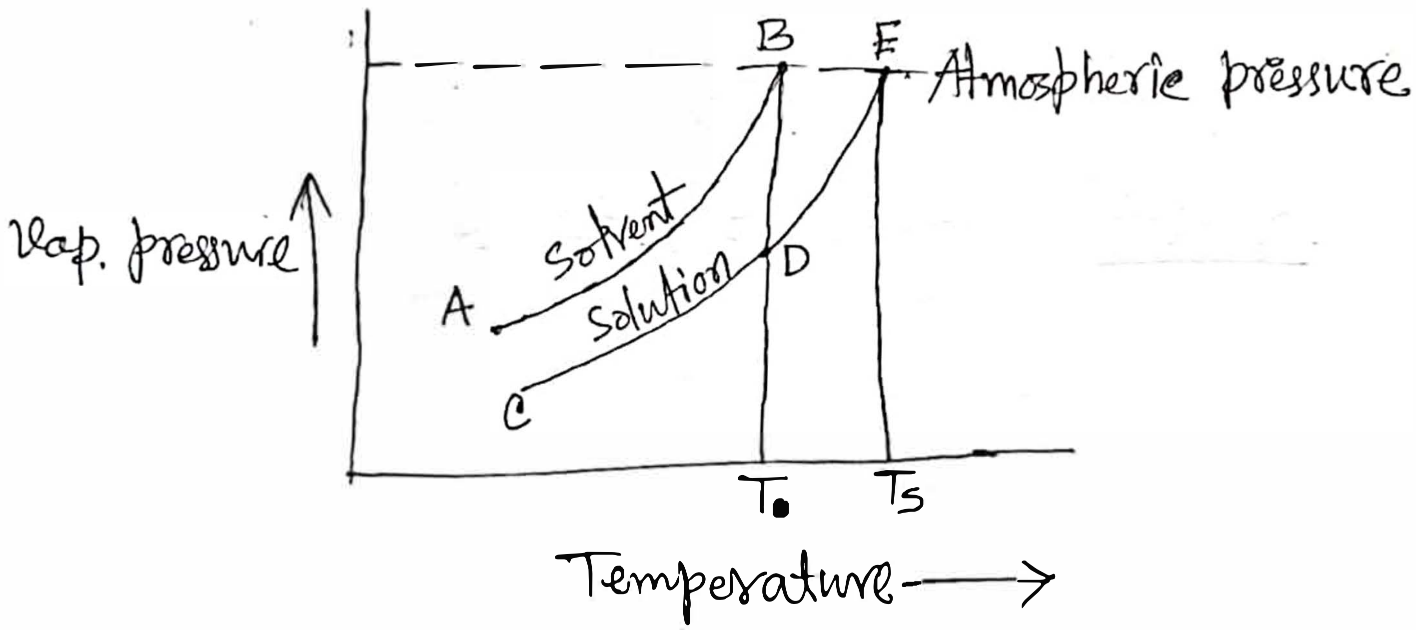
Elevation of boiling point:

The temperature in which the vapour pressure of a liquid is equal to atmospheric pressure, is known as boiling point of that liquid.

We know that the vapour pressure of a liquid increases with increasing temperature.



In the vapour pressure vs temperature graph, AB is the vapour pressure curve of a pure solvent. At the point B, the vapour pressure of the pure solvent and atmospheric pressure are same. So the boiling point of the pure solvent is T_0.

Now we add non-volatile and non-electrolyte solute in this solvent, the vapour pressure curve decrease at the temperature T_0, which is indicated by CD curve. At the point D ~~and~~ and T_0 temperature the solution will not boil.

Now if we increase the temperature the CD curve meets the point E. At the point E, the vapour pressure of the solution and atmospheric pressure are same. So, the boiling point of the solution is T_S. Thus, from the diagram we can say that the boiling point of the solution is greater than that of pure solvent.

- Application:

Consider a solution in which w_2 g solute are dissolved in w_1 g solvent. The molecular mass of the solute is M_2. Thus,

moles of solute in solution $= \frac{w_2}{M_2}$

$\therefore$ w_1 g solvent contains w_2/M_2 moles solute

1000 g solvent contains $\frac{w_2 \times 1000}{w_1 \times M_2}$ moles solute.

Thus, the molality of the solution $(m) = \frac{w_2 \times 1000}{w_1 \times M_2}$

Again we know that, the elevation of boiling point (ΔT_b) of a solution is proportional to the molality of the solution (m).

i.e., $\Delta T_b \propto m$

or, $\Delta T_b = K_b \cdot m$ ——— (1)

(where K_b is the molal elevation constant.)

Put the value of m in equation (1), we get

$$\Delta T_b = K_b \cdot \frac{w_2 \times 1000}{w_1 \times M_2}$$

$$\text{or, } M_2 = K_b \cdot \frac{w_2 \times 1000}{w_1 \times \Delta T_b} \quad \text{——— (2)}$$

Knowing the value of ΔT_b, we can calculate the molecular mass of a solute using equation (2).

Problem 1: Calculate the boiling point of a solution containing 5 g urea ($M_2 = 60$) in 100 g water. (Given $K_b = 0.513$).

Sol^n:

$$\Delta T_b = K_b \cdot \frac{w_2 \times 1000}{w_1 \times M_2}$$

$$\text{or, } \Delta T_b = 0.513 \times \frac{5 \times 1000}{100 \times 60}$$

$$\text{or, } \Delta T_b = 0.428\,^\circ C$$

$$\text{or, } T_s - T_o = 0.428$$

$$\text{or, } T_s = T_o + 0.428$$

$$= 100 + 0.428$$

$$= 100.428\,^\circ C \text{ (Ans.)}$$

$T_o = 100\,^\circ C$ (for water)