**AP Chemistry Lab 13**

**Solubility Curve of Potassium Nitrate**

**PURPOSE**
- To calculate the solubility of a potassium nitrate as a function of temperature.
- To construct a solubility curve based on experimental data.

**INTRODUCTION**

A key factor affecting the solubility of a substance (how much solute can be dissolved in a solvent) is temperature. For most solid substances, increasing temperature increases solubility.

A solubility curve illustrates how the solubility of a substance varies with temperature. By determining the mass of solute that can be dissolved in a volume of solvent under a variety of temperatures we can construct a solubility curve.

In this lab exercise you will create a solubility curve for an ionic compound, potassium nitrate, KNO₃

**DEFINITION**

Solute, solvent, solution, solubility

**EQUIPMENT**
- analytical balance
- large test tube
- 400 mL beaker
- digital thermometer
- 10 mL pipet
- solid potassium nitrate
- distilled water

**SAFETY**
- safety goggles

**PROCEDURE**

*Note: Your lab group will be assigned one particular quantity of potassium nitrate between 4.5g and 13g to use for this experiment. You will need to get the data from all lab groups in order to do the data analysis.*

1. Prepare a water bath by filling a 400 mL beaker approximately two-thirds full with water. Place the beaker on a ring stand above a gas burner and begin heating the water to ~80°C. Use the glass thermometer in you lab drawer to monitor the temperature of the water bath. While this is heating, continue with Step 2.
2. Use the analytical balance to accurately measure the mass of solid potassium nitrate assigned to your group. Place it in a large test tube. It is not necessary that you measure exactly the mass assigned to your group, but you must record the precise mass you actually use.
3. Add exactly 10.00 mL of water to the test tube using a pipette.
4. Place the test tube in the water bath in order to dissolve the solid KNO₃. Use the digital thermometer as a stirring rod to help the dissolving process.
5. Remove the test tube from the hot water bath once the KNO₃ has fully dissolved, keeping the digital thermometer in the tube. Stir constantly. Watch the solution very carefully. Record the temperature as soon as you see crystals forming within the test tube. This could happen almost immediately or this may take a while, depending on the quantity of salt you use. If you miss the exact temperature that
crystallization starts, you need to return the test tube to the water bath to redissolve the salt and allowing it to recrystallize again.

6. Repeat steps 4 and 5 with the same solution to get a second temperature data point. If the two temperature measurements agree to within one-half degree, you do not need to do a third measurement.

7. Write your result (the two temperatures and the amount of potassium nitrate) on the white board. Record the data from other lab groups.

ANALYSIS

1. Average the two temperatures at which crystallization occurred for each quantity of salt.

2. Convert the quantity of salt used into units of grams per 100 grams of water. Assume water has a density of 1.0 g/mL at all temperatures.

3. Prepare a graph showing the mass of potassium nitrate per 100 g water vs. temperature over a temperature range of 0°C to 100°C. Add these points to your data for the graph:
   - solubility at 0.0°C: 13. g/100 g water
   - solubility at 100.0°C: 247 g/100 g water

4. On the same graph, plot the actual solubility of potassium nitrate in grams KNO₃ per 100 g water using data from the internet or other source (state the source of this data). Qualitatively, how do the two curves compare?

5. Based on your solubility curve, would you best describe the following solutions as unsaturated or saturated?
   - 85 g / 100 mL H₂O at 40°C
   - 85 g / 100 mL H₂O at 70°C

6. If a saturated solution of KNO₃ in 100 g water at 70°C is cooled to 40°C, how much KNO₃ would crystallize out?

7. Describe the interparticle forces/bonds that are broken and formed for the process of dissolving potassium nitrate in water. State the specific forces/bonds that are broken and formed in each step. Label each step of this dissolving process as endothermic or exothermic.

8. Draw a particle diagram showing KNO₃(aq). The diagram must include at least one formula unit of potassium nitrate and ten water molecules.

9. How does temperature affect the solubility of most gases?

EXPERIMENTAL ERROR
Calculate the percent error for only the data point at 50.0°C.

You were asked to constantly stir as the solution cooled to prevent supersaturation from occurring. How would the recorded temperature of crystallization be affected if supersaturation had occurred?