

## THE SOLUBILITY OF A SALT

The solubility of a solute in a solvent refers to the mass of solute that will dissolve in a given mass of solvent, usually 100 grams. Solubility varies with temperature. For most ionic solids, the higher the temperature of the water, the more solid will dissolve in it. A **solubility curve** plots the *solubility* (grams of solute/100 grams of solvent) against *temperature*.

**Purpose:** to construct the solubility curve for  $\text{KNO}_3$  and to study how solubility varies with temperature.

### Materials:

Hot Plate	Stirring Rod
Test tube rack	Potassium Nitrate ( $\text{KNO}_3$ )
4 test tubes	Distilled Water
400 mL beaker	Paper Towels
10 mL graduated cylinder	

**Safety Precautions:** Wear safety goggles at all times. Review precautions for using hot plates.

### Procedure:

*(One lab partner should do steps 1-4 while the other partner goes onto step 5).*

1. Obtain a test tube rack and 4 test tubes. Label the test tubes 1-4.
2. Measure out exactly 2.0 grams of  $\text{KNO}_3$  onto weighing paper. Transfer it to test tube 1.
3. Repeat step 2 using the following quantities:

Test tube 2:	4.0 g $\text{KNO}_3$
Test tube 3:	6.0 g $\text{KNO}_3$
Test tube 4:	8.0 g $\text{KNO}_3$
4. Add exactly 5.0 mL of distilled water to each test tube.
5. Fill a 400 mL beaker about  $\frac{3}{4}$  full of tap water to use as a water bath. Heat the water to about  $90^\circ\text{C}$ .
6. Place the first test tube in the water and heat until the contents of the tube are at  $90^\circ\text{C}$ . Adjust the heat, if necessary, to keep the water bath at a constant temperature.
7. Stir the contents of the test tube with a stirring rod until the solid completely dissolves. Remove the stirrer and rinse it. Carefully remove the test tube from the water bath. **Dip a thermometer in the water bath to warm it.** Quickly dry the thermometer with paper towels and insert it into the solution.

8. Hold the test tube up to the light and watch for the first sign of crystallization at the bottom of the test tube. At the instant this occurs, record the temperature of the contents of the test tube. Be patient! It may take several minutes for crystallization to occur in test tube 1.
9. Repeat steps 6-8 for the remaining test tubes, recording the temperature at which crystals first form. (If you are in doubt of any of your results, these steps can simply be repeated). If the thermometer is too cold when you insert it, crystallization will occur too quickly. In that case, repeat the steps using a warmer thermometer.

**Data Table:**

Trial #	Grams of $\text{KNO}_3$ / 5.0 mL water	Grams of $\text{KNO}_3$ /100 mL water	Crystallization Temperature

**Calculations and Questions:**

Please answer the following on separate paper:

1. Make a graph with solubility (in grams of  $\text{KNO}_3$  per 100 mL of water) on the y-axis and crystallization temperature on the x-axis. Draw a smooth curve through the points.
2. From your graph, how many grams of  $\text{KNO}_3$  can be dissolved in 100 mL of water at 30°C? At 60°C? At 70°C?
3. How many grams of  $\text{KNO}_3$  should be added to 100 mL of water at 25°C to make a saturated solution?
4. Classify the following solutions as saturated, unsaturated, or supersaturated:
  - a. 75 g  $\text{KNO}_3$ /100 mL water at 40°C
  - b. 50 g  $\text{KNO}_3$ /100 mL water at 55°C
5. The solubility of  $\text{KNO}_3$  increases as temperature increases. When  $\text{KNO}_3$  dissolves, is the process endothermic or exothermic?
6. When  $\text{CaCl}_2$  dissolves, the process is exothermic. Is  $\text{CaCl}_2$  more soluble at high temperatures or low temperatures?

**Lab Checklist:**

- Data Table (on this handout)
- Graph (with labeled axes)
- Answers to questions on separate paper