Exercise-1

Marked Questions may have for Revision Questions.

OBJECTIVE QUESTIONS

Section	on (A) : Concentration terms		
A-1.			
	8 40		
Sol.	1 = 0.2 M		
A-2.	Sol. $\frac{\frac{0.02}{500} \times 10^6}{= 40}$		
A-6. A-7. Sol.	Sol. $n_{N_2} = \frac{7}{28} = \frac{1}{4}$; $n_{O_2} = \frac{8}{32} = \frac{1}{4}$; $X_{O_2} = \frac{1}{4} \left(\frac{1}{4} + \frac{1}{4}\right) = 0.5$		
	Total mass of solution = (15 + 35) gram = 50 gram $\frac{Mass \text{ of methyl alcohol}}{Mass \text{ of methyl alcohol}} = \frac{15}{15}$		
	mass percentage of methyl alcohol = Mass of solution $\times 100 = 50 \times 100 = 30\%$		
A-9.	Sol. $ \frac{0.25}{1} = \frac{\frac{w}{46}}{\frac{w}{46} + \frac{100 - w}{18}} $ $ \frac{0.25}{1} = \frac{\frac{w}{46} + \frac{100 - w}{18}}{\frac{w}{46} + \frac{100 - w}{18}} $ $ w = 46 $		
	w% = 46%		
A-11.	Sol. $V = \frac{W(\text{mass})}{d} = \frac{205.5}{0.79} = 260.13 \text{ mL}$ $M = \frac{W_B \times 1000}{m_B \times V} = \frac{5.5 \times 1000}{36.5 \times 260.13} = 0.58 \text{ M}$		
A-12.	Sol. We know, m = $\frac{\frac{x_B \times 1000}{(1 - x_B)m_A}}{3}$ Given : m = 5.2 and m _A = 18 $5.2 = \frac{\frac{x_B \times 1000}{(1 - x_B)18}}{x_B = 0.086}$		

SOLUTIONS & COLLIGATIVE PROPERITES

◆					
A-14.	Sol.	Volume of 100 gram of the solution = $\frac{100}{d} = \frac{100}{1.09} \text{ mL} = \frac{100}{1.09 \times 1000} \lim_{\text{litre}} = \frac{1}{1.09 \times 10} \lim_{\text{litre}}$			
	Numb	Number of moles of H ₂ SO ₄ in 100 gram of the solution = $\frac{13}{98}$			
	Molari	ty = $\frac{100 \times 100}{\text{Volume of solution in litre}} = \frac{100 \times 10}{98} \times \frac{1.00 \times 10}{1} = 1.445 \text{ M}$			
Sectio	on (B) : \	Vapour Pressure			
B-1.	Sol.	(2) V.P. does not depends on surface area of liquid. (it depends on temperature).			
B-2.	Sol.	(a) V.P. depends on temperature.			
B-3.	Sol.	(2) Non volatile substance has no V.P.			
B-4.	Sol.	(2) Atmospheric pressure is low.			
B-6.	Sol.	Vapour pr. depends on temperature not volume.			
Sectio	on (C) : \$	Solutions of Solid and Gases in Liquids			
C-1.	Sol. P = pr ∴	Henry's law is m = $K \cdot P$; where m = mass of gas absorbed by given volume of the solvent. essure of gas ; log m = log K + log P			
C-3.	Sol.	$CO_2 + H_2O \longrightarrow H_2CO_3 \longrightarrow 2 H^+ + CO_3^{2-}$			
	NH₃ + HCl + But Cł	$H_2O \longrightarrow NH_4OH \longrightarrow NH_4^+ + OH^-$ $H_2O \longrightarrow H_3O^+ + CI^-$ H_4 and H_2 are insoluble gases in water.			
C-4.	Sol. pressu	bl. Solubility increases with decrease in temperature. But solubility increases with increase in ressure according to Henry's Law.			
C-5.	Sol. $\frac{S_2}{S_1} =$	Solubility \propto pressure $\frac{P_2}{P_1}$ $\frac{760}{2}$			
	S ₂ = 5	$.3 \times 10^{-4} \times {}^{593} = 6.8 \times 10^{-4} \text{ M}$			
Sectio	on (D) : (Completely miscible liquids : Raoult's law			
D-3.	Sol. 120 = 100 X _B X _B = 0	$P = P_B^{\circ}X_B + P_T^{\circ} X_T$ 150(X _B) + 50 (1 - X _B) B = 70 .7			
	2	$X_{B}P_{B}^{0} = \frac{0.7 \times 150}{1}$ $\frac{Y_{B}}{1} = \frac{7}{4}$			
	Ч _в =	$P = 120 = 0.875$ $Y_T = 1 - 0.875 = 0.125$			
D-4.	Sol. Hg.	As $X_A \longrightarrow 1$. Then we will have pure methanol so $P_T = 120 X_A + 140 = 120 + 140 = 260$ mm of			
D-6.	Sol.	For two miscible liquids,			

Sol. For two miscible liquids, $P_{total} = mol.$ fraction A x p⁰A mol. fraction B x p⁰B

28

No. of moles of $A = \overline{140} = 0.2$ Liquid B is water. Its mass is (100 - 28) = i.e. 72No. of moles of $B = \frac{72}{18} = 4.0$ Total number of moles = 0.2 + 4.0 = 4.2Given $P_{total} = 160$ mm $p^{0}B = 150$ mm So, $160 = \frac{0.2}{4.2} \times p^{0}A + \frac{4.0}{4.2} \times 150$ $\frac{17.15 \times 4.2}{0.2} = 360.15$ mm ≈ 360 mm

D-10. Sol.

A : Benzene B : Toluene P = P_A + P_B P = $P_A^0 X_A + P_B^0 X_B$ = 75 x $\frac{1}{2}$ +22x $\frac{1}{2}$ = 37.5 + 11= 48.5

Mole fraction of benzene in vapour , $Y_A = \frac{\frac{P_A}{P}}{\frac{P}{P}} = \frac{\frac{37.5}{48}}{0.78} = 0.78$

Similarly, mole fraction of toluene in vapour , $Y_B = 0.22$ \therefore The vapour will contain higher percentage of benzene

- **D-11.** Sol. Given is vapour pressure of pure component 'A', $P_A^o = 120$ torr Partial vapour pressure of 'A', $P_A = 72$ torr Suppose, its mole fraction in solution is x_A , then according to Raoult's law $P_A = P_A^o \cdot x_A$ $72 = 120 \times x_A$ or $x_A = \frac{72}{120} = 0.6$
- **D-12.** Sol. Mole fraction of A in vapour phase $Y_A = 0.4$ & in liquid phase $X_A = 0.75$ $P_{total} = 400$ torr

Let V.P. of pure A and B are P_{A_0} & P_{B_0} .

$$\therefore \qquad X_A P_{A_0} = Y_A P_{total}$$

$$P_{A_0} = \frac{\frac{Y_A P_{Total}}{x_A}}{P_{A_0} = 213.33 \text{ torr}} = \frac{0.4 \times 400}{0.75} = \frac{160}{0.75}$$

Section (E) : Ideal & nonideal solution

- **E-2. Sol.** (2) CHCl₆ + CHCOCH₃
- **E-11.** Sol. $X_A = \frac{1}{3}, X_B = \frac{2}{3}$ $P = P_A^0 X_A + P_B^0 X_B$

$$\frac{1}{3} + 240 \times \frac{2}{3}$$

= 50 + 160 = 210 mm
Pexp. < P calculated

 \div There is negative deviation from Raoult 's law

Section (F) : Colligative properties & Van't Hoff factor

 $A_x B_v \xrightarrow{} xA^{m+} + vB^{n+}$ F-2. Sol. Initial moles 0 0 n At eq b. n(1–α) nxα nyα Total mol at equilirium $n[(1-\alpha) + x\alpha + y\alpha]$ Initial mol n i = = $i = (1 - \alpha) + x\alpha + y\alpha$ It can also seen that all other expressions imply the same thing. ∴ (4). $\frac{C (1-\alpha) + \frac{C\alpha}{n}}{C} \Rightarrow i = 1 - \alpha + \frac{\alpha}{n}$ F-4. i = Sol. F-6. Sol. For dissociation (i > 1)F-9. Sol. If the solution is infinitely dilute, NaHSO₄ would dissociate completely. \therefore NaHSO₄ \longrightarrow Na⁺ + HSO₄⁻ HSO₄- would further dissociate as : $HSO_{4^{-}} \longrightarrow H^{+} + {}^{SO_{4^{-}}}$ i = 3 ∴ (3).

Section (G) : Relative lowering of vapour pressure (RAOULT'S LAW)

G-10. Sol.
RLVP =
$$\frac{in}{in+N}$$

so $0.167 = \frac{2 \times n}{2n + \frac{180}{18}}$
so $n = 1$
G-11. Sol. RLVP = $\frac{i \quad n_{NaCl}}{i \quad n_{NaCl} + n_{H_2O}}$; $0.4 = \frac{i}{i+3}$
so $i = 2$
 \therefore $i = 1 + \alpha$ so $\alpha = 1$ or 100%

G-12. Sol. $\frac{268 - 167}{167} = x/1 \Rightarrow \text{So } x = 0.605$

P⁰ – P

- **G-16.** Sol. $P^{\circ} = 0.05 = X_{B}$ Where $X_{B} =$ mole fraction of solute. $\frac{1000 \times X_{B}}{(X_{A} \times M_{A})} = 1000 \times 0.05 / 0.95 \times 18$
- **G-17.** Sol. Lowering of V.P. is colligative property thus, i (K₂SO₄) = 1 + (y - 1) x = 1 + 2x = 3 $\therefore \qquad If \frac{\Delta p}{p^{\circ}} = \frac{n_1 i}{n_1 i + n_2}$ $\frac{10}{50} = \frac{3n_1}{3n_1 + 12} = \frac{n_2}{n_1 + 4}$ $n_1 = 1$

Section (H) : Elevation in boiling point

- H-1. Sol. (2) Atmospheric pressure is low.
- H-5. Sol. w = 6g, W = 1000g, Mol. wt. of glucose =180 $\Delta T_{b} = \frac{1000 \times K_{b} \times w}{m \times W} = \frac{1000 \times 0.52 \times 6}{180 \times 1000} = 0.0173^{\circ}C$ Hence boiling point of solution = b.p. of water + ΔT_b = 100 + 0.0173 = 100.0173^{\circ}C.
- H-6. Sol. AIPO₄ \longrightarrow AI³⁺ + PO₄³⁻ i = 1 + x = 2 ΔT_b = molality K_bi $\therefore \qquad \frac{\Delta T_b}{K_b} = 0.02.$
- **H-9.** Sol. Highest boiling point will be of that solutions for which ΔT_b is high. Here in this case $\Delta T_b \propto i$ (van't hoff factor)

i = 4 for Al(NO₃)₃
Al (NO₃)₃
$$\longrightarrow$$
 Al³⁺ + 3 NO₃⁻

- **H-10.** Sol. $x_{3}y_{2} \xrightarrow{} 3x^{2+} + 2y^{3-}$ for complete ionization. $1 - \alpha$ $n\alpha$ $m\alpha$ $i = 1 + (m + n - 1) \alpha$ $i = 1 + (2 + 3 - 1) \times 0.25 = 1 + 1 = 2$ $\Delta T_{b} = i \times k_{b} \times m = 2 \times 0.52 \times 1 = 1.04$ B.P. of solution (T_{b}) = $\Delta T_{b} + T_{b}^{\circ} = 1.04 + 373 = 374.04$ K Ans.
- H-12. Sol. Molal elevation constant of the solvent.

$$K_{b} = \frac{RT^{2}_{b}}{\mathbb{V}_{v} \times 1000} = \frac{2 \times 373 \times 373}{536 \times 1000} = 0.519 \text{K-kg/mol}$$

H-13. Sol. $\Delta T_{b} = m \ k_{b} = \frac{w}{M} \times \frac{1000}{W} \times k_{b}$ $\Delta T_{b} = 47.98 - 46.3 = 1.68$ $1.68 = \frac{28}{M} \times \frac{1000}{315} \times 2.38$ $M = \frac{28 \times 1000 \times 2.38}{315 \times 1.68} = 125.92$ Atomicity $= \frac{Mol. \ wt.}{At. \ wt.} = \frac{125.92}{31} = 4.02$ So. Molecule is $= P_{4}$.

Section (I) : Depression in freezing point

I-10. Sol. Higher freezing point \Rightarrow lesser $\Delta T_f \Rightarrow$ lesser molality \Rightarrow

lesser number of particles

I-12. Sol. Given,
$$w = 0.2 \text{ g}$$
, $W = 20 \text{ g}$,
 $\Delta T = 0.45^{\circ}\text{C}$
 $\Delta T = \frac{1000 \times \text{K} \times w}{\text{m} \times W}$
 $\Delta T = \frac{1000 \times 5.12 \times 0.2}{20 \times \text{m}}$
 $\therefore \text{ m(observed)} = 113.78$
Now for $2\text{CH}_3\text{COOH} \longrightarrow (\text{CH}_3\text{COOH})_2$
Before association $1 - \alpha$ $\alpha/2$
Where α is degree of association
 $\therefore \frac{\text{m}_{normal}}{\text{m}_{observed}} = 1 - \alpha + \alpha/2$
or $\frac{60}{113.78} = 1 - \alpha + \alpha/2$
or $\alpha = 0.945$
or 94.5%

Section (J) : Osmosis and osmotic pressure

J-2. Sol. Colligative properties of the solution depend upon concentration of solute particles.

J-5. Sol. Semipermeable membrane allows the solvent particles only to pass through it.

J-8. Sol.
$$\pi V = \frac{\frac{W_B}{m_B}RT}{\frac{4}{m_B} \times 0.082 \times 300}$$

 $mg = 1.6 \times 10^{-5}$
J-11. Sol. $\pi_f V_f = \pi_1 V_1 + \pi_2 V_2$
 $\pi_f = \frac{1.2V + 2.5V}{2V} = \frac{3.7V}{2V}$

 $\pi_{\rm f} = 1.85$ atm.

J-12. Sol. For isotonic solution $\pi_1 = \pi_2$; $C_1 = C_2$; $n_1 = n_2$

 $\frac{W_1}{M_1} = \frac{W_2}{M_2} \qquad \Rightarrow \frac{10.5}{M} = \frac{30}{180} \qquad \Rightarrow \qquad M = \frac{10.5 \times 180}{30} = 63 \text{ Ans.}$

J-15. Sol. All solution have same No. of particle and also have same value of π . $n_1 = n_2$; $\pi_1 = \pi_2$ (Isotonic).

J-16. Sol. (1) HA \longrightarrow H⁺ + A⁻, pH = 2 0.1 pH = 2 so [H⁺] = 0.01 Total Concetration = 0.1 + 0.01 = 0.11 M π = CRT = 0.11 RT Ans.

Exercise-2

Marked Questions may have for Revision Questions.

OBJECTIVE QUESTIONS

		<u>18</u> 180 ×1000			
1.	Sol.	1000 =	0.1 mola	al eksyy	
		$\frac{98}{98}{100} \times 1000$)		
2.	Sol.	M = 1.8	= 18 M		
3.	Sol.	Mole of $H_2O =$	$\frac{36}{18} = 2$		
	$\frac{46}{92} = 0.5$ total mole = 2 + 0.5 = 2.5				
	Mole fra	actions of glycer $X_0 = 0.$	ine = ⁿ , - 2 Ans.	$\frac{n_1}{n_2} = \frac{0.3}{2.3}$	5
4.	Sol.	(1) B.P. of wate	er is elev	ated.	
5.	Sol.	(1) V.P. depend	ds on ter	nperatur	e. (ok"i nkc rki ij fuHkZj djrk gSaA)
6.	Sol. (1) (2) (3) (4)	Solute KCl K ₂ SO ₄ FeCl ₃ SnCl ₄	y 2 3 4 5	x 0.5 0.4 0.3 0.2	i = [1 + (y – 1) x] 1.5 1.8 1.9 1.8
7.	Sol. on com so	Pressure of air pressing P⊤ = (1950 + 10	= 750 – P _f = Hg 00) = 205	100 = 69 650 × 3 50 mm o	50 mm of Hg mm of Hg = 1950 mm of Hg f Hg

8.	Sol.	More is the value of Vant Hoff factor, more will be RLVP.		
9. Sol.	$P = X_A P_A^0 + X_B P_B^0 = (P_A^0 - P_B^0) X_A + P_B^0$ So $P_B^0 = 254$			
		$P_{A^0} - P_{B^0} = -119$ $P_{A^0} = 135$		
10.	Sol. ⇒ ⇒	$760 = 300 X_{A} + 800 (1 - X_{A})$ $760 = 800 - 500 X_{A}$ $500 X_{A} = 40$ $\frac{40}{X_{A} = 500} = 0.08.$		
11.	Sol.	(1) for a ideal solution $\Delta S_{mix} \neq 0$		
12.	Sol.	For a ideal solution $\Delta G \text{ mix} < 0.$		
13.	Sol.	It shows negative deviation from Raoult's law p_s (actual) = 580 torr p_s (Raoult) = 0.4 × 300 + 0.6 × 800 = 600 torr.		
15.	Sol. According to Raoult's law $P_T = (0.08 \times 300 + 0.92 \times 800)$ torr = (24 + 736) torr = 760 torr = 1 atm $P_{exp.} = 0.95$ atm < 1 atm Hence solution shows -ve deviation so ${}^{\Delta H_{mix}} < 0$,and ${}^{\Delta V_{mix}} < 0$.			
16.	Sol.	$P_{\text{Total}} = 0.4 \times 80 + 0.6 \times 120 = 104 > 100 \text{ mm of Hg}.$		
17.	Sol.	$\Delta T = \frac{\frac{1000 \times K_{b} \times Y}{250 \times M}}{250 \times M} = \frac{4K_{b}Y}{M}$		
18.	Sol. value o so so	Ba ₃ (PO ₄) ₂ \longrightarrow 3 Ba ²⁺ + 2 PO ₄ ³⁻ f i = 5 (100% ionised) $\Delta T_f = i k_f m$ $m = \frac{\Delta T_f}{i k_f} = \frac{0.05}{5} = 0.01$		
19.	Sol. 0.69 = i	$\Delta T_{f} = i. \text{ kb.m}$ $\frac{5.12 \times 20 \times 1000}{94 \times 1000}$ $i = 0.63$		
	for dime	erization $i = 1 - \alpha/2$ $0.63 = 1 - \alpha/2$ $\alpha = 0.74$.		
20	Sel	0.1 M alugada colution has higher F.D. hassung it has lowest A		

Sol. 0.1 M glucose solution has higher F.P. because it has lowest ΔT_f . 20.

0.2

Sol. (i) $\Delta T_f = m \times K_f$ 21. X×1000 $0.2 = \frac{1000}{100} \times 1.86 \qquad \qquad X = \frac{0.2}{10 \times 1.86}$ after freezing

$$\begin{split} \Delta T_f &= m \times K_f \\ \Delta T_f &= \times 1.86 \qquad \Delta T_f = 0.25 \\ \text{On solving, Amount of ice } y &= 20 \text{ g ice} \end{split}$$

22. Sol. $\pi = CRT$ 7.40 = n × 0.0821 × 300

$$\pi = \frac{n}{v} RT$$
 $n = \frac{7.4}{0.0821 \times 300} = 0.3.$

23. Sol. Isotonic solution has same conc.

$$\pi_{1} = \pi_{2} \quad C_{1} = C_{2} \quad n_{1} = n_{2} \qquad \boxed{\frac{W_{1}}{M_{1}} = \frac{W_{2}}{M_{2}}}$$
So, $\frac{X}{18} = \frac{4}{60} \implies x = 12 \text{ g Ans.}$

- 24. Sol. When dried fruits and vegetables are place in water, they solwly get swelled osmosis takes place i.e. water molecules pass through SPM present in cell-walls. If temperature is increased osmosis will be faster.
- 25. Sol. $\pi \alpha$ No. of particle/ion. BaCl₂ = 3, NaCl = 2 glucose = 1 So. order of π = BaCl₂ > NaCl > glucose.
- **26.** Sol. Osmosis is a process in which solvent (water in this case) flows from low concⁿ solⁿ to high concⁿ solⁿ by SPM.

OFFLINE JEE-MAIN

- 1. Sol. Moles of urea = $\frac{6.02 \times 10^{20}}{6.02 \times 10^{23}} = 10^{-3}$ moles Concentration (molarity) of solution = $\frac{10^{-3}}{100} = 1000 = 0.01$ M.
- 2. Sol. Elevation in boiling point is a colligative property which depends upon the number of solute particles. Greater the number of solute particles in a solution, higher the extent of elevation in boiling point.

$$Na_2SO_4 \rightarrow 2Na^+ + SO_4^{2-}$$

- 3. Sol. Na₂So₄ $2Na^+ + SO_4^{2-}$ 1 0 0 1 - a 2a a Vant Hoff factor (i) = $\frac{1 - \alpha + 2\alpha + \alpha}{1} = 1 + 2\alpha$.
- **4. Sol.** According to Raoult's law equimolar solutions of all the substances in the same solvent will show equal elevation in boiling points as well as equal depression in freezing point.

5.	Sol. Total millimoles of solute $= 480 \times 1.5 + 520 \times 1.2 = 720 + 624 = 1344.$ Total volume $= 480 + 520 = 1000.$	
	Molarity of the final mixture = $\frac{1000}{1000}$ = 1.344 M.	
6.	Sol. $P_B = P_B^{\circ} XB$ $P_B^{\circ} = 75 \text{ torr}$ $\frac{78/78}{(78/78) + (46/92)} = \frac{1}{1 + 9.5} = \frac{1}{1.5} = \frac{1}{1.5}$	
	$X_{B} = (76776) + (40792) = 1 + 0.5 = 1.5 P_{B} = 75 \times 1.5 = 50 \text{ torr.}$	
7.	Sol. Molality, m = $\frac{M}{1000d - MM_2} \times 1000$ where M = molarity, d = density, M ₂ = molecular mass 2.05	
	$m = \frac{1000 \times 1.02 - 2.05 \times 60}{1000 \times 1.02 - 2.05 \times 60} = 2.28 \text{ mol kg}^{-1}$	
8.	Sol. According to Raoult's law $P = P_A + P_B = P_{a}x + P_{B}x_B$ or $290 = P_{A} \times (0.6) + 200 \times (1 - 0.6)$	
9.	Sol. Isotonic solutions have same osmotic pressure. $\pi_1 = C_1 RT$, $\pi_2 = C_2 RT$ For isotonic solution, $\pi_1 = p_2$ $\therefore \qquad C_1 = C_2.$ or $\qquad \frac{1.5/60}{V} = \frac{5.25/M}{V}$ [where M = molecular weight of the substance] $\qquad \frac{1.5}{60} = \frac{5.25}{M}$ or M = 210.	
12.	Sol. The solution is non-ideal, showing +ve deviation from Raoult's Law.	
13.	Sol. $P_{\text{total}} = P^{0}_{A} X_{A} + P^{0}_{B} X_{B} = P^{0}_{A} \times \frac{1}{4} + P^{0}_{B} \times \frac{1}{4} = 550 \Rightarrow P^{0}_{A} + 3P^{0}_{B} = 550 \times 4$ similary $560 = P^{0}_{A} \times \frac{1}{5} + P^{0}_{B} \times \frac{4}{5} \Rightarrow P^{0}_{A} + 4P^{0}_{B} = 560 \times 5$ eq. (ii) - eq.(i) $P^{0}_{B} = 560 \times 5 - 550 \times 4 = 600$ so $\frac{1}{2} P^{0}_{A} = 400$.	(i) (ii)
14.	Sol. Na ₂ SO ₄ (s) $\xrightarrow{H_2O}$ 2Na ⁺ (aq.) + SO ₄ ^{2−} (aq.) $\Delta T_f = i K_f m$ = 3 × 1.86 × 0.01 = 0.0558 K.	
15.	Sol. $P_T = X_{Heptane} P^{0}_{Heptane} + X_{Octane} P^{0}_{Octane}$ $P_T = X_{gsIVsu} P^{0}_{gsIVsu} + X_{vkWDVsu} P^{0}_{vkWDVsu}$ $= \frac{0.25}{0.557} + \frac{0.307}{0.557} $	
16.	Sol. $\Delta I_f = I \times k_f \times M$	

17.

$$2.8 = 1 \times 1.86 \times \frac{x}{62 \times 1}$$

$$x = \frac{2.8 \times 62}{1.86} = 93 \text{ gm}$$
Sol.
$$0.5 \text{ M C}_2\text{H}_5\text{OH} \text{ (aq)}$$

$$i = 1$$
effective molarity = 0.5

0.25 M KBr (aq) i = 2 effective molarity = 0.5 M 0.1 M Mg₃ (PO₄)₂ (aq) i = 5 effective molarity = 0.5 m 0.125 M Na₃PO₄ (aq) i = 4 effective molarity = 0.5 M

Hence all colligative properties are same.

Note : This equation is solved by assuming that the examinar has taken $Mg_3(PO_4)_2$ to be completely soluble. However the fact is that it is insoluble (sparingly soluble).

18. Sol.
$$\frac{P_0 - P_S}{P_S} = \frac{n}{N}$$

 $\frac{185 - 183}{183} = \frac{1.2/M}{100/58}$
 $M \approx 64 \text{ g/mol}$
19. Ans. (2/Bonus)
Sol. Moles of glucose $= \frac{18}{180} = 0.1$; Moles of water $= \frac{178.2}{18} = 9.9$
 $\Rightarrow n_{Total} = 10$
 $\Rightarrow \frac{\Delta P}{P^0} = \frac{0.1}{10}$
 $\therefore \Delta P = 0.01 P^0 = 0.01 \times 760 = 7.6 \text{ torr}$
 $P_S = 760 - 7.6 = 752.4 \text{ torr}$
20. Sol. $\Delta T_r = 0.45$
 $m = \frac{\left(\frac{0.2}{60}\right) \times 1000}{20} = \frac{1}{6}$
 $K_r = 5.12 \text{ k kg/mol}$
 $i = 1 + \left(\frac{1}{n} - 1\right)\beta$ (n = 2)
 $= 1 - \frac{\beta}{2}$
Now, $\Delta T_r = i K_r m$
 $0.45 = \left(1 - \frac{\beta}{2}\right)(5.12)\left(\frac{1}{6}\right)$
 $\Rightarrow \beta = 0.94$
 $\therefore \%$ Association (% laxq.ku) ≈ 94 %

ONLINE JEE-MAIN

1.5 $x_{Benzene} = 5 = 0.3, x_{toluene} = 0.7$ 4. Sol. $P_T = 74.7 \times 0.3 + 0.7 \times 22.3 = 22.41 + 15.61 = 38.02$ torr ⇒ 22.41 $y_{benzene} = \overline{38.02} = 0.589$ and 5. Sol. Benzene is non-polar solvent. According to Henery law 6. Sol. $P_1 S_1$ $P_2 _ S_2$: S1 & S2 are solubility of gas (g/L) 500 0.01 $\overline{750} = S_2$ 750×0.01 500 S₂ = = 0.015 g/L *:*. 7. Sol. For MX₂ type salt Vant factor (i) = $1 + 2\alpha = 2$ $\alpha = 0.5$ ⇒ 8. g Sol. $\Delta T_f = imk_f$ 3.82= [1+(3-1).815]m ×1.86 3.82 _ 2.63×1.86 $\frac{3.82}{2.63 \times 1.86} = \frac{5}{142} \times \frac{1000}{x}$ x = 45 g9. Sol. Apply raoult's law : $P_{\text{Total}} = X_A P_A^o + X_B P_B^o$ $\left(\frac{0.1}{0.1+0.1}\right) \times 415 + \left(\frac{0.1}{0.1+0.1}\right) \times 200$ = 307.5 mm Hg $X_B X_B^o$ 0.5×200 Mole fraction of CHCl₃ in vapour form $(Y_B) = P_{Total} =$

PART - II : JEE (ADVANCED) / IIT-JEE PROBLEMS (PREVIOUS YEARS)

- 1. Sol. The freezing point of a solvent depresses as a non-volatile solute is added to a solvent. According to Raoult's law, when a non-volatile solute is added to a solvent the vapour pressure of the solvent decreases. At freezing point it will be only the solvent molecules which will solidify.
- **2.** Sol. Van't Hoff factor, $i = 1 + (n 1) \alpha$ Here n = 3

So, $2.74 + 1 + (3 - 1) \alpha$

	So,	α = 0.87 i.e. 87%			
3.	Sol.	Weight of water = $500 \times 0.997 = 498.5 \text{ g}$ Wt. of CH ₂ COOH (in gm) $3 \times 10^{-3} \times 10^{3}$			
	No. of r	moles of acetic acid = $\frac{Maler CH_3COCH}{Mol.wt.of CH_3COOH} = \frac{3 \times 10^{-1} \times 10^{-1}}{60} = 0.05$			
	Since 4	198.5 g of water has 0.05 moles of CH ₃ COOH			
		$\frac{0.05 \times 1000}{408.5}$			
	1000 g Determ	of water has = $^{490.5}$ = 0.1 nination of van`t Hoff factor, i			
	No. of r	moles at start 1 0 0			
	No. of r ∆T _f = (1	moles at equb. 1 – 0.23 0.23 0.23 I – 0.23 + 0.23 + 0.23) × 1.86 × 0.1 = 0.228K.			
4.	Sol. equilibr	Only solvent molecule under go solidification. So liquid solvent and solid solvent remain in rium.			
5.	Sol.	$(\pi_{obs})_{Na_2SO_4} = \pi_{glucose}$			
		$\frac{10}{1} = \frac{1+2\alpha}{1}$			
	or 10	4 1 or $10 = 4 + 8\alpha$			
	$\alpha = \frac{10}{8}$	$\frac{-1}{8} = 0.75$ % of $\alpha = 75\%$			
6.	Sol.	$\Delta T_b = i K_b m$ i (vant Haff factor) of CuCl ₂ = 3			
		13.44			
	$\Delta T_{b} = 3$	$3 \times 0.52 \times {}^{134.4 \times 1} = 0.156 = 0.16.$			
_	.	$\frac{20}{172} \frac{1000}{50}$			
7.	501.	$\Delta I_f = I \times K_f \times \text{molality} \implies 2 = I \times 1.72 \times 172 \times 300$ $\implies 2 = 4i$			
		\Rightarrow i = 1/2 = 0.5			
8.	Sol.	$P_{N2} = K_{H} \times {}^{X_{N_2}}$			
	X., 4	$\frac{1}{10^5}$			
	$M_2 = 10^{\circ} \times 0.8 \times 5 = 4 \times 10^{-5}$ per mole In 10 mole solubility is 4×10^{-4} .				
		0.1			
9.	Sol. ⇒	$\Delta T_f = \mathbf{i} \times K_f \times \mathbf{m} = 4 \times 1.86 \times 3^{-2} \times 0^{-1} = 2.3 \times 10^{-2}$ $T_f = 0 - 2.3 \times 10^{-2} = -2.3 \times 10^{-2} \text{oC}.$			
10.	Sol.	$\Delta T_{\rm b} = 2^{\rm o} C$; $m_{\rm a} = 2.5 \ {\rm g}$			
		$m_{solvent} = 100 g$			
		$K_b = 0.76 \text{ K. kg. mol}^{-1}$ $P_{\text{solution}} = ?$			
	$\Delta T_{b} = K$	K _b × m			
	0 07	$6 \dots m = \frac{2}{0.76}$			
	∠ = 0.7				

$$\frac{P^{0} - P}{P} = m \times MM \times 10^{-3} \therefore \qquad \frac{760 - P}{P} = \frac{2}{0.76} \times 18 \times 10^{-3}$$

$$760 - P = \frac{36}{760}P \qquad \qquad \therefore 760 = \frac{796}{760}P$$

$$\therefore P = 760^{\left(\frac{760}{796}\right)} \text{ torr} = 725.6 \text{ torr} 724 \text{ torr}$$

11. Ans. (BD)

Sol. For a mixture of two liquids L and M, For ideal solution obey Raoult's law $P_L = (1 - X_M)P_L^o = P_L^o - X_M P_L^o$ Graph between $P_L \& X_M$ has intercept = $P_L^o \&$ slope = -ve But graph representing +ve deviation from Raoult's law therefore M - L < M - M or L - LPoint Z represents intercept which is P_L^o when $X_L \rightarrow 1$

12. Ans. (A)

Sol. As T increase, V.P. increases. So C & D options get rejected.

 $\Delta T_f = K_f \times m$

 $273 - T'_{f} = \frac{2 \times \frac{34.5/46}{0.5}}{\therefore T'_{f} = 270 \text{ K}}$

APSP Solutions

PART-I

1. Mole of $H_2O = \frac{18}{18} = 2$

Mole of glycerine = $\frac{46}{92} = 0.5$ total mole = 2 + 0.5 = 2.5

36

Mole fractions of glycerine = $\frac{n_1 + n_2}{X_0} = \frac{2.5}{2.5}$ X₀ = 0.2 Ans.

- 2. I. Melting of snow by salt : Depression in freezing point
 - II. Desalination of sea water : Reverse osmosis
 - III. Osmosis is used to determine the molar mass.
- **3.** When non volatile solute added to solvent. Due to elevation in boiling point, boiling point and due to dispression in freezing point, freezing temperature \downarrow .

4.		HA <u>→</u> H+ + A ⁻
		i = [1 + (y - 1) x] = 1 + x
		$pK_a = 4 = -\log K_a$
	.: .	$K_a = 10^{-4} = Cx^2$
		$1 \times 10^{-4} = 0.01 \times x^2 \implies x = 0.1$ \therefore $i = 1 + x = 1.1$
5.	As	$\Delta T_{\rm b} = {\rm i} \ {\rm K}_{\rm b} {\rm m}$
	SO	$iK_b m$ can be expressed in degree (Unit of temperature)
	and	$K_b m$ can be expressed in degree (Unit of temperature)
		ΔT_{b}
	and	ⁱ can be expressed in degree (Unit of temperature)
	But uni	t of K₀ is mol ⁻¹ kg K
6.	As	$\Delta T_{\rm b}$ = molality × K _b
		$0.52 = m \times 0.52$
		molality = 1 mol kg^{-1}
	. .	urea = 1 mol
		1000
		moles of water = $18 = 55.55$
		1
	mole fr	action of urea = $\frac{56}{56} = 0.018$
7.	π = CR	т
	C	
	$\pi = \frac{\overline{O}}{M}F$	C = moles/liter, c = kg/m ³
	π R	T
	$\overline{c} = \overline{N}$	1

$$M = \frac{RT}{\pi/c} [\pi/c = 8.314 \times 10^{-3}]$$

[T = 293 k]
$$M = \frac{8.314 \times 293}{8.314 \times 10^{-3}} = 293 \times 10^{3}$$



Normal boiling point of the solution is that temperature at which vapour pressure of solution equals to 1 atm.

9. Given $\Delta T_b = 1.08^{\circ}C$, i = 2 at boiling pt. of solution.

and $\Delta T_f = 1.80^{\circ}C$, and $\frac{k_b}{k_f} = 0.3$ so $\frac{\Delta T_b}{\Delta T_f} = \frac{i_b k_b m}{i_f k_f m}$ so $i_f = 1$

i.e., AB behaves as non-electrolyte at the f.p of the solution.

- **10.** 1M $C_6H_{12}O_6$ (molar mass = 180 g mol⁻¹) 1000 mL solution has = 180 g solute 1180 g solution has = 180 g solute 1000 g solvent has = 180 g solute Thus, molality = 1 molal
 - \therefore $\Delta T_f = K_f \text{ molality} = 1.86 \times 1 = 1.86^{\circ}$
 - ∴ F.P. = 1.86°C
- **11.** Firstly we have to convert mole fraction into molality .

$$\begin{split} \text{Molality} = & \frac{x_{\text{solute}}}{x_{\text{solvent}} - M_{\text{solvent}} / 1000} = & \frac{0.07 \times 1000}{0.93 \times 18} = 4.18 \\ \text{Now,} & \Delta T_{\text{f}} = k_{\text{f}} \, \text{m} = 1.86 \times 4.18 = 7.78^{0} \; . \end{split}$$

- **12.** From given graph , we can say T₁ is that temp at which solid state and liquid (solution) are in equilibrium.
- 13.

8.

100 60×3

 $P = P_A^{\circ}X_A + P_B^{\circ}X_B$

4 + 4 = 70 mm < 75 mm (experimental)

Thus, there is positive deviation (1) is true, mixture is more volatile due to decrease in b.p. Thus, (2) is true also force of attraction is decreased thus (3) is true.

- 14. Colligative property of a solution depends on no. of particles of solute in solution.
- **15.** Value of van't Hoff factor is least for urea solution, so there will be least depression in freezing point i.e., maximum freezing point.

16. In HF hydrogen bonding is present so there is association of molecules due to this van't hoff factor is less , so depression in f.p decreases therefore f.p. value is larger than HCI. Similarly value of i = 2 for NaCI and i = 1 for Glucose.

17.

:.

$$32 = X_A \ 40$$
$$X_A = \frac{32}{40} = 0.8.$$

18.
$$P_T = X_A p^{\circ}_A + X_B p^{\circ}_B$$

= $\left(\frac{2}{4}\right)_{x \ 80} + \left(\frac{2}{4}\right)_{x \ 120} = 100 \text{ Torr}$

Now mole fraction in vapour phase =
$$\frac{X_A P_A^0}{P_T} = \frac{40}{100} = 0.4.$$

19. Boiling point get lowered when vapour pr. increases and it happens when there is a positive deviation from Raoult's law.

- $k_{\rm f} = \frac{\Delta T_{\rm f}}{m} = \frac{1.86}{1} = 1.86$ 20. For urea, $\Delta T_f = k_f \times m$ or Now for CH₃COOH $\Delta T_f = i k_f m$ 0.02046 $i = 1.86 \times 0.01 = 1.1$ SO Now $i = 1 + \alpha$ $\alpha = 1.1 - 1 = 0.1$ SO CH₃COOH $\overline{}$ CH₃COO⁻ H+ Now С 0 0 $C - C\alpha$ Сα Сα $[H^+] = C\alpha = 0.01 \times 0.1 = 0.001$ pH = 3.so
- **21.** Mixtures of CHCl₃ and CH₃COCH₃ shows negative deviation from Raoult's law , so vapour pressure decreases and boiling point increases.
- **22.** $\Delta T_f = k_f m.$

 $\Delta T_{\rm f} = 1.86 \times 0.5 = 0.93.$ so $T_{\rm f} = -0.93^{\circ}C$.

- 23. More the value of van't hoff factor , more will be the depression in freezing point.
- 24. Acetone and chloroform forms hydrogen bonding so volume decreases.

25. All are facts.

We should remember that , Entropy of solution is more than entropy of pure solvent. So the difference in entropy change will be less in case of solution.

26. $M_{observed} = \frac{58.5}{i}$; i > 1.

27. Due to weak force of attraction more vapour will be forrmed so vapour pressure will be high.

- **28.** The order of force attraction and boiling point is $CH_3OH > CH_4 > H_2$.
- **29.** At freezing point liquid solvent and solid solvent are in equilibrium.
- **30.** There is very weak attraction between benzene and methanol as compare to attraction between molecules of methanol.

PART - II

1. Volume of solution $= \frac{Density}{Density} = \frac{1.15}{Density}$ mL Molarity of solution can be calculated as

$$M = \frac{W_{B} \times 1000}{M_{B} \times V} = \frac{120 \times 1000}{60 \times (1120)/1.15} = 2.05 \text{ M}$$

2. KOH solution is 30% by weight.

 \therefore wt. of KOH = 30 g and Wt. of solution = 100 g

 \therefore Volume of solution = d

Molarity= 6.90 =
$$\left(\frac{30}{56 \times \frac{100}{1000 \times d}}\right)$$
 = **1.288 g mL⁻¹**

7. (2) Non volatile substance has no V.P.

...

 Here w = 0.5 g, W = 100 x 1.58 = 158 g (since d = W / V), m = 65,

M of CCl₄ = 154.
$$\frac{p^{\circ}-p}{p^{\circ}} = \frac{wM}{mW}$$

 $\frac{143-p}{143} = \frac{0.5 \times 154}{65 \times 158}$ or

10. According to question $P_s = 0.95 P_0$ according raoult's law $P_s = P_0 X_A$

or

$$\frac{W_{A}}{M_{A}}$$

$$0.95 P_0 = P_0 \left[\frac{\frac{M_A}{M_A}}{\frac{M_A}{M_A} + \frac{M_B}{M_B}} \right]$$

$$0.95 = \frac{\frac{W_{A}}{0.3 M_{B}}}{\frac{W_{A}}{0.3 M_{B}} + \frac{W_{B}}{M_{B}}}$$

$$W_A$$
 = gram wt. of solvent W_B = gram wt. of solute

p = 141.93 mm

given $M_A = 0.3 M_B$

 M_A = molecular wt. of solvent M_B = molecular wt. of solute

on solving
$$\frac{W_{A}}{W_{B}} = 5.7.$$

14. Let molecular wt. of solute = m

16.

18.

and V.P. of water (solvent) = P⁰
P_{statem} = 20 tor
moles of solven N =
$$\frac{6}{m}$$

moles of solvent N = $\frac{180}{18}$ = 10
 $\therefore P_{0} = \left(\frac{N}{n+N}\right)p_{0} \Rightarrow 20 = \left(\frac{10}{\frac{6}{n+10}}\right)p_{0} \Rightarrow 20 = \left(\frac{10m}{6+10m}\right)p_{0} \dots (1)$
If 1 mol water is further added moles of solvent
N = 10 + 1 = 11 mol
& V.P. of solution becomes
P_{5} = 20 + 0.02 = 20.02 tor
P_{5} = \frac{N}{n+N}p_{0} \Rightarrow 20.02 = \left(\frac{11}{\frac{6}{m}+11}\right)p_{0} \Rightarrow 20.02 = \left(\frac{11m}{6+11m}\right)p_{0} \dots (2)
divide eqn. (2) by (1)
 $\frac{20.02}{20} = \frac{11(6+10m)}{10(6+11m)}$
m = 54 gm
Put this value of m in equation. (1) or (2)
P⁰ = 22.22 tor
16. As $\rightarrow m0$ (infinite dilution) both electrolytes will be completely dissociated so
NaCl $\implies Na^{*} + C^{\top}$
NaHSOA $\implies Na^{*} + H^{*} + SOA^{2^{*}}$.
 $\frac{\left(\frac{0.1 \times 1000}{100 \times 100}\right)_{p}}{0.2}$
 $\frac{0.2}{0.4} = \frac{\left(\frac{0.1 \times 1000}{100 \times 100}\right)_{p}}{100 \times m_{0}}$
 $\frac{1}{2} = \frac{(m_{0})_{0}}{100}$
 $m_{a} = 50$
 \therefore (m_{b}): (m_{b})_{0} = 100 : 50
 $= 2 : 1$
18. $\Delta T_{b} = ik_{b} m$ so $i = \frac{2.08}{0.52 \times 1} = 4$
so the compax is K₀ [Fe(CN)]
 K_{0} [Fe(CN)] $\implies 3 K^{*} + [Fe(CN)]^{3^{*}}$

 $w_{_{B}} imes 1000$ $\Delta T = K_f \times m_B \times W_A$ 20. 50×1000 $9.3 = 1.86 \times 62 \times W_{A}$ $w_A = 161.29 \text{ gm}$ (water) Amount of ice = 200 - 161.29 = 38.71 g 0.849 Μ 0.05 21. 1.24 = 34.3 ⇒ M = 469.68 : as Hg₂Cl₂ molecules. Heptane (A) Octane (B) 24. 25 35 $n_A = 100 = 0.25$ $n_{\rm B} = 114 = 0.3$ 0.25 0.3 $x_A = \overline{0.55}$ $x_{\rm B} = 0.55$ $\mathbf{p} = \mathbf{p}_{A}^{0} \mathbf{x}_{A} + \mathbf{p}_{B}^{0} \mathbf{x}_{B}$ $= \left[105 \times \frac{0.25}{0.55}\right] + \left[45 \times \frac{0.3}{0.55}\right]$ = 47.72 + 24.54 = 72.265 kPa $\chi_{\rm B} = \frac{2}{3}, \chi_{\rm C} = \frac{1}{3}$ 20 mole C₆H₆, 10 mole C₆H₅Cl \Rightarrow 25. 2 1 at t = 100°C \Rightarrow p_s = 300 x $\frac{1}{3}$ + 1350 x $\frac{1}{3}$ = 100 + 900 (=1000).