Expt. No. 2
Date: 17/07/19

DETERMINATION OF MOLECULAR WEIGHT BY TRANSITION TEMPERATURE METHOD

Aim:

To determine the transition temperature of the given salt hydrate and to determine the molar depression of transition temperature of the salt hydrate with the given salt hydrate with given known solute and using the information to the determine the molecular weight of the given unknown substance.

principle:

when a salt hydrate changes from hydrated, state, changes accompained by absorption of heat, If the unhydrate salt changes to hydrated salt, changes accompained by evaluation of heat. That temperature remains steady on heating or cooling until the transition temperature is complete, the steady temperature correspond to the transition temperature of the salt hydrate is depressed by the addition of the solute, the depression in transition temperature this given by the following expression.

$$\Delta T = \frac{K_{Tr} \times 1000 \times W_2}{M \times W_1}$$

where,

W_1 - weight of salt hydrate
W_2 - weight of solute
K_{Tr} - molar depression constant of the salt hydrate.
M - molecular weight of solute.

TABLE-I

COMPOUND - A

S.NO	Time (minutes)	Temperature (°c)	
		Melting point (°c)	Freezing point (°c)
1.	0	40	72
2.	1	42.5	71
3.	2	45	70
4.	3	48	69
5.	4	51	67.4
6	5	53.8	65.4
7	6	55.5	63.8
8	7	57	61.8
9	8	58	60
10	9	58.5	59.4
11	10	58.8	58.8
12	11	58.8	58.8
13	12	58.8	58.8
14	13	58-8	58.8
15	14	59.5	56
16	15	61	54
17	16	64	52
18	17	66.5	50
19	18	69	48.3
20	19	72	46.5
21	20	75	44
22	21	78	42.3

procedure:

Accurately weighed salt hydrate (above 5g) is taken in a transition temperature apparatus tube which is fitted with a cork carrying a sensitive thermometer and a stirrer. The tube is when fixed on an air jacket and mounted vertically in a water bath, taking 250ml beaker. The beaker is heated in the small flame a stop watch is also started at the same time, the temperature is noted for every one minute. The condens of tube was stirred well. The time temperature reading are recorded till the substance reach is a temperature of steady state. The tube is taken out from the bath and substance is allowed to cool slowly and steady with the constant stirring. The temperature reading is noted for every one minute as the substance cool down. The steady state of temperature on both process of heating and cooling corresponded to the transition temperature of the salt hydrate.

Accurately weighed solute of known molecular weight 0.5g is added to the above salt hydrate and the transition temperature is determined and explained above.

The molecular depression of transition temperature of the salt hydrate is determine using the expression,

$$K_{Tr} = \frac{\Delta T \times W_1 \times M}{W_2 \times 1000}$$

Now the tube is cooled well and accurately weighed salt hydrate (5g) and accurately weighed

TABLE - II.

COMPOUND - A+B.

S.NO	Time (minutes)	Temperature (°C)	
		melting point (°C)	Freezing point (°C)
1.	0	45	65
2.	1	46	64
3	2	47	62
4	3	48.5	61
5	4	50	60
6	5	51	58.5
7	6	52	57.5
8	7	53	56.5
9	8	54	55.5
10	9	55	55
11	10	55	55
12	11	55	55
13	12	55	55
14	13	55	55
15	14	56	53
16	15	56.5	51
17	16	58	49
18	17	59	47
19	18	60	45
20	19	61.5	44
21	20	63	42

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solute unknown molecular weight of (0·5g) are taken in tube. The transition temperature determined as explained above knowing the molar depression of transition temperature of the salt hydrate.

0·5g the molecular weight of unknown a solute is determined using the expression

$$M = \frac{K_{Tr} \times W_2 \times 1000}{\Delta T \times W_1}$$

TABLE - III

COMPOUND - A + C.

S.NO	Time (minutes)	Temperature (°c)	
		Melting point (°c)	Freezing point (°c)
1.	0	40	74
2.	1	41.6	72
3	2	43.2	70.5
4	3	44.8	68
5	4	46.5	66
6	5	48.5	64.2
7	6	50.5	62.8
8	7	52.5	60.8
9	8	54	59
10	9	55.2	58
11	10	55.8	57
12	11	56	56
13	12	56	56
14	13	56	56
15	14	56	56
6	15	56	56
7	16	56.6	55.5
8	17	58	55.1
9	18	59.6	54
0	19	62	53.5.

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Result:

i) The transition temperature of the given salt hydrate } = 58.8 °C

ii) The molar depression constant of the salt hydrate K_{Tr} } = 6.8 deg/mole

iii) The molecular weight of unknown salt M } = 242.85

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Calculation :

(i) To find molar depression constant:

$T_1 = 58.8°c$ $w_1 = 5g$

$T_2 = 55°c$ $w_2 = 0.5g$

$M_2 = 180.15$

$\Delta T = T_1 - T_2 = 58.8 - 55$

$\Delta T = 3.8°c$

$$K_{Tr} = \frac{\Delta T \times w_1 \times M_2}{1000 \times w_2}$$

$$= \frac{3.8 \times 5 \times 180.15}{1000 \times 0.5}$$

$$= 6.8 \text{ deg}/m$$

$$K_{Tr} = 6.8 \text{ deg}/\text{mole}$$

The molar depression constant $K_{Tr} = 6.8 \text{ deg}/m$.

(ii) To find molecular weight of the substance:

$T_1 = 58.8°c$ $w_1 = 5g$

$T_2 = 56°c$ $w_2 = 0.5g$

$\Delta T = 58.8 - 56 = 2.8$

$\Delta T = 2.8°c$

$$M = \frac{K_{Tr} \times w_2 \times 1000}{\Delta T \times w_1}$$

$$= \frac{6.8 \times 0.5 \times 1000}{2.8 \times 5}$$

$$= 242.85$$

The molecular weight of the substance = 242.85