Molar Mass Determination of an Unknown by Freezing Point Depression

Chemistry 101*: General Chemistry I*

Post-Lab & Lab Report #8

Sitthiphol Yuwanaboon

Professor Nina Ram

Lab Professor

February 2, 2020

Molar Mass Determination of an Unknown by Freezing Point Depression

Purpose:

Part I: to determine the freezing point in the solvent tert-butyl alcohol by measuring the temperature of a sample of alcohol when it becomes solid
Part II: To determine K_f for tert-butyl alcohol by adding water to it

Part III: to determine the molar mass of an unknown compound. You will make a solution by dissolving a small amount of unknown mass in the solvent tert-butyl alcohol

Procedures:

Part I: Measure and record mass of a clean and dry large test tube in 250 mL Erlenmeyer flask, with the rubber stopper, thermometer, and stirrer them add 25 ml of t-butyl alcohol in the test tube then measure mass again. Find the difference in mass of both measurement.

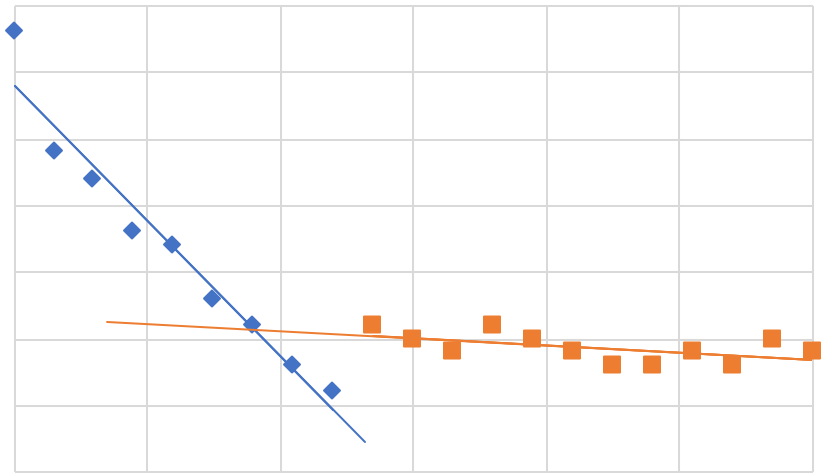
Add water to beaker add the ice to make it reach 14-16 degree C^o then use the timer to measure 15 second block for temperature then put the test tube in the beaker and record the temperature that makes it slush and become solid.(initial) for 3 minute

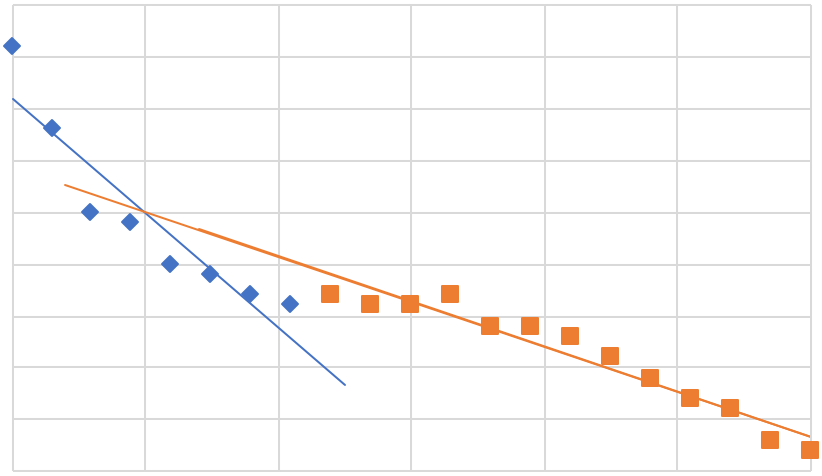
Part II: repeat the part I experiment instead of adding 4 drops of water to test tube with alcohol and record the temperature till it becomes slush and solid.

Part III: Repeat part II , Put 2 mL of unknown instead of water then record temperature that makes it become slush then wait for 3 minute. Then make all graphs.

Data & graphs:

Part I : Freezing point Determination of t-Butyl Alcohol

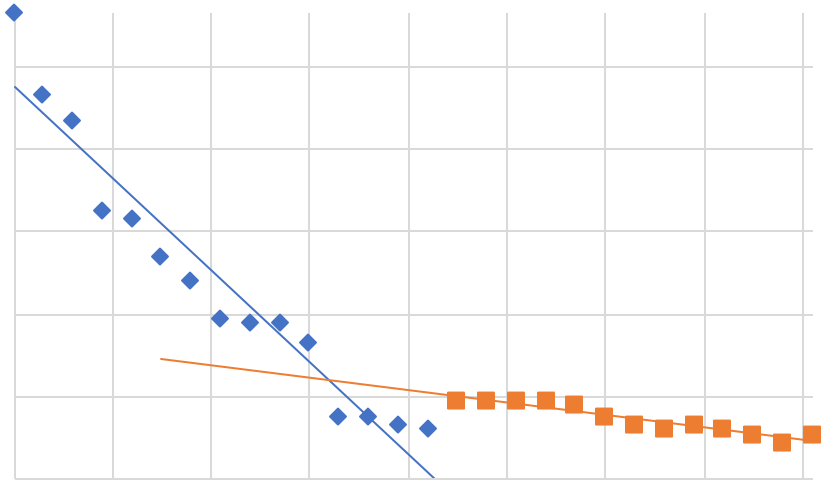




TIME	TEMPERATURE	TIME	TEMPERATURE
0	23.3	0	23.6
15	22.4	15	22.8
30	22.2	30	22
45	21.8	45	21.9
60	21.7	60	21.5
75	21.3	75	21.4
90	21.1	90	21.2
105	20.8	105	21.1
120	20.6	120	21.2
135	21.1	135	21.1
150	21	150	21.1
165	20.9	165	21.2
180	21.1	180	20.9
195	21	195	20.9
210	20.9	210	20.8
225	20.8	225	20.6
240	20.8	240	20.4
255	20.9	255	20.2
270	20.8	270	20.1
285	21	285	19.8
300	20.9	300	19.7

TEMPERATURE TIME TEMPERATURE

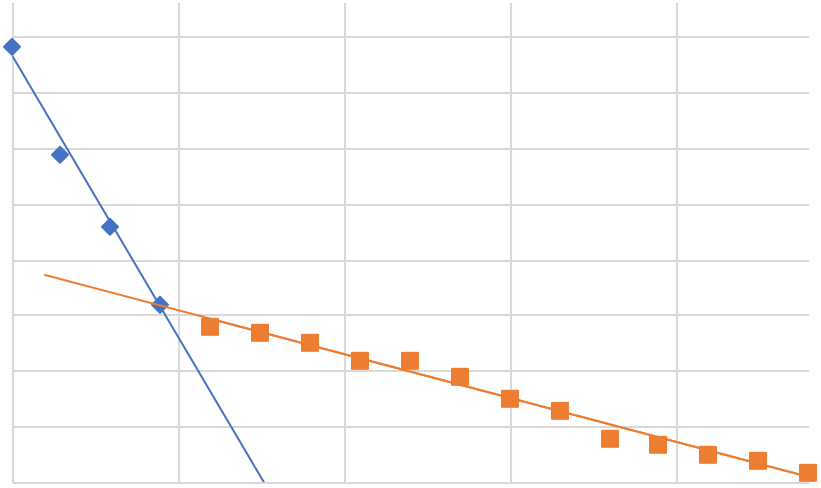
Part II: Determination of Kf of t-Butyl Alcohol



TIME			
0	26.3	0	23.2
15	24.3	15	21.4
30	23.7	30	21.4
45	21.5	45	20.4
60	21.3	60	19.3
75	20.4	75	18.7
90	19.8	90	18.2
105	18.9	105	18
120	18.8	120	17.3
135	18.8	135	16.9
150	18.3	150	16.9
165	16.5	165	17
180	16.5	180	17
195	16.3	195	16.9
210	16.2	210	16.9
225	16.9	225	16.8
240	16.9	240	16.7
255	16.9	255	16.4
270	16.9	270	16.3
285	16.8	285	16.3
300	16.5	300	16.1
315	16.3	315	16.1
330	16.2	330	16.1
345	16.3	345	16
360	16.2	360	15.9
375	16.1	375	15.8
390	15.9	390	15.8
405	16.1	405	15.7

TEMPERATURE TIME TEMPERATURE

Part III: Determine the molar mass of an Unknown



TIME			
0	25.4	0	26.2
15	23.5	15	26.1
30	22.2	30	23.7
45	20.8	45	21.4
60	20.4	60	20.9
75	20.3	75	20.6
90	20.1	90	20.4
105	19.8	105	20.2
120	19.8	120	20
135	19.5	135	19.7
150	19.1	150	19.4
165	18.9	165	19.1
180	18.4	180	18.7
195	18.3	195	18.4
210	18.1	210	18.5
225	18	225	18.2
240	17.8	240	18.1

Calculation:

Graph 1 :

Set Y values equal and solve for x then y

-.0203x+22.909 = -.0011x+21.167

Then we got x equal 90.729 then we need to solve for y by plugging either equations.

We got the temperature around 21.06 for the first trial

Second graph for second Trial:

We got the x value equal to 48.57 then we need to solve for Y

I got temperature = 22.02 for second trial

The mean of Freezing point is 21.54 C^o

Graph 2:

Set Y values equal and solve for x then y

First trial I got the Time is 160 second then we need to solve for temperature a the point.

The temperature is 17.39 degree C^o

Second trial we got the time equal to 114 second then we need to solve for temperature at the point.

The temperature is 17.23 degree Celsius

The mean temperature is 17.32 celsius

Change in butanol – change in butanol + water = 21.54 -17.32 =4.22 (from the graph)

We used .2 mL water is equal to 11.098*10^3 mol (1.1*10^-2)

We used .018415 gram of butanol

Molality is equal to = .6027 mol / kg (.60 sig fig)

The K_f is equal to change in temperature / molarity which is equal = 7.0 C^o kg/ mol

Part III:

Graph 3:

Set Y values equal and solve for x then y

First trial:

I got the Time is 44.31 second then we solve for Y (temperature)

First temperature is equal to 20.8 Celsius.

Second trial:

First trial I got the Time is 56.74 second then we solve for Y (temperature)

First temperature is equal to 20.9 Celsius.

The mean temperature is equal to 20.85 Celsius.

Change in butanol – change in butanol + unknown = 21.54 -20.85 =.69 (from the graph)

The molality equal to change in of temperatures / Kf of pure butanol = 0.099 molality

2 mL of unknown equal to 1.648 gram

We got 18.716 gram of butanol

Mole of unknown = m (18.716kg /1000) = 1.84*10^-3 mole

Molar mass of unknow equal to 893 gram/ mole(8.9*10^2gram/mole)

Conclusion:

From part I the average of both graph is a down by 1 degree for what I have observed in the experiment and part III an average of the temperatures is equal to the experiment and what I have expect for the solution of lab

We are unsure for the molar mass of substance we put, because the miss calculation might be the cause of the experiment but molarity and molality is simply ambiguous. So we have to conclude that experiment is not likely exact. The volume of butanol is relatively small than because the density is significant less than normal

Temperature from part II is little bit higher from what I observed.

I used the mean value to calculate for each trial, so it might not be exact for what we should conclude because of human error.