Name _____ Date _____ Class _____

LAB 15.1 LABORATORY MANUAL

Making a Solubility Curve

Use with Section 15.1

A solution is a homogeneous mixture of a solute in a solvent.

Solvents, however, are only able to dissolve (solvate) a limited amount of solute. As solute is added to a solvent and the solution is being formed, the solvent has an ever-decreasing ability to dissolve more solute. As long as the solvent is able to dissolve more solute, the solution is unsaturated. When the solvent can no longer dissolve additional solute, the solution is saturated. Any additional solute added will collect on the bottom of the container and remain undissolved. The amount of solute that can be dissolved in a given amount of solvent at a specific temperature and pressure is defined as the solubility of the solute.

Solubility is dependent upon temperature. Generally, solvents at lower temperatures cannot dissolve as much solute as solvents at higher temperatures. In this activity, you will determine the solubility of a salt at different temperatures and will plot a solubility curve for the solute.

Problem

How do you determine the solubility curve for a given salt?

Objectives

- **Prepare** a saturated solution in ice water.
- **Graph** solubility as a function of temperature and **observe** how the solubility changes with changing temperature.

Materials

Sodium chloride (NaCl)
Ammonium chloride (NH_4Cl)
Distilled water
250-mL beakers (2)
100-mL graduated Cylinder
Thermometer
Watch Glass
Pan with Ice
Weighing Dish (2)
Hot Plate
Stirring Rod
Balance
Scoopula

Safety Precautions

- **Always wear safety goggles and a lab apron.**
- **Never taste any substance used in the lab.**
- **Use caution around hot items.**

Pre-Lab Questions

1. How will you know when the solution is saturated?
2. Why is a mixture of ice and water used to make the freezing ice-water bath?
3. Why must a saturated solution be obtained in order to make a solubility curve?
4. Read over the entire laboratory activity. Hypothesize what will happen to the solubility when a saturated solution is heated. Record your hypothesis on page 114.

Procedure

1. Select one of the two salts to test and record its identity in **Data Table 1.**
2. Using a graduated cylinder, measure 50 mL of water into a 250-mL beaker.
3. Add the ice to the beaker and insert the stirring rod. Stir the ice and water mixture for 1 minute, then use the thermometer to measure the temperature of the mixture. **CAUTION: Do not use the thermometer to stir the mixture.**
4. When the temperature is consistently between 0°C and 2°C, remove the thermometer and the stirring rod. Place a watch glass over the beaker. Pour exactly 50-mL of the cold water into a graduated cylinder. Pour the remaining ice/water mixture into the ice pan.
5. Record the volume of the cold water in **Data Table 1.** Place the beaker of cold water in a pan containing ice. Surround the breaker with additional ice. Use the thermometer to measure the temperature of the water and record it in **Data Table 1**. During the solubility test, the cold water needs to stay under 5°C
6. Using the balance, measure 5.0 g of the selected salt and add it to the water in the beaker. Stir the mixture until the solid is dissolved.
7. Repeat step 6 until no more of the salt will dissolve. The solution is now saturated. Make sure to keep track of the total mass of the salt added to the water. Any excess solid will remain on the bottom of the beaker. Record the amount of salt added to make the saturated solution in **Data Table 1.**
8. Remove the beaker form the pan and carefully dry the outside of the beaker with a paper towel. Place the beaker on the hot plate.
9. Using the thermometer to measure the temperature of the solution in the beaker, heat the solution to 20°C. Remove and replace the beaker from the hot plate as needed to maintain a constant 20°C temperature.
10. When the undissolved solid from the saturated solution dissolves, add another 5.0 g of the salt to the water. Stir until the salt dissolves. Continue adding the salt at 5.0-g increments until no more solid will dissolve in the water. The solution is saturated again. Any excess solid will remain on the bottom of the beaker. Record the amount of solid added to make the saturated solution in **Data Table 1.**
11. Repeat steps 9 and 10 at temperatures of 50°C and 80°C. **CAUTION: The beaker is hot.**
12. Remove the beaker from the hot plate and gently set it on the lab bench to cool.
13. Plot a graph of the mass of salt dissolved versus temperature. Draw a best-fit smooth curve through the data points. With the help of your teacher, obtain solubility data from the other groups in your class for the remaining three salts. Graph this data on your graph to obtain a family of solubility curves.

Hypothesis

_____

_____

_____

Cleanup and Disposal

1. Turn off the hot plate and allow it to cool.
2. Make sure all glassware is cool before emptying the contents.
3. Place all chemicals in appropriately labeled waste containers.
4. Return all lab equipment to its proper place.
5. Clean up your work area.

Data and Observations

Data Table 1			
Temperature (°C)	Identity of salt		
	NaCl	NH_4Cl	Volume of Water: _____
	Mass of salt added to make a saturated solution (g)		
0°C			
20°C			
50°C			
80°C			

Analyze and Conclude

1. **Observing and Inferring:** What happened to the solubility of the salt as the temperature increased?

2. **Comparing and Contrasting:** The solubility of which of the four salts is the most temperature dependent?

3. **Predicting:** What would happen to the solubility of each salt if it was tested at temperatures above 80°C?

4. **Thinking Critically** Why was the excess ice removed from the water before any salt was added?

5. Error Analysis Compare the results of this lab with the predictions of your hypothesis. Explain possible reasons for any disagreement.

Real-World Chemistry

1. In a dishwasher, the temperature of the water is very hot. Explain why it is better to use hot water in a dishwasher rather than cold water.

2. Unlike solids for which solubility in a liquid generally increases with increasing temperature, the solubility of a gas in a liquid usually decreases as the temperature increases. Knowing this, explain why you should never heat a can containing a carbonated soft drink.

Solubility Curve Graph of 2 Salts