

<H1> Additional Objective Questions

<H2> Single Correct Choice Type

1.(D) Due to weakest intermolecular forces; evaporation is fastest in A.

2.(A) On freezing a solution, only pure solvent freeze, out but the solute does not.

3.(C) Due to more volatile nature of methanol, it forms more vapor than H₂O at same *T*.

4.(B) For positive deviation, $pV = nRT + npb$. Thus, the factor npb is responsible for increasing the pV value above ideal value. Here, b is actually the effective volume of molecule. So, it is the finite size of molecules that leads to the origin of b and hence positive deviation at high pressure.

5.(C) Ideal solutions obey Raoult's law over a wide range of temperature and pressure.

6.(A) Concept based.

7.(B) We know

$$m = \frac{x_A \times 1000}{(1 - x_A) \times M_B} \quad (1)$$

Substituting the values in Eq. (1), we get

$$m = \frac{0.2 \times 1000}{0.8 \times 78} = 3.2$$

8.(A) For an ideal solution $\Delta H_{\text{mix}} = 0$; $\Delta S_{\text{mix}} > 0$; $\Delta G_{\text{mix}} < 0$, $\Delta V_{\text{mix}} = 0$

9.(A) According to Raoult's law, $p_A = p_A^{\circ} x_2$ and Dalton law, $p_A = p_{\text{Total}} x_1$

Therefore,
$$p_{\text{Total}} = p_A^{\circ} \times \frac{x_2}{x_1}$$

10.(B) The solutions in which solute has van't Hoff < 1 will exhibit positive deviation. For example, Benzene + Methanol.

$$11.(B) \text{ Molality of solution} = \frac{\text{Number of moles of ethylene glycol}}{\text{Mass of solvent in kg}} = \frac{222.6}{\frac{62}{200 \times 10^{-3}}} = 17.95 \text{ molal}$$

$$\text{Now, } d = 1.072 = \frac{422.6}{V} \Rightarrow V = \frac{422.6}{1.072} \text{ cm}^3. \text{ Therefore,}$$

$$\text{Molarity of solution} = \frac{222.6}{\frac{\frac{422.6}{1.072} \times 10^{-3}}{62}} = 9.11 \text{ M}$$

12.(D) We know

$$\Delta T_b = K_b \times m$$

$$\Rightarrow m = \frac{0.216}{2.16} = 0.1$$

$$\text{where } m = \frac{w_A}{M_A \times w_B} \Rightarrow M_A = \frac{w_A}{m \times w_B} = \frac{15}{0.1 \times 0.15} = 1000 \text{ g mol}^{-1}$$

13.(B) We know

$$\Delta T_b = K_b \times m$$

$$\Rightarrow K_b = \frac{\Delta T_b}{m}$$

14.(A) According to Raoult's law

$$x_{\text{solute}} = \frac{p_0 - p_s}{p_0} = \frac{\frac{0.5}{65}}{\frac{0.5}{65} + \frac{158}{154}} \Rightarrow \frac{143 - p_s}{143} = 0.00745$$

Solving, we get $p_s = 141.93 \text{ mm Hg}$.

15.(B) Given that $k_H = 4.27 \times 10^5 \text{ mm Hg}$, $p = 760 \text{ mm Hg}$ and $x = \text{solubility}$

$$p = k_H \cdot x \Rightarrow x = \frac{p}{k_H} = \frac{760}{4.27 \times 10^5} = 1.78 \times 10^{-5}$$

16.(A) We know that

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

Therefore, for 1 molal solution

$$\Delta T_f = 1.86 \times 1 = 1.86$$

$$\text{Also, } \Delta T_f = K_f \times \frac{1000 \times w_B}{M_B \times w_A} \Rightarrow 1.86 = 1.86 \times \frac{1000 \times w_{\text{sucrose}}}{342 \times w_{\text{water}}} \Rightarrow \frac{w_{\text{water}}}{w_{\text{sucrose}}} = \frac{342}{1000}$$

Also, $w_{\text{water}} + w_{\text{sucrose}} = 1000 \text{ g}$. Therefore, using two relations we get

$$w_{\text{water}} = 745.16 \text{ g and } w_{\text{sucrose}} = 254.84 \text{ g}$$

When the solution is cooled to -3.534°C , the amount of sucrose in the solution does not change, so the amount of water in solution can be calculated as

$$\Delta T_f = K_f \times \frac{1000 \times w_B}{M_B \times w_A} \Rightarrow 3.534 = 1.86 \times \frac{1000 \times 254.84}{342 \times w_{\text{water}}} \Rightarrow w_{\text{water}} = 392.18 \text{ g}$$

The amount of ice separated is: $745.16 - 392.18 = 352.98 \text{ g}$

17.(D) Total pressure of the solution is given by (Raoult's law)

$$p_{\text{Total}} = X_B p_B^\circ + X_T p_T^\circ = 0.4 \times 119 + 0.6 \times 37 = 47.6 + 22.2 = 69.8 \text{ torr}$$

Applying Dalton's law for mole fraction in vapor phase, we get

$$Y_B = \frac{p_B}{p_{\text{Total}}} = \frac{p_B^\circ X_B}{p_A^\circ X_A + p_B^\circ X_B} = \frac{0.4 \times 119}{69.8} = 0.763$$

$$Y_T = 1 - 0.763 = 0.237$$

18.(C) Colligative properties is an extensive property.

19.(A) Relative lowering of vapor pressure is

$$\frac{p^\circ - p_s}{p^\circ} = \frac{n_A}{n_A + n_B}$$

$$\Rightarrow \frac{17.5 - p_s}{17.5} = \frac{\frac{25}{180}}{\frac{25}{180} + \frac{450}{18}}$$

Solving, we get
$$p_s = 17.5 - \frac{25 \times 17.5}{4525} = 17.4 \text{ mm Hg}$$

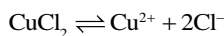
20.(B) $\text{NaCl} \rightleftharpoons \text{Na}^+ + \text{Cl}^-$ (for 100% ionization, $i = 2$)

Now, $\Delta T_f = T_f - T_f^\circ = 0 - 3.72$. Therefore,

$$\Delta T_f = i \times \text{molality} \times K_f = 1 \times 2 \times 1.86 = 3.72^\circ\text{C}$$

Therefore, $T_f^\circ = -3.72^\circ\text{C}$

21.(A) In aqueous solution, CuCl_2 dissociates as



The number of ions in solution is 3. Therefore, the van't Hoff factor is given by

$$i = \frac{\text{Number of moles of solute after dissociation/association}}{\text{Number of moles of solute before dissociation/association}}$$

$$= \frac{3}{1} = 3$$

We know that elevation in boiling point is given by

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

where m is the molality of the solution. Substituting values, we get

$$\Delta T_b = 3 \times 0.52 \times \frac{13.44}{134.4} \times \frac{1000}{1000} = 0.16^\circ\text{C}$$

22.(B) We know

$$p_T = x_A p_A^0 + x_B p_B^0 \quad (1)$$

The mole of benzene = $\frac{80}{78} = 1.02$

The mole of naphthalene = $\frac{100}{120} = 1.02$

The mole fraction of benzene = $\frac{n_{\text{Benzene}}}{n_{\text{Benzene}} + n_{\text{Naphthalene}}} = \frac{1.02}{2.04} = 0.5$

Mole fraction of naphthalene = $\frac{n_{\text{Naphthalene}}}{n_{\text{Benzene}} + n_{\text{Naphthalene}}} = \frac{1.02}{2.04} = 0.5$

Substituting the values in Eq. (1), we get

$$p_T = 0.5 \times 50.71 + 0.5 \times 32.06 = 41.38 \text{ mm Hg}$$

We know

$$y_A = \frac{p_A}{p_T} \text{ or } y_B = \frac{p_B}{p_T}$$

Solving, we get $y_B = 0.675$

23.(D) We know

$$M_{\text{solute}} = \frac{x_{\text{solute}} \times 1000}{x_{\text{solvent}} \times (\text{GMW})_{\text{solvent}}}; \frac{p^0 - p_s}{p^0} = x_{\text{solute}}$$

From 1 molal solution,

Number of moles of solute = 1

Number of moles of solvent = $\frac{1000}{18} = 55.5$

$$\frac{12.3 - p_s}{12.3} = \frac{1}{1 + 55.5}$$

$$12.3 \times 56.5 - p_s \times 56.5 = 12.3$$

$$p_s = \frac{682.55}{56.5} = 12.08 \text{ kPa}$$

24.(A) We know

$$\Delta T_f = K_f \times m \text{ where } m = \frac{W_A}{M_A \times W_B (\text{kg})}$$

$$\Delta T_f = \frac{1000 \times K_f \times w}{MW} = \frac{1000 \times 1.86 \times 34.2}{100 \times 342} = 1.86^\circ\text{C}$$

$$T_f = 0 - 1.86 = -1.86^\circ\text{C}$$

25.(D) We know that $\Pi = iCRT$. For $\Pi_1 = \Pi_2$, C_1 should be equal to C_2 at constant T .

Now, i of $\text{NaCl} = 2$, i of $\text{MgCl}_2 = 3$; i of Urea = 1; i of $\text{Na}_2\text{SO}_4 = 3$; $\text{Ca}(\text{NO}_3)_2 = 3$. Therefore,

$$C = 3 \times 0.1 = 0.3 \text{ for both } \text{Ca}(\text{NO}_3)_2 \text{ and } \text{Na}_2\text{SO}_4.$$

26.(B) We know

$$K_b = \frac{R \times T_b^2}{1000 L_v} \text{ or } \frac{MR \times T_b^2}{1000 \Delta_{\text{vap}} H} \left(\text{as } L_v = \frac{\Delta_{\text{vap}} H}{M} \right)$$

Therefore, $\Delta_{\text{vap}}H = \frac{M \times R \times T_b^2}{K_b \times 1000} = \frac{92 \times 8.34(383.7)^2}{3.32 \times 1000} \text{ kJ mol}^{-1} = 34.0 \text{ kJ mol}^{-1}$

27.(B) Given, $\Pi_1 = \Pi_2$, that is, $C_1 = C_2$. Therefore,

$$\frac{5}{100 \times 342} = \frac{1}{M_B \times 100} \Rightarrow M_B = 68.4 \text{ g mol}^{-1}$$

28.(C) Let the mass of solution be 100 g, then $\Delta T_f = K_f m$.

Case I: $(273.15 - 271) = K_f \times \frac{5/242}{95 \times 10^{-3}}$ (1)

Case II: $(273.15 - T_{f(\text{glucose})}) = K_f \times \frac{5/180}{95 \times 10^{-3}}$ (2)

Solving Eqs. (1) and (2), we get

$$T_{f(\text{glucose})} = 269.07 \text{ K}$$

29.(B) Based on van't Hoff factor values, we find that $i = 2$ for KCl, $i = 5$ for $\text{Al}_2(\text{SO}_4)_3$, $i = 1$ for $\text{C}_6\text{H}_{12}\text{O}_6$ and $i = 1$ for $\text{C}_{12}\text{H}_{22}\text{O}_{11}$. Hence, the value of ΔT_f will be maximum for $\text{Al}_2(\text{SO}_4)_3$ and so it has the lowest freezing point.

30.(A) We know

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

During freezing, only solvent freezes and separates out.

$$\Delta T = \frac{1000 \times K_f \times w}{W \times M}$$

$$\Rightarrow 9.3 = \frac{1000 \times 1.86 \times 50}{62 \times W}$$

$$\Rightarrow W = 161.29 \text{ g}$$

Thus, the ice separated is $200 - 161.29 = 38.71 \text{ g}$

31.(D) $\Pi = iCRT$. From the given values, $i \times C$ product is lowest for FeCl_3 . Therefore, osmotic pressure is lowest for 0.03 M FeCl_3 .

32.(A) According to Henry's law, at constant temperature, the aqueous phase concentration (x_a) of a gas is proportional to the partial pressure of the gas (p_a) above the fluid. Mathematically,

$$p_a = K_H x_a$$

As the graphs in the options show a plot of p_a vs x_{water} , so the expression becomes

$$p_a = K_H(1 - x_{\text{water}}) \Rightarrow p_a = K_H - K_H x_{\text{water}}$$

the slope of the lines obtained is $-K_H$. The increasing order of K_H for the given gases w, x, y and z is $w < x < y < z$. So, for slopes $-K_H$, the order becomes $z < y < x < w$. Thus, correct graph is (1).

33.(A) Given, $\frac{\Pi_1}{\Pi_2} = \frac{C_1}{C_2} = \frac{2/2}{0.5 \times 2} = 1$ (at constant T), $i = 2$ for both (as 100% ionization). Therefore, both the solutions are isotonic.

34.(D) Elevation of boiling point $\propto i$ (as CaCl_2 , $i = 3$). Hence, it is highest for CaCl_2 .

35.(A) NaCl solution used should be isotonic with blood stream. For NaCl, $i = 2$

$$\Pi = iCRT \Rightarrow C = \frac{7.8}{2 \times 0.083 \times 310} = 0.15 \text{ mol L}^{-1}$$

36.(A) Mole fraction of $x = 1/4$ and of $y = 3/4$.

Total pressure = Partial pressure of $x \times$ Mole fraction of x + Partial pressure of $y \times$ Mole fraction of y

$$550 = \frac{p_x^\circ}{4} + \frac{3p_y^\circ}{4} \Rightarrow 550 \times 4 = p_x^\circ + 3p_y^\circ \quad (1)$$

When one mole of y is added, then mole fraction of x becomes $1/(1+4) = 1/5$ and mole fraction of y becomes $4/(1+4) = 4/5$. So, the total pressure given is 560 mm Hg.

$$560 = \frac{p_x^\circ}{5} + \frac{4p_y^\circ}{5} \Rightarrow 560 \times 5 = p_x^\circ + 4p_y^\circ \quad (2)$$

Solving (1) and (2), we get

$$p_x^\circ = 400 \text{ mmHg and } p_y^\circ = 600 \text{ mmHg}$$

37.(C) Volume of solution = 1000 mL

Mass of the solution = $V \times d = 1000 \text{ mL} \times 1.04 \text{ g mL}^{-1} = 1040 \text{ g}$

Amount of solute in 1000 mL solution = $1 \text{ M} = 1 \text{ M} \times \text{Molecular mass} = 1 \text{ M} \times 74.5 \text{ g mol}^{-1} = 74.5 \text{ g}$

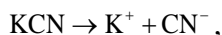
Mass of water = Mass of solution – Mass of KCl = $1040 \text{ g} - 74.5 \text{ g} = 965.5 \text{ g}$

Molality of the solution = $m = \frac{\text{Moles of solute}}{\text{Mass of solvent in kg}} = \frac{1 \text{ mol}}{(965.5/1000)\text{kg}} = 1.0357$

$\Delta T_b = i K_b m = 2 \times 0.52 \text{ K kg mol}^{-1} \times 1.0357 = 1.078^\circ\text{C}$

Boiling point of the solution is $100^\circ\text{C} + 1.078^\circ\text{C} = 101.078^\circ\text{C}$

38.(A) Given,



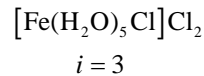
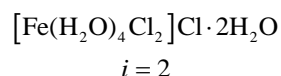
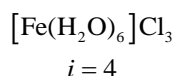
where $i = 2$.

Hence,

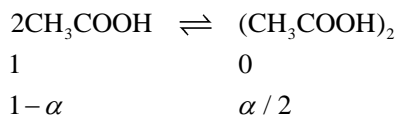
$$\Delta T_b = i \times m \times K_b = 2 \times \frac{32.5}{65} \times 0.52 = 5.2^\circ\text{C}$$

Therefore, $T_b^s = 373.15 + 5.2 = 378.35 \text{ K} = 378.35 - 273.15 = 105.20^\circ\text{C}$

39.(D) Smaller the value of i , higher will be the freezing point. Therefore, in the case of non-electrolytes, $i = 1$.



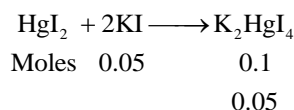
40.(C) The reaction involved is



$$i = 1 - \frac{\alpha}{2} \text{ or } \alpha = 2(1 - i) = 2(1 - 0.52) = 0.96$$

Hence, degree of dissociation = 96%.

41.(B) When HgI_2 is added to KI:



This is the case of association in which 2 moles of KI combine with one mole of HgI_2 to form the complex K_2HgI_4 . Hence, 0.05 mol of HgI_2 are required to react completely with 0.1 solution of KI.

Thus, as HgI_2 is being added, the number of solute molecules will decrease ($i < 1$) causing ΔT_f to decrease, that is, causing T_f to increase. When whole of KI has been converted into K_2HgI_4 , further addition of HgI_2 does not change the T_f , since it is a sparingly soluble salt.

42.(A) We know $pV = nRT$ for glucose and blood. If isotonic, $p_{\text{glucose}} = p_{\text{blood}}$

Thus,
$$7.65 \times V = \frac{W}{180} \times 0.0821 \times 310$$

or
$$\frac{W}{V} = 54 \text{ g L}^{-1} = 5.41\% \text{ (wt vol}^{-1}\text{)}$$

43.(C) We know

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

$$\Rightarrow \Delta T_f \propto i$$

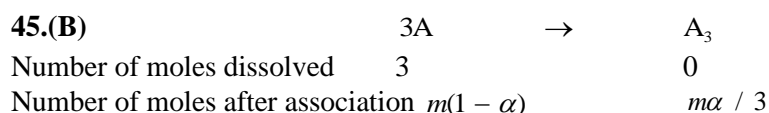
where $i = 1$ for urea, $i = 2$ for NaCl and $i = 3$ for Na_2SO_4 .

Therefore, ratio of number of molecules after ionization = 1:2:3

44.(A) $\text{K}_2\text{SO}_4 \rightarrow 2\text{K}^+ + \text{SO}_4^{2-}$; van't Hoff factor, $i = 3$ (as 100% ionization)

Given that $V = 2 \text{ L}$, $T = 25 + 273 = 298 \text{ K}$. So, the osmotic pressure is

$$\Pi = i \frac{n}{V} RT = 3 \times \frac{25 \times 10^{-3}}{174 \times 2.0} \times 0.0821 \times 298 = 5.27 \times 10^{-3} \text{ atm}$$



Total moles present after association is

$$m(1-\alpha) + m\frac{\alpha}{3} = m\left(1-\alpha + \frac{\alpha}{3}\right) = m\left(1 - \frac{2\alpha}{3}\right) = 0.25m\left[\frac{3-2\times 0.8}{3}\right] = 0.177m$$

$$\Delta T_f = K_f m \Rightarrow T_f^{\circ} - T_f = 5.12 \text{ K molal}^{-1} \times 0.177 m = 0.6$$

$$T_f = T_f^{\circ} - 0.6^{\circ}\text{C} = 5.5 - 0.6 = 4.9^{\circ}\text{C}$$

46.(B) We know

$$i \text{ for } \text{AgNO}_3 = \frac{\text{Normal molecular weight}}{\text{Observed molecular weight}} = 1 + \alpha$$

$$\alpha = \frac{170}{92.64} - 1 = 0.835$$

So, the percentage dissociation is 83.5%.

<H2> Multiple Correct Choice Type

1.(A, D) When a non-volatile solute is added to a pure solvent to form a solution, vapor pressure of the solution decreases compared to that of a solution. At freezing point, only solvent freezes in a solution.

2.(A, C) Both the mole fraction and molality do not change on changing the temperature because both do not involve any volume term.

3.(A, B, D) In an ideal solution

(i) the solute-solute and solvent-solvent interactions are identical to those of solute-solvent.

(ii) $\Delta H_{\text{mix}} = 0$

(iii) $\Delta S_{\text{mix}} > 0$

4.(C, D) If a mixture is less volatile, then the solution exhibits negative deviation and if the mixture is more volatile, then the solution exhibits positive deviation from Raoult's law.

5.(A, B, C, D) When a non-volatile solute is added to a pure solvent, the solution vapor pressure decreases than that of pure solvent.

6.(A, B) For both urea and glucose $i = 1$

For both $\text{K}_4[\text{Fe}(\text{CN})_6]$ and $\text{Al}_2(\text{SO}_4)_3$, $i = 1 + 4\alpha$

For association of a solute in a solution $i < 1$

Glucose and sucrose undergo neither association or dissociation.

7.(A, B) We know

$$p_T = x_A p_A^{\circ} + x_B p_B^{\circ}$$

Or

$$p_T = p_{\text{benzene}}^{\circ} x_{\text{benzene}} + p_{\text{toluene}}^{\circ} x_{\text{toluene}}$$

Therefore,

$$p_T = 42 \times \frac{1}{3} + 36 \times \frac{2}{3} = 38 \text{ mm Hg}$$

8.(A, C)

Option (B) is wrong because K_H increases with increase of temperature.

Option (D) is wrong because different noble gases have different value for K_H at the same temperature.

9.(A, B) Benzene and toluene form an ideal solution, as A–A and B–B attractions are similar to A–B attractions.

$$p_{\text{Total}} = p_A^{\circ}x_A + p_B^{\circ}x_B = 42 \times \frac{1}{3} + 36 \times \frac{2}{3} = 38 \text{ mm Hg}$$

$$x_A = \frac{1}{3} \text{ and } x_B = 1 - \frac{1}{3} = \frac{2}{3}$$

Now, mole fraction of vapors of benzene above liquid mixture is

$$x_{\text{Benzene}}^{\text{Vap}} = \frac{p_{\text{Benzene}}}{p_{\text{Total}}} = \frac{42 \times \frac{1}{3}}{38} = \frac{7}{19}$$

10.(A, D) 1 molal NaCl will have greater depression in freezing point, and hence, lower actual freezing point. So (A) is false. If solute undergoes association, $i < 1$.

11.(B, D) In azeotropic mixture, both components will boil at the same temperature.

12.(A, B, C) Due to the intermolecular interaction between acetone and aniline, therefore, it shows negative deviation from Raoult's law while other shows positive deviation from Raoult's law.

13.(A, C) Both are having same molar concentration as well non-electrolytes.

$$14.(A, C, D) \frac{\Delta p}{p^{\circ}} = \frac{n}{N} = \frac{n \times M \times 1000}{W \times 1000} = \frac{\text{Molality} \times M}{1000}$$

$$\text{For electrolyte } \frac{\Delta p}{p^{\circ}} = \frac{\text{Molality} \times M}{1000} \times (1 + 3\alpha) \quad (\text{where } M = 18 \text{ for } \text{H}_2\text{O})$$

Also,

$$\Pi_{\text{obs}} = C \times R \times T (1 + 3\alpha)$$

$$\Delta M_{\text{f(obs.)}} = K_f \times \text{Molality} \times (1 + 3\alpha)$$

$$i = (1 + 3\alpha) = \frac{\text{Calculated molecular weight}}{\text{Observed molecular weight}}$$

$$\text{Molecular weight of } \text{K}_2\text{PO}_4 = M_{\text{obs}} \times (1 + 3\alpha)$$

15.(A, B, C) Henry's law states that the mole fraction of the gas in the solution is directly proportional to the partial pressure of the gas above the solution, that is, $p_A = k_H \times a$ (where k_H is the Henry's constant).

The solubility of gas does not depend on its volume, but it decreases with increase in temperature. The enthalpy change for solubility of gas is negative, so Gibbs energy change is also negative ($\Delta G = \Delta H - T\Delta S$).

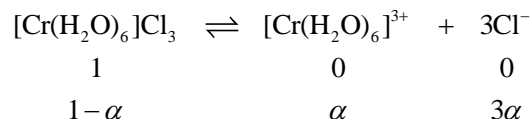
16.(A, C, D) $\text{CrCl}_3 \cdot 6\text{H}_2\text{O}$

$$\Pi = CRT(1 - \alpha + x\alpha + y\alpha)$$

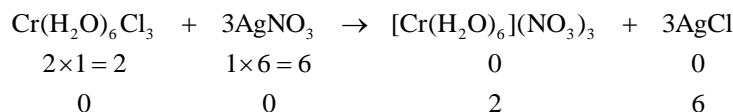
$$93.52 = 1 \times 0.0821 \times 300 \times (x + y) \quad (\text{as } \alpha = 1)$$

Solving, we get $x + y = 4$.

The reactions involved are



and



Weight of AgCl formed = $6 \times 143.5 = 861$ g

$$\Pi = CRT \times (1 + 3\alpha) = \frac{2}{3} \times 0.0821 \times 300 \times 4 = 65.68 \text{ atm}$$

17.(A, B) We know

$$p_T = p_A^\circ x_A + p_B^\circ x_B$$

Also,

$$p' = p_M x_{A(v)} = p_A^\circ x_{A(l)} = p_A^\circ x_A + p_B^\circ (1 - x_A)$$

Therefore,

$$x_A = \frac{p_T - p_B^\circ}{p_A^\circ - p_B^\circ}$$

18.(A, C, D) According to Ostwald and Walker experiment, we have

Loss in weight of solution (w_1) $\propto p_s$

Loss in weight of solvent (w_2) $\propto p_0 - p$

19.(B, D) $\Delta V_{\text{mixing}} = 0$; $\Delta H_{\text{mixing}} = 0 \Rightarrow$ Look for ideal solutions.

If $\Delta V_{\text{mix}} = +\text{ve}$, $\Delta H_{\text{mix}} = +\text{ve}$, positive deviation
and $\Delta V_{\text{mix}} = -\text{ve}$, $\Delta H_{\text{mix}} = -\text{ve}$, negative deviation

20.(A, C, D)

- (A) There will be a depression in freezing point by the addition of glucose in water.
- (B) α increases as concentration decreases. (Ostwald's law)
- (C) $\Delta_{\text{sol}} H = \Delta H_{\text{Lattice}} + \Delta H_{\text{Hydration}}$
(+ve) Endothermic (-ve) Exothermic
- (D) Mixing of solution is always accompanied by an increase in entropy (randomness).

<H2> Assertion–Reasoning

1.(B) For azeotropes, the boiling point of solution is either lower or higher than that of pure components (depending on the type of deviation).

2.(A) KCl ($i = 2$), urea ($i = 1$). As $\Delta T_b = i \times k_b \times m \Rightarrow \Delta T_b \propto i$, so ΔT_b for urea is less than KCl.

3.(D) Azeotropes are constant boiling mixtures having the same composition throughout.

4.(C) We know

$$P_{\text{solution}} \propto x_{\text{solvent}} \Rightarrow P_{\text{solution}} = P^{\circ} x_{\text{solvent}}$$

where P° = vapor pressure of pure solvent.

5.(A) Only osmotic pressure is most suitable for determination molecular weights of polymers because ΔT_f and ΔT_b are very low.

6.(C) Since molecular weight of polymers is very high, ΔT_f and ΔT_b will be very small so that accurate values cannot be obtained. But osmotic pressure of polymer solution can be measured accurately.

7.(A) In the process of reverse osmosis, solvent flows from concentrated side to dilute side of the solution. Therefore, saline water can be purified.

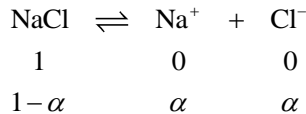
8.(B) Follow Henry's Law, for dissolution of gases.

9.(D) On heating a solution, volume decreases and molarity increases. Therefore, colligative property also changes. (Molality does not involve volume term.)

10.(A) Equilibrium constant changes with temperature, so vapor pressure also will change because vapor pressure is defined at equilibrium state.

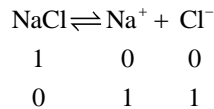
<H2> Comprehension Type

1.(A) For NaCl



Initially, at equilibrium $i = 1 - \alpha + \alpha + \alpha = 1 + \alpha$. Now, $i = \frac{1 + \alpha}{1} = 1.4$. Therefore, $\alpha = 0.4$ or 40%.

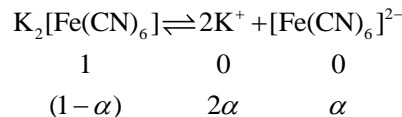
2.(B) For NaCl, $i = 2$ and the reaction is



Sugar is non-electrolyte ($i = 1$).

$$\frac{\Delta T_{\text{b NaCl}}}{\Delta T_{\text{b sugar}}} = \frac{i_{\text{NaCl}}}{i_{\text{sugar}}} = \frac{2}{1}$$

3.(B) The reaction involved is



Thus,

$$i = 1(n-1)\alpha = 1 + 3\alpha = 2.5$$

$$\Pi = iCST = 2 \times 0.01 \times 0.0821 \times 300 = 0.4926 \text{ atm}$$

Now, $\alpha = 0.5$, so

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

4.(A) Only benzene and acetone show positive deviation because the interactions present in the benzene molecule and the acetone molecules will be stronger than that present in the solution of benzene + acetone. All others show negative deviation as the solutions formed by them have greater forces of interactions than the individual molecules.

5.(B) Boiling point of solution is lower than either of the liquid, which means that the vapor pressure is higher than as predicted by Raoult's law, $p_A > p_A^\circ x_A$, so there is positive deviation from Raoult's law. Solutions that show negative deviation from Raoult's law form maximum boiling azeotropes.

6.(B) Mole fraction of pentane = $\frac{1}{1+4} = 0.2$ and that of hexane = $1 - 0.2 = 0.8$. Now substituting these in the equation $p = p_p^\circ x_p + p_H^\circ x_H$, we get

$$p = 0.2 \times 440 + 0.8 \times 120 = 88 + 96 = 184 \text{ mm Hg}$$

Therefore, vapor pressure of pentane in vapor phase is

$$x_{\text{P(vap)}} = \frac{88}{184} = 0.478$$

<H2> Integer Answer Type

1.(4) $i = 1 + (5 - 1) 0.75 = 4$

2.(5) Elevation in boiling point for $\text{Al}_2(\text{SO}_4)_3$ is $= 0.3 \times 5 \times K_b = 1.5K_b$

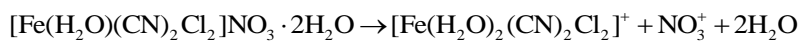
Elevation in boiling point for Na_2SO_4 is $= 0.1 \times 3 \times K_b = 0.3K_b$

Hence, it is five times.

3.(8)

Urea – 1	Glucose – 0.5	NaCl – 25
K_2SO_4 – 3	1:0.5:2:3	$x + 2 = 2 + 6 = 8$
	2:1:4:6	
	$x:0:y:z$	

4.(2) As the complex ionizes as



It gives two species, therefore, $i = 2$.

5.(5.5) From Raoult's, we have

$$m = \left(\frac{p^0 - p_s}{p^0} \right) \times \frac{1000}{M_{\text{solvent}}} \quad (1)$$

Given, lowering of vapor pressure = 1.008 mm Hg

$$m = 1 \text{ molal}$$

Substituting the values in Eq. (1), we get

$$p^0 = \frac{1.008}{1} \times \frac{1000}{18}$$

$$\Rightarrow p^0 = 56 = 5.6 \times 10.$$

Therefore, value of $Z = 5.5$

<H2> Matrix–Match Type

1. **A → (q, t); B → (p, t); C → (r, s); D → (r, s)**

$\Pi = iCRT$, where $i = 1 + 3$

So, the maximum boiling point of azeotrope is when there is a –ve deviation from Raoult's law, and the minimum boiling point of azeotrope is when there is a +ve deviation from Raoult's law.

2. **A → (s, t); B → (r); C → (p); D → (q)**

(A) CH_3COOH in H_2O undergoes dissociation ($\therefore i > 1$).

(B) CH_3COOH in C_6H_6 undergoes dimerization ($\therefore i < 1$).

(C) Polymer in water undergoes neither association nor dissociation (so, $i = 1$).

3. A → (r, t); B → (p); C → (r, s, t); D → (p, q)

Matrix matching – conceptual

$$\text{(A)} \quad K_f = \frac{RT_f^{0^2}}{1000L_f} = \frac{RT_f^{0^2} M}{1000\Delta H_f}; T_f^0 (\text{water}) = 273 \text{ K}, M = 18$$

$$\text{(B)} \quad K_b = \frac{RT_b^{0^2}}{1000L_v} = \frac{RT_b^{0^2} M}{1000\Delta H_v}; T_b^0 (\text{water}) = 373 \text{ K}, M = 18$$

$$\text{(C)} \quad \Delta T_f = K_f \times m = K_f \times \frac{9 \times 1000}{180 \times 50} = K_f$$

$$\text{(D)} \quad \Delta T_b = K_b \times m = K_b \times \frac{3 \times 1000}{60 \times 50} = K_b$$