Name _____ Date _____ Class _____

Solubility of a Salt

Lab 30

Text reference: Chapter 16, pp. 440–444

Pre-Lab Discussion

The solubility of a pure substance in a particular solvent is the quantity of that substance that will dissolve in a given amount of the solvent. Solubility varies with the temperature of the solvent. Thus, solubility must be expressed as quantity of solute per quantity of solvent at a specific temperature. For most ionic solids, especially salts, in water, solubility varies directly with temperature. That is, the higher the temperature of the solvent (water), the more solute (salt) that will dissolve in it.

In this experiment, you will study the solubility of potassium nitrate (KNO_3) in water. You will dissolve different quantities of this salt in a given amount of water at a temperature close to the water's boiling point. Each solution will be observed as it cools, and the temperature at which crystallization of the salt occurs will be noted and recorded. The start of crystallization indicates that the solution has become saturated. At this temperature, the solution contains the maximum quantity of solute that can be dissolved in that amount of solvent.

After solubility data for several different quantities of solute have been collected, the data will be plotted on a graph. A solubility curve for KNO_3 will be constructed by connecting the plotted points.

Purpose

Collect the experimental data necessary to construct a solubility curve for potassium nitrate (KNO_3) in water.

Equipment

balance
burner
microspatula
test tubes, 18×150-mm (4)
test tube holder
test tube rack
beaker, 400-mL
thermometer
graduated cylinder, 10-mL
stirring rod
ring stand
iron ring
utility clamp
wire gauze
marking pencil
safety goggles
lab apron or coat

Materials

potassium nitrate (KNO_3)
distilled water

Safety

Tie back long hair and secure loose clothing when working with an open flame. Be sure you use a test tube holder when removing tubes from the hot water bath. Note the caution alert symbols here and with certain steps

in the "Procedure." Refer to page xi for the specific precautions associated with each symbol. Always wear safety goggles and a lab apron or coat when working in the lab.

Procedure

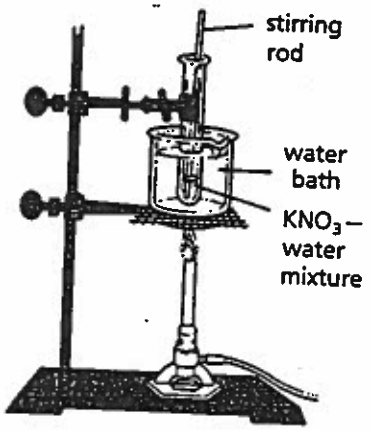

Figure 30-1

While one lab partner carries out the instructions in steps 1 through 4, the other partner should go on to step 5.

1. Using a marking pencil, number four test tubes 1 through 4. Place the tubes in a test tube rack.
2. On the balance, measure out exactly 2.0 g of potassium nitrate (KNO_3). Pour the salt into test tube #1.
3. Repeat step 2 for the following masses of KNO_3. Add each quantity to the test tube indicated:
   - 4.0 g to test tube #2
   - 6.0 g to test tube #3
   - 8.0 g to test tube #4
4. Add exactly 5.0 mL distilled water to each test tube.
5. Fill a 400-mL beaker about three-fourths full of tap water. This will be used as a water bath. Using the water bath and test tube #1, prepare the setup shown in Figure 30-1. Heat the water to 90°C and adjust the flame to maintain the water at about this temperature.
6. Stir the KNO_3-water mixture with a glass stirring rod until the KNO_3 is completely dissolved. Remove the stirrer and rinse it off. Loosen the clamp and, using a test tube holder, remove the tube.
7. While lab partner number one repeats step 6 for test tube #2, lab partner number two should place a *warm* thermometer (dipped into the hot-water bath) into the solution in test tube #1. Hold the test tube up to the light and watch for the first sign of crystallization in the solution. At the *instant* crystallization starts, observe and record the temperature. Should crystallization start too quickly (because of a cold thermometer), redissolve the solid in the hot-water bath and repeat this step.
8. Steps 6 and 7 should be followed for all four test tubes. One lab partner should stir the KNO_3 until it dissolves, and the other partner should record the temperatures of crystallization. Record all temperatures in "Observations and Data."
9. If any doubtful results are obtained, the procedure can be repeated by redissolving the salt in the hot-water bath and allowing it to recrystallize.

Observations and Data

test tube #	grams of KNO_3/5.0 mL H_2O	crystallization temperature (°C)
1	2.0 g/5.0 mL	_____
2	4.0 g/5.0 mL	_____
3	6.0 g/5.0 mL	_____
4	8.0 g/5.0 mL	_____

Name _____

30 Solubility of a Salt (continued)

Calculations

1. Using proportions, convert the experimental mass/volume ratios to equivalent mass/100-mL ratios.

2.0 g/5.0 mL = _____ g/100 mL

4.0 g/5.0 mL = _____ g/100 mL

6.0 g/5.0 mL = _____ g/100 mL

8.0 g/5.0 mL = _____ g/100 mL

2. Plot your experimental data on the grid provided. Plot mass of solute per 100 mL of water on the *y*-axis and temperature on the *x*-axis.

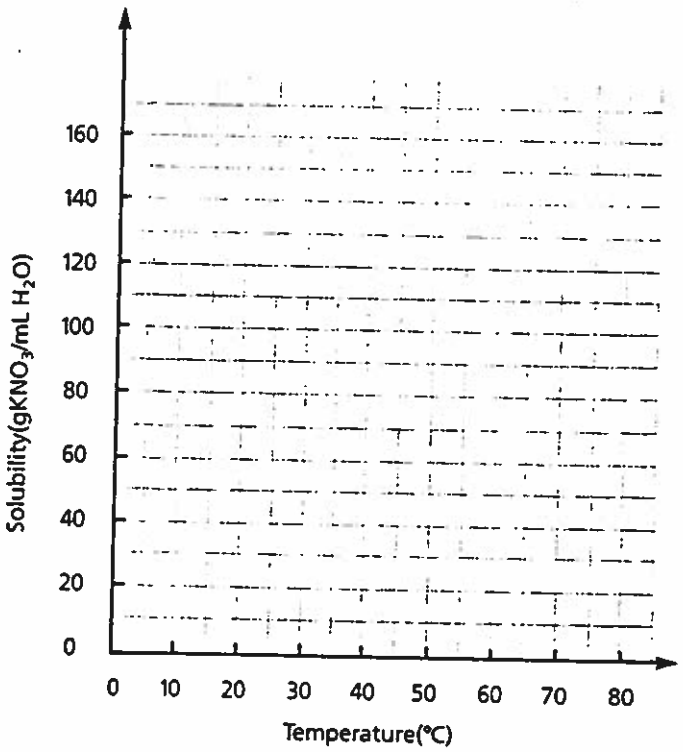

Figure 30-2

3. Construct a solubility curve by connecting the plotted points on your graph.

Conclusions and Questions

1. How many grams of KNO_3 can be dissolved in 100 mL of H_2O at the following temperatures?

a. 30°C **b.** 60°C **c.** 70°C

_____

_____

_____

2. Define the terms saturated, unsaturated, and supersaturated.

3. Classify the following KNO_3 solutions as saturated, unsaturated, or supersaturated. Explain your answer.
   a. 75 g KNO_3/100 mL H_2O at 40°C
   b. 60 g KNO_3/100 mL H_2O at 50°C

4. Do the solubilities of all ionic solids increase as the temperature increases? Explain.

5. How does the solubility of a gas change with increasing temperature? Draw a rough sketch showing the general shape of a solubility curve of a gas.

6. The graph in Reference Table G shows solubility curves for several compounds. Which of the compounds represented on this graph become *less* soluble as temperature increases?