

Solubility Curve of KNO_3

Lab 49

Text reference: Chapter 17

Introduction

The maximum amount of solute that will dissolve in a given amount of solvent is called its solubility. What factors determine the solubility of a substance? Certainly the identity of the solute affects the amount of the substance that can dissolve. For example, sodium iodide is more soluble than sodium chloride in a given amount of water. The identity of the solvent also affects the solubility of a substance. Sodium chloride is highly soluble in water but not very soluble in ethanol. Temperature of the solvent is another factor affecting solubility. The solubility of most solids varies directly with temperature. In other words, the higher the temperature of the solvent, the more solute will dissolve—that is, the greater the solubility of the solid.

In this investigation, you will study the relationship between the solubility of potassium nitrate (KNO_3) and the temperature of the water solvent. Different amounts of KNO_3 will be dissolved in a given amount of water at a temperature close to its boiling point. You will observe each solution as it cools and note the temperature at which crystallization occurs. Crystallization indicates a saturated solution, or one that contains the maximum amount of KNO_3 in that amount of water. From this solubility data, a solubility curve for KNO_3 can be constructed.

Pre-Lab Discussion

Read the entire laboratory investigation and the relevant pages of your textbook. Then answer the questions that follow.

1. Define the following terms.

solubility: _____

saturated solution: _____

unsaturated solution: _____

supersaturated solution: _____

2. Determine the solubility of sodium sulfate, Na_2SO_4 , in grams per 100 g of water, if 0.94 g of Na_2SO_4 in 20 g of H_2O results in a saturated solution.

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3. Why is it necessary to warm the thermometer in Procedure Step 2 before placing it into the solutions? _____

4. A student stated that the solubility of potassium chloride, KCl, at 20°C was 36 g of KCl per 100 g of solution. What is wrong with this statement? _____

5. How do you know when the solid is completely dissolved? _____

6. What special precautions should be taken while doing this investigation? _____

Problem

How does the solubility of potassium nitrate depend on temperature?

Materials

chemical splash goggles	laboratory balance
laboratory apron	potassium nitrate (KNO ₃)
4 test tubes, 18 mm × 150 mm	graduated cylinder, 10-mL
marking pen	distilled water
test-tube rack	utility clamp
beaker, 400-mL	ring stand
thermometer	stirring rod
hot plate	test-tube holder

Safety



Wear your goggles and lab apron at all times during the investigation. Do not touch the hot plate or heated water with your bare skin. Note the caution alert symbols here and with certain steps of the Procedure. Refer to page *xi* for the specific precautions associated with each symbol.

Procedure



1. Put on your goggles and lab apron. Label four test tubes 1–4 with a marking pen. Place them in a test-tube rack.





2. Fill a 400-mL beaker three-fourths full of tap water, place a thermometer in it, and heat the water on a hot plate until its temperature is about 90°C. **CAUTION:** Do not touch the hot plate or heated water with your bare skin. While you are waiting for the water to heat, go on to Steps 3 and 4.



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3. Place the following masses of potassium nitrate (KNO_3) into the test tubes:
 - 2.0 g in test tube 1
 - 4.0 g in test tube 2
 - 6.0 g in test tube 3
 - 8.0 g in test tube 4
4. Add 5.0 mL distilled water to each test tube. Attach a utility clamp to a ring stand.
-  5. Place test tube 1 in the clamp and lower it into the hot water bath. Stir the KNO_3 solution with the stirring rod until the solid is completely dissolved. Remove the stirring rod and rinse it off. Loosen the utility clamp and, using a test-tube holder, remove the test tube.
6. One lab partner should place the warm thermometer from the hot water bath into test tube 1 while the other repeats Step 5 for test tube 2.
7. Watch test tube 1 for the first sign of crystallization and when it occurs record the temperature in the Data Table. Remove test tube 2 from the hot water bath and repeat Steps 6 and 7.
8. Repeat Steps 5–7 for test tubes 3 and 4.
-  9. Place all the test tubes back in the hot water bath and redissolve the solid. Flush the solutions down the drain with plenty of hot water. Turn off the hot plate. Clean up your work area and wash your hands before leaving the laboratory.

Observations

DATA TABLE

Test Tube #	Temperature ($^{\circ}\text{C}$)
1	
2	
3	
4	

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Calculations

1. For each test tube, determine the solubility of KNO_3 in grams per 100 g H_2O .

test tube 1:

test tube 2:

test tube 3:

test tube 4:

Critical Thinking: Analysis and Conclusions

1. Construct a solubility curve for KNO_3 by graphing the mass of KNO_3 per 100 grams H_2O (solubility) versus temperature. Place temperature on the x-axis and solubility on the y-axis. Connect the points in a smooth curve. (*Interpreting data*)

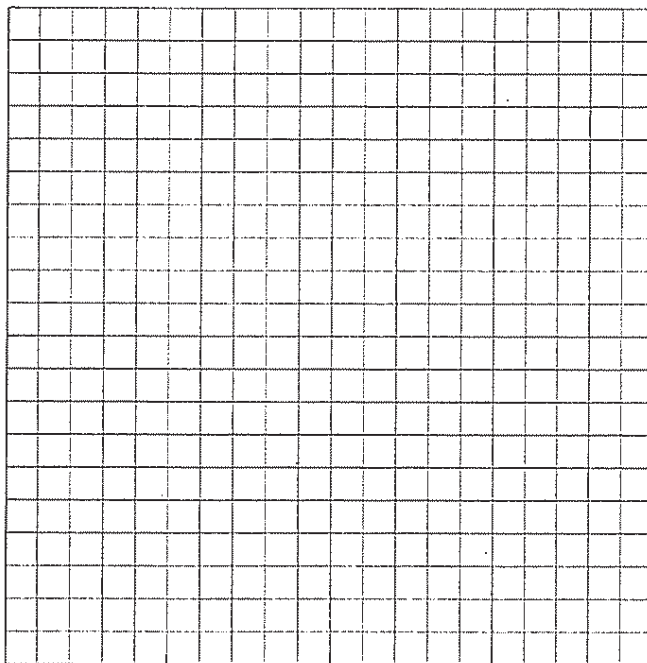


Figure 49-1

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2. Describe the relationship between the solubility of KNO_3 and the temperature of the solvent. (*Interpreting diagrams*) _____

3. Using your graph, determine how many grams of KNO_3 can be dissolved in 100 g of H_2O at the following temperatures: (*Interpreting diagrams*)

35°C _____

60°C _____

70°C _____

Critical Thinking: Applications

1. Using your graph, predict whether the following solutions of KNO_3 would be considered saturated, unsaturated, or supersaturated. (*Making predictions*)

75 g KNO_3 /100 g H_2O at 40°C _____

60 g KNO_3 /100 g H_2O at 50°C _____

2. Sketch the general shape for a solubility curve for a gas. (*Applying concepts*) _____

