FREE NOTES · NCERT + JEE/NEET LEVEL

Solutions

Solutions ke types, concentration terms, solubility aur Henry's law, Raoult's law, ideal aur non-ideal solutions, chaar colligative properties aur van't Hoff factor.

01 Solutions ke types
02 Concentration terms
03 Solubility & Henry's law
04 Raoult's law
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01 Solutions ke types

Solution do ya zyada cheezon ka homogeneous mixture hai. Jo zyada matra me ho wo **solvent**, baaki **solute**. Do components wala solution = binary solution.

Solvent ki state	Example
Gas	Hawa (gas in gas), N_2 me camphor (solid in gas)
Liquid	Paani me O_2, paani me ethanol, paani me cheeni
Solid	Palladium me H_2, Hg ka Na ke saath amalgam, brass/alloys

02 Concentration terms

Term	Formula	Temperature pe depend?
Mass %	(solute ka mass / solution ka mass) $\times$ 100	Nahi
ppm	(solute ke parts / total parts) $\times 10^6$	Nahi
Mole fraction (x)	$x_A = n_A/(n_A+n_B)$; $\Sigma x = 1$	Nahi
Molarity (M)	solute ke moles / solution ka volume (L)	**Haan** (volume badalta)
Molality (m)	solute ke moles / solvent ka mass (kg)	Nahi

YAAD RAKHO

Jisme **volume** aata hai (molarity, volume %) wo temperature se badalta hai. Molality aur mole fraction sirf mass pe depend karte, isliye nahi badalte. Isi liye colligative formulas me molality use hoti hai.

03 Solubility & Henry's law

Solid in liquid: "like dissolves like" (polar me polar). Ghulna endothermic ho to temperature badhane pe solubility badhti, exothermic ho to ghatti. Pressure ka asar lagbhag nahi.

Gas in liquid: temperature badhao to solubility **ghatti** hai (gas ka ghulna exothermic hai), pressure badhao to **badhti** hai.

$$p = K_H \cdot x$$

Henry's law: solution ke upar gas ka partial pressure, solution me uske mole fraction ke proportional hota hai. **K_H zyada ⇒ solubility kam.** Temperature badhne pe K_H badhta hai.

REAL LIFE ME

- Soda bottle high CO_2 pressure pe band ki jaati hai.
- Deep-sea divers me **bends**: high pressure pe ghula N_2 tezi se upar aane pe blood me bubbles banata. Isliye tank me He mila hota hai (11.7% He, 56.2% N_2, 32.1% O_2).
- Pahadon pe **anoxia**: O_2 ka pressure kam ⇒ blood me O_2 kam.

04 Raoult's law

Do volatile liquids ke solution me har component ka partial vapour pressure uske mole fraction ke proportional hota hai.

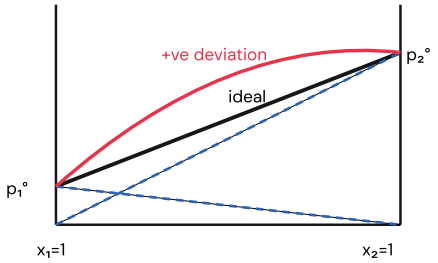
$$p_1 = p_1^\circ x_1, \quad p_2 = p_2^\circ x_2$$

$$p_{total} = p_1^\circ + (p_2^\circ - p_1^\circ)\, x_2$$

Vapour me: $y_1 = p_1/p_{total}$. Vapour me zyada volatile component zyada hota hai.

Non-volatile solute ho to sirf solvent ka vapour pressure hota hai. Isse milta hai **relative lowering of vapour pressure**:

$$(p^\circ - p)/p^\circ = x_{solute}$$



Vapour pressure vs composition: ideal ke liye seedhi line, positive deviation me upar uthi curve

05 Ideal & non-ideal solutions

	Ideal	Positive deviation	Negative deviation
A–B attraction	= A–A, B–B	Kamzor	Mazboot
ΔH_{mix}, ΔV_{mix}	0, 0	+ve, +ve	-ve, -ve
Vapour pressure	Raoult follow karta	Expected se zyada	Expected se kam
Example	n-hexane + n-heptane, benzene + toluene	ethanol + paani, ethanol + acetone, CS_2 + acetone	$CHCl_3$ + acetone (H-bond), HNO_3 + paani, phenol + aniline
Azeotrope	Nahi	Minimum-boiling (95% ethanol)	Maximum-boiling (68% HNO_3)

Azeotrope ek fixed temperature pe ubalta hai aur liquid aur vapour ka composition same rehta hai, isliye fractional distillation se alag nahi hota.

06 Colligative properties

Ye properties sirf solute ke **particles ki ginti** pe depend karti hain, unke nature pe nahi. Chaar hain.

Property	Formula	Constant
Relative lowering of VP	$\Delta p/p^\circ = x_B \approx n_B/n_A$	Koi nahi
Boiling point ka badhna	$\Delta T_b = K_b \cdot m$	K_b (ebullioscopic), paani 0.52 K kg/mol
Freezing point ka girna	$\Delta T_f = K_f \cdot m$	K_f (cryoscopic), paani 1.86 K kg/mol
Osmotic pressure	$\pi = CRT = (n/V)RT$	R = 0.083 L bar/(mol K)

MOLAR MASS NIKALNA

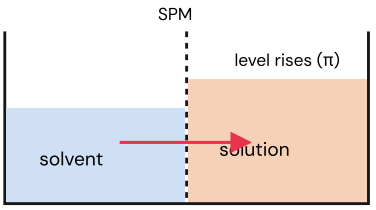
$M_B = (K_b \times w_B \times 1000)/(\Delta T_b \times w_A)$ (K_f, ΔT_f ke saath bhi same)

Polymers aur proteins ke liye osmotic pressure best hai: kam concentration pe bhi effect bada hota hai aur room temperature pe naapa jaata hai.

07 Osmosis & van't Hoff factor

Osmosis: solvent semipermeable membrane (SPM) se hokar solvent (ya dilute solution) se concentrated solution ki taraf jaata hai. Jo extra pressure is flow ko bas rok de, wahi **osmotic pressure π** hai.

- **Isotonic:** same π (0.9% NaCl = blood, "normal saline").
- Bahar **hypertonic** ⇒ cell sikudta (plasmolysis). Bahar **hypotonic** ⇒ cell phoolta.
- **Reverse osmosis:** π se zyada pressure lagao to solvent ulti taraf jaata. Samundar ka paani meetha karne me use (cellulose acetate membrane).



Solvent SPM se hokar solution me jaata hai

VAN'T HOFF FACTOR I

$$i = \text{observed colligative property / calculated} = \text{normal molar mass / observed molar mass}$$

$$\Delta T_f = i\,K_f\,m, \quad \pi = iCRT$$

Dissociation (NaCl, K_2SO_4) ⇒ i > 1 (poora tootne pe NaCl → 2, K_2SO_4 → 3). Association (benzene me acetic acid ka dimer) ⇒ i < 1 (≈ ½).

Degree of dissociation α = (i − 1)/(n − 1); degree of association α = (1 − i)/(1 − 1/n).

08 JEE Extra + Tricks

JEE LEVEL

- van't Hoff factor ke saath colligative: $\Delta T_b = iK_b m$, $\Delta T_f = iK_f m$, $\pi = iCRT$, relative lowering = $i \cdot x_{solute}$.
- Dissociation me $i = 1 + \alpha(n - 1)$; association me $i = 1 - \alpha(1 - 1/n)$ (benzene me acetic acid dimer, $i \approx ½$).
- Raoult law: positive deviation (ethanol + paani, acetone + CS_2) ⇒ minimum boiling azeotrope; negative (acetone + chloroform, HNO_3 + paani) ⇒ maximum boiling azeotrope.
- Henry law $p = K_H x$: zyada K_H ⇒ kam solubility; temperature badhe to gas ki solubility ghate.
- Isotonic solutions ka osmotic pressure barabar (0.9% NaCl = normal saline). Reverse osmosis se khaare paani ko meetha.

09 Solved numericals

Q1. 18 g glucose (M = 180) 1 kg paani me ghola. Boiling point nikalo. (K_b = 0.52)

m = 0.1/1 = 0.1 mol/kg ⇒ $\Delta T_b = 0.52 \times 0.1 = 0.052$ K ⇒ $T_b = 373.15 + 0.052 =$ **373.202 K**.

Q2. 300 K pe 0.1 M NaCl ka π nikalo (poora dissociation).

i = 2 ⇒ $\pi = 2 \times 0.1 \times 0.083 \times 300 =$ **4.98 bar**.

Q3. Pure benzene ka vapour pressure 640 mm Hg hai. Non-volatile solute dalne pe 600 mm Hg ho gaya. Solute ka mole fraction?

$x_B = (640 - 600)/640 =$ **0.0625**.

Q4. Sabse kam freezing point kiska: 0.1 m glucose, 0.1 m NaCl, 0.1 m $CaCl_2$?

i × m: 0.1, 0.2, 0.3 ⇒ $CaCl_2$ ka ΔT_f sabse bada ⇒ **sabse kam freezing point**.

10 Common mistakes

- Molality me **solvent** ki jagah **solution** ka mass le lena.
- Sochna ki K_H zyada to solubility zyada. Ulta hai.
- Electrolytes (NaCl, $CaCl_2$) ke colligative sawaal me i bhool jaana.
- mol/L concentration ke saath R = 8.314 lagana. π bar me chahiye to 0.083 L bar/(mol K).
- Minimum aur maximum boiling azeotrope me confusion (positive deviation ⇒ minimum boiling).

11 Formula sheet & practice

Henry's law	$p = K_H\, x$
Raoult's law	$p_{total} = p_1^{\circ} x_1 + p_2^{\circ} x_2$
RLVP	$(p^{\circ} - p)/p^{\circ} = x_B$
Boiling / freezing	$\Delta T = i\, K\, m$
Osmotic pressure	$\pi = iCRT$
Molar mass	$M = 1000\, K\, w_B/(\Delta T\, w_A)$
Dissociation	$\alpha = (i - 1)/(n - 1)$

1. Molarity ki jagah molality kyun better hai?
2. Negative deviation wale solution ka example do aur kaaran batao.
3. Barf wali sadak pe namak kyun daalte hain?
4. $K_4[Fe(CN)_6]$ ka i (poora dissociation)?
5. Kacche aam brine me kyun sikud jaate hain?

ANSWERS

1) Temperature se nahi badalti · 2) Chloroform + acetone: dono ke beech H-bond banta · 3) Namak paani ka freezing point gira deta · 4) 5 · 5) Brine hypertonic hai, osmosis se paani aam se bahar nikal jaata

12 Quick revision: exam se 5 minute pehle

CONCENTRATION

- Molarity T se badalti, molality nahi.
- Henry: $p = K_H x$; K_H zyada = kam soluble.
- T badhe to gas ki solubility ghate.

RAOULT

- Har volatile part ke liye $p = p^{\circ} x$.
- +ve deviation ⇒ min-boiling azeotrope.
- -ve deviation ⇒ max-boiling azeotrope.

COLLIGATIVE

- Particles ki ginti pe depend.
- $\Delta T_b = iK_b m$, $\Delta T_f = iK_f m$, $\pi = iCRT$.
- Polymers/proteins ke liye π best.

VAN'T HOFF

- $i > 1$ dissociation, $i < 1$ association.
- 0.9% NaCl blood ke saath isotonic.
- RO = paani meetha karna.

Koi doubt? padhaiadda.netlify.app pe AI Doubt Solver se poocho, ya is chapter ka mock test do.