Temperature and Solubility

Background: The maximum amount of solute that is capable of dissolving in a given mass of solvent is affected by temperature. If the heat of solution (ΔH) is positive, the dissolving process is endothermic and the solubility is greater at higher temperature. If the heat of solution is negative, the dissolving process is exothermic and the solubility decreases with temperature increases.
In this experiment you will measure the solubility of potassium chloride (KCl) at an assigned temperature. Other members of the class will determine the solubility at different temperatures. The class results will be used to construct a solubility curve for potassium chloride and to predict the solubility at unmeasured temperatures.

Objective: To measure the solubility of potassium chloride and to construct a solubility curve from class results which will allow you to predict solubility at temperatures not measured.

Safety: Wear chemical splash goggles, gloves, and an apron. Be sure to check the temperature of heated objects before touching them. Do not heat the evaporating dish too rapidly, as spattering may occur.

Disposal: Flush the potassium chloride solution down the drain. The dry potassium chloride in the evaporating dish can be flushed down the drain.

Materials

• centigram or electronic balance	• **i**ron ring (if using a Bunsen burner)
• evaporating dish	• buret clamp
• watch glass	• ceramic-centered wire gauze (if using a Bunsen burner)
• 600 ml beaker	• 12 g potassium chloride
• funnel	• hot plate or Bunsen burner
• non-mercury thermometer	• test tube (25 x 200 mm)
• stirring rod	• test tube holder
• distilled water	• crucible tongs
• ceramic plate	• 20 ml distilled water
• double buret clamp	• ring stand

Procedure

1. Use a graduated cylinder to transfer 20 mL distilled water to a 25 x 200 mm test tube.
2. Weigh out approximately 12 g of potassium chloride and transfer it to the test tube. Set up a water bath as depicted in Figure 28.1 and clamp the test tube into position. Support a thermometer in the water bath using a double buret clamp.

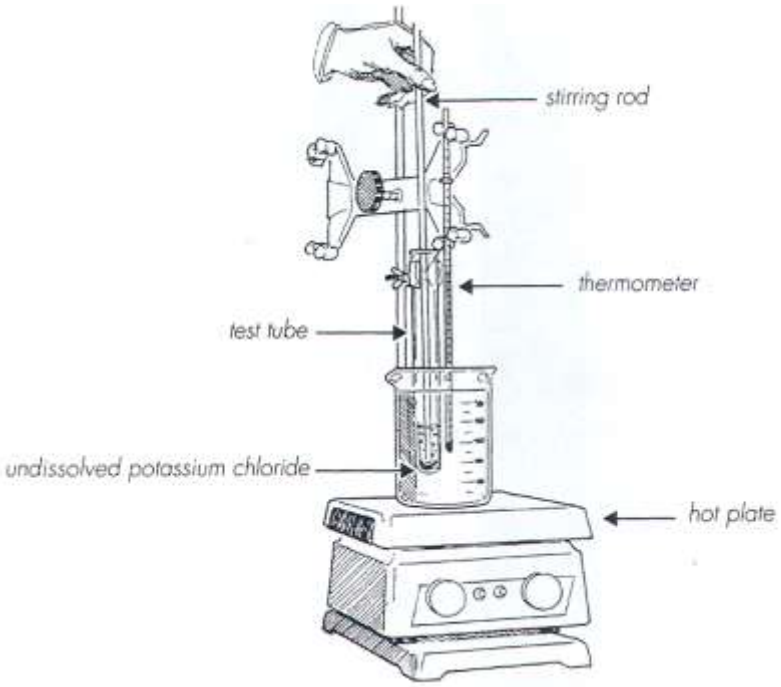

FIGURE 28.1 Experimental setup for measuring the solubility of potassium chloride

3. Adjust the heat of the hot plate or Bunsen burner to bring the water bath to the temperature assigned by your instructor. Using a stirring rod, stir the solution continuously for five minutes. Be sure to maintain a constant temperature.
4. Weigh an evaporating dish and watch glass to +/- 0.01 g and record the result in the Data Table. Place the watch glass on a clean surface.
5. Turn off the heat.
6. Place the test tube in a test tube holder and loosen the jaws of the buret clamp.
7. Decant the test tube contents into the evaporating dish. Hold your stirring rod over the end of the tube to prevent undissolved potassium chloride from entering the evaporating dish. .
8. Determine the mass of the evaporating dish, contents, and watch glass to 0.01 g and record the result.
9. Place the watch glass on the evaporating dish and heat the assembly until the contents are totally dry (see Fig. T19, p. 11). As the water evaporates, reduce the heat to prevent splattering
10. Using crucible tongs, carefully remove the evaporating dish assembly and place it on a clean ceramic plate to cool.
11. When the assembly is cool, determine its mass to 0.01 g and record the result
12. Reheat the sample for an additional five minutes and reweigh the assembly when it has cooled. Record the result.
13. Rinse the product down the drain.
14. Clean up your lab area.

Calculations

1. Determine the mass of the potassium chloride solution by subtracting the mass of the evaporating dish plus watch glass from the mass of the evaporating dish assembly plus contents prior to heating.
2. Determine the mass of the potassium chloride by subtracting the mass of the evaporating dish plus watch glass from the mass of the evaporating dish assembly plus contents after heating.
3. Determine the mass of solvent (water that evaporated)
4. Determine the solubility of potassium chloride in **grams per 100 g of water (note <u>not</u> mass%)**. Record your value in the Calculations Table.
5. Obtain the accepted solubility value for potassium chloride at your assigned temperature and record the value.
6. Determine the percentage error and record the result.
7. Obtain class data and graph the results. Plot the temperature on the abscissa and the solubility on the ordinate.
8. From your graph, calculate the solubility of potassium chloride at 40°C
9. Look up the solubility of potassium chloride at 40^0C and determine the class percentage error.

Data Table	**Measurement**	**Units**
temperature		
mass of evaporating dish assembly		
mass of assembly plus KCl solution		
mass of assembly plus KCl solution after first heating		
mass of assembly plus KCl solution after second heating		

Calculations Table	**Measurement**	**Units**
mass of KCl solution		
mass of dry KCl		
mass of solvent (water)		
experimental solubility		
accepted solubility		g KCl/100 g H_2O
percentage error		
solubility at 40°C (from graph)		
solubility at 40°C (accepted)		
percentage error		

Scoring

Lab technique, safety, and procedure	9 points
Data Table	5 points
Calculations Table	11 points