Course Title:Physical Chemistry
Course Code: CHEM 5101 (LAB)

EXPERIMENT

Determination of Heat of solution by solubility method

Theory:

This experiment will involve a solution formed with a solid solute (a chemical salt) and a liquid solvent (water).

Solubility of a solid in a liquid is dependent on temperature, thus, at a given temperature, only a certain maximum amount of solute will dissolve in a given amount of solvent. Beyond that amount of solute, no more will dissolve and excess solute will remain in the solid form, settling to the bottom of the solution container. This maximum amount of dissolved solute, expressed quantitatively, is given in units of grams of solute/100 g of solvent. Such a solution is termed a *saturated solution*.

When saturated solutions of solid solutes are prepared at elevated temperatures and then permitted to cool, the excess solute usually separates from the solution by crystallizing. However, if a saturated solution is prepared at an elevated temperature and any excess, undissolved solute is removed, crystallization often does not take place when the solution is allowed to cool undisturbed. The solution can contain more of the solute than normally is held in equilibrium with the solid state. Such solutions are said to be *supersaturated*.
Solubility: The maximum quantity of solute that can be dissolved in a given quantity of solvent at a given temperature to make a saturated solution.

Principle:

When a substance is dissolved in water or any other solvent, heat is evolved or absorbed.The amount of heat evolved or absorbed depends upon the nature and the amount of solvent used.When a solid is brought in contact with a liquid in which it can dissolve, a certain amount of it passes into solution until the solution is saturated.The amount of the substance dissolved depends also on the temperature.Solubility of a substance may either increase or decrease with the rise of temperature according to whether the dissolution is endothermic or exothermic.

*Vant' Hoff Equatio*n can be used to calculate the heat of solution as follow

$$\log S = -\frac{\Delta H^0}{2.303RT} + C$$

and to calculate the heat of solution at two different temperature

$$\log \frac{S_2}{S_1} = -\frac{\Delta H^0}{2.303R}\left[\frac{1}{T_2} - \frac{1}{T_1}\right]$$

where S is the solubility at different temperatures (T in kelvin), ΔH is the average heat of solution over the temperature range used, and R = 8.314 J mol^{-1} K^{-1}.

Tools and Materials

Thermometer, hot water bath, pipette, burette, Aspirin tablet, NaOH, distilled water and phenolphthalein indicator.

Procedure

1) Grind up two aspirin tablet to a fine powder using the pestle and mortar.

2) Prepare saturated solution form aspirin in 100mL distilled water at room temperature (**25 ^oC**).

3) Filtrate the aspirin solution and transfer 10 ml from filtrated solution to conical flask.

4) Add **2-3 drops** of phenolphthalein indicator solution (**Swirl for at least 3 minutes**).

5) Titrate carefully with **0.05M** sodium hydroxide (**Swirl the flask continuously, The NaOH solution should be added very slowly, The end point is reached at the first instance of the pink colour persisting).**

6) Record the volume of the sodium hydroxide used. **Repeat the titration procedure twice.**

7) Repeat this procedure at **40 ^oC** and **60 ^oC (using water bath for 10-15 min.).**

Calculations

1) Calculate the Aspirin concentration from this relation:

(Aspirin) M ×10 = 0.05× V (calculated from burette) (NaOH)

2) Arrange results as in the following table:

Saturated solution	Temperature	Aspirin concentration
1	25+273.15	
2	40+273.15	
3	60+273.15	

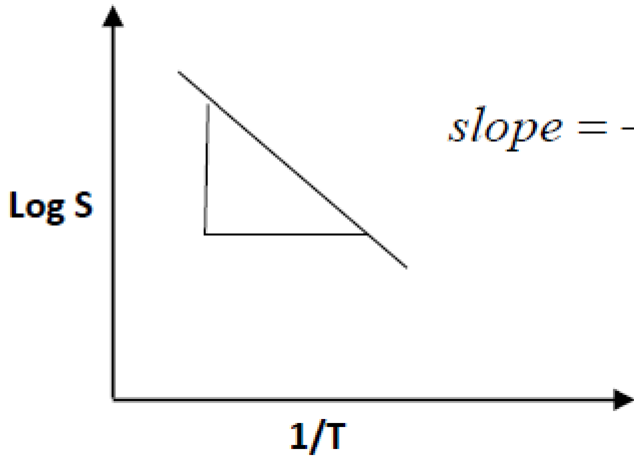
3) Calculate the aspirin solubility by the following equation:

$$S = \frac{M.wt\ of\ aspirin\ (180)\ \times M\ aspirin}{100}$$

4) Arrange results as in the following table:

Saturated solution	Temperature	1/T	S	Log (S)
1	25+273.15			
2	40+273.15			
3	60+273.15			

5) Draw a straight line between log S and 1/T and calculate the heat of solution from the slope.



$$slope = -\frac{\Delta H^0}{2.303R}$$

6) Calculate the heat of solution for any two temperatures by the following equation:

$$\log \frac{S_2}{S_1} = -\frac{\Delta H^0}{2.303R}\left[\frac{1}{T_2} - \frac{1}{T_1}\right]$$