Solubility Curve of a Salt

Prepared by
Prof. Nalband S. Hussain,
Dept of Natural Sciences (Chemistry)
LaGuardia Community College

Goals:

- To observe the effect of temperature on the solubility of a salt
- Identify the temperature of recrystallization of a salt
- To plot a curve between solubility (g of solute in 100g of solvent) and temperature.
- To calculate the concentration of the solution at a given temperature using the solubility curve.

Discussion:

Solutions are homogeneous mixtures of two or more pure substances. In this experiment we will be dealing with aqueous (in water) solutions of a salt. The salt is referred to as the solute and the water as the solvent. The same way if you consider glucose solution- glucose is the solute and water as the solvent.

There is a limiting amount of a salt that will dissolve in a given amount of solvent at a given temperature. For most of the solutions the amount of salt dissolved in water increases as the temperature is increased sometimes very markedly. A solution that contains a maximum amount of solute at a given temperature is saturated. The term solubility (g of solute/100g solvent) refers to the concentration of a saturated solution.

A graph which plots the solubility of a solute as a function of temperature is called the solubility curve of the substance. Given such a graph, the solubility of a given solute at any temperature can be determined. Solubility curves are obtained experimentally by determining the salt solubility at different temperatures and plotting the data.

Concentration of solutions can be calculated as % (w/w or w/v) as shown in the following examples:

a. A student dissolved 5.00 g of NaCl in 120.0 mL of water
The concentration of the solution (w/w) will be 5.00g/125.0g X 100 = 4.00%.

b. A student prepared a solution by dissolving 5.00g of NaCl in enough water to give a final volume of 250mL.

The mass/volume % will be 5.00/250.0 X 100 = 2.00 %

Experimental Procedure:

Preparation of a solubility curve for ammonium chloride

This experiment will be done as a class project. The class will be divided into 6 groups of 4 students. Each group of students will be assigned a certain weight of ammonium chloride and transferred carefully in to a test tube.

10.0 mL of water will be carefully added to the salt and heated in a water bath with a thermometer. As soon as all the salt has been dissolved, the solution will then be cooled and the recrystallization temperature (saturation) will be determined by observing the temperature at which solid separates from the solution. The experiment will be repeated until two trials give results within 1° C of each other.

The saturation temperature is the solubility temperature for the weight of ammonium chloride used per 100 mL of water. Multiplying the mass of ammonium chloride by 10 will give the solubility of Ammonium chloride in grams/100g of water.
The instructor will record the data from each group on the board. The class data will then be used to prepare the solubility curve.

Results:

Student Group #	Mass of Ammonium Chloride (g)	Mass of water (g)	Temperature of recrystallization ($^{\circ}$C) (x-axis)	Solubility g/100g H_2O (y-axis)
1	4.00	10.0		
2	4.50	10.0		
3	5.00	10.0		
4	5.50	10.0		
5	6.00	10.0		
6	6.50	10.0		

If there are only 20 students there can be only 5 groups and students can use from 4.50g – 6.50g of ammonium chloride.

Calculations:

1. Plot a solubility curve using the class results. Plot solubility in grams per 100g of water on the y-axis and temperature (^{o}C) on the x-axis.

2. From your solubility curve predict :

    a. The solubility of ammonium chloride at 60^{o} C.

    b. The solubility of ammonium chloride at 50^{o} C.

    c. The solubility of ammonium chloride at 70^{o} C.

3. The true value for the solubility of ammonium chloride at 50^{o} C is 50g/100 g H_2O. Determine your % error.

$$\% \text{ error} = \frac{\text{Difference between true and experimental values}}{\text{True value}} \times 100$$

Questions:

1. Calculate the mass percent (m/m) for NaCl in each of the following solutions:

    a. 20.0g NaCl and 250.0 g of water
    b. 12.5g of glucose and 125.0 mL of water.
    c. 6.50g of KI and 100.0 mL of water.

2, A student prepared a solution by dissolving 5.50g of KCl in enough water to make 200.0 mL of solution. Calculate the % of the solution.

3. Calculate how much glucose was dissolved in a 250.0 mL solution of 10.0 %.