpaper to make the surface of the nail shiny. Find the mass of the nails and record it in your notebook.



**CAUTION:** Copper(II) chloride is very poisonous and can kill you. Do not get it in your mouth. Do not swallow any.

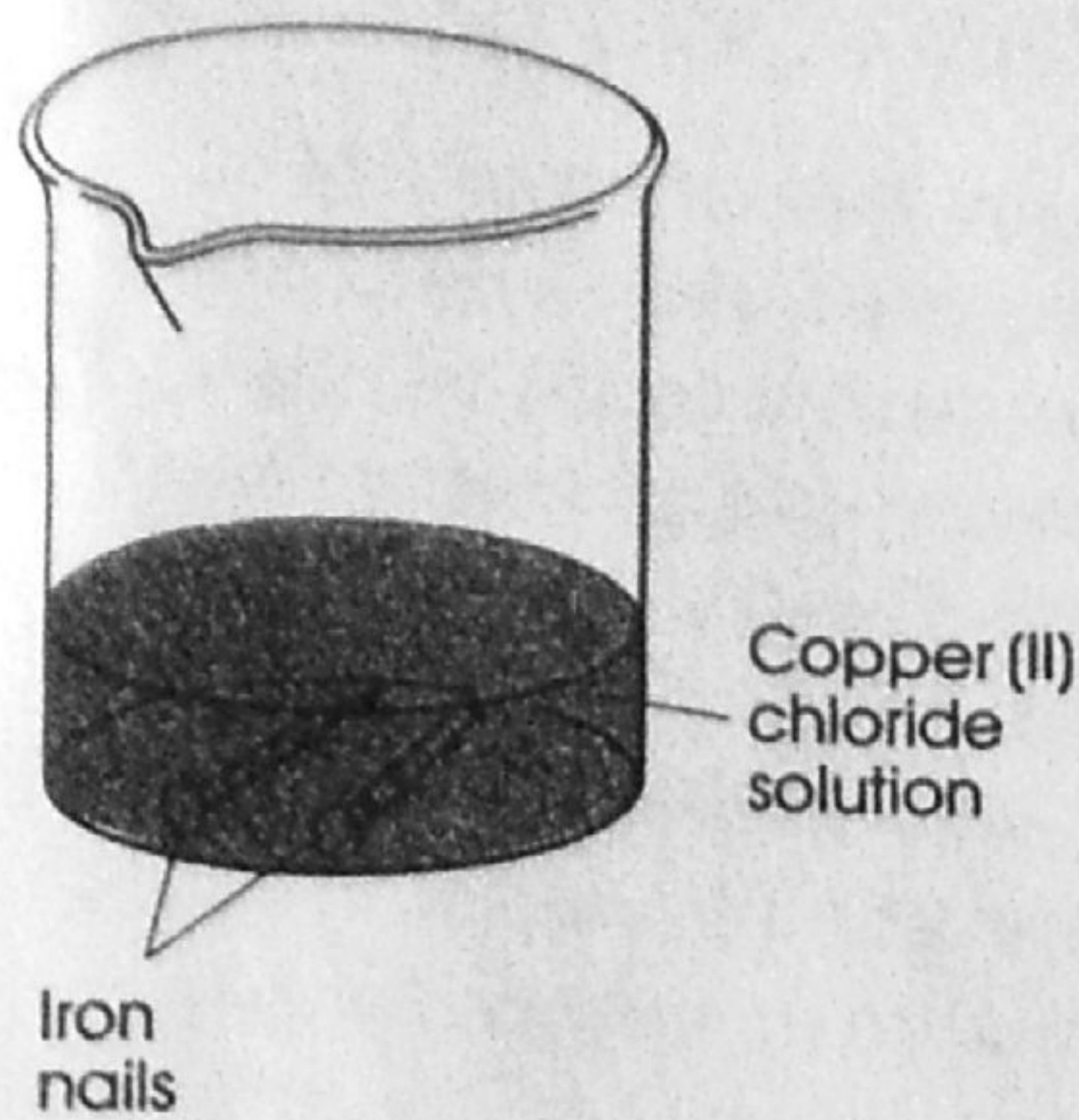
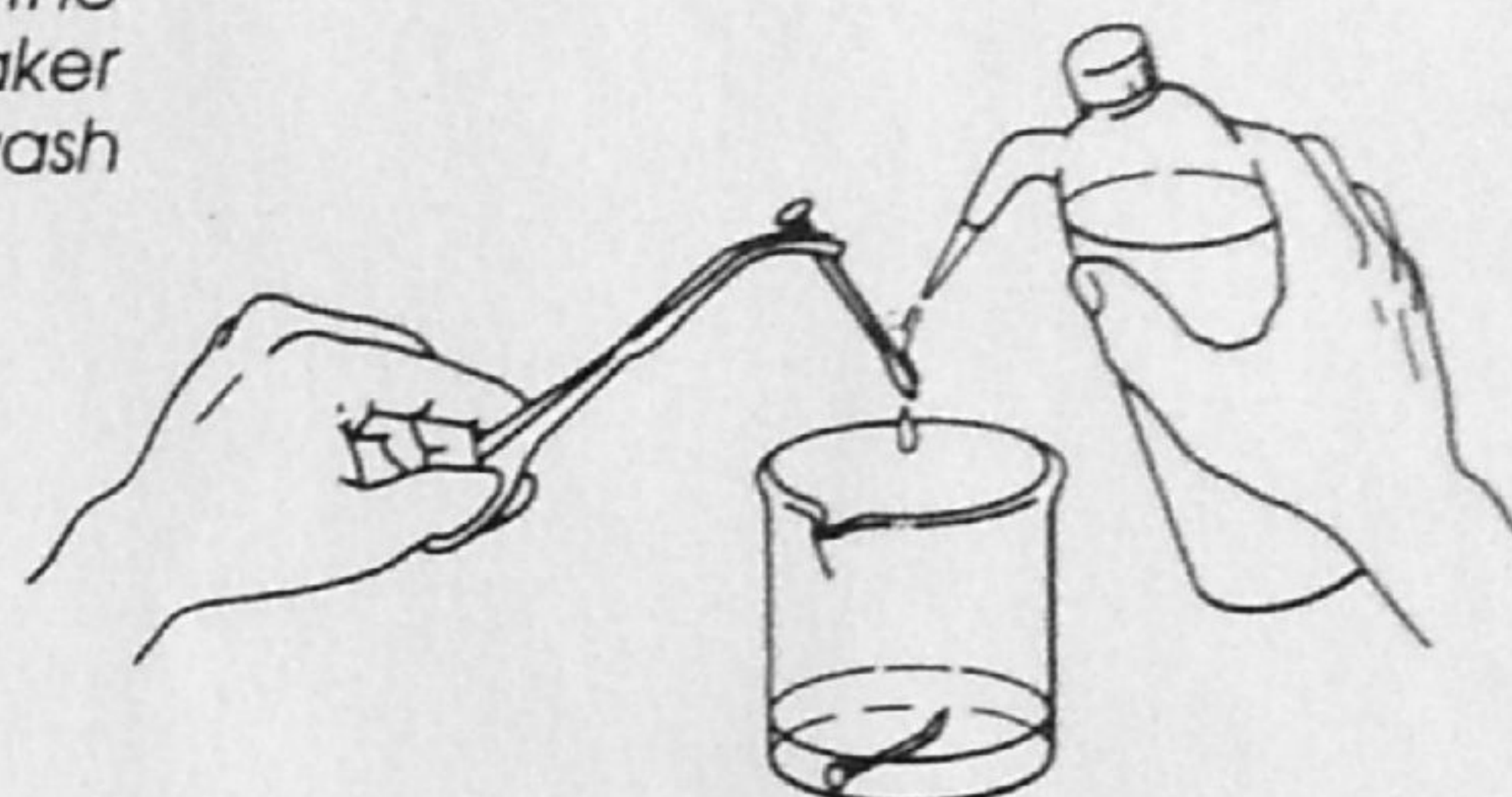


Figure 4B-1

- Place the nails into the copper(II) chloride solution, as shown in Figure 4B-1. Leave them undisturbed for approximately 20 min. During that time, you should see the formation of copper in the beaker. At the same time, some of the iron will be used up.
- Use the tongs to carefully pick up the nails, one at a time. Use distilled water in a wash bottle to rinse off any remaining copper from the nails before removing them completely from the beaker. (See Figure 4B-2.) If necessary, use a stirring rod to scrape any excess copper from the nails. Set the nails aside to dry on a paper towel.

Figure 4B-2 Any copper remaining on the nails may be washed back into the beaker with the use of distilled water from a wash bottle.



- After the nails are completely dry, find the mass of the nails and record it in your notebook.
- Decant* means to pour off only the liquid from a container that is holding both solid and liquid. Carefully decant the liquid from the solid. (See Figure 4B-3.) Pour the liquid into another beaker so that in case you overpour, you can still recover the solid.

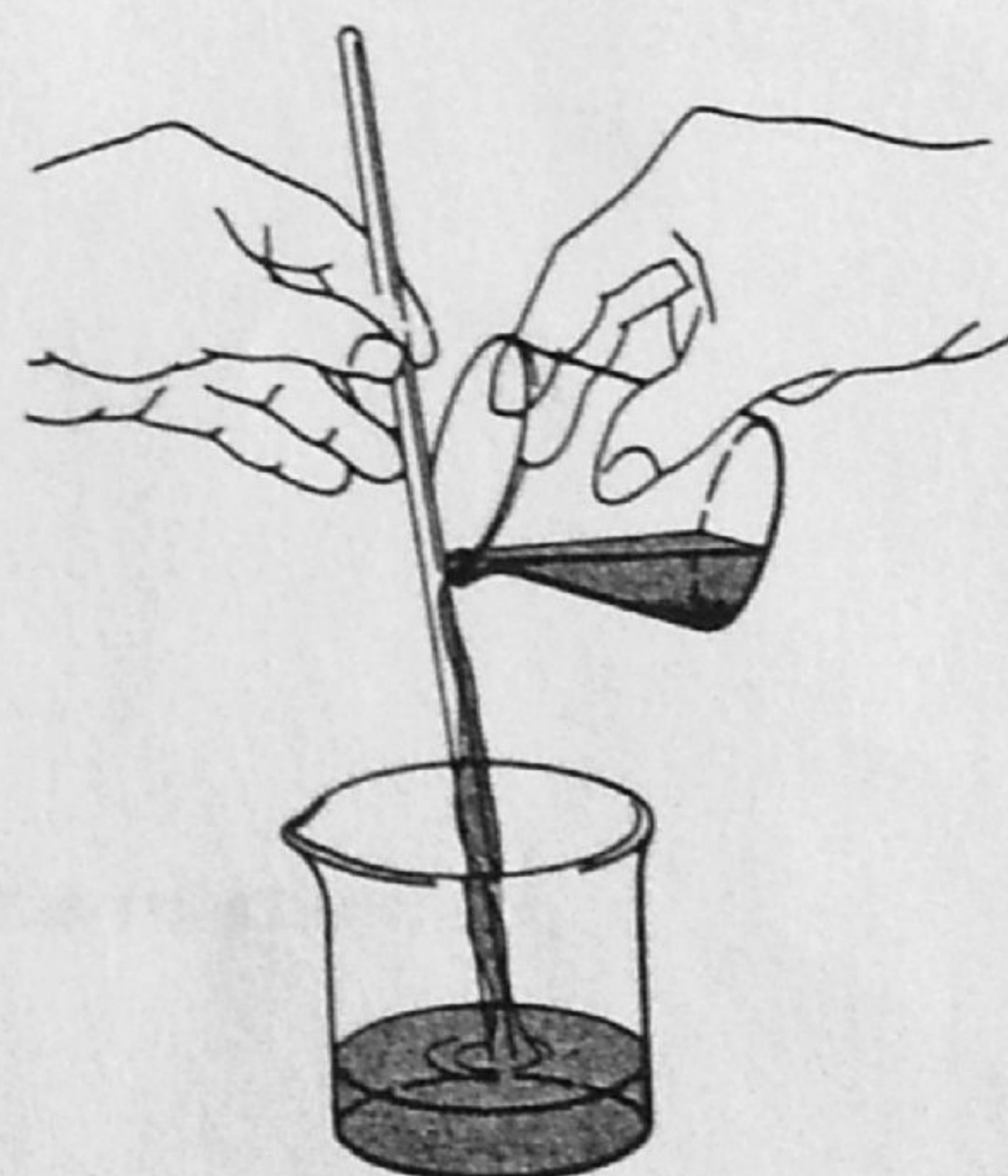


Figure 4B-3 When decanting, it is helpful to direct the liquid into the second beaker along a stirring rod, as shown here.



**CAUTION:** Hydrochloric acid is corrosive to skin, eyes, and clothing. When handling 1M hydrochloric acid, wear safety goggles, lab apron, and use a full face shield and gloves. Wash spills and splashes off your skin and clothing immediately using plenty of water. Call your teacher.

- After decanting, rinse the solid again with about 25 mL of distilled water. Decant again. Repeat this step three or four more times.
- Next, wash the solid with about 25 mL of 1M hydrochloric acid. Decant again; then, once more, clean the solid with 25 mL of distilled water.
- After the final washing with water, place the copper in a drying oven to dry.
- Allow the copper to become completely dry, then find the mass of the beaker plus the copper and record it in your notebook.
- Clean up all of your materials. Before you leave the laboratory, wash your hands thoroughly with soap and water; use a fingernail brush to clean under your fingernails.

## REAGENT DISPOSAL

Rinse all solutions down the drain with plenty of water. Place solids in the designated waste containers.