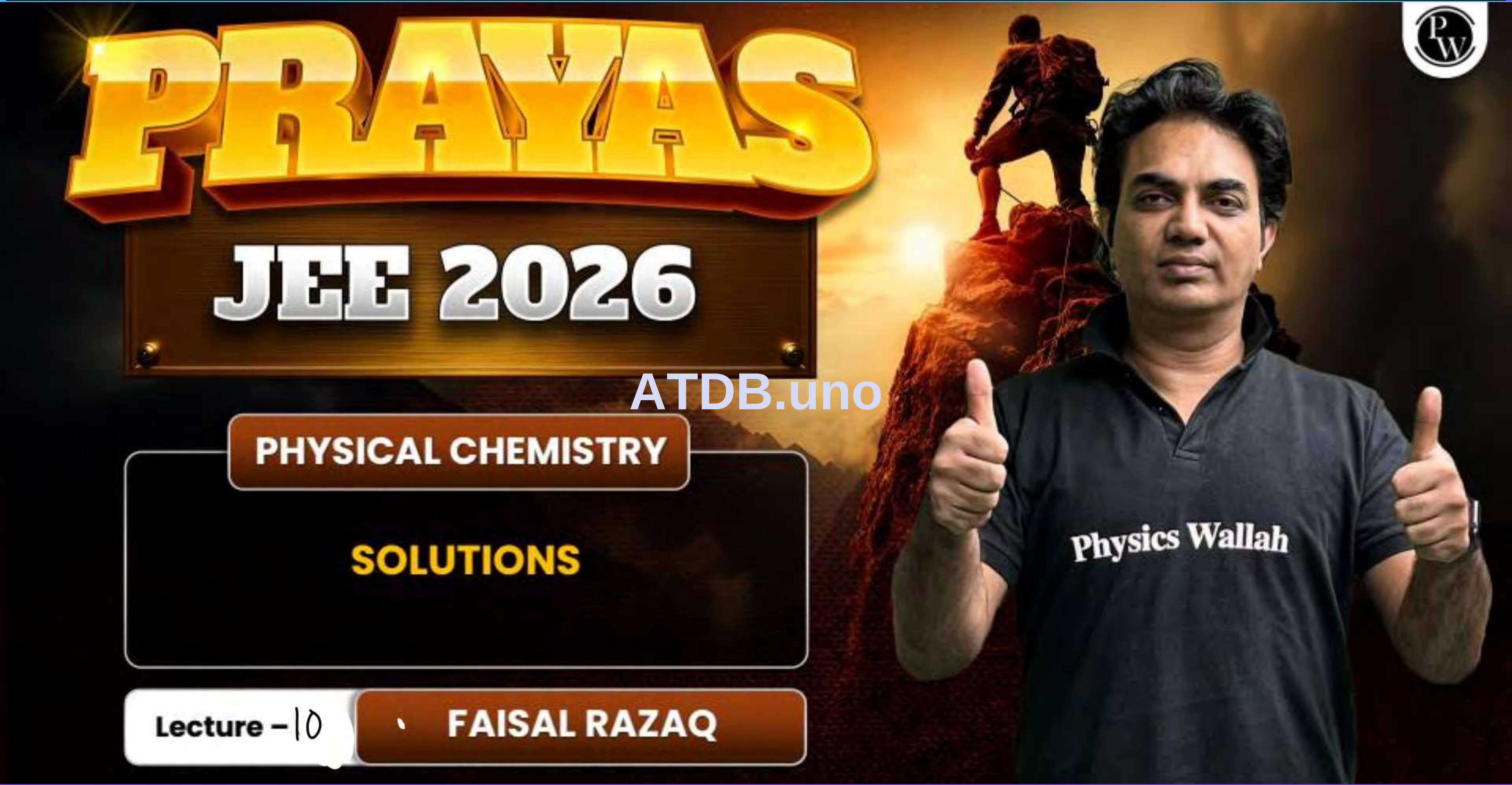
PRAYAS
JEE 2026
PHYSICAL CHEMISTRY
SOLUTIONS
Lecture – 10
FAISAL RAZAQ
Physics Wallah

Topics to be covered

A. Van't Hoff Factor

Osmotic Pressure

- $\pi = CRT$
- $\pi = h\rho g$

$1\ L = 10^{-3}\ m^3$

$$gm/cc \text{ or } gm/ml = \frac{10^{-3}\ kg}{10^{-6}\ m^3} = 10^3\ kg/m^3$$

$R = 8.314\ J/K\text{-}mol$

if (π = atm)

$C = mol/L$

$R = 0.0821\ atm\text{-}L/K\text{-}mol$

T = kelvin

if (π = N/m^2 or pascals)

$C = 10^3\ mol/m^3$

$R = 8.314\ J/K\text{-}mol$

T = kelvin

π = Osmotic pressure

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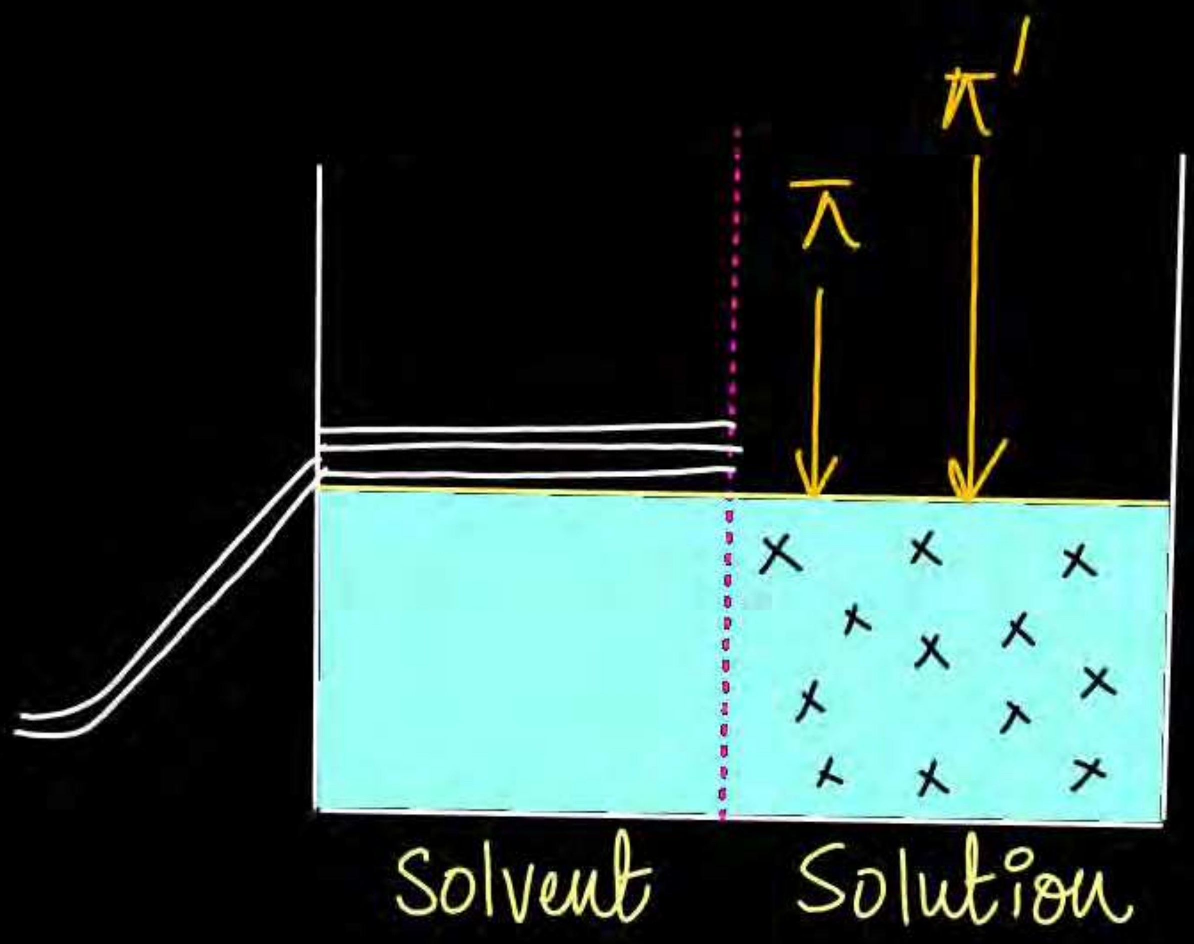
$$(\pi' - \pi) = hdg$$

$$\pi' > \pi$$



To carry out reverse osmosis we need to increase pressure on higher concentration side continuously.

Hypertonic, Hypotonic and isotonic solutions

Solutions having more osmotic pressure are hypertonic solutions wrt the solutions with low osmotic pressure.

$C_1 \not{R} T_1 > C_2 \not{R} T_2$

$C_1 T_1 > C_2 T_2$

$C_1 > C_2 \rightarrow T_1 = T_2$

A: π_1 B: π_2

if $\pi_1 > \pi_2$

Sol^n A is hypertonic

Sol^n B is hypotonic

Solutions having same osmotic pressure are isotonic.

$$\pi_1 = \pi_2$$

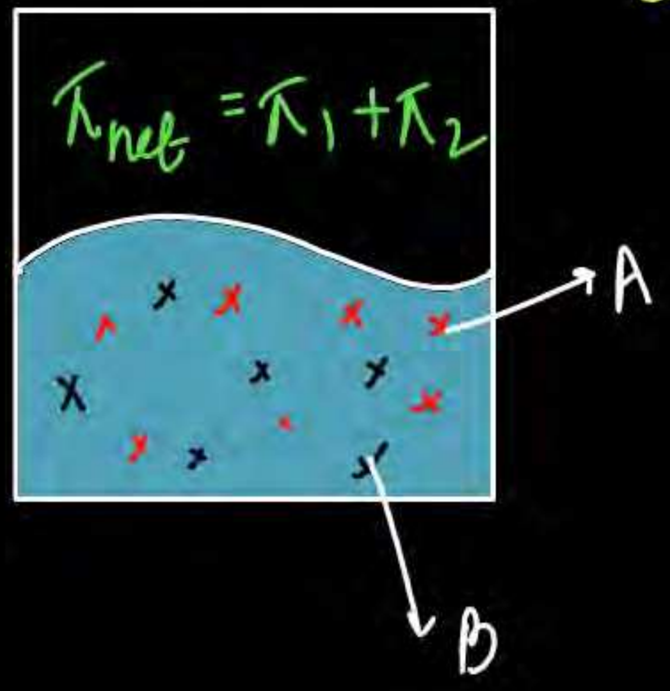
$$C_1 R T_1 = C_2 R T_2$$

$$C_1 T_1 = C_2 T_2$$

$$C_1 = C_2 \rightarrow T_1 = T_2$$

Osmotic Pressure of solution having two or more solutes

Osmotic Pressure of a solⁿ having two or more solutes is equal to the sum of partial osmotic pressures.



$$\pi_{net} = \pi_1 + \pi_2$$

$$\pi_{net} = \sum \pi_i$$

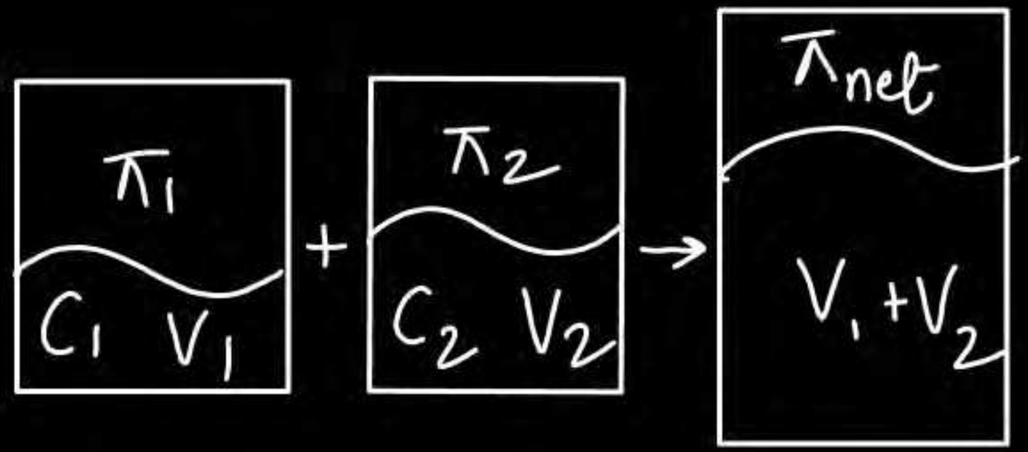
$$\pi_1 = C_1RT = \frac{n_A}{V}RT$$

$$\pi_2 = C_2RT = \frac{n_B}{V}RT$$

(*)
$$\pi_{net} = \frac{(n_A + n_B)RT}{V}$$

Osmotic pressure of a resultant solution when two solutions of same substance of different osmotic pressure are mixed

$$\text{net conc} = \frac{\text{net mole}}{\text{net volume}} = \left(\frac{\frac{\pi_1 V_1}{RT} + \frac{\pi_2 V_2}{RT}}{V_1 + V_2}\right)$$



$$\pi_{net} = C_{net} RT = \frac{\pi_1 V_1 + \pi_2 V_2}{V_1 + V_2}$$

$$\pi_1 = C_1 RT = \frac{n_1}{V_1} RT$$

$$\pi_2 = C_2 RT = \frac{n_2}{V_2} RT$$

Question Two solutions of glucose have osmotic pressures 1.5 atm and 2.5 atm. 1 L of first solution is mixed with 3 L of second solution. Calculate the Osmotic pressure of resultant solution.

$$\pi_{net} = \frac{\sum(\pi V)}{\sum(V)}$$

A solution is formed by adding two or more solutions.

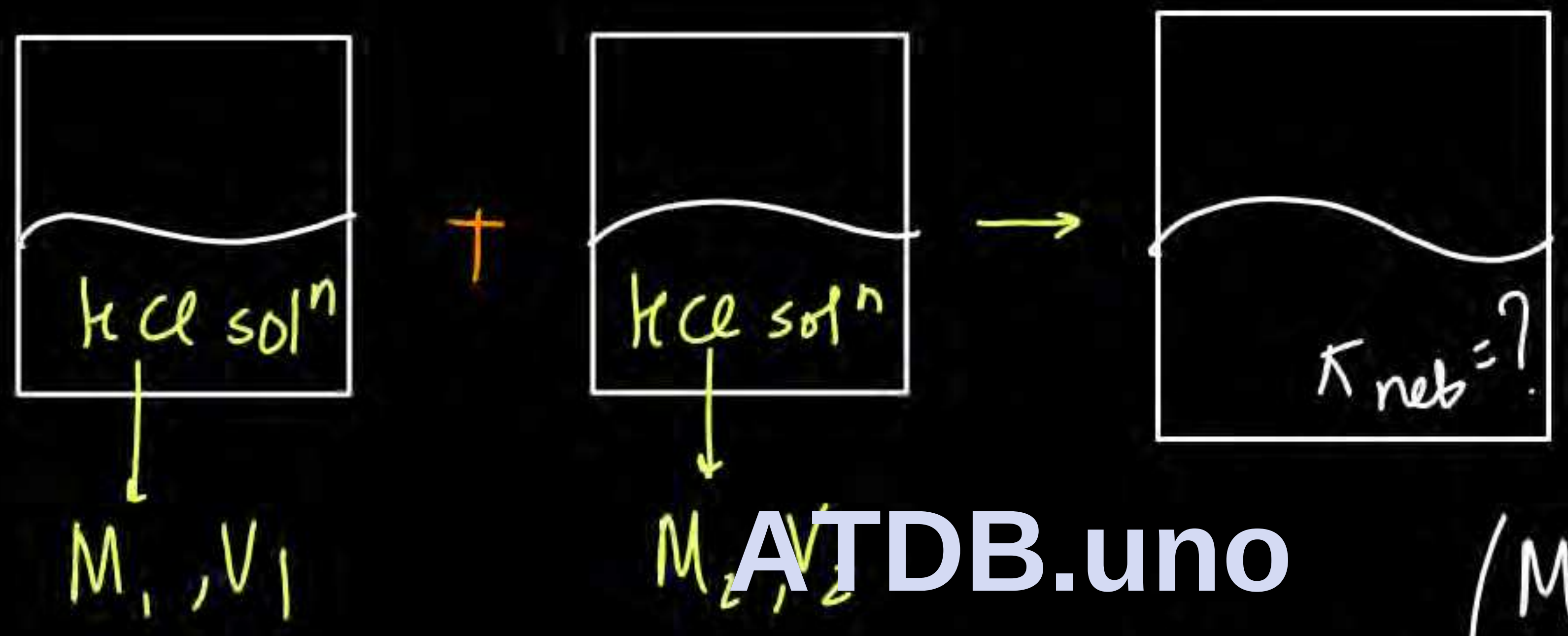
$$\pi_{net} = \frac{\sum n \; RT}{V}$$

A sol^n is having more than one solute

$$= \frac{1.5 \times 1 + 2.5 \times 3}{4} = 2.25 \text{ atm}$$

Question

$$\pi_{net} = C_{net} RT$$



$$\pi_{net} = \left(\frac{M_1V_1 + M_2V_2}{V_1 + V_2}\right) RT$$

Concept of ice separation

$$\Delta T_F = K_F m$$

$$= K_F \cdot \left(\frac{\text{mole of solute}}{\text{Weight of } H_2O} \right)$$

Question A solution contains 62 gm ethylene glycol ($CH_2OH - CH_2OH$) in 250 gm H_2O is cooled upto $-10°C$. If $K_f = 1.86\ K\ kg\ mol^{-1}$, then amount of water (in gm) separated as ice is —

[JEE-Mains 2019]

A) 32

B) 48

C) 64 ✓

D) 16

$$\Delta T_f = 10 = K_f \cdot m$$

$$10 = 1.86 \times \left(\frac{62/62}{W}\right)$$

$$W = 0.186\ Kg = 186\ g$$

weight of ice separated $= 250 - 186 = 64$ gm.

Van't Hoff factor (i)

1 mole salt (NaCl) is dissolved in 1 Kg water. find out ΔT_b.

$$\Delta T_b = K_b \cdot m = K_b \times \frac{1}{1}$$

$$\Delta T_b = K_b$$

$$\text{Van't Hoff factor} = \frac{\text{Obs C.P}}{\text{Th CP}}$$

$$\text{Obs C.P} = i \ \text{Th. CP}$$

$$RLVP = \frac{P^0 - P_s}{P^0} = \frac{i\, n_{solute}}{i\, n_{solute} + n_{solvent}} \simeq \frac{i\, n_{solute}}{n_{solvent}}$$

$$\Delta T_b = i\, K_b \cdot m$$

$$\Delta T_f = i\, K_f \cdot m$$

$$\pi = i\, CRT$$

Vant Hoff factor during dissociation

n = Jitne logo mein solute toota.

$$A_n \rightleftharpoons nA$$

A_n	nA
C	0
$C(1-\alpha)$	$nC\alpha$

$$(\Delta T_b)_{th} = K_b \cdot \left(\frac{C}{W}\right)$$

$$(\Delta T_b)_{obs} = K_b \frac{C[1+(n-1)\alpha]}{W}$$

if the dod is α = Ek mei se 'α' toota

moles of solute after diss = $C(1-\alpha) + nC\alpha = C[1+(n-1)\alpha]$

$$i = \frac{(\Delta T_b)_{obs}}{(\Delta T_b)_{th}} = \frac{K_b \cdot \frac{c[1+(n-1)\alpha]}{W}}{K_b \cdot \frac{c}{W}} = 1+(n-1)\alpha$$

$$\boxed{i = 1+(n-1)\alpha}$$

n = Jitne logo mei toota

α = degree of dissociation

Van't Hoff Factor during association

$$(\Delta T_f)_{th} = K_f\left(\frac{C}{W}\right)$$

$$(\Delta T_f)_{obs} = K_f \frac{C\left[1-\left(1-\frac{1}{n}\right)\beta\right]}{W}$$

n = 2 dimer

n = 3 trimer

$$nA \rightleftharpoons 1A_n$$

$$C \qquad 0$$

$$C(1-\beta) \qquad \frac{C\beta}{n}$$

$$\boxed{i = 1-\left(1-\frac{1}{n}\right)\beta}$$

β = degree of association

$$\text{Total moles of Solute} = C(1-\beta) + \frac{C\beta}{n} = C\left[1-\left(1-\frac{1}{n}\right)\beta\right]$$

#

Dissociation → $[1+(n-1)\alpha]$

- n = Jitne logo mei toota
- α = dod

Association → $\left[1-\left(1-\frac{1}{n}\right)\beta\right]$

- n = Jitne log jude
- β = doa

Question

Molal depression constant for the solvent is 4 K kg mol^{-1}. The depression in freezing point of the solvent for 0.03 mol/kg solution of K_2SO_4 is (assuming complete dissociation).

A) 0.12 K

B) 0.36 K ✓

C) 0.18 K

D) 0.24 K

$K_2SO_4 \rightarrow 2K^+ + SO_4^{2-}$

$\alpha = 1$

$i = 1 + (n-1)\alpha = 1 + (3-1)1$ ✓

$i = 3$

$\Delta T_f = i K_f m = 3 \times 4(0.03) = 0.36 K$


THANK
YOU