

Class \Rightarrow B.Sc. (Part I) Subsidiary
 Subject \Rightarrow Chemistry
 Chapter \Rightarrow colligative properties
 Topic \Rightarrow Elevation of Boiling point

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Elevation of Boiling point

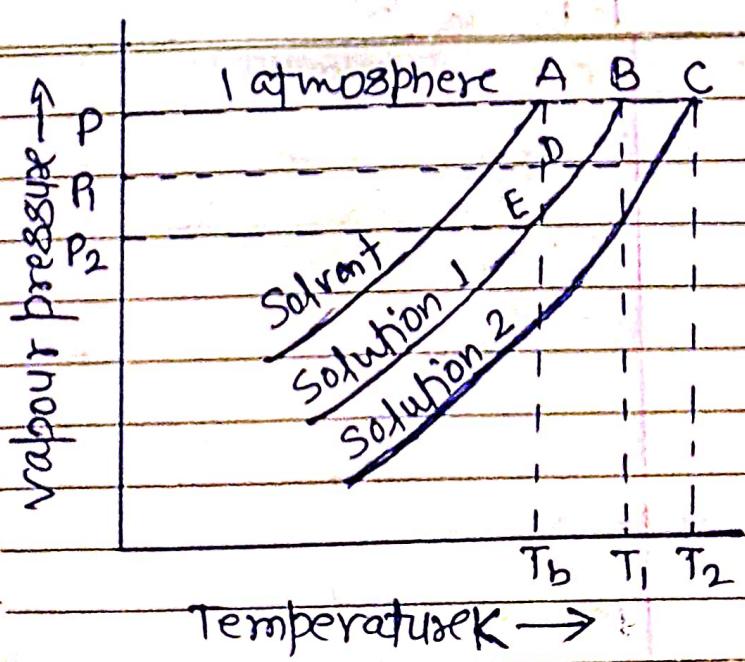
The boiling point, T_b of a liquid is the temperature at which its vapour pressure is equal to the atmospheric pressure.

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.



②

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

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

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

where $P - P_1$ and $P - P_2$ are lowering of vapour pressure for sol¹ ① and sol² ② respectively.

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

$$\Delta T \propto P - P_s \quad \text{--- ①}$$

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

$$\Delta T \propto \frac{P - P_s}{P} \quad \text{--- ②}$$

But from Raoult's law for dilute solutions,

$$\frac{P - P_s}{P} \propto \frac{\omega M}{Wm} \quad \text{--- ③}$$

since M (mol. Mass of solvent) is constant, from ③

$$\frac{P - P_s}{P} \propto \frac{\omega}{Wm} \quad \text{--- ④}$$

from eqn ② and ④

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

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

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

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

(3)

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 gms., it has to be converted into kg. Thus the eqⁿ (5) assumes the form

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

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

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 $K_b \Rightarrow \text{K Kg mol}^{-1}$

g m^2