Liquid Solution

SOLUTIONS

Exercise – I (JEE-Main Pattern)

SECTION-A

1. Ans. (2)

Since solubility of gas decrease with increasing K_H.

2. Ans. (3)

Raoult's law:

$P_S = P_A^o X_A + P_B^o X_B$; where

$X_A; X_B$ = mole fractions of A & B in the liquid phase, respectively

P_A^o, P_B^o = vapour pressures of pure A & pure B, respectively

P_s = total vapour pressure of the binary solution of A & B

Substituting $X_A = 1 - X_B$; we get

$P_S = P_A^o - (P_A^o - P_B^o)X_B$; comparing with equation given in question; we get

$P_A^o = 120$; $P_A^o - P_B^o = 75$

$\Rightarrow \quad P_B^o = 120 - 75 = 45\text{mm}$

3. Ans. (4)

Raoult's law:

$P_S = P_A^o X_A + P_B^o X_B$; where

$X_A; X_B$ = mole fraction of A & B in the liquid phase, respectively

$P_A^o; P_B^o$ = vapour pressures of pure A & pure B; respectively

P_S = vapour pressure of the binary solution of A & B

Substituting values given in the question we get

$$P_S = \left(\frac{2}{5}\right)(100 \text{ torr}) + \left(\frac{3}{5}\right)(300 \text{ torr}) = 220\text{torr}$$

4. Ans. (3)

Raoult's law;

$P_S = P_A^o X_A + P_B^o X_B$; where

X_A; X_B mole fractions of A & B in the liquid phase, respectively

$P_A^o; P_B^o$ = vapour pressures of pure A & pure B; respectively

P_S = vapour pressure of the binary solution of A & B

Substituting values given in the question; we get

P_S = 84 torr = 70 torr × 0.8 + $P_B^o \times 0.2$

$$\Rightarrow \quad P_B^o = \left(\frac{84 - 56}{0.2}\right) = 140 \text{ torr}$$

5. Ans. (4)

Boiling will take place when the external pressure becomes equal to the vapour pressure of solution

$\Rightarrow$ P_S = 760 torr = (900 torr) X_{Benzone} + 360 torr (1 – X_{Benzene})

$\Rightarrow$ X_{Benzene} = 0.74

6. **Ans. (2)**

$\Delta T_b = i.\ K_b.m$

$\Delta T_b \propto i$ (For same K_b, m)

i for $AlCl_3 = 4$,

i for $CaCl_2 = 3$,

$\Delta T_b \propto i$

Van't Hoff factor increases boiling point of solution increases.

7. **Ans. (2)**

$\Delta T_f = K_f.m$

If m = 1mol/Kg, $\Delta T_f = K_f$

8. **Ans. (1)**

$\Delta T_b = 0.513 \times 0.69$

$T_{final} - 99.725 = 0.35397$

$T_{final} = 100.079°\ C$

9. **Ans. (2)**

$\Delta T_f = i \times K_f \times m = 2 \times 1.86 \times 1 = 3.72$

$T_f = T_f^0 - \Delta T_f = 0 - 3.72 = -3.72°C$

10. **Ans. (3)**

$\Delta T_b = iK_bm$

$$0.3 = \frac{\frac{10}{100}}{100} \times 1000 \times K_b$$

$K_b = 0.3$

11. **Ans. (2)**

According to relative lowering of vapour pressure,

$$\frac{P^o - P_s}{P^o} = \frac{\Delta P}{P^o} = \frac{n_{solute}}{n_{solute} + n_{solvent}}\text{; where}$$

P^o = vapour pressure of pure solvent;

P_S = vapour pressure of solution;

$\frac{\Delta P}{P^o}$ = relative lowering of vapour pressure

substituting values given in the question; we get

$$\frac{(10-9)\text{ torr}}{10\text{ torr}} = \frac{\left(\frac{1}{M_B}\right)}{\left(\frac{1}{M_B}\right) + \left(\frac{20}{200}\right)}$$

$\Rightarrow$ $M_B = 90$ amu.

12. **Ans. (1)**

$$i = \frac{\text{Theoretical molecular mass}}{\text{Observed molecular mass}}$$

$$i = 1 + \alpha = \frac{58.5}{31.8}$$

$\alpha = 83.96\%$

13. Ans. (2)

There will be formed a positive deviation solution as the resultant forces of attraction after mixing are weaker as compared to those present in the individual components.

14. Ans. (3)

The solutions that show large positive deviation from Raoult's law form minimum boiling azeotrope at a specific composition.

15. Ans. (2)

According to relative lowering of vapour pressure,

$\frac{P^o - P_S}{P^o} = \frac{\Delta P}{P^o} = \frac{n_{solute}}{n_{solute} + n_{solvent}}$; where

P^o = vapour pressure of pure solvent;

P_S = vapour pressure of solution;

$\frac{\Delta P}{P^o}$ = relative lowering of vapour pressure

Substituting values given in the question; we get $\left(\frac{0.8-0.6}{0.8}\right) = X_Y = \frac{1}{4}$

16. Ans. (3)

$$1.38 = \frac{2.5}{34 \times M} \times 10^3 \times 2.53$$

$$M = \frac{2.5 \times 10^3 \times 2.53}{34 \times 1.38}$$

17. Ans. (2)

$$0.27 = i \times \frac{0.1}{100} \times 1000 \times 0.54$$

$$i = \frac{1}{2}$$

$$1 + \alpha\left(\frac{1}{n} - 1\right) = \frac{1}{2} \Rightarrow \boxed{n = 2}$$

18. Ans. (2)

T – 100 = 0.573 × 0.1

T = 100.0573

19. Ans. (2)

According to osmotic pressure equation;

$\pi = CRT \times i$; where

π = osmotic pressure of the solution

c = molarity of the solution

R = $0.0821 \frac{\ell - atm}{mol - k}$

T = temperature of the solution

$$\% \text{ w/v} = \frac{\text{wt. of solute(g)}}{\text{vol. of solution(ml)}} \times 100$$

Given in question that; $\pi_{sucrose} = \pi_A$

$(iCRT)_{sucrose} = (iCRT)_A$

$C_{sucrose} = C_A$

$$\frac{5\times1000}{342\times100} = \frac{1\times1000}{M\times100}$$

$$\Rightarrow \left(\frac{5\times10}{342}\right) = \frac{1\times10}{M} \Rightarrow M = 68.4$$

20. Ans. (4)

Consider 1 mole of liquid A.

$\Rightarrow$ mass = 80g/mol × 1 mol = 80 gm

$\Rightarrow$ volume of liquid A = $\frac{80\text{gm}}{0.8\,\text{gm/ml}} = 100\text{ml}$

$\Rightarrow$ Given that volume increases by 2000 times upon vaporisation;

$\Rightarrow$ volume of vapour A = $\frac{100\times2000}{1000}\ell = 200\ell$

$\Rightarrow$ If vapour pressure of pure A = P_A^o ; applying ideal gas equation,

PV = nRT

$$\Rightarrow P_A^o.(200\ell) = 1\text{ mol} \times 0.08\frac{\ell-\text{atm}}{\text{mol}-\text{k}} \times 200\text{K}$$

$$\Rightarrow P_A^o = 0.08\text{ atm}$$

SECTION-B

1. Ans. (0.25)

Raoult's law,

$P_S = P_A^o.X_A$ where

P_S = vapour pressure of solution

P_A^o = vapour pressure of pure solvent

X_A = mole fraction of A in the solution

$P_s = P^oX_{solvent}$

$0.6 = 0.8X_{solvent}$

$X_A = 3/4$

$\Rightarrow X_B = 1/4$

2. Ans. (65.25)

According to lowering of vapour pressure

$P_A^oX_A$ $\frac{P^o - P_S}{P_S} = \frac{n}{N}$; where

P_S = vapour pressure of solution

P^o = vapour pressure of pure solvent

Given: $p^o_{Benzene} = 640 mm Hg$

P_S = 600 mm Hg

$\Rightarrow \frac{640-600}{600} = \frac{2.175\times 78}{M\times 39}$

M = 65.25 g/mol

3. Ans. (40)

According to osmotic pressure equation;

π = CRT × i; where

π = osmotic pressure of the solution

C = molarity of the solution

R = 0.0821 $\frac{\ell - atm}{mol\ k}$

T = Temperature of the solution

% w/v = $\frac{\text{wt. of solute (g)}}{\text{vol. of solution(ml)}}\times 100$

$\Rightarrow \pi_{\text{cane-sugar}} = \pi_{\text{non-volatile solute}}$

$\Rightarrow C_{\text{cane-sugar}} = C_{\text{non-volatile solute}}$

$\Rightarrow \frac{6.84\times 1000}{342\times 100} = \frac{0.8\times 1000}{M\times 100}$

$\Rightarrow \left(\frac{6.84}{342}\right) = \frac{0.8}{M} \Rightarrow M = \left(\frac{0.8\times 342}{6.84}\right) = 40$

4. Ans. (3)

According to depression in freezing point,

$\Delta T_f = T_f - T_f' = iK_f.m$

T_f = freezing point of pure solvent

T_f' freezing point of solution

K_f = cryoscopic constant or molal depression constant

m = molality of solution;

i = Van't Hoff factor

normal molecular weight in benzene means that the solute is neither dissociating nor associating ;

$\Rightarrow i_{benzene} = 1$

Complete dissociation in water means; $\alpha = 1$

$\Rightarrow i_{solute} = 1 + (n-1)(1) = n$

$\Rightarrow \frac{(\Delta T_b)_{benzene}}{(\Delta T_b)_{water}} = \frac{(K_b)_{benzene}\times m\times i_{benzene}}{(K_b)_{H_2O}\times m\times i_{solute}}$

molality is same in both the solvent,

$$\Rightarrow \left(\frac{1.28}{1.4}\right)=\left(\frac{5.12}{1.86}\right)\times\frac{1}{i_{solute}}$$

$\Rightarrow i_{solute} = 3 = n_{solute}$

5. Ans. (3.00)

$\Delta T_2 = i.K_f.m$

$= 2 \times 1.5 \times 0.05 = 0.15$

$\Delta T_1 = i.K_b.m$

$= 1 \times 0.5 \times 0.1 = 0.05$

$$\frac{\Delta T_2}{\Delta T_1}=\frac{0.15}{0.05} = 3$$

6. Ans. (6080.00)

$$\pi = \frac{n_B RT}{V}; n_B = \frac{w_B}{M_B}$$

$$\pi = \frac{w_B}{M_B}\times\frac{RT}{V}$$

$$M_B = \frac{w_B}{V}\times\frac{RT}{\pi}=\frac{2\times0.08\times300\times760}{0.3\times20}$$

$= 6080 \text{ gm mol}^{-1}$

7. Ans. (50)

$$\frac{P^o - P_S}{P_S}=\frac{n}{N}$$

$$\frac{306-300}{300}=\frac{20}{M}\times\frac{25}{500}$$

$$M = \frac{300}{6} = 50 \text{ g/mole}$$

8. Ans. (5.00)

$\pi = i\,CRT$

$3.6 = i\,CRT$

$$3.6 = (1 + \alpha)\,(0.1) \times \frac{8}{100} \times 300$$

$$\Rightarrow (1 + \alpha) = \frac{3}{2}$$

$\alpha = 0.5$

% dissociation = 50%

5 + 0 = 5

9. Ans. (6.00)

Enthalpy change of mixture, ΔH_{mix} is equal to zero for ideal solutions. To identify ideal solutions, we must check for the nature of interactions between different components of a mixture. If (A – A) interactions $\cong$ (B – B) interactions $\cong$ (A – B) interactions; for a binary solution made of two miscible liquids A & B; then they will be making an ideal solution upon mixing. Such solutions from question are:

(1) Benzene + Toluene
(2) n-hexane + n-heptane
(3) $C_2H_5Br + C_2H_5I$
(4) $CCl_4 + SiCl_4$
(5) $C_2H_4Br_2 + C_2H_4Cl_2$
(6) $C_2H_5Br + C_2H_5Cl$

Positive deviation

Acetone + Benzene

Ethanol + cyclohexane

10. Ans. (4.50)

$$X_{O_2} = \frac{n_{O_2}}{n_{O_2} + n_{H_2O}} \qquad \left(n_{H_2O} >> n_{O_2}\right)$$

$$P_{O_2} = K_H.m \times \frac{18}{1000}$$

$$0.81 = 10^5 \times m \times \frac{18}{1000}$$

$$m = 4.5 \times 10^{-4}$$

Exercise – II (JEE-Main PYQs)

1. Ans. (2)

Applying formula of elevation in boiling points & depression in freezing point;

$\Delta T_f = K_f \times m \times i$; $\Delta T_b = K_b \times m \times i$; where;

K_b; K_f = ebullioscopic & cryoscopic constants of solvent, respectively

m = molality of solution;

i = Van't Hoff factor of solute;

Given; $\Delta T_b = 2\ k = K_b \times (1\ molal) \times i$ ...(1)

$\Delta T_f = 2\ k = K_f \times (2\ molal) \times i$ ...(2)

From (1) & (2); $K_b = 2K_f$

2. Ans. (3)

According to Henry's law;

$P_i = K_H . X_i$; where

P_i = partial pressure of gas above the solution

X_i = mole fraction of gas in the solution

K_H = Henry's constant

$\Rightarrow P_i = K_H.\left(1 - X_{H_2O}\right)$;

$\Rightarrow P_i = \left(-K_H\right).X_{H_2O} + K_H$; comparing with

Y = (m)X + C;

Slope = $-K_H$; y-intercept = K_H

3. Ans. (4)

Given : $\Delta V_{mixing} = 0 \Rightarrow$ solution obtained is an ideal solution.

According to Raoult's law;

$Ps = P_A^0 X_A + P_B^0 X_B$; where

X_A; X_B = mole fractions of A & B in the liquid phase, respectively

P_A^0; P_B^0 = Vapour pressures of pure A & pure B; respectively

Ps = vapour pressure of the binary solution of A & B

Given; P_A^0 = 400 mm; P_B^0 = 600 mm;

$X_A = 0.5$; $X_B = 0.5$

$\Rightarrow$ P_s = (400 mm) (0.5) + (600 mm) (0.5) = 500 mm

According to Dalton's & Raoult's law;

$P_A^0 X_A = P_s Y_A$; where

Y_A = mole fraction of A in the vapours above the solution

$\Rightarrow$ $Y_A = \frac{(400\,mm)(0.5)}{500\,mm} = 0.4$; $Y_B = 1 - 0.6$

4. Ans. (1)

For XY;

$XY \rightleftharpoons X^{\oplus} + Y^{\ominus}$; i = 2;

For $BaCl_2$;

$BaCl_2 \rightleftharpoons Ba^{2\oplus} + 2Cl^{\ominus}$; i = 3;

According to osmotic pressure equation; $\pi = CRT \times i$; where

π = osmotic pressure of the solution

C = molarity of the solution

R = 0.0821 l-atm/mol-k

T = Temperature of the solution

i = Van't Hoff factor

Given : $\pi_{XY} = 4\pi_{BaCl_2}$

$\Rightarrow$ $(CRT \times i)_{XY} = 4 \times (CRT \times i)_{BaCl_2}$

$\Rightarrow$ $C_{XY} \times 2 = 4 \times 0.01 \times 3$

$\Rightarrow$ $C_{XY} = 0.06$ M

5. Ans. (3)

According to Raoult's law;

$P_M = P_M^0 X_M$; $P_N = P_N^0 X_N$;

According to Dalton's law;

$P_M = P_S.Y_M$; $P_N = P_S.Y_N$

$\Rightarrow$ $P_M^0 X_M = P_S.Y_M$ ...(1)

& $P_N^0 X_N = P_S.Y_N$ ...(2)

Divide (1) & (2);

$\frac{P_M^0.X_M}{P_N^0.X_N} = \frac{Y_M}{Y_N}$;

Given; P_M^0 = 450 mmHg & P_N^0 = 700 mmHg

$\Rightarrow \frac{Y_M}{Y_N}=\left(\frac{X_M}{X_N}\right)\left(\frac{450}{700}\right)$

$\Rightarrow \frac{Y_M}{Y_N}<\frac{X_M}{X_N}$; as $\left(\frac{X_M}{X_N}\right)$ when multiplied by a number less than 1 gives $\left(\frac{Y_M}{Y_N}\right)$.

6. Ans. (3)

According to elevation in Boiling point ; ΔT_f

$\Delta T_b = K_b \times m \times i$; where

K_b = Ebullioscopic constant

m = molality of the solution;

i = Van't Hoff factor of solute

$\Rightarrow$ For solvent A;

$(\Delta T_b)_A = (K_b)_A \times m \times i$ ...(1)

$\Rightarrow$ For solvent B;

$(\Delta T_b)_B = (K_b)_B \times m \times i$ ...(2)

Divide (1) & (2);

$\frac{(\Delta T_b)_A}{(\Delta T_b)_B}=\frac{(K_b)_A}{(K_b)_B}=\frac{1}{5}$

7. Ans. (1)

According to Raoult's law;

$Ps = P_A^0 X_A + P_B^0 X_B$; where

X_A; X_B = mole fractions of A & B in the liquid phase, respectively

$P_A^0; P_B^0$ = Vapour pressures of pure A & pure B; respectively

Ps = vapour pressure of the binary solution of A & B

Given; Ps = 250 mmHg; $X_A = \frac{1}{3}$; $X_B = \frac{2}{3}$

Ps = 300 mmHg; $X_A = \frac{1}{2}$; $X_B = \frac{1}{2}$ [when additional 1 mol of A is added]

$\Rightarrow 250 = \frac{1}{3}P_A^0 + \frac{2}{3}P_B^0$ ...(1)

$\Rightarrow 300 = \frac{1}{2}P_A^0 + \frac{1}{2}P_B^0$ ...(2)

Solve (1) & (2) to get P_A^0 & P_B^0

$P_A^0 = 450$, $P_B^0 = 150$ mm Hg

8. Ans. (3)

The vapour pressure of mixture (P_T = 600 mm Hg) is greater than the individual vapour pressure of its constituents (Vapour pressure of CS_2 = 512 mm Hg, acetone = 344 mm Hg). Hence, the solution formed shows positive deviation from Raoult's law.

(1) $\Delta_{Sol}H > 0$,

(2) Raoult's law is not obeyed

(3) $\Delta_{sol.}$ Volume > 0

(4) CS_2 and Acetone are less attracted to each other than to themselves.

9. Ans. (3)

Order of B.P. is : Z > Y > X

Order of vapour pressure : Z < Y < X

order of intermolecular interaction : Z > Y > X.

10. Ans. (1.74 - 1.76)

$\Delta T_f = i \times m \times K_f$

$0.2 = 2 \times 2 \times \dfrac{w/58.5}{600/1000}$

w = 1.755 gm

11. Ans. (177)

Let molar mass of protein A = x g/mol

Let molar mass of protein B = y g/mol

π_A = osmotic pressure of protein A = $\dfrac{\left(\frac{0.73}{x}\right)}{0.25}RT$

π_B = osmotic pressure of protein B = $\dfrac{\left(\frac{1.65}{y}\right)}{1}RT$

$\pi_A = \pi_B$

$\Rightarrow \left(\dfrac{0.73}{x \times 0.25}\right)RT = \left(\dfrac{1.65}{y}\right)RT$

$\Rightarrow \left(\dfrac{x}{y}\right) = \dfrac{0.73}{0.25 \times 1.65} = 1.769 \cong 1.77$

12. Ans. (167)

Osmotic pressure = $\pi = i \times C \times RT$

For NaCl i = 2 so

$\pi_{NaCl} = i \times C_{NaCl} \times RT$ $\quad C_{NaCl}$ = conc. of NaCl

$0.1 = 2 \times C_{NaCl} \times RT$

$C_{NaCl} = \dfrac{0.05}{RT}$ $\quad C_{glucose}$ = conc. of glucose

For glucose i = 1 so

$\pi_{Glucose} = i \times C_{glucose} \times RT$

$0.2 = 1 \times C_{glucose} \times RT$

$C_{Glucose} = \dfrac{0.2}{RT}$ $\quad \eta_{NaCl}$ = No. of moles NaCl

η_{NaCl} in 1 L = $C_{NaCl} \times V_{Litre}$

$= \frac{0.05}{RT}$ $\eta_{glucose}$ = No. of moles glucose

$\eta_{glucose}$ in 2 L = $C_{glucose} \times V_{Litre}$

$= \frac{0.4}{RT}$

$V_{Total} = 1 + 2 = 3L$

so Final conc. NaCl = $\frac{0.05}{3RT}$

Final conc. glucose = $\frac{0.4}{3RT}$

$\pi_{Total} = \pi_{NaCl} + \pi_{glucose}$

$= \left[i \times C_{NaCl} + C_{glucose}\right] \times RT$

$= \left(\frac{2 \times 0.05}{3RT} + \frac{0.4}{3RT}\right) \times RT$

$= \frac{0.5}{3}$ atm

= 0.1666 atm

= 166.6×10^{-3} atm

$\Rightarrow 167.00 \times 10^{-3}$ atm

So, x = 167.00

Alternate solution:

$\pi_{mix} = (iC)_{mix}RT$

$= \left(\frac{i_1C_1RTV_1 + i_2C_2RTV_2}{V_1 + V_2}\right)RT$

$= \frac{i_1C_1RTV_1 + i_2C_2RTV_2}{V_1 + V_2}$

$\pi_{mix} = \frac{\pi_1V_1 + \pi_2V_2}{V_1 + V_2}$

$\pi_{mix} = \frac{0.1 \times 1 + 0.2 \times 2}{1 + 2} = 0.167 = 167 \times 10^{-3}$ atm

13. Ans. (600)

$550 = P_A^o \times \frac{1}{4} + P_B^o \times \frac{3}{4}$

$2200 = P_A^o + 3P_B^o$ ...(i)

$560 = P_A^o \times \frac{1}{5} + P_B^o \times \frac{4}{5}$

$2800 = P_A^o + 4P_B^o$ ...(ii)

From (i) & (ii)

$P_B^o = 600, P_A^o = 400$

14. Ans. (518)

Let mass of water initially present = x gm

$\Rightarrow$ Mass of sucrose = (1000 - x) gm

$\Rightarrow$ moles of sucrose = $\left(\frac{1000 - x}{342}\right)$

$\Rightarrow 0.75 = \frac{\left(\frac{1000 - x}{342}\right)}{\left(\frac{x}{1000}\right)} \Rightarrow \frac{x}{1000} = \frac{1000 - x}{342 \times 0.75}$

$\Rightarrow 256.5\,x = 10^6 - 1000x$

$\Rightarrow x = 795.86$ gm

$\Rightarrow$ moles of sucrose = 0.5969

New mass of H_2O = a kg

$\Rightarrow 4 = \frac{0.5969}{a} \times 1.86 \Rightarrow a = 0.2775$ kg

$\Rightarrow$ ice separated = (795.86 – 277.5) = 518.3 gm

15. Ans. (13)

With benzene as solvent

$\Delta T_b = i K_b m$

$$\Delta T_b = \frac{1}{2} \times 2.6 \times \frac{1.22/M_w}{100/1000} \quad \ldots(1)$$

With Acetone as solvent

$\Delta T_b = i K_b m$

$$0.17 = 1 \times 1.7 \times \frac{1.22/M_w}{100/1000} \quad \ldots(2)$$

(1) / (2)

$$\frac{\Delta T_b}{0.17} = \frac{\frac{1}{2} \times 2.6 \times \frac{1.22/M_w}{100/1000}}{1 \times 1.7 \times \frac{1.22/M_w}{100/1000}}$$

$$\Delta T_b = \frac{0.26}{2}$$

$\Delta T_b = 13 \times 10^{-2}$

$\Rightarrow x = 13$

16. Ans. (3)

[HCOOH] = 0.5 mol L^{-1}

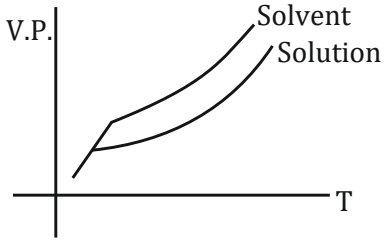
$\Rightarrow$ (0.5 ml × 1.05 g ml^{-1}) HCOOH in 1L

$\Rightarrow$ 0.525 g HCOOH in 1L

$m = \frac{(0.525/46)}{1kg}$ mol [Assuming dilute solution]

$$\therefore \Delta T_f = iK_f m \Rightarrow i = \frac{\Delta T_f}{k_f m} = \frac{0.0405 \times 46}{1.86 \times 0.525} = 1.9$$

17. Ans. (1)



Vapour pressure (V.P.) of solvent is greater than vapour pressure (V.P.) of solution.
Only solvent freezes.

18. Ans. (314)

Let V.P. of pure A be P_A^0

Let V.P of pure B be P_B^0

When $X_A = 0.7$ & $X_B = 0.3$

$P_s = 350$

$\Rightarrow P_A^0 \times 0.7 + P_B^0 \times 0.3 = 350$ ...(i)

When $X_A = 0.2$ & $X_B = 0.8$

$P_s = 410$

$\Rightarrow P_A^0 \times 0.2 + P_B^0 \times 0.8 = 410$ ...(ii)

Solving (i) and (ii)

$P_A^0 = 314$ mm Hg

$P_B^0 = 434$ mm Hg

= (314)

19. Ans. (116)

Amount of solvent = 100 – (29.25 + 19) = 51.75g

$$\Delta T_b = \left[\frac{2\times 29.25\times 1000}{58.5\times 51.75} + \frac{3\times 19\times 1000}{95\times 51.75}\right]\times 0.52$$

$\Delta Tb = 16.075$

$\Delta Tb = (T_b)_{solution} - (T_b)_{solvent}$

$(T_b)_{solution} = 100 + 16.07$

$= 116.07°C$

20. Ans. (4)

$$\frac{P^0 - P_s}{P^0} = \frac{n}{N}$$ (for dilute solution)

$$\frac{0.2}{54.2} = \frac{n\times 18}{100}$$

$$n = \frac{100}{271\times 18}$$

$$w = \frac{100\times 180}{271\times 18}$$; w = 3.69g

Exercise - III (JEE Advanced Pattern)

SECTION-I

1. Ans. (B)

$X_{Pentane}$; X_{Hexane}: mole fraction of pentane & hexane in liquid phase

$$X_{Pentane} = \frac{n_{Pentane}}{n_{Pentane} + n_{Hexane}} = \frac{1}{1+4} = \frac{1}{5}$$

$\Rightarrow X_{Hexane} = 1 - X_{Pentane} = 1 - \frac{1}{5} = \frac{4}{5}$

P_T = total vapour pressure of solution of hexane & pentane

According to Raoult's law:

$P_T = P^o_{hexane}X_{hexane} + P^o_{pentane}X_{Pentane}$

$= (120 \text{ mm Hg})\left(\frac{4}{5}\right) + (440 \text{ mm Hg})\left(\frac{1}{5}\right) = 184 \text{ mm Hg}$

combining Raoult's & Dalton's law;

$P^o_{Hexane}X_{Hexane} = P_T \times y_{Hexane}$

$P^o_{pentane}X_{Pentane} = P_T \times y_{Pentane}$;

where,

Y_{Hexane} ; $Y_{Pentane}$ = mole fractions of hexane and pentane, respectively in vapour phase

$\Rightarrow$ Substituting values,

$$120 \times \frac{4}{5} = 184 \times y_{Hexane}$$

$\Rightarrow$ $Y_{Hexane} = 0.52$

$\Rightarrow$ $Y_{Pentane} = 1 - Y_{Hexane} = 0.48$

2. Ans. (B)

$P_T = P^o_A X_A + P^o_B X_B = 0.08 \times 300 + 0.92 \times 800 = 760$ torr

$= 760$ torr $\Rightarrow 1$ atm $> P_{obs}$

Show negative deviation from Raoult law.

3. Ans. (C)

$P_A = P_B$

(We know)

$P^o_A X_A = P^o_B X_B$

$P^o_A X_A = P^o_B (1 - X_A)$ $\quad (\because X_B = 1 - X_A)$

$P^o_A X_A = P^o_B - P^o_B X_A$

$$X_A = \frac{P^o_B}{P^o_A + P^o_B} \quad \ldots(1)$$

Total vapour pressure $P_T = P_A + P_B$

But $P_A = P_B$

$P_T = 2P_A = 2P^o_A X_A$ $\quad \ldots(2)$

substitute the value of X_A from equation (1) to equation (2)

$$P_T = \frac{2P^o_A P^o_B}{P^o_A + P^o_B}$$

4. Ans. (C)

According to Raoult's law for a binary mixture of A & B;

$P_T = P^o_A X_A + P^o_B X_B$; where

P^o_A ; P^o_B = vapour pressures of pure A & B respectively

X_A; X_B = mole fractions of A & B in liquid phase

$X_A + X_B = 1$

$\Rightarrow \quad P_T = P_A^o(1-X_B)+P_B^oX_B$

$P_T = (P_B^o - P_A^o)X_B + P_A^o$; comparing with

$y = mx + c$

Slope = $P_B^o - P_A^o$; Y – intercept = P_A^o

Also; $\frac{1}{P_T} = \frac{y_A}{P_A^o} + \frac{y_B}{P_B^o}$; where

y_A & y_B: mole fractions of A & B in vapour phase where

$y_A + y_B = 1$

$\Rightarrow \quad \frac{1}{P_T} = \frac{y_A}{P_A^o} + \frac{1-y_A}{P_B^o}$

$\Rightarrow \quad \frac{1}{P_T} = y_A\left(\frac{1}{P_A^o} - \frac{1}{P_B^o}\right) + \frac{1}{P_B^o}$

$\Rightarrow$ Graph between $\frac{1}{P_T}$ v/s y_A is linear with slope $\left(\frac{1}{P_A^o} - \frac{1}{P_B^o}\right)$ & y-intercept = $\frac{1}{P_B^o}$

5. Ans. (A)

$i = 1 + \alpha\,(n - 1)$

for $CaCl_2$

$i = 1 + 0.5\,(3 - 1)$

$i = 2$

SECTION-II

6. Ans. (A,D)

$\Delta T_b = i.K_b.m$

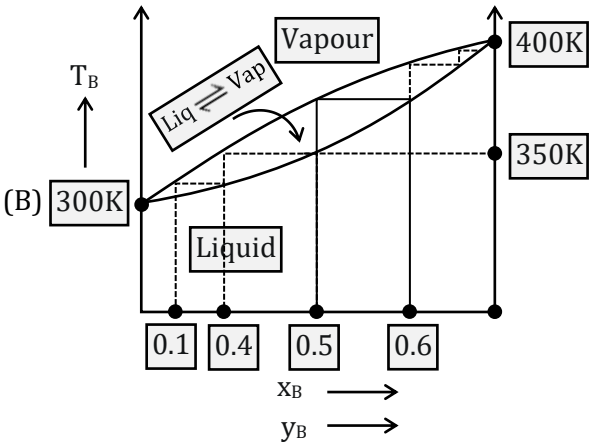
$0.17 = i \times 1.7 \times \frac{1.22/122}{100} \times 1000$

i = 1, so no association or dissociation take place.

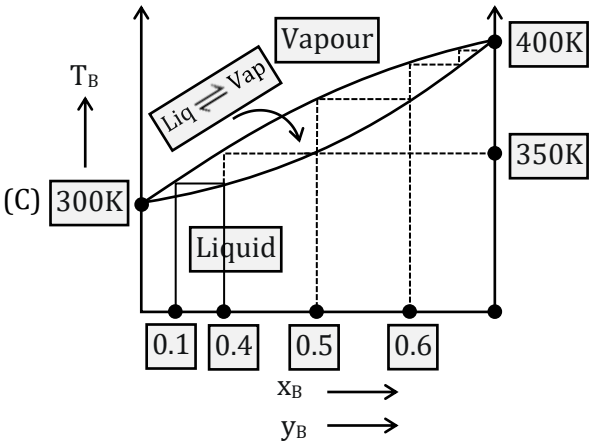
7. Ans. (A,B,D)

(A) T_{bp} of A = 300K; T_{bp} of B = 400 K;

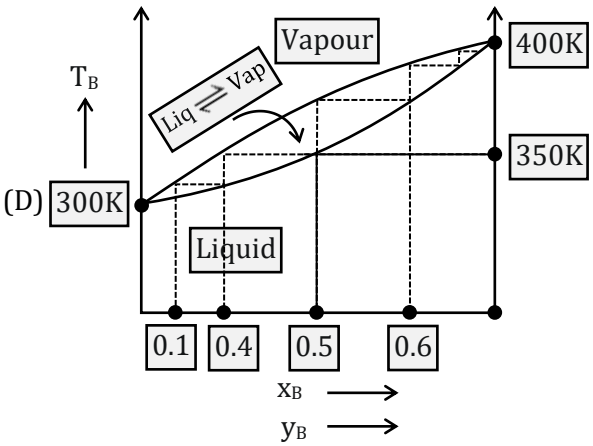
A less volatile substance has a higher boiling point.



$X_B = 0.6; \Rightarrow X_A = 0.4 \Rightarrow y_A = 0.5$ according to graph



for $X_B = 0.4$; $y_B = 0.1$



for $X_A = 0.5$; $X_B = 0.5 \Rightarrow$ According to graph; $T_{bp} = 350$ K

8. Ans. (C,D)

For solution S_1;

$\pi_1 = C_1RT \times i$; $C_1 = 0.1$ M

$i = 1 + (n - 1)\alpha$;

$NaCl \rightarrow Na^{\oplus} + Cl^{\ominus}$; $n = 2$; $\alpha = 1$ (assuming 100% dissociation)

$\Rightarrow$ $i = 2$

$\Rightarrow$ $\pi_1 = 0.1 \times RT \times 2 = 0.2RT$

for solution (2);

$BaCl_2 \rightarrow Ba^{2\oplus} + 2Cl^{\ominus}$; $n = 3$; $\alpha = 1$ (assuming 100% dissociation)

$i = 3$

$\Rightarrow$ $\pi_2 = (0.08)RT \times 3 = 0.24RT$

$\because$ $\pi_2 > \pi_1 \Rightarrow S_2$ is hypertonic as compound to S_1

SECTION-III

9. Ans. (C)

- If in the mixture obtained by mixing two components there are stronger inter-molecular forces of attraction, then the solution shows negative deviation from ideal behaviour. For such solutions $\Delta H_{mix} < 0$; $\Delta G_{mix} < 0$ & $\Delta S_{mix} > 0$
  Also, they form maximum boiling azetropes.
- If in the mixture obtained by mixing two components there are weaker inter-molecular forces of attraction, then the solution shows positive deviation from ideal behaviour. For such solutions $\Delta H_{mix} > 0$; $\Delta G_{mix} < 0$ & $\Delta S_{mix} > 0$
  Also, they form minimum boiling azetropes

10. Ans. (A)

- If in the mixture obtained by mixing two components there are stronger inter-molecular forces of attraction, then the solution shows negative deviation from ideal behaviour. For such solutions $\Delta H_{mix} < 0$; $\Delta G_{mix} < 0$ & $\Delta S_{mix} > 0$
  Also, they form maximum boiling azetropes.
- If in the mixture obtained by mixing two components there are weaker inter-molecular forces of attraction, then the solution shows positive deviation from ideal behaviour. For such solutions $\Delta H_{mix} > 0$; $\Delta G_{mix} < 0$ & $\Delta S_{mix} > 0$
  Also, they form minimum boiling azetropes

11. Ans. (C)

- If in the mixture obtained by mixing two components there are stronger inter-molecular forces of attraction, then the solution shows negative deviation from ideal behaviour. For such solutions $\Delta H_{mix} < 0$; $\Delta G_{mix} < 0$ & $\Delta S_{mix} > 0$
  Also, they form maximum boiling azetropes.
- If in the mixture obtained by mixing two components there are weaker inter-molecular forces of attraction, then the solution shows positive deviation from ideal behaviour. For such solutions $\Delta H_{mix} > 0$; $\Delta G_{mix} < 0$ & $\Delta S_{mix} > 0$
  Also, they form minimum boiling azetropes

SECTION-IV

12. Ans. (A)

$$\frac{Y_A}{Y_B} = \frac{P_A^0 X_A}{P_B^0 X_B} = \frac{300 \times 2}{200 \times 3} = \frac{1}{1}$$

$Y_A = ½$ $Y_B = ½$

This mole fraction are present in distillate form

$P_T = P_A^o X_A^{'} + P_B^o X_B^{'}$

$300 \times \frac{1}{2} + 200 \times \frac{1}{2} = 250$ torr.

13. Ans. (A)

Above solution is ideal, cannot form an Azeotropic mixture.

So it can be separated by fractional distillation

$P_T = P_A^0 X_A + P_B^0 X_B$

$= 300 \times \frac{2}{5} + 200 \times \frac{3}{5} = \frac{1200}{5} = 240$ torr

SECTION-V

14. Ans. (68.4)

Applying formula for elevation in boiling point;

$\Delta T_b = T_b - T_b^o = K_b \times$ molality;

T_b = boiling point of solution;

T_b^o = boiling point of pure solvent

k_b = molal elevation constant

Substituting values;

$\Delta T_b = T_b - 100 = 0.5 \times m$ ...(1)

Applying formula of depression in freezing point;

$\Delta T_f = K_f \times$ molality; where

T_f = freezing point of the solution;

T_f^o = freezing point of pure solvent

k_f = molal depression constant;

molality = molality of solution

$\Delta T_f = 0 - T_f = 2 \times m$ ...(2)

adding (1) & (2)

$\Delta T_b + \Delta T_f = 0.5m + 2\ m$

$(T_b - T_b^o) + (T_f - T_f^o) = 2.5\ m$

$(T_b - T_f - 100) = 2.5 \times m$

Given that; $T_b - T_f = 105$

$\Rightarrow (105 - 100) = 2.5 \times m$

$\Rightarrow m = 2 = \frac{n_{Glucose}}{w_{solvent}(kg)}$

$\Rightarrow n_{glucose} = (2 \times 0.1) = 0.2$ mol

$\Rightarrow w_{glucose} = 0.2 \text{ mol} \times \frac{342g}{mol} = 68.4$ gm

15. Ans. (5)

Final concentration will be

$C = \frac{0.1 \times 1000}{250} = 0.4M$

$\pi = CRT = 0.4\ M \times 0.0821\ \frac{L.atm}{mol\,K} \times 300\ K$

$= 9.852$ atm ≈ 10 atm.

$\therefore$ Final answer $= \frac{10}{2} = 5$

16. Ans. (3.2)

The reaction is:

	$Pb(NO_3)_2(aq)$	+ $2KI(aq)$	→ $PbI_2(s)$	+ $2KNO_3(aq)$
t = 0	(0.1V) mole	(0.2V) mol		
t = ∞	0	0		0.2V moles

Total final concentration of solutes = $[K^{\oplus}] + [NO_3^{\ominus}]$

$$= \frac{0.2V}{3V} \times 2 = \frac{0.4}{3} M$$

Final osmotic pressure = $CRT = \frac{0.4}{3} \times 0.08 \times 300 = 3.2$ atm

17. Ans. (38.71)

According to depression in freezing point;

$\Delta T_f = T_f^o - T_f = k_f \times$ molality; where

T_f^o = freezing point of pure solvent;

T_f = freezing point of solution

K_f = molal depression constant

substituting all variables;

$$0 - (-9.3) = 1.86 \times \frac{\left(\frac{50}{62}\right)}{wt_{water}(\text{in kg})}$$

$$\Rightarrow \quad wt_{water} = \frac{1.86 \times 50}{62 \times 9.3} = 0.1612 \text{ kg}$$

$\Rightarrow$ mass of ice separated = 200g – 161.2 g = 38.7 g

18. Ans. (49.20)

$MgCl_2 + 2AgNO_3 \rightarrow Mg(NO_3)_2 + 2AgCl(s)$

2	4	0	0
0	0	2 moles	4 moles

$\pi_f = i\,CRT \Rightarrow 3 \times \frac{2}{3} \times 0.082 \times 300$

$\Rightarrow 49.20$ atm

19. Ans. (6.97)

$C_2H_5OC_2H_5(\ell) \rightleftharpoons C_2H_5OC_2H_5(g)$

at $T_1 = 27°C$ $P_1 = 190$ mmHg

at $T_2 = 327°C$ $P_2 = 1$atm

$K_{P_1} = [P_1]$ at T_1

$K_{P_2} = [P_2]$ at T_2

$T_1 = 27°C = 300$ K

$T_2 = 327° = 600$ K

Here $T_2 = 327°C$ is its Normal Boiling Point

So, $P_2 = 1$ atm = 760 mm Hg

We know

$$\ell n\frac{k_2}{k_1}=\frac{\Delta H_{vap.}}{R}\left\{\frac{1}{T_1}-\frac{1}{T_2}\right\}$$

$$\ell n\frac{P_2}{P_1}=\frac{\Delta H_{vap.}}{R}\left\{\frac{1}{300}-\frac{1}{600}\right\}$$

$$\ell n\frac{760}{190}=\frac{\Delta H_{vap.}}{R}\left\{\frac{1}{600}\right\}$$

$$2\ell n2=\frac{\Delta H_{vap.}}{R}\left\{\frac{1}{600}\right\}$$

$\Delta H_{vap.} = 2\ell n_2 \times 600 \times R$

$= 2 \times 0.7 \times 600 \times 8.3$

$= 6.97 \times 10^3$ J/mol

$\Delta H_{vap.}$ = 6.97 KJ/mole

20. Ans. (60)

Applying formula of depression in freezing point;

$\Delta T_f = K_f \times$ molality $\times$ i; where

T_f = freezing point of the solution;

T_f^o = freezing point of pure solvent

K_f = molal depression constant;

i = Van't Hoff factor = $1 + (n - 1)\alpha$

α = degree of dissociation;

n = no. of moles of product per mole of reactant

substituting values;

$i = 1 + (2 - 1)\alpha = (1 + \alpha)$

$$\Delta T_f = 0.372\ k = \left(1.86\frac{k-kg}{mol}\right)\left(\frac{0.025 mol}{0.2 kg}\right)(1+\alpha)$$

$\Rightarrow\ 1 + \alpha = 1.6 \Rightarrow \alpha = 0.6$

Exercise - IV (JEE Advanced PYQs)

1. Ans. (A)

According to depression in freezing point = $\Delta T_f = i \times K_f \times m$

K_f = cryoscopic constant or molal depression constant

m = molality of solvent;

i = Van't Hoff factor

For $K_3[Fe(CN)_6] \rightarrow 3K^{\oplus} + [Fe(CN)_6]^{3\ominus}$

$i = 1 + (4 - 1)(1) = 4$

$\Delta T_f = T_f^o - T_f = 0 - T_f = (1.86\ \text{k-kg/mol}) \dfrac{\left(\dfrac{0.1\,g}{329\ g/mol}\right)}{0.1\ kg} \times 4 = 2.26 \times 10^{-2} = 2.3 \times 10^{-2}$

$T_f = T_f^o - \Delta T_f = -2.3 \times 10^{-2}\ K$

2. Ans. (A)

According to relative lowering of vapour pressure,

$\dfrac{P^0 - P_s}{P^0} = \dfrac{\Delta P}{P^0} = \dfrac{n_{solute}}{n_{solute} + n_{solvent}}$; where

P^0 = vapour pressure of pure solvent ;

P_s = vapour pressure of Solution ;

$\dfrac{\Delta P}{P^0}$ = relative lowering of vapour pressure

Now, for very low amount of solute as compared to solvent;

$\dfrac{\Delta P}{P^0} = \dfrac{n_{solute}}{n_{solvent}}$

$\Rightarrow \dfrac{760 - Ps}{760} = \dfrac{n_{solute}}{wt._{(solvent)}(gm)} \times 18\ g/mol$

$= \dfrac{n_{solute}}{wt._{H_2O}(kg) \times 1000} \times 18\ g/mol$

$\left(1 - \dfrac{Ps}{760}\right) = (\text{molality}) \times \dfrac{18\ g/mol}{1000}$

According to elevation in boiling point;

$\Delta T_b = K_b \times \text{molality} \times i$

$\Rightarrow$ $2K = (0.76\ \text{K-kg/mol}) \times \text{molality}$

$\Rightarrow$ $\text{molality} = \left(\dfrac{2}{0.76}\right) mol/kg$

$\Rightarrow$ substituting the value of molality in the expression of relative lowering in vapour pressure;

$1 - \dfrac{P_s}{760\,mm} = \left(\dfrac{2}{0.76} \times \dfrac{18}{1000}\right)$

$\Rightarrow$ $P_s = 724$ mm

3. Ans. (B,C,D)

$\rightarrow$ $\Delta S_{mixing} > 0$; as two solutions are getting mixed & hence overall randomness increases

$\rightarrow$ $\Delta S_{surrounding} = 0$; $\because$ no heat gets released or absorbed in the process

$\rightarrow$ $\Delta H_{mixing} = 0$; for the same reason as above

4. Ans. (1)

According to depression in freezing point = $\Delta T_f = K_f \times m$

K_f = cryoscopic constant or molal depression constant

m = molality of solvent;

i = Van't Hoff factor

$\Delta T_f = 0.0558\ K = (1.86\ \text{k-kg/mol}) \times 0.01\ mol/kg \times i$

$\Rightarrow$ i = 3

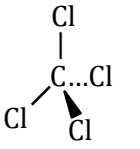
$\Rightarrow$ Assuming complete dissociation; a total of three ions are getting furnished in the solution.

$\therefore$ other than the co-ordination sphere; two ion are getting released.

$\therefore$ two $Cl^{\ominus}$ ions are outside the co-ordination sphere & the remaining 1 $Cl^{\ominus}$ is inside the co-ordination sphere ($[Co(NH_3)_5Cl]Cl_2$).

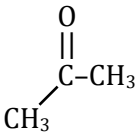
5. Ans. (A,B)

Theory based

(A)  : non-polar molecule

CH_3OH : polar molecule

(B) CS_2 : S = C = S : non-polar molecule

 polar molecule

6. Ans. (A,C)

$\rightarrow$ solution showing positive deviation from Raoult's law

$\therefore$ L-M interactions are weaker than L-L & M-M interactions.

7. Ans. (D)

Molality of solution = $\left(\frac{\frac{34.5\text{ g}}{46\text{ g/mol}}}{0.5\text{ kg}}\right)$ = 1.5 mol/kg

According to depression in freezing point = $\Delta T_f = K_f \times m$

T_f = freezing point of pure solvent

T_f' = freezing point of Solution

K_f = cryoscopic constant or molal depression constant

m = molality of solvent;

i = Van't Hoff factor

$\Rightarrow$ $\Delta T_f = 273K - T_f' = (2K\text{-kg/mol}) \times 1.5\text{ mol/kg} = 3K$

$\Rightarrow$ $T_f' = 270K$

8. Ans. (19)

According to Raoult's law;

$P_s = P_A^0 X_A + P_B^0 X_B$; where

X_A ; X_B = mole fractions of A & B in the liquid phase, respectively

$P_A^0; P_B^0$ = vapour pressures of pure A & pure B; respectively

P_s = vapour pressure of the binary solution of A & B

$\Rightarrow$ Given : P_s = 45 torr; when $X_A = X_B = \frac{1}{2}$

P_s = 22.5 torr, X_A & X_B

P_A^0 = 20 torr

$\Rightarrow$ 45 torr = (20 torr) $\left(\frac{1}{2}\right) + P_B^0\left(\frac{1}{2}\right)$

$\Rightarrow$ P_B^0 = 70 torr

22.5 torr = (20 torr) (X_A) + 70 torr (1 – X_A)

$\Rightarrow$ $X_A = \frac{(70-22.5)\text{torr}}{50\text{torr}}$ = 0.95 torr

$\Rightarrow$ $X_B = 1 - X_A = 0.05$ torr

$\Rightarrow$ $\frac{X_A}{X_B} = \frac{0.95}{0.05} = 19$

9. Ans. (0.05)

According to Elevation in Boiling point; ΔT_b

$\Delta T_b = K_b \times m \times i$; where

K_b = Ebullioscopic constant

m = molality of the solution

i = Van't Hoff factor of solute

for NaCl in Solvent X

$(\Delta T_b)_x = 2K = (K_b)_x \,.\, m \times i_{NaCl}$ ...(1)

$NaCl \rightarrow Na^{\oplus} + Cl^{\ominus}$; i = 2

for NaCl in solvent Y;

$(\Delta T_b)_y = 1K = (K_b)_y \times m \times i_{NaCl}$ ...(2)

$\Rightarrow$ Divide (1) & (2); $\frac{(K_b)_x}{(K_b)_y} = 2$ ...(3)

for solute s in solvent x;

$2S \rightleftharpoons S_2$; n = $\frac{1}{2}$; α_x

$\Rightarrow$ $i = 1 + \left(\frac{1}{2} - 1\right)\alpha_x = 1 - \frac{\alpha_x}{2}$

$(\Delta T_b)_x = (K_b)_x \,.\, m \,.\, i_x = (K_b)_x \,.\, m \,.\, \left(1 - \frac{\alpha_x}{2}\right)$ ...(4)

for solute S in solvent Y;

$2S \rightleftharpoons S_2$; n = $\frac{1}{2}$; $\alpha = 0.7$; $i_y = 1 - \frac{0.7}{2} = 0.65$

$\Rightarrow$ $(\Delta T_b)_y = (K_b)_y \,.\, m \,.\, i_y = (K_b)_y \,.\, m \,.\, (0.65)$ ...(5)

$\Rightarrow$ $\frac{(\Delta T_b)_x}{(\Delta T_b)_y} = \frac{(K_b)_x}{(K_b)_y} \cdot \frac{1 - \frac{\alpha_x}{2}}{0.65} = \frac{(2)\left(1 - \frac{\alpha}{2}\right)}{0.65}$ (using (2)) ;

Given that $(\Delta T_b)_y$ ::3 : 1

$\Rightarrow$ $\left(\frac{3}{1}\right) = \left(\frac{2}{0.65}\right)\left(1 - \frac{\alpha}{2}\right)$

$\Rightarrow$ $\alpha = 0.05$

10. Ans. (1.02 or 1.03)

According to relative lowering in vapour pressure;

$\frac{\Delta P}{P^0} = \frac{n_{solute}}{n_{solute} + n_{solvent}}$; where

$\Delta P = P^0 - P_s$ = lowering of vapour pressure

P^0; P_s ; vapour pressure of the pure solvent & the solution respectively

$$\frac{P^0 - P_s}{P_s} = \frac{n_{solute}}{n_{solvent}}$$

$$\frac{650 - 640}{640} = \frac{0.5 \times 78}{M \times 39}$$

$$\boxed{M = 64 \text{ gm}}$$

$$\Delta T_f = K_f.m = \frac{5.12 \times 0.5 \times 1000}{64 \times 39} = 1.0256$$

11. Ans. (0.20)

$$P_T = P_A^o X_A + P_B^o X_B$$

$$0.3 = P_A^o \times 0.25 + P_B^o \times 0.75 \quad \text{...(i)}$$

$$0.4 = P_A^o \times 0.5 + P_B^o \times 0.5$$

$$0.8 = P_A^o + P_B^o \quad \text{...(ii)}$$

on solving eq^n (i) & (ii)

$$P_A^o = 0.6, \quad P_B^o = 0.2$$

12. Ans. (100.10)

$$AgNO_3(aq) \longrightarrow Ag^{\oplus}(aq) + NO_3^{\ominus}(aq)$$

0.1 m 0.1 m

$\Delta T_b = 0.2 \times 0.5$

$= 0.1°C = 0.1$ K

Boiling point of solution = 100.1°C = X

13. Ans. (2.50)

$$AgNO_3(aq) \longrightarrow Ag^{\oplus}(aq) + NO_3^{\ominus}(aq)$$

0.05 m 0.05 m 0.05 m

$$BaCl_2(aq) \longrightarrow Ba^{2\oplus}(aq) + 2Cl^{\ominus}(aq)$$

0.05 m 0.05 m 0.1 m

$Ag^{\oplus}$ and $Cl^{\ominus}$ combine to form AgCl precipitate

$$Ag^{\oplus}(aq) + Cl^{\ominus}(aq) \longrightarrow AgCl(s)$$

t = 0	0.05 m	0.1 m	
t = ∞	0	0.05 m	

In final solution total concentration of all ions :

$[Cl^{\ominus}]+[NO_3^{\ominus}]+[Ba^{2\oplus}]=0.05+0.05+0.05=0.15$ m

$\Delta T_b = 0.5 \times 0.15 = 0.075$ °C

B.P. of solution 'B' = 100.075°C

B.P. of solution 'A' = 100.1°C

$|y| = 100.1 - 100.075$

$= 0.025 = 2.5 \times 10^{-2}$

14. Ans. (5)

0.1 mole ionic salt in 1.8 kg water at 35° C

Vapour pressure of solution = 59.724 mm of Hg

Vapour pressure of pure H_2O = 60.000 mm of Hg

Let the number of ions present per formula unit of the ionic salt be 'x'

A_x	$\longrightarrow$	xA
(Salt)		(Ions)
0.1		–
0.1 (1 – 0.9)		(0.1 × 0.9) x

Total moles of non-volatile particles = 0.01 + 0.09 x

in 1.8 kg water

Moles of water = $\frac{1.8\times10^3}{18}=100$ moles

Relative lowering of vapour pressure $\frac{P^\circ - P_s}{P^\circ}$ = Mole fraction of non – volatile particles

$$\frac{P^\circ - P_s}{P_s}=\frac{\text{moles of non-volatile particles}}{\text{moles of water}}$$

$$\frac{60.000-59.724}{59.724}=\frac{0.01+0.09x}{100}$$

$(0.276) \times 100 = 0.59274 + (0.59274 \times 9)x$

$27.6 - 0.59274 = (0.59274 \times 9)x \Rightarrow x \simeq \frac{27}{0.6\times9}=5$

15. Ans. (682)

Weight of 50 ml 0.2 molal urea = V × d = 50 × 1.012 = 50.6 gm

Given 0.2 molal implies

1000 gm solvent has 0.2 moles urea

So weight of solution = 1000 + 0.2 × 60 = 1012 gm.

So wt. of urea in 50.6 gm solution = $\frac{12\times50.6}{1012}$ = 0.6 gm

Total urea = 0.6 + 0.06 = 0.66 gm

Total volume = 300 ml

Now, osmotic pressure $\pi = C \times R \times T = \frac{0.66\times62\times300}{60\times0.3}$ = 682 Torr.