C 141 (Experiment No.____)

NAME : ________________________________ **BATCH :** ______

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DATE : ______

DETERMINATION OF THE HEAT OF SOLUTION (ΔH) OF OXALIC ACID FROM ITS SOLUBILITY AT DIFFERENT TEMPERATURES

AIM

To determine the solubility of oxalic acid in water at different temperatures, and to calculate the heat of solution (ΔH).

THEORY

The dissolution of a solid into a liquid is usually accompanied with a heat effect (heat is either evolved or absorbed). The heat evolved or absorbed can be determined when 1 mole of the solid is dissolved in a solution which is already saturated. Since the solubility of a substance is a special case of the equilibrium constant, the Van't Hoff relation is applicable. Thus, by obtaining the solubility at different temperatures, and by applying the Van't Hoff equation, it is possible to determine the heat of solution (ΔH).

When applied to solubility, the Van't Hoff equation can be expressed as :

$$\log S = (-)\,\Delta H / 2.303\,RT + \text{constant} \quad \rightarrow \quad (1)$$

where **S is the solubility (moles/litre) at different temperatures (T in kelvin)**, **ΔH** is the **average heat of solution** over the temperature range used, and **$R = 8.314\ J\ mol^{-1}\ degree^{-1}$**. The solubility is expressed as grams of solute per 100g of solvent.

The heat of solution so calculated is approximately the average heat of solution over the temperature range studied, and corresponds to the heat of solution at the saturation concentration.In this experiment, the heat of solution of oxalic acid in water will be measured at 5 different temperatures (10, 20, 30, 40 and 45 ^{o} C).

MATERIALS REQUIRED **O**xalic acid, NaOH solution, thermometer, hot water bath, ice-bath, distilled water, hard glass test tube, pipettes (10 ml, 2 ml), burette, phenolphthalein indicator.

PROCEDURE

Step I: Determination of Strength of NaOH Solution using Standard Oxalic acid (0.1N)

1. 10ml of given 0.1N standard Oxalic acid is pipetted out into a 100 ml conical flask.
2. Titrate the solution with the given unknown concentration of NaOH using 2 drops of phenolphthalein indicator until the end point is colorless to pale pink.
3. Tabulate the values and repeat the titration for concurrent readings and determine the unknown concentration of supplied NaOH solution.

Table 1

Sl no	Vol. of oxalic acid taken(ml)	Burette Readings Intial Final	Volume of NaOH Consumed ml

Step II: Determination of Heat of Solubility of Saturated solution of Oxalic acid

1. 2 ml of the saturated solution is pipetted out into 100 ml conical flask using a filter tip attached to the pipette (a rubber tubing stuffed with glass wool / cotton), so as to prevent solid particles from entering into the pipette and 2 drops of phenolphthalein indicator is added to it.
2. The solution is titrated with the standard NaOH solution at room temperature until the endpoint is colorless to pale pink. Note the titre values.

Note

Take the solution directly from the beaker with excess of undissolved oxalic acid at bottom for all desired temperatures accurately.

3. The saturated solution is brought to 4 different temperatures on the hot water bath (or ice cubes when required to lower the temperature), in turn.
4. At each temperature, 2 ml of solution is pipetted out into the conical flask.
5. This solution is titrated against standard0.2N NaOH solution, using phenolphthalein as indicator and and determine the solubility of oxalic acid.
6. **Here, solubility (S) is nothing but normality or molarity in table 2.**

OBSERVATIONS AND CALCULATIONS

1. From the volumes of NaOH used and its strength, the weight of oxalic acid and the equivalent weight of oxalic acid, calculate the grams of oxalic acid per 100 g of water for each temperature.

2. Suppose the solubilities (in normality) comes out to be s_1, s_2, s_3, s_4, s_5 at the 5 different temperatures. Then these values are converted into solubilities (in moles per 1000 g of water), as follows :

S1(moles per 1000g of water)= $(s_1 \times 1000) / m \times 100$ at T1 ^oC

S_2 (moles per 1000g of water)= $(s_2 \times 1000)/m \times 100$ at T2 ^oC

and so on for S3,S4 etc Here, m is the molecular weight of oxalic acid = 126.0g

Sn (moles per 1000 gm of water) = s_n / 2 n=1,2,3,4)→(2)

<u>Note</u>(s) is in normality unit and (S) is in Molarity unit.

3. This will give the solubility of oxalic acid (in moles per 1000g of water) at each temperature. Convert the solubility of oxalic acid from normality to molarity and calculate the solubilities at different temperatures (equation 2). Show each and every calculation wherever necessary in proper format.

4. Plot log S versus [1 / T (in kelvin)] , and obtain ΔH(**J/ mol)** from the slope.

Note- S corresponds to the solubility of oxalic acid in 1000g of solvent(water)

Table 2

S.No	<u>Tempertaure</u> ° C	Vol of Solution taken in ml	Burette readings Intial Final	Vol of NaOH consumed	*<u>Solubility (S)</u>*	log S	1/T
1							
2							
3							
4							

RESULTS

1. Strength of given NaOH solution = ________
____ (HCOO)2 N1 V1 = N2 V2 (NaOH) __________
2. Heat of Solution of Oxalic acid solution (saturated), ΔH = ______________________
3. Comment on the nature of graph.