Factors Affecting Solubility

bility is defined as the amount of a substance capable of dissolving specified amount of another substance. Solutions are mixtures con- ng a *solute* (substance being dissolved) and a *solvent* (material that olves another substance). Solutes and solvents can be solids, liquids, ases, but the most common solutions have liquid solvents.

here are several factors that affect the solubility of a solute in a par- ar solvent. In this experiment, you will examine the effects of tem- ture, of size of solute particles, and of shaking or stirring on solu- with water as the solvent and sodium chloride, potassium nitrate, carbon dioxide as the solutes.

Objectives

etermine the effect of temperature, size of particles, and stirring on e solubility of solids and gases in water.

mpare the solubilities of two ionic compounds at three temperatures.

ntrast the solubility of gases and solids and ***relate*** the differences to olecular motion.

Materials

aratus

x 100-mm test tubes
ube rack
ube holder
L graduated cylinder
vatch or watch with
cond hand
ometer
-mL beakers
ring rods
late
gram balance
goggles
atory apron

Reagents

sodium chloride (large crystals)
sodium chloride (fine powder)
sodium chloride (normal crystals)
potassium nitrate
club soda
distilled water
ice

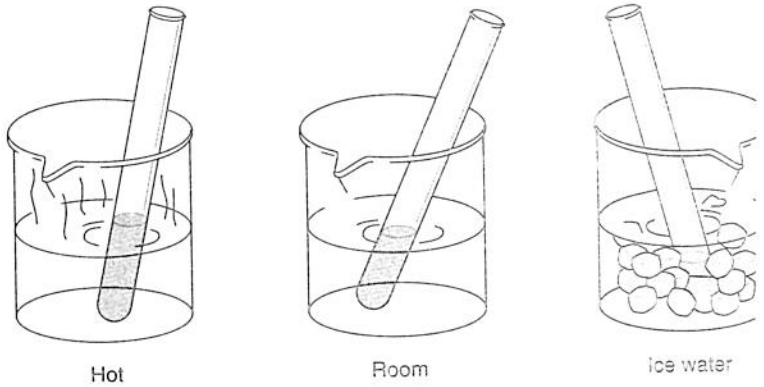
Prelab

1. Read the introduction and procedure before you begin.
2. Answer prelab questions 1–6 on the Report Sheet.

Procedure

Part 1

1. Put on your safety goggles and laboratory apron.
2. In a beaker on the hot plate, begin heating about 75 mL of water to approximately 70°C.
3. Put 75 mL of water in a second beaker and 75 mL of an ice and water mixture in a third beaker.
4. Using the balance, measure out three samples of the sodium chlorid having normal-sized crystals. Each sample should have a mass of 0.25
5. Place 5 mL of distilled water in each of the three test tubes. Place one test tube in the hot water, one in the room temperature water, a one in the ice water as shown in the Figure. Find and record the tem perature of the water in each of the beakers.
6. Find how long it takes to dissolve 0.25 g of sodium chloride in 5 m of water at each of the three temperatures. Be careful to keep all th conditions identical in the experiment *except* for the variable you a testing (in this case, the temperature). Stir each of the solutions wit a different stirring rod. If you don't have three stirring rods, test th solutions one at a time and rinse off the rod between tests. Record the amount of time needed to dissolve the solid in each test tube.



7. Pour the solutions down the drain and rinse the test tubes and stir rods. Do not pour out the water from the beakers. You will need these for the next part.

Part 2

1. Obtain 2 g of normal-sized crystals of sodium chloride and 2 g of potassium nitrate crystals. If necessary, put the hot water back on the hot plate so that the temperature remains about 70°C.
2. Label two test tubes *S* and *P*. In each of the test tubes, place 5 mL of distilled water. Place the test tubes in the ice water and wait for about 2 minutes. Put the sodium chloride in Tube *S* and the potassium nitrate in Tube *P*. Stir each of the solutions (with different stirring rods) for approximately 2 minutes. Record your observations on the Report Sheet.
3. Remove the test tubes from the ice water and place them in the hot water. Continue stirring for about 2 minutes. Again record your observations.
4. Put the test tubes back in the ice water for another 2 minutes. Record your observations.
5. Pour the solutions down the drain. Clean and rinse the test tubes and stirring rods. Keep the hot water for Part 5.

Part 3

1. Obtain 0.25 g samples of each of the three different crystal sizes of sodium chloride.
2. In each of three test tubes, place 5 mL of distilled water at room temperature.
3. With the help of your partner, find how long it takes to dissolve the samples. Stir all the solutions at the same rate. Record the amount of time needed to dissolve all the solid.
4. Pour the solutions down the drain. Clean and rinse the test tubes and stirring rods.

Part 4

1. Obtain two 0.25 g samples of fine crystals of sodium chloride.
2. In each of two test tubes, place 5 mL of distilled water at room temperature. Add a sample of the sodium chloride to each of the tubes. Stir one of the test tubes; leave the other undisturbed. Record the time necessary to dissolve the one that is stirred. The one left unstirred will take much longer. Keep an eye on this one throughout the rest of the lab and estimate the time it takes to dissolve the sample without stirring.
3. Pour the solution down the drain. Clean and rinse the test tubes and stirring rods.

2. Club soda is a solution having carbon dioxide as the solute and water as the solvent. Open a container of club soda and record your immediate observations on the Report Sheet. Pour 5 mL of the liquid into a test tube. Lightly shake the tube. Record your observations. Pour out the sample.
3. Put another 5 mL of club soda in a test tube. Place the test tube in the boiling water. Record your immediate observations and your observations after one minute.
4. Before leaving the laboratory, clean up all materials and wash your hands thoroughly.

Experiment 15-1

Name _____

Class _____

Date _____

Report Sheet

Factors Affecting Solubility

Prelab Questions

1. In a solution of salt water,
   (a) what is the solute?
   (b) what is the solvent?

2. Give five examples of solutions that you use on a regular basis. Identify the solute and solvent in each of the solutions.

   a. _____

   b. _____

   c. _____

   d. _____

   e. _____

3. Why is it necessary to keep all the conditions of an experiment identical except for the factor being studied?

   _____

   _____

   _____

4. Give two examples of gases dissolved in liquids.

   a. _____

   b. _____

5. What are the three factors affecting solubility examined in this experiment?

a. _____

b. _____

c. _____

6. In your own words, write the purpose of this experiment.

_____

_____

_____

_____

_____

_____

Data and Observations

Data Table 1

beaker	temp in °C	Time to dissolve
hot		
room temp		
cold		

Data Table 2

Observations	KNO_3	NaCl
ice water		
hot water		
ice water (2nd)		

Data Table 3

Size of crystals	Time to dissolve
finely powdered	
normal size	
large	

Data Table 4

	Time to dissolve
no stirring	
stirring	

Data Table 5

when bottle is opened	
test tube is shaken	
test tube is heated	

Analysis and Conclusions

1. Based on what you observed in this experiment, what factors favor the dissolving of solids in liquids?

2. Based on what you observed in this experiment, what factors favor the dissolving of gases in liquids?

3. In terms of molecular motion, explain the differences between the dissolving of solids in liquids and the dissolving of gases in liquids.

4. Which solid, potassium nitrate or sodium chloride, is more soluble in water at the temperatures given?

   a. 10°C

   b. 90°C

Synthesis

1. What effect would an increase in pressure have on the solubility of solids in liquids?

2. What effect would an increase in pressure have on the solubility of gases in liquids?

3. The potassium nitrate solution, as you prepared it, is a saturated solution at the higher temperature. What does this mean?

Real World Connections

Many people drink both iced tea and hot tea with lemon juice and sugar to enhance the flavor. Explain any differences in the rate of dissolving both the sugar and the lemon juice in the two types of tea.