A solution of 0,64g of adrenaline in 36 of carbon tettrachloride causes an elevation of 49°C in the boiling point What is the molas mass of the adrenaline? Show the solution.

Solution

To find molar mass of Adrenaline we should use formula (Clausius-Clapeyron relation and Raoult's law together):

$\Delta T_b = iK_b b_B$;

ΔT_b - the boiling point elevation;

K_B - ebullioscopic constant;

b_B – molality of the solution;

I – number of particles the solute splits into of forms when dissolved.

$K_b (CCl_4) = 5.03$ K·kg/mol;

i for adrenaline =1 (does not dissociate in CCl_4);

$b_B = n_{solute}/m_{solvent} = m_{solute}/M_{solute} \cdot m_{solvent.}$

We should use $m_{solvent}$ in kg, then $b_B = 1000 \cdot m_{solute}/M_{solute} \cdot m_{solvent}$

The final formula is:

$\Delta T_b = iK_b 1000 \cdot m_{solute}/M_{solute} \cdot m_{solvent}.$

$49 = 1 \cdot 5.03 \cdot 1000 \cdot 0.64/M_{adrenaline} \cdot 36;$

$M_{adrenaline} = 1.8249$ (g/mole) But this can not be true!

Let's check up this: suppose we know molar mass of adrenaline (we can count it), let's find the boiling point elevation:

$M(C_9H_{13}NO_3) = 12.01 \cdot 9 + 1.01 \cdot 13 + 14.01 + 16.00 \cdot 3 = 183.23$ (g/mol);

$\Delta T_b = 1 \cdot 5.03 \cdot 1000 \cdot 0.64/183.23 \cdot 36;$

$\Delta T_b = 0.49$ °C.

So, we see, that the solution of 0,64g of adrenaline in 36 of carbon tettrachloride causes an elevation of **0.49°C** in the boiling point !

Therefore there is a mistake in the task: 0.49 °C, not 49°C.

The solution for the task is:

$\Delta T_b = iK_b 1000 \cdot m_{solute}/M_{solute} \cdot m_{solvent}.$

$0.49 = 1 \cdot 5.03 \cdot 1000 \cdot 0.64 / M_{adrenaline} \cdot 36;$

$M_{adrenaline} = 182.49$ g/mole

Answer: a mistake in the task has place: not 49°C but 0.49°C

If $\Delta T = 0.49$°C then $M_{adrenaline} = 182.49$ g/mole