Solutions

1. Which amongst the following aqueous solution of electrolytes will have minimum elevation in boiling point? Choose the correct option: **(2023)**
   (a) 0.05 M NaCl
   (b) 0.1 M KCl
   (c) 0.1 M $MgSO_4$
   (d) 1 M NaCl
2. The following solutions were prepared by dissolving 10 g of glucose ($C_6H_{12}O_6$) in 250 ml of water (P_1), 10 g of urea (CH_4N_2O) in 250 ml of water (P_2) and 10 g of sucrose ($C_{12}H_{22}O_{11}$) in 250 ml of water (P_3). The right option for the decreasing order of osmotic pressure of these solutions is: **(2021)**
   (a) $P_1 > P_2 > P_3$
   (b) $P_2 > P_3 > P_1$
   (c) $P_3 > P_1 > P_2$
   (d) $P_2 > P_1 > P_3$
3. The correct option for the value of vapour pressure of a solution at 45°C with benzene to octane in molar ratio 3 : 2 is: **(2021)**
   [At 45°C vapour pressure of benzene is 280 mm Hg and that of octane is 420 mm Hg. Assume Ideal gas]
   (a) 168 mm of Hg
   (b) 336 mm of Hg
   (c) 350 mm of Hg
   (d) 160 mm of Hg
4. The mixture which shows positive deviation from Raoult's law is: **(2020)**
   (a) Benzene + Toluene
   (b) Acetone + Chloroform
   (c) Chloroethane + Bromoethane
   (d) Ethanol + Aceton
5. The freezing point depression constant (Kf) of benzene is 5.12 K kg mol^{-1}. The freezing point depression for the solution of molality 0.078 m containing a non-electrolyte solute in benzene is (rounded off upto two decimal places): **(2020)**
   (a) 0.80 K
   (b) 0.40 K
   (c) 0.60 K
   (d) 0.20 K
6. If 8 g of a non-electrolyte solute is dissolved in 114 g of n-octane to reduce its vapour pressure to 80%, the molar mass (in $g\ mol-1$) of the solute is
   [Given that molar mass of n-octane is 114 g mol^{-1}] **(2020 Covid Re-NEET)**
   (a) 60
   (b) 80
   (c) 20
   (d) 40
7. Isotonic solutions have same **(2020 Covid Re-NEET)**
   (a) Freezing temperature
   (b) Osmotic pressure
   (c) Boiling temperature
   (d) Vapour pressure
8. For an ideal solution, the correct option is: **(2019)**
   (a) $\Delta_{mix}\ S = 0$ at constant T and P
   (b) $\Delta_{mix}\ V \neq 0$ at constant T and P
   (c) $\Delta_{mix}\ H = 0$ at constant T and P
   (d) $\Delta_{mix}\ G = 0$ at constant T and P
9. The mixture that forms maximum boiling azeotrope is: **(2019)**
   (a) Water + Nitric acid
   (b) Ethanol + Water
   (c) Acetone + Carbon disulphide
   (d) Heptane + Octane
10. If molality of the dilute solution is doubled, the value of molal depressin constant (K_f) will be: **(2017-Delhi)**
    (a) Unchanged
    (b) Doubled
    (c) Halved
    (d) Tripled
11. Which of the following is dependent on temperature? **(2017-Delhi)**
    (a) Weight percentage
    (b) Molality
    (c) Molarity
    (d) Mole fraction
12. Toluene in the vapour phase is in equilibrium with a solution of benzene and toluene having mole fraction of toluene

0.50. If vapour pressure of pure benzene is 119 torr and that of toluene is 37.0 torr at the same temperature, mole fraction of toluene in vapour phase will be:
(2018-Gujarat)

(a) 0.325
(b) 0.462
(c) 0.237
(d) 0.506

13. Which one of the following is incorrect for ideal solution? **(2016-II)**
(a) $\Delta P = P_{obs} - P_{calculated\ by\ Raoult's\ law} = 0$
(b) $\Delta G_{mix} = 0$
(c) $\Delta H_{mix} = 0$
(d) $\Delta U_{mix} = 0$

14. The van't Hoff factor (i) for a dilute aqueous solution of the strong electrolyte barium hydroxide is: **(2016-II)**
(a) 2
(b) 3
(c) 0
(d) 1

15. At 100°C, the vapour pressure of a solution of 6.5 g of a solute in 100 g water is 732 mm. If $K_b = 0.52$, the boiling point of this solution will be: **(2016-I)**
(a) 103°C
(b) 101°C
(c) 100°C
(d) 102°C

16. Which of the following statements about the composition of the vapour over an ideal 1:1 molar mixture of benzene and toluene is correct? Assume that the temperature is at 25°C.
(Given, vapour pressure data at 25°C, benzene = 12.8 kPa, toluene = 3.85 kPa)
(2016)
(a) The vapour will contain equal amounts of benzene and toluene
(b) Not enough information is given to make a prediction
(c) The vapour will contain a higher percentage of benzene
(d) The vapour will contain a higher percentage of toluene

17. What is the mole fraction of the solute in a 1.00 m aqueous solution? **(2015 Re)**
(a) 0.0177
(b) 0.177
(c) 1.770
(d) 0.0354

18. Which one of the following electrolytes has the same value of van't Hoff's factor (i) as that of $Al_2(SO_4)_3$ (if all are 100% ionized)?
(2015)
(a) $K_3[Fe(CN)_6]$
(b) $Al(NO_3)_3$
(c) $K_4[Fe(CN)_6]$
(d) K_2SO_4

19. Which one is not equal to zero for an ideal solution? **(2015)**
(a) ΔS_{mix}
(b) ΔV_{mix}
(c) $\Delta P = P_{observed} - P_{Raoult}$
(d) ΔH_{mix}

20. The boiling point of 0.2 $mol\ kg^{-1}$ solution of X in water is greater than equimolal solution of Y in water. Which one of the following statements is true in this case?
(2015)
(a) Molecular mass of X is greater than the molecular mass of Y
(b) Molecular mass of X is less than the molecular mass of Y
(c) Y is undergoing dissociation in water while X undergoes no change
(d) X is undergoing dissociation in water

21. Of the following 0.10 m aqueous solutions, which one will exhibit the largest freezing point depression? **(2014)**
(a) $C_6H_{12}O_6$
(b) $Al_2(SO_4)_3$
(c) K_2SO_4
(d) KCl

22. How many grams of concentrated nitric acid solution should be used to prepare 250 mL of 2.0 M HNO_3? The concentrated acid is 70% HNO_3. **(2013)**
(a) 70.0 g of conc. HNO_3
(b) 54.0 g conc. HNO_3
(c) 45.0 g conc. HNO_3
(d) 90.0 g conc. HNO_3

Answer Key

S1. Ans. (a)

S2. Ans. (d)

S3. Ans. (b)

S4. Ans. (d)

S5. Ans. (b)

S6. Ans. (d)

S7. Ans. (b)

S8. Ans. (c)

S9. Ans. (a)

S10. Ans. (a)

S11. Ans. (c)

S11. Ans. (c)

S13. Ans. (b)

S14. Ans. (b)

S15. Ans. (b)

S16. Ans. (c)

S17. Ans. (a)

S18. Ans. (c)

S19. Ans. (a)

S20. Ans. (d)

S21. Ans. (b)

S22. Ans. (c)

Solutions

S1. Ans.(a)

$i \times M\downarrow \Longrightarrow \Delta T_b\downarrow$

Electrolyte	i × M
NaCl	2 × 0.05 = 0.1
KCl	2 × 1.0 = 0.2
$MgSO_4$	2 × 0.1 = 0.2
NaCl	2 × 1 = 2

S2. Ans.(d)

$\pi = iCRT$

$P_1 = 1 \times \frac{10}{180} \times R \times T$ (For Glucose)

$P_2 = 1 \times \frac{10}{60} \times R \times T$ (For Urea)

$P_3 = 1 \times \frac{10}{342} \times R \times T$ (For Sucrose)

$\therefore\ P_2 > P_1 > P_3$

S3. Ans.(b)

S4. Ans.(d)

While ethanol-acetone mixture shows positive deviation due to weaker A-B interaction in comparison to A-A or B-B interaction.

Pure ethanol molecules are hydrogen bonded. When acetone is added, its molecules get in between the ethanol molecules and break some of the hydrogen bonds between them.

Thus, the intermolecular attractive interactions are weakens and the solution shows positive deviation from Raoult's law.

S5. Ans.(b)

$\Delta T_f = K_f \times molality(m)$

$\Delta T_f = 5.12 \times 0.078$

$\Rightarrow\ 0.3993$

= 0.40 K

S6. Ans.(d)

Assuming dilute solution

$\frac{\Delta P}{P_A^0} = \frac{n_B}{n_A} = \frac{w_B}{m_B} \cdot \frac{m_A}{w_A}$

$\frac{20}{100} = \frac{8}{m_B} \cdot \frac{114}{114}$

$m_B = \frac{8 \times 100}{20} = 40\ g\ mol^{-1}$

S7. Ans.(b)

Solutions that have same osmotic pressure at a given temperature are called isotonic solutions.

S8. Ans.(c)

For ideal solution,

$\Delta_{mix}H = 0$, i.e., no heat should be absorbed or evolved during mixing

$\Delta_{mix}V = 0$

S9. Ans.(a)

Maximum boiling azeotrope will forms by solutions that show negative deviation from Raoult's law.

Water and Nitric acid → forms maximum boiling azeotrope

S10. Ans.(a)

If molality of a dilute solution is doubled, the value of molal depression constant (K_f) will be unchanged because the value of molal depression constant will depend only on number of solute and solvent particle, as it is colligative property.

S11. Ans.(c)

Molarity will depend upon temperature as molarity will depend upon the volume of the solution which change with temperature.

S12. Ans.(c)

$P_b^\circ = 37\ torr$, $P_b^\circ = 119\ torr$

$y_1 = \frac{P_t^\circ X_t}{P_t^\circ X_t + P_b^\circ X_b}$, $X_t = 0.5$

$y_t = \frac{37 \times 0.5}{(37)(0.5)+(119)(0.5)} = \frac{37}{37+119} = 0.237$

S13. Ans.(b)

In case of an ideal solution $\Delta S_{mix} \neq 0$

$\Delta U_{mix} = 0$ but $\Delta S_{mix} \neq 0$

According to 3rd law of thermodynamics:

$\Delta G = \Delta H - T\Delta S$

$\Delta G_{mix} \neq 0$

S14. Ans.(b)

$Ba(OH)_2$ is a strong electrolyte. It will 100% dissociate in aqueous solution:

$Ba(OH)_2 \rightleftharpoons Ba^{2+} + 2OH^-$

van't Hoff factor becomes 3.

S15. Ans.(b)

Two colligative properties will be used to solve the question.

$\frac{p_0 - p_s}{p_s} = \frac{w_A/M_A}{w_B/M_B}$

$\frac{760-732}{732} = \frac{6.5 \times m}{100/18}$

m = 32 g/mol

S16. Ans.(c)

$P_{Benzene} = x\ P^o$

$P_{Toluene} = x\ P^o$

For an ideal 1:1 molar mixture of Benzene and Toluene.

$X_{Benzene} = \frac{1}{2}; X_{Toluene} = \frac{1}{2}$

$P_{Benzene} = \frac{1}{2} \times 12.8\ KPa = 6.4\ K\ Pa$

$P_{Toluene} = \frac{1}{2} \times 3.85\ K\ Pa = 1.925\ KPa$

Thus, the vapour will contain a high percentage of Benzene than Toluene.

S17. Ans.(a)

$X_{solution} = \frac{1}{55.5+1} = \frac{1}{56.5} = 0.0177$

S18. Ans.(c)

$Al_2(SO_4)_3 \rightleftharpoons \underset{i=5}{2Al^{3+}} + 3SO_4^{2-}$

$K_4[Fe(CN)_6] \rightleftharpoons \underset{i=5}{4K^+} + [Fe(CN)_6]^-$

S19. Ans.(a)

$\Delta S_{mix} > 0$

As entropy increases after mixing.

S20. Ans.(d)

X must be going dissociation in water thus increasing vant's Hoff factor (i) as after dissolution the number of solute particles increases.

S21. Ans.(b)

Depression in freezing point depends on vant's Hoff factor which depends on dissociation entities.

So, among 4 options

$Al_2(SO_4)_3$ will have $2Al^{3+} + 3SO_4^{2-} = 5$ entities exhibiting maximum depression in freezing point.

S22. Ans.(c)

$Molarity = \frac{W \times 1000}{M \times V_{(mL)}}$

$2 = \frac{W}{63} \times \frac{1000}{250}$

$W = \frac{63}{2}$

Because 70% HNO_3 ;

$Mass\ of\ acid \times \frac{70}{100} = \frac{63}{2}$

$Mass\ of\ acid = 45\ g$