

PURPOSE

To investigate factors that influence the rate of solution formation.

BACKGROUND

When you put a spoonful of sugar into a glass of iced tea, you probably begin to stir it up immediately. Why? If your reply is that the sugar will sink to the bottom and not easily dissolve if it is not stirred, you already understand an important fact about solution formation. Stirring is one of several factors that determines how fast a substance will dissolve and form a solution.

A solution consists of a *solute*, the material that is dissolved, and a *solvent*, the material that the solute is dissolved in. In this experiment, you will investigate the effects of stirring, temperature, and particle size on the rate of dissolution.

MATERIALS (PER PAIR)

safety goggles	1 spatula
7 large test tubes	1 thermometer
1 test-tube rack	1 glass-marking pencil
2 100-mL beakers	sodium chloride, NaCl
1 50-mL graduated cylinder	copper(II) sulfate pentahydrate,
1 ring stand	$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  
1 ring support	crushed ice
1 wire gauze	paper towels
1 gas burner	weighing paper
1 mortar and pestle	distilled water

SAFETY FIRST!

In this lab, 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 your safety goggles. (All steps.)



Caution: Do not touch hot equipment. (Step 8.)



Caution: $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ is toxic and irritating. Avoid contact with this material. (Steps 1 and 2.)



Caution: Exercise care when working with an open flame. Tie back hair and loose clothing. Do not use the burner near flammable materials. (Step 5.)



Caution: Return or dispose of all materials according to the instructions of your teacher (Steps 4 and 9.)

PROCEDURE

As you perform the experiment, record your observations in Data Tables 1 and 2.

Part A. Effects of Particle Size and Mixing



1. Label four large test tubes with the numbers 1–4. Use a spatula to put four pea-sized crystals of copper(II) sulfate pentahydrate, $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$, on a piece of weighing paper.
2. Put one crystal of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ into tube 1 and another crystal into tube 2. Crush a third crystal with the mortar and pestle and pour the powder into tube 3. Crush the fourth crystal and pour the powder into tube 4.
3. Fill each of the four test tubes about one-third full of water. Place tubes 1 and 3 in the test-tube rack without shaking them. Flick tubes 2 and 4. Note how long it takes for the contents of each of the four tubes to dissolve. Record your observations in Data Table 1.
4. Follow your teacher's instructions for proper disposal of the materials. Be sure to wash your hands thoroughly after completing Part A.

Part B. Effect of Temperature



5. Add 50 mL of distilled water to a 100-mL beaker. Using a gas burner, heat the water until it is almost boiling. While the water is heating, proceed to Step 6.
6. Half-fill a 100-mL beaker with crushed ice and then add approximately 30 mL of distilled water to the beaker. While the water is chilling, proceed to Step 7.
7. Label three large test tubes with the numbers 1–3. Add 1 g of sodium chloride to each test tube. Place the tubes in a test-tube rack.
8. Fill tube 1 one-third full with ice-cold water (see Step 6). Fill tube 2 one-third full with distilled water at room temperature. Fill tube 3 one-third full with hot water (see Step 5). **CAUTION:** Pour the hot water from the beaker using a paper towel "handle" as illustrated in Figure 30.1. Gently flick the contents of the test tubes. Note how long it takes for the contents of each tube to dissolve. Record your observations in Data Table 2.
9. Dispose of the contents of the three test tubes by pouring them down the drain.

OBSERVATIONS

DATA TABLE 1: EFFECTS OF PARTICLE SIZE AND MIXING ON SOLUTION FORMATION				
Tube	Particle Size	Mixed?	Time to Dissolve	Observations
1				
2				
3				
4				

DATA TABLE 2: EFFECTS OF TEMPERATURE ON SOLUTION FORMATION			
Tube	Temperature	Time to Dissolve	Observations
1			
2			
3			

ANALYSES AND CONCLUSIONS

1. What effects does particle size appear to have on the rate at which a solute dissolves? Why should particle size make a difference in the rate of dissolving?

2. Does shaking the test tube affect the rate at which a solute dissolves? Explain your results.

- Using kinetic theory, explain the effect of temperature on the dissolution rate of a solute.

GOING FURTHER

Develop a Hypothesis

Based on the results of this lab, develop a hypothesis concerning the effect of temperature on the amount of solute that will dissolve in a given volume of solvent.

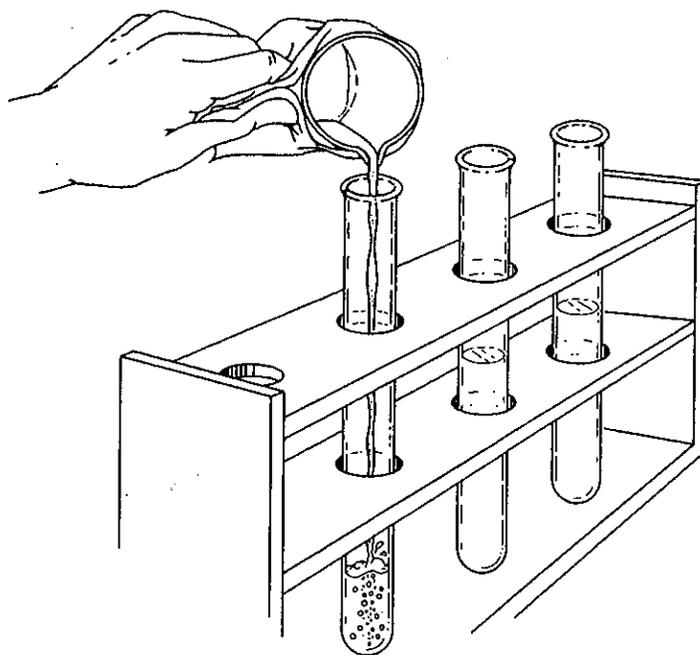


Figure 30.1