

Class $\Rightarrow$ B.Sc. Chemistry
Subject $\Rightarrow$ Chemistry
Chapter $\Rightarrow$ colligative properties
Topic $\Rightarrow$ Elevation of Boiling point

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Elevation of Boiling point

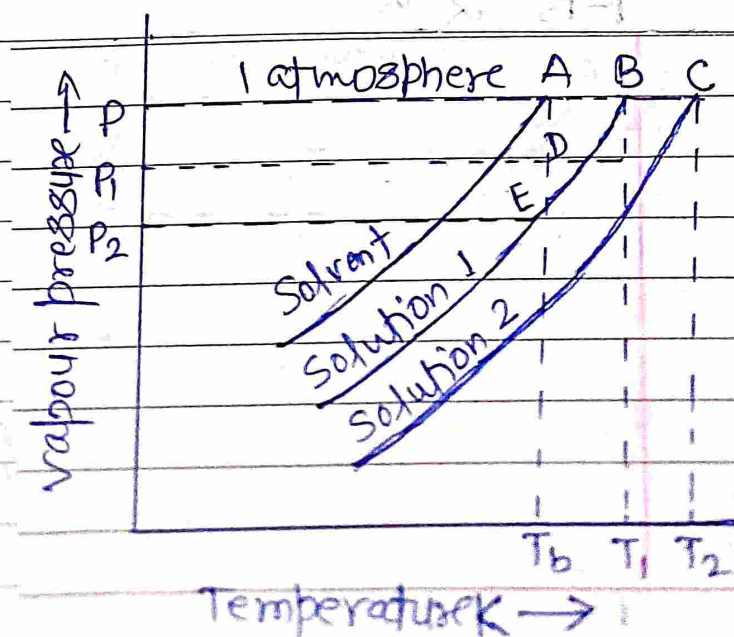
The boiling point, T_b of a liquid is the temperature at which its vapour pressure is equal to the atmospheric pressure.

When a non-volatile solute is added to a liquid, the vapour pressure of the liquid is decreased and consequently elevates the boiling point.

If T_b is the boiling point of the solvent and T is the boiling point of the solution, the difference in the boiling point (ΔT) is called the elevation of boiling point.

$$\Delta T = T_b - T$$

The vapour pressure of the pure solvent and solutions (1) and (2) with different concentrations of solute are shown in figure.



for dilute solutions, the curves AD and CE are parallel and straight lines approximately. Therefore, for similar triangles ACE and ADB, we have

$$\frac{AB}{AC} = \frac{AD}{AE}$$

$$\therefore \frac{T_1 - T_b}{T_2 - T_b} = \frac{P - P_1}{P - P_2}$$

Where $P - P_1$ and $P - P_2$ are lowering of vapour pressure for soln ① and soln ② respectively.

Thus, the elevation of boiling point is directly proportional to the lowering of vapour pressure.

$$\Delta T \propto P - P_2 \quad \text{--- (1)}$$

Determination of molecular mass from Elevation of Boiling point

Since P is constant for the same solvent at a fixed temperature, from (1) we have

$$\Delta T \propto \frac{P - P_2}{P} \quad \text{--- (2)}$$

But from Raoult's law for dilute solutions,

$$\frac{P - P_2}{P} \propto \frac{wM}{Wm} \quad \text{--- (3)}$$

Since M (mol. mass of solvent) is constant, from (3)

$$\frac{P - P_2}{P} \propto \frac{w}{Wm} \quad \text{--- (4)}$$

from eqn (2) and (4)

$$\Delta T \propto \frac{w}{m} \times \frac{1}{W}$$

$$\therefore \Delta T = K_b \times \frac{w}{m} \times \frac{1}{W} \quad \text{--- (5)}$$

Where K_b is a constant called Boiling point constant or Ebullioscopic constant of molal elevation constant.

If $w/m = 1$, $W = 1$, $K_b = \Delta T$ Thus,

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Molal elevation constant may be defined as the boiling-point elevation produced when 1 mole of solute is dissolved in 1 kg (1000 gm) of the solvent.

If the mass of the solvent (W) is in gm., it has to be converted into kg. Thus the eqn (5) assumes the form

$$\Delta T = K_b \times \frac{W}{m} \times \frac{1}{W/1000}$$

$$\text{or } m = \frac{1000 \times K_b \times W}{\Delta T \times W} \quad \text{--- (6)}$$

Where ΔT = Elevation of Boiling point, K_b = molal elevation constant, W = mass of solute in gm., m = mol mass of solute and W = mass of solvent in gm.

The value of K_b is determined by measurement of ΔT by taking a solute of known molecular mass (m) and substituting the values in expression (6).

The unit of $K_b \Rightarrow \text{K kg mol}^{-1}$

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