Exercise-1

✍ **Marked Questions may have for Revision Questions.**

ONLY ONE OPTION CORRECT TYPE

Section (A) : Concentration terms

1. 8 g NaOH is dissolved in one litre of solution, its molarity is :
(1) 0.8 M (2) 0.4 M (3) 0.2 M (4) 0.1 M

2. A 500 g tooth paste sample has 0.02 g fluoride concentration. What is the concentration of fluorine in terms of ppm level ?
(1) 250 (2) 40 (3) 400 (4) 1000

3. A mixture has 18 g water and 414 g ethanol. The mole fraction of water in mixture is (assume ideal behaviour of the mixture) :
(1) 0.1 (2) 0.4 (3) 0.7 (4) 0.9

4. 25 mL of 3.0 M HNO_3 are mixed with 75 mL of 4.0M HNO_3. If the volumes are additive, the molarity of the final mixture would be-
(1) 3.25 M (2) 4.0 M (3) 3.75 M (4) 3.50 M

5. 15 gram of methyl alcohol is dissolved in 35 gram of water. What is the mass percentage of methyl alcohol in solution ?
(1) 30% (2) 50% (3) 70% (4) 75%

6. An X molal solution of a compound in benzene has mole fraction of solute equal to 0.2. The value of X is :
(1) 14 (2) 3.2 (3) 1.4 (4) 2

7.✍ Mole fraction of ethanol in ethanol water mixture is 0.25. Hence precentage concentration of ethanol by weight of mixture is :
(1) 25% (2) 75% (3) 46% (4) 54%

8. Density of a 2.05 M solution of acetic acid in water is 1.02 g/mL. The molality of the solution is
(1) 3.28 mol Kg^{-1} (2) 2.28 mol Kg^{-1} (3) 0.44 mol Kg^{-1} (4) 1.14 mol Kg^{-1}

9. What is the molarity of HCl in a solution prepared by dissolving 5.5g HCl in 200g ethanol if the density of the solution is 0.79 g mL^{-1} ?
(1) 21 M (2) 0.93 M (3) 6×10^{-4} (4) 0.58 M

10. A 5.2 molal aqueous solution of CH_3OH is supplied. What is the mole fraction of methyl alcohol in the solution ?
(1) 0.050 (2) 0.100 (3) 0.190 (4) 0.086

11. The density of a solution containing 13% by mass of sulphuric acid is 1.09 g/mL. Calculate the molarity of the solution-
(1) 1.445 M (2) 14.45 M (3) 144.5 M (4) 0.1445 M

Section (B) : Vapour Pressure

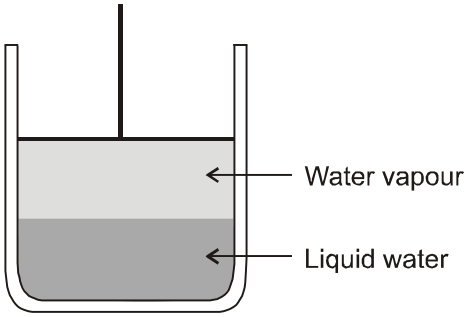
1. A liquid is kept in a closed vessel. If a glass plate (negligible mass) with a small hole is kept on top of the liquid surface, then the vapour pressure of the liquid in the vessel is :
(1) More than what would be if the glass plate were removed
(2) Same as what would be if the glass plate were removed
(3) Less than what would be if the glass plate were removed
(4) Cannot be predicted

2. The vapour pressure of water depends upon :
(1) Surface area of container (2) Volume of container
(3) Temperature (4) All

3. Among the following substances, the lowest vapour pressure is exerted by :
(1) Water (2) Mercury (3) Acetone (4) Ethanol

4. At higher altitudes, water boils at temperature < 100ºC because
(1) temperature of higher altitudes is low (2) atmospheric pressure is low
(3) the proportion of heavy water increases (4) atmospheric pressure becomes more.

5. The vapour pressure of water at 20°C is 17.54 mmHg. What will be the vapour pressure of the water in the apparatus shown after the piston is lowered, decreasing the volume of the gas above the liquid to one half of its initial volume (assume temperature constant).



(1) 8.77 mmHg (2) 17.54 mmHg
(3) 35.08 mmHg (4) between 8.77 and 17.54 mmHg

Section (C) : Colligative properties, Van't Hoff factor and its applications

1. Colligative properties of the solution depend upon
(1) Nature of the solution (2) Nature of the solvent
(3) Concentration of solute particles (4) Both (2) and (3)

2. Van't Hoff factor is :
(1) Less than one in case of dissociation (2) More than one in case of association
(3) Always less than one (4) Less than one in case of association

3. For the given electrolyte A_xB_y, the degree of dissociation 'α' can be given as

(1) $\alpha = \frac{i-1}{x+y-1}$ (2) $i = (1-\alpha) + x\alpha + y\alpha$ (3) $\alpha = \frac{1-i}{1-x-y}$ (4) All of these

4. The experimental molecular weight of an electrolyte will always be less than its calculated value because the value of vant Hoff factor, 'i' is :
(1) Less than 1 (2) Greater than 1 (3) One (4) Zero

5. The substance A when dissolved in solvent B shows the molecular mass corresponding to A_3. The vant Hoff's factor will be -
(1) 1 (2) 2 (3) 3 (4) 1/3

6. The value of observed and calculated molecular weight of silver nitrate are 92.64 and 170 respectively. The degree of dissociation of silver nitrate is :
(1) 60 % (2) 83.5% (3) 46.7% (4) 60.23%

7. One mole of a solute A is dissolved in a given volume of solvent. The association of the solute take place as follows:
$nA \rightleftharpoons A_n$
If α is the degree of association of A, the van't Hoff factor i is expressed as:
(1) $i = 1-\alpha$ (2) $i = 1+\frac{\alpha}{n}$ (3) $i = \frac{1-\alpha+\frac{\alpha}{n}}{1}$ (4) i = 1

8. The Vant Hoff factor (i) for a dilute solution of $K_3[Fe(CN)_6]$ is :
(1) 10 (2) 4 (3) 5 (4) 0.25

9. Which of the following salt has the same value of Vont Hoff's factor as that of $K_3[Fe(CN)_6]$
(1) $Al_2(SO_4)_3$ (2) NaCl (3) $Al(NO_3)_3$ (4) Na_2SO_4

10. The van't Hoff factor i for an infinitely dilute solution of $NaHSO_4$ is :
(1) 1/ 2 (2) 1/ 3 (3) 3 (4) 2

11. The experimental molecular weight of CH_3COOH dissolved in benzene will always be more than its calculated value because the value of vant Hoff factor, 'i' is -
(1) Less than 1 (2) Greater than 1 (3) One (4) Zero

Section (D) : Raoult's law

1. If Raoult's law is obeyed, the vapour pressure of the solvent in a solution is directly proportional to
(1) Mole fraction of the solvent (2) Mole fraction of the solute
(3) Mole fraction of the solvent and solute (4) The volume of the solution

2. For a binary ideal liquid solution, the total pressure of the solution is given as :
(1) $P_{total} = P^o_A + (P^o_A - P^o_B) X_B$ (2) $P_{total} = P^o_B + (P^o_A - P^o_B) X_A$
(3) $P_{total} = P^o_B + (P^o_B - P^o_A) X_A$ (4) $P_{total} = P^o_B + (P^o_B - P^o_A) X_B$

3. At 323 K, the vapour pressure in millimeters of mercury of a methanol-ethanol solution is represented by the equation $p = 120 X_A + 140$, where X_A is the mole fraction of methanol. Then the value of $\lim_{x_A \to 1} \frac{p_A}{X_A}$ is
(1) 250 mm (2) 140 mm (3) 260 mm (4) 20 mm

4. 1 mole of heptane (V.P. = 92 mm of Hg) was mixed with 4 moles of octane (V.P. = 31 mm of Hg) The vapour pressure of resulting ideal solution is :
(1) 46.2 mm of Hg (2) 40.0 mm of Hg (3) 43.2 mm of Hg (4) 38.4 mm of Hg

5. The vapour pressure of a pure liquid 'A' is 70 torr at 27°C. It forms an ideal solution with another liquid 'B'. The mole fraction of 'B' is 0.2 and total vapour pressure of the solution is 84 torr at 27°C. The vapour pressure of pure liquid 'B' at 27°C is
(1) 14 (2) 56 (3) 140 (4) 70

6. The vapour pressure of two liquids 'P' and 'Q' are 80 and 60 torr, respectively. The total vapour pressure of solution obtained by mixing 3 mole of P and 2 mol of Q would be :
(1) 68 torr (2) 140 torr (3) 72 torr (4) 20 torr

7. Which statement about the composition of vapour over an ideal 1 : 1 molar mixture of benzene and toluene is correct ? Assume the temperature is constant at 25°C.

Vapour pressure date (25°C) :

Benzene 75 mm Hg

Toluene 22 mm Hg

(1) The vapour will contain higher percentage of benzene

(2) The vapour will contain higher percentage of toluene

(3) The vapour will contain equal amount of benzene and toluene

(4) Not enough information is given to make a prediction

8. The vapour pressure of pure liquid 'A' at 310ºC is 120 torr. The vapour pressure of this liquid in solution with liquid B is 72 torr. Calculate the mole fraction of 'A' in solution if the mixture obeys Raoult's law.
(1) 0.06 (2) 0.9 (3) 0.3 (4) 0.6

9. The vapour pressure of pure benzene and toluene are 160 and 60 torr respectively. The mole fraction of toluene in vapour phase in contact with equimolar solution of benzene and toluene is :
(1) 0.50 (2) 0.6 (3) 0.27 (4) 0.73

Section (E) : Relative lowering of vapour pressure

1. If P_0 and P are the vapour pressures of a solvent and its solution with non-volatile solute respectively and N_1 and N_2 are the mole fractions of the solvent and solute respectively, then correct relation is :
(1) $P = P_0N_2$ (2) $P = P_0N_1$ (3) $P_0 = PN_1$ (4) $P = P_0(N_1/N_2)$

2. Which one of the following is the incorrect form of Raoult's law
(1) $\frac{P_s}{P^\circ} = \frac{N}{n+N}$ (2) $\frac{P^\circ}{P^\circ - P_s} = 1 + \frac{N}{n}$ (3) $\frac{P^\circ - P_s}{P_s} = \frac{n}{n+N}$ (4) $\frac{P_s}{P^\circ - P_s} = \frac{N}{n}$

3. The vapour pressure of a dilute aqueous solution of Glucose is 750 mm of mercury at 373 K. The mole fraction of solute is -
(1) $\frac{1}{10}$ (2) $\frac{1}{7.6}$ (3) $\frac{1}{35}$ (4) $\frac{1}{76}$

4. The vapour pressure of water at room temperature is 23.8 mm of Hg. The vapour pressure of an aqueous solution of sucrose with mole fraction 0.1 is equal to -
(1) 23.9 mm Hg (2) 24.2 mm Hg (3) 21.42 mm Hg (4) 31.44 mm Hg

5. Relative lowering in vapour pressure of a solution containing 1 mole K_2SO_4 in 54 g H_2O is : (K_2SO_4 is 100% ionised)
(1) $\frac{1}{55}$ (2) $\frac{3}{55}$ (3) $\frac{3}{4}$ (4) $\frac{1}{2}$

6. What weight of solute (molecular weight = 60) is required to dissolve in 180 g of water to reduce the vapour pressure to $\frac{4}{5}$ th of pure water ?

(1) 48 g (2) 96 g (3) 150 g (4) 175 g

7. 18 g of glucose ($C_6H_{12}O_6$) is added to 178.2 g of water. The vapour pressure of water for this aqueous solution at 100^0C is

(1) 7.60 torr (2) 76.00 torr (3) 752.40 torr (4) 759.00 torr

8. The mass of glucose that should be dissolved in 100 g of water in order to produce same lowering of vapour pressure as is produced by dissolving 1 g of urea (mol. mass =60) in 50 g of water is :

(1)1 g (2) 2 g (3) 6 g (4) 12 g

9. Relative decrease in vapour pressure of an aqueous NaCl is 0.167. Number of moles of NaCl present in 180g of H_2O is :

(1) 2 mol (2) 1 mol (3) 3 mol (4) 4 mol

10. An aqueous solution is 1.00 molal in KI. Which change will cause the vapour pressure of the solution to increase ?

(1) Addition of NaCl (2) Addition of Na_2SO_4

(3) Addition of 1.00 molal KI (4) Addition of water

11. The vapour pressure of pure benzene, C_6H_6 at 50°C is 268 Torr. How many moles of non-volatile solute per mol of benzene is required to prepare a solution of benzene having a vapour pressure of 167 Torr at 50°C?

(1) 0.377 (2) 0.605 (3) 0.623 (4) 0.395

12. The vapour pressure of pure A is 10 torr and at the same temperature when 1 g of B is dissolved in 20 gm of A, its vapour pressure is reduced to 9.0 torr. If the molecular mass of A is 200 amu, then the molecular mass of B is :

(1) 100 amu (2) 90 amu (3) 75 amu (4) 120 amu

13. The vapour pressure of a solution of a non-volatile solute B in a solvent A is 95% of the vapour pressure of the solvent at the same temperature. If the molecular weight of the solvent is 0.3 times the molecular weight of the solute, what is the ratio of weight of solvent to solute.

(1) 0.15 (2) 5.7 (3) 0.2 (4) none of these

14. The lowering of vapour pressure of 0.1 M aqueous solution of NaCl, $CuSO_4$ and K_2SO_4 are :

(1) All equal (2) In the ratio of 1 : 1 : 1.5

(3) In the ratio of 3 : 2 : 1 (4) In the ratio of 1.5 : 1 : 2.5

15. The vapour pressure of water at room temperature is lowered by 5% by dissolving a solute in it, then the approximate molality of solution is :

(1) 2 (2) 1 (3) 4 (4) 3

16. The boiling point of C_6H_6, CH_3OH, $C_6H_5NH_2$ and $C_6H_5NO_2$ are 80°C, 65°C, 184°C and 212°C respectively which will show highest vapour pressure at room temperature :

(1) C_6H_6 (2) CH_3OH (3) $C_6H_5NH_2$ (4) $C_6H_5NO_2$

17. The vapour pressure of an ideal solution having 0.2 mole non-volatile solute & 0.8 mole solvent is 60 mm. The vapour pressure of pure solvent at this temperature will be
(1) 120 mm (2) 150 mm (3) 60 mm (4) 75 mm

18. The vapour pressure of pure water at 26°C is 25.21 torr. What is the vapour pressure of a solution which contains 20.0 g glucose, $C_6H_{12}O_6$, in 70 g water ?
(1) 22.5 torr (2) 23.4 torr (3) 24.4 torr (4) 24.5 torr

Section (F) : Osmosis and osmotic pressure

1. Osmotic pressure of aqueous solution is determine by :
(1) haber's method (2) solvay method
(3) Berkeley and Hartley mothod (4) Ostwalds method

2. The compound whose 0.1 M solution has maximum osmotic pressure at 25°C will be
(1) $CaCl_2$ (2) KCl (3) Glucose (4) Urea

3. A solution containing 500 g of a protein per litre is isotonic with a solution containing 3.42 g of sucrose per litre. The molecular mass of protein is :
(1) 5 (2) 146 (3) 34200 (4) 50000

4. The best colligative property used for the determination of molecular masses of polymers is :
(1) Relative lowering in vapour pressure (2) Osmotic pressure
(3) Elevation in boiling point (4) depression in freezing point

5. If 0.1 M solution of glucose and 0.1 M urea solution are placed on two sides of a semipermeable membrane to equal heights, then it will be correct to say that :
(1) There will be no net movement across the membrane
(2) Glucose will flow towards urea solution
(3) Urea will flow towards glucose solution
(4) Water will flow from urea solution towards glucose solution.

6. Osmotic pressure of a sugar solution at 24°C is 2.5 atmosphere. The concentration of the solution in mole per litre is :
(1) 10.25 (2) 1.025 (3) 1025 (4) 0.1025

7. A solution containing 4g of polyvinyl chloride in 1 litre of dioxane was found to have an osmotic pressure of 6×10^{-4} atm at 300K . The molecular mass of polymer is :
(1) 3×10^3 (2) 1.6×10^5 (3) 5×10^4 (4) 6.4×10^2

8. Equal volumes of 0.1 M urea and 0.1 M glucose solution are mixed. The mixture will have
(1) Lower osmotic pressure (2) Higher osmotic pressure
(3) Same osmotic pressure (4) None of these

9. Which has maximum osmotic pressure at temperature T :
(1) 100 mL of 1 M urea solution
(2) 300 mL of 1 M glucose solution
(3) mixture of 100 mL of 1 M urea solution and 300 mL of 1 M glucose solution
(4) all are isotonic

10. 1 mol each of following solutes are taken in 9 mol water

A. NaCl B. K_2SO_4 C. Na_3PO_4 D. glucose

Osmotic pressure will be in order

(1) A < B < C < D (2) D < C < B < A (3) D < A < B < C (4) equal

11. A solution containing 4 g of a non volatile organic solute per 100 ml was found to have an osmotic pressure equal to 500 cm of mercury at 27°C. The molecular weight of solute is :

(1) 14.97 (2) 149.7 (3) 1697 (4) 1.497

12. Osmotic pressure of 30% solution of glucose is 1.20 atm and that of 3.42% solution of cane sugar is 2.5 atm. The osmotic pressure of the mixture containing equal volumes of the two solutions will be

(1) 2.5 atm (2) 3.7 atm (3) 1.85 atm (4) 1.3 atm.

13. A solution of a substance containing 1.05 g per 100 mL was found to be isotonic with 3%(w/v) glucose solution. The molecular mass of the substance is :

(1) 31.5 (2) 6.3 (3) 630 (4) 63

Section (G) : Elevation in boiling point

1. The molal elevation constant of water is 0.51K-kg/mol. The boiling point of 0.1 molal aqueous NaCl solution is nearly -

(1) 100.05 °C (2) 100.1 °C (3) 100.2 °C (4) 101.0 °C

2. An aqueous solution containing 1g of urea boils at 100.25 °C. The aqueous solution containing 3g of glucose in the same volume will boil at -

(1) 100.75 °C (2) 100.5 °C (3) 100 °C (4) 100.25 °C

3. Elevation in boiling point was 0.52 °C when 6 g of a compound x was dissolved in 100 g of water. Molecular weight of x is : ($K = 0.52$ kg mol^{-1})

(1) 120 (2) 60 (3) 100 (4) 342

4. Aluminium phosphate is 100% ionised in 0.01 molal aqueous solution. Hence, $\Delta T_b / K_b$ is :

(1) 0.01 (2) 0.015 (3) 0.0175 (4) 0.02

5. The correct relationship between the boiling points of very dilute solution of $AlCl_3(t_1)$ and $CaCl_2$ (t_2), having the same molar concentration is :

(1) $t_1 = t_2$ (2) $t_1 > t_2$ (3) $t_2 < t_1$ (4) $t_2 \leq t_1$

6. Which has the highest boiling point ?

(1) 0.1 M Na_2SO_4 (2) 0.1 M $C_6H_{12}O_6$ (glucose)

(3) 0.1 M $MgCl_2$ (4) 0.1 M Al $(NO_3)_3$

7. Consider equimolal aqueous solutions of $NaHSO_4$ and NaCl with ΔT_b and $\Delta T'_b$ as their respective boiling point elevations. The value of $\lim_{m\to 0} \frac{\Delta T_b}{\Delta T'_b}$ will be :

(1) 1 (2) 1.5 (3) 3.5 (4) 2 / 3

8. 1.0 molal aqueous solution of an electrolyte X_3Y_2 is 25% ionized. The boiling point of the solution is (K_b for H_2O = 0.52 K kg/mol)

(1) 375.5 K (2) 374.04 K (3) 377.12 K (4) 373.25 K

9. A solution containing 28 g of phosphorus in 315 g CS_2 (b.p. 46.3ºC) boils at 47.98ºC. If K_b for CS_2 is 2.38 K kg mol^{-1}. The formula of phosphorus is (at. mass of P = 31).
(1) P_6 (2) P_4 (3) P_3 (4) P_2.

10. A complex of iron and cyanide ions is 100% ionised at 1m (molal). If its elevation in boiling point is 2.08K. (K_b = 0.52K mol^{-1} kg), then the complex is :
(1) $K_3[Fe(CN)_6]$ (2) $Fe(CN)_2$ (3) $K_4[Fe(CN)_6]$ (4) $Fe(CN)_4$

Section (H) : Depression in freezing point

1. What is the effect of the addition of sugar on the boiling and freezing point of water
(1) Both boiling point and freezing point increases
(2) Both boiling point and freezing point decreases
(3) Boiling point increases and freezing point decreases
(4) Boiling point decreases and freezing point increases

2. Which of the following aqueous molal solution have highest freezing point
(1) Urea (2) Barium chloride (3) Potassium bromide (4) Aluminium sulphate

3. Glucose is added to 1 litre water to such an extent that $\frac{\Delta T_f}{K_f}$ becomes equal to $\frac{1}{1000}$, the weight of glucose added is :
(1) 180 g (2) 18 g (3) 1.8 g (4) 0.18 g

4. What should be the freezing point of aqueous solution containing 17 g of C_2H_5OH in 1000 g of water (water K_f = 1.86 deg – kg mol^{-1})
(1) – 0.69°C (2) – 0.34°C (3) 0.0°C (4) 0.34°C

5. 1.00 g of a non-electrolyte solute (molar mass 250 g mol^{-1}) was dissolved in 51.2 g of benzene. If the freezing point depression constant, K_f of benzene is 5.12 K kg mol^{-1}, the freezing point of benzene will be lowered by :
(1) 0.4 K (2) 0.3 K (3) 0.5 K (4) 0.2 K

6. What is the freezing point of a solution containing 8.1 g. of HBr in 100 g. water assuming the acid to be 90% ionised (K_f for water = 1.86 K $molality^{-1}$)
(1) 0.85 °C (2) – 3.53°C (3) 0°C (4) – 0.35°

7. The boiling point of an aqueous solution of a non volatile solute is 100.15°C. What is the freezing point of an aqueous solution obtained by diluting the above solution with an equal volume of water? The values of K_b and K_f for water are 0.512 and 1.86 K $molality^{-1}$:
(1) – 0.544°C (2) – 0.512°C (3) – 0.272°C (4) – 1.86°C

8. Which of the following has been arranged in order of decreasing freezing point?
(1) 0.05 M KNO_3 > 0.04 M $CaCl_2$ > 0.140 M sugar > 0.075 M $CuSO_4$
(2) 0.04 M $BaCl_2$ > 0.140 M sucrose > 0.075 M $CuSO_4$ > 0.05 M KNO_3
(3) 0.075 M $CuSO_4$ > 0.140 M sucrose > 0.04 M $BaCl_2$ > 0.05 M KNO_3
(4) 0.075 M $CuSO_4$ > 0.05 M $NaNO_3$ > 0.140 M sucrose > 0.04 M $BaCl_2$

9. 50 g of antifreeze (ethylene glycol) is added to 200 g water. What amount of ice will separate out at – 9.3°C ? (K_f =1.86K kg mol^{-1})

(1) 45 mg (2) 42 g (3) 38.71 g (4) 38.71 mg

Section (I) : Ideal & nonideal solution

1. Which of the following will form an ideal solution?
(1) C_2H_5OH and water (2) HNO_3 and water
(3) $CHCl_3$ and CH_3COCH_3 (4) C_6H_6 and $C_6H_5CH_3$

2. Which of the following shows negative deviation from Raoult's law?
(1) $CHCl_3$ and acetone (2) $CHCl_3$ and C_2H_5OH (3) $C_6H_5CH_3$ and C_6H_6 (4) C_6H_6 and CCl_4

3. A solution of sulphuric acid in water exhibits :
(1) Negative deviations from Raoult's law (2) Positive deviations from Raoult's law
(3) Ideal properties (4) The applicability of Henry's law

4. Which of the following solution containing components A and B follows Raoult's law :
(1) A – B attraction force is greater than A – A and B – B
(2) A – B attraction force is less than A – A and B – B
(3) A – B attraction force remains same as A – A and B – B
(4) Volume of solution is different from sum of volume of solute and solvent

5. The vapour pressure of the solution of two liquids A(p^o = 80 mm) and B(p^o = 120 mm) is found to be 100 mm when x_A = 0.4. The result shows that
(1) solution exhibits ideal behaviour
(2) solution shows positive deviations
(3) solution shows negative deviations
(4) solution will show positive deviations for lower concentration and negative deviations for higher concentrations.

6. Consider a binary mixture of volatile liquids. If at X_A = 0.4 the vapour pressure of solution is 580 torr then the mixture could be (p_A^o = 300 torr, p_B° = 800 torr) :
(1) $CHCl_3 – CH_3COCH_3$ (2) $C_6H_5Cl – C_6H_5Br$ (3) $C_6H_6 – C_6H_5CH_3$ (4) $nC_6H_{14} – nC_7H_{16}$

7. A maxima or minima obtained in the temperature composition curve of a mixture of two liquids indicates
(1) an azeotropic mixture
(2) an eutectic formation
(3) that the liquids are immiscible with one another
(4) that the liquids are partially miscible at the maximum or minimum

8. When KCl dissolves in water (assume endothermic dissolution), then :
(1) ΔH = + ve, ΔS = + ve, ΔG = + ve (2) ΔH = + ve, ΔS = – ve, ΔG = – ve
(3) ΔH = + ve, ΔS = + ve, ΔG = – ve (4) ΔH = – ve, ΔS = – ve, ΔG = + ve

9. The dissolving process is exothermic when :
(1) The energy released in solvation exceeds the energy used in breaking up solute-solute and solvent-solvent interactions.

(2) The energy used in solvation exceeds the energy released in breaking up solute-solute and solvent-solvent interactions.
(3) The energy released in solvation is about the same as the energy used in breaking up solute-solute and solvent-solvent interactions.
(4) The energy used in solvation is about the same as the energy used in breaking up solute-solute and solvent-solvent interactions.

10. Azeotropic mixture are :
(1) Mixture of two solids (2) Those which boil at different temperature
(3) Those which can be fractionally distilled (4) Constant boiling mixtures

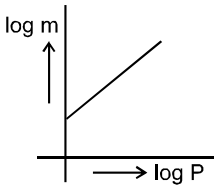
11. An azeotropic mixture of two liquids boil at a lower temperature than either of them when
(1) It is saturated
(2) It does not deviate from Raoult's law
(3) It shows negative deviation from Raoult's law
(4) It show positive deviation from Raoult's law

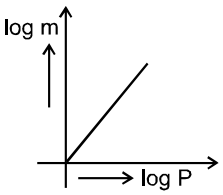
12. The azeotropic mixture of water (B.P 100°C) and HCl (B.P. 85°C) boils at 108.5°C. When this mixture is distilled, it is possible to obtain -
(1) Pure HCl (2) Pure water
(3) Pure water as well as HCl (4) Neither HCl nor H_2O in their pure states

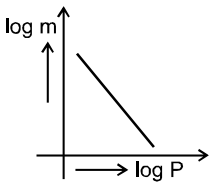
Section (J) : Solutions of Gases in Liquids

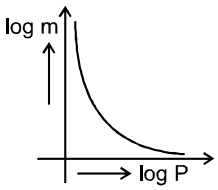
1. The solubility of gases in liquids :
(1) increases with increase in pressure and temperature
(2) decreases with increase in pressure and temperature
(3) Increases with increase in pressure and decrease in temperature
(4) decreases with increase in pressure and increase in temperature

2. Which of the following curves represents the Henry's law ?

(1) 

(2) 

(3) 

(4) 

3. According to Henry's law, the solubility of a gas in a given volume of liquid increases with increase
(1) Temperature (2) Pressure (3) Both (1) and (2) (4) None of these

4. Some of the following gases are soluble in water due to formation of their ions :
I : CO_2 ; II : NH_3 ; III : HCl ; IV : CH_4 ; V : H_2
Water insoluble gases can be :
(1) I, IV , V (2) I, V (3) I, II, III (4) IV, V

5. The solubility of $N_2(g)$ in water exposed to the atmosphere, when its partial pressure is 593 mm is 5.3×10^{-4} M. Its solubility at 760 mm and at the same temperature is :
(1) 4.1×10^{-4} M (2) 6.8×10^{-4} M (3) 1500 M (4) 2400 M

Exercise-2

Marked Questions may have for Revision Questions.

1. The molarity of 98% H_2SO_4 (d = 1.8 g/ ml) by wt. is :
(1) 6 M (2) 18 M (3) 10 M (4) 4 M

2. Mole fraction of $C_3H_5(OH)_3$ in a solution of 36 g of water and 46 g of glycerine is :
(1) 0.46 (2) 0.36 (3) 0.20 (4) 0.40

3. A sample of air is saturated with benzene (vapor pressure = 100 mm Hg at 298 K) at 298K, 750mm Hg pressure. If it is isothermally compressed to one third of its initial volume, the final pressure of the system is
(1) 2250 torr (2) 2150 torr (3) 2050 torr (4) 1950 torr

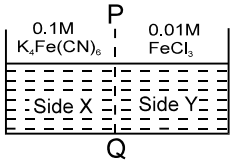
4. Pressure cooker reduces cooking time because
(1) the heat is more evenly distributed inside the cooker
(2) a large flame is used
(3) boiling point of water is elevated
(4) whole matter is converted into steam

5. Mixture of volatile components A and B has total vapour pressure (in Torr) p = 254 – 119 x_A where x_A is mole fraction of A in mixture. Hence p_A^0 and p_B^0 are (in Torr)
(1) 254, 119 (2) 119, 254 (3) 135, 254 (4) 119, 373

6. In which case van't Hoff factor is maximum ?
(1) KCl, 50% ionised (2) K_2SO_4, 40% ionised (3) $FeCl_3$, 30% ionised (4) $SnCl_4$, 20% ionised

7. pH of a 0.1 M monobasic acid is found to be 2. Hence its osmotic pressure at a given temperature T K is-
(1) 0.1 RT (2) 0.11 RT (3) 1.1 RT (4) 0.01 RT

8. $FeCl_3$ on reaction with $K_4[Fe(CN)_6]$ in aq. solution gives blue colour. These are separated by a semipermeable membrane PQ as shown. Due to osmosis there is-



(1) blue colour formation in side X
(2) blue colour formation in side Y
(3) blue colour formation in both of the sides X and Y
(4) no blue colour formation

9. If 'A' contains 2% NaCl and is separated by a semipermeable membrane from 'B' which contains 10% NaCl, which event will occur ?
(1) NaCl will flow from 'A' to 'B' (2) NaCl will flow from 'B' to 'A'
(3) Water will flow from 'A' to 'B' (4) Water will flow from 'B' to 'A'

10. Osmotic pressure of blood is 7.40 atm at 27°C. Number of mol of glucose to be used per L for an intravenous injection that is to have the same osmotic pressure as blood is :
(1) 0.3 (2) 0.2 (3) 0.1 (4) 0.4

11. The osmotic pressure of equimolar solutions of $BaCl_2$, NaCl and glucose will be in the order
(1) glucose > NaCl > $BaCl_2$ (2) $BaCl_2$ > NaCl > glucose
(3) NaCl > $BaCl_2$ > glucose (4) NaCl > glucose > $BaCl_2$

12. A solution of glucose ($C_6H_{12}O_6$) is isotonic with 4 g of urea (NH_2–CO–NH_2) per liter of solution. The concentration of glucose is :
(1) 4 g/ℓ (2) 8 g/ ℓ (3) 12 g/ ℓ (4) 14 g/ ℓ

13. Y g of non-volatile organic substance of molecular mass M is dissolved in 250 g benzene. Molal elevation constant of benzene is K_b. Elevation in its boiling point is given by :
(1) $\frac{M}{K_bY}$ (2) $\frac{4K_bY}{M}$ (3) $\frac{K_bY}{4M}$ (4) $\frac{K_bY}{M}$

14. 0.01 mol each of following solutes are taken in 5 mol water,
A. NaCl B. $KHSO_4$ C. $[CO(NH_3)_6]Cl_3$ D. glucose
Assuming 100% ionisation of the electrolyte, relative decrease in vapour pressure will be in order :
(1) A < B < C < D (2) D < C < B < A (3) D < A < B < C (4) equal

15. Aqueous solution of barium phosphate which is 100% ionised has ΔT_f / K_f as 0.05. Hence, given solution is
(1) 0.01 molal (2) 0.02 molal (3) 0.04 molal (4) 0.05 molal

16. If mole fraction of the solvent in solution decreases then
(1) Vapour pressure of solution increases (2) B.P. decreases
(3) Osmotic pressure increases (4) All are correct

17. A solute'S' undergoes a reversible trimerization when dissolved in a certain solvent. The boiling point elevation of its 0.1 molal solution was found to be identical to the boiling point elevation in case of a 0.08 molal solution of a solute which neither undergoes association nor dissociation. To what percent had the solute 'S' undergone trimerization?
(1) 30% (2) 40% (3) 50% (4) 60%

18. Given at 350 K p_A° = 300 torr and p_B° = 800 torr, the composition of the mixture having a boiling point of 350 K is
(1) X_A = 0.08 (2) X_A = 0.06 (3) X_A = 0.04 (4) X_A = 0.02

19. Which of the following is not correct for an ideal solution ?
(1) $P_A = P_A^0X_A$ (2) $\Delta H_{mix} = 0$ (3) $\Delta V_{mix} = 0$ (4) $\Delta S_{mix} = 0$

20. If vapour pressures of pure liquids 'A' & 'B' are 300 and 800 torr respectively at 25°C. When these two liquids are mixed at this temperature to form a solution in which mole percentage of 'B' is 92, then the total vapour pressure is observed to be 0.95 atm. Which of the following is true for this solution ?
(1) $\Delta V_{mix} > 0$ (2) $\Delta H_{mix} < 0$ (3) $\Delta V_{mix} = 0$ (4) $\Delta H_{mix} = 0$

21. The vapour pressure of the solution of two liquids A(p^o = 80 mm) and B(p^o = 120 mm) is found to be 100 mm when x_A = 0.4. The result shows that
(1) solution exhibits ideal behaviour
(2) solution shows positive deviations
(3) solution shows negative deviations
(4) solution will show positive deviations for lower concentration and negative deviations for higher concentrations.

22. Consider a binary mixture of volatile liquids. If at X_A = 0.4 the vapour pressure of solution is 580 torr then the mixture could be (p_A^o = 300 torr, p_B° = 800 torr) :
(1) $CHCl_3 - CH_3COCH_3$ (2) $C_6H_5Cl - C_6H_5Br$
(3) $C_6H_6 - C_6H_5CH_3$ (4) $nC_6H_{14} - n\,C_7H_{16}$

23. The solubility of N_2(g) in water exposed to the atmosphere, when the partial pressure is 593 mm is 5.3×10^{-4} M. Its solubility at 760 mm and at the same temperature is :
(1) 4.1×10^{-4} M (2) 6.8×10^{-4} M (3) 1500 M (4) 2400 M

Exercise-3

PART - 1 : NEET / AIPMT QUESTION (PREVIOUS YEARS)

1. The mole fraction of the solute in one molal aqueous solution is **[AIPMT 05]**
(1) 0.027 (2) 0.036 (3) 0.018 (4) 0.009

2. The vapour pressure of two liquids P and Q are 80 and 60 torr, respectively. The total vapour pressure of solution obtained by mixting 3 moles of P and 2 moles of Q would be : **[AIPMT 05]**
(1) 140 torr (2) 20 torr (3) 68 torr (4) 72 torr

3. A solution of urea (mol. mass 56 kg mol^{-1}) boils at 100.18°C at the atmospheric pressure. If k_f and k_b for water are 1.86 and 0.512 K kg mol^{-1} respectively, the above solution will freeze at : **[AIPMT 05]**
(1) – 6.54°C (2) 6.54°C (3) 0.654°C (4) – 0.654°C

4. A solution has 1 : 4 mole ratio of pentane to hexane. The vapour pressure of the pure hydrocarbons at 20°C are 440 mm of Hg for pentane and 120 mm of Hg for hexane. The mole fraction of pentane in the vapour phase would be : **[AIPMT 05]**
(1) 0.549 (2) 0.200 (3) 0.786 (4) 0.478

5. A solution containing 10 g per dm^3 of urea (molecular mass = 60 g mol^{-1}) is isotonic with a 5% solution of a non-volatile solute. The molecular mass of this non-volatile solute is : **[AIPMT 06]**
(1) 250 g mol^{-1} (2) 300 g mol^{-1} (3) 350 g mol^{-1} (4) 200 g mol^{-1}

6. 1.00 g of non-electrolyte solute (molar mass 250 g mol^{-1}) was dissolved in 51.2 g of benzene. If the freezing point depression constant, k_f of benzene is 5.12 K kg mol^{-1}, the freezing point of benzene will be lowered by: **[AIPMT 06]**
(1) 0.4 K (2) 0.3 K (3) 0.5 K (4) 0.2 K

7. A solution of acetone in ethanol **[AIPMT 06]**
(1) Behave like a near ideal solution
(2) obeys Raoult's law

(3) Shows a negative deviation from Raoult's law
(4) Shows a positive deviation from Raoult's law

8. During osmosis, flows of water through a semipermeable membrane is **[AIPMT 06]**
(1) from both sides of semipermeable membrane with unequal flow rates
(2) from solution having lower concentration only
(3) from solution having higher concentration only
(4) from both sides of semipermeable membrane with equal flow rates.

9. 0.5 molal aqueous solution of a weak acid (HX) is 20% ionised. If K_f for water is 1.86 K kg mol^{-1}, the lowering in freezing point of the solution is **[AIPMT 07]**
(1) – 0.56 K (2) – 1.12 K (3) 0.56 K (4) 1.12 K

10. Concentrated aqueous sulphuric acid is 98% H_2SO_4 by mass and has a density of 1.80 g ML^{-1} volume of the acid required to make one litre of 0.1 M H_2SO_4 solution is **[AIPMT 07]**
(1) 5.55 mL (2) 11.10 mL (3) 16.65 mL (4) 22.20 mL

11. The freezing point depression constant for water is 1.86ºC m^{-1}. If 5.00 g Na_2SO_4 is dissolved in 45.0 g H_2O, the freezing point is changed by – 3.82ºC. Calculate the van't Hoff factor for Na_2SO_4. **[AIPMT 2011,Screening]**
(1) 2.05 (2) 2.63 (3) 3.11 (4) 0.381

12. The van't Hoff factor i for a compound which undergoes dissociation in one solvent and association in other solvent is respectively : **[AIPMT 2011,Screening]**
(1) less than one and greater than one. (2) less than one and less than one.
(3) greater than one and less than one. (4) greater than one and greater than one.

13. A 0.1 molal aqueous solution of a weak acid is 30% ionized. If K_f for water is 1.86ºC/m, the freezing point of the solution will be : **[AIPMT 2011,Screening]**
(1) –0.18ºC (2) –0.54ºC (3) –0.36ºC (4) –0.24ºC

14. 200 mL of an aqueous solution of a protein contains its 1.26 g. The Osmotic pressure of this solution at 300 K is found to be 2.57×10^{-3} bar. The molar mass of protein will be (R = 0.083 L bar mol^{-1} K^{-1}) : **[AIPMT 2011]**
(1) 51022 g mol^{-1} (2) 122044 g mol^{-1} (3) 31011 g mol^{-1} (4) 61038 g mol^{-1}

15. P_A and P_B are the vapour pressure of pure liquid components, A and B, respectively of an ideal binary solution. If X_A represents the mole fraction of component A, the total pressure of the solution will be. **[AIPMT 2012]**
(1) $P_A + X_A (P_B - P_A)$ (2) $P_A + X_A (P_A - P_B)$ (3) $P_B + X_A (P_B - P_A)$ (4) $P_B + X_A (P_A - P_B)$

16. Vapour pressure of chloroform ($CHCl_3$) and dichloromethane (CH_2Cl_2) at 25ºC are 200 mm Hg and 41.5 mm Hg respectively. Vapour pressure of the solution obtained by mixing 25.5 g of $CHCl_3$ and 40 g of CH_2Cl_2 at the same temperature will be : (Molecular mass of $CHCl_3$ = 119.5 u and molecular mass of CH_2Cl_2 = 85 u). **[AIPMT 2012]**
(1) 173.9 mm Hg (2) 615.0 mm Hg (3) 90.92 mm Hg (4) 285.5 mm Hg

17. Of the following 0.10m aqueous solutions, which one will exhibit the largest freezing point depression ? **[AIPMT 2014]**

(1) KCl (2) $C_6H_{12}O_6$ (3) $Al_2(SO_4)_3$ (4) K_2SO_4

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% ionised) ? **[AIPMT 2015]**

(1) $K_3[Fe(CN)_6]$ (2) $Al(NO_3)_3$ (3) $K_4[Fe(CN)_6]$ (4) K_2SO_4

19. 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 ? **[AIPMT 2015]**

(1) Molecular mass of X is greater than the molecular mass of Y.
(2) Molecular mass of X is less than the molecular mass of Y.
(3) Y is undergoing dissociation in water while X undergoes no change.
(4) X is undergoing dissociation in water.

20. Which one is not equal to zero for an ideal solution ? **[AIPMT 2015]**

(1) ΔS_{mix} (2) ΔV_{mix} (3) $\Delta P = P_{observed} - P_{Raoult}$ (4) ΔH_{mix}

21. The van't Hoff factor (i) for a dilute aqueous solution of the strong electrolyte barium hydroxide is **[NEET-2 2016]**

(1) 3 (2) 0 (3) 1 (4) 2

22. Which one of the following is incorrect for ideal solution ? **[NEET-2 2016]**

(1) $\Delta G_{mix} = 0$ (2) $\Delta H_{mix} = 0$
(3) $\Delta U_{mix} = 0$ (4) $\Delta P = P_{obs} - P_{calculated\ by\ Raoult's\ law} = 0$

23. If molality of the dilute solution is doubled, the value of molal depression constant (K_f) will be : **[NEET 2017]**

(1) doubled (2) halved (3) tripled (4) unchanged

24. On which of the following properties does the coagulating power of an ion depend **[NEET 2018]**

(1) The magnitude of the charge on the ion alone
(2) The sign of charge on the ion alone
(3) both magnitude and sign of the charge on the ion
(4) Size of the ion alone

25. For an ideal solution, the correct option is : **[NEET-1- 2019]**

(1) Δ_{mix} G = 0 at constant T and P (2) Δ_{mix} S = 0 at constant T and P
(3) Δ_{mix} V $\neq$ 0 at constant T and P (4) Δ_{mix} H = 0 at constant T and P

26. The mixture that forms maximum boiling azeotrope is : **[NEET-1- 2019]**

(1) Heptane + Octane (2) Water + Nitric acid
(3) Ethanol + Water (4) Acetone + Carbon disulphide

27. Which of the following statements is correct regarding a solution of two component A and B exhibiting positive deviation from idea behavior? **[NEET-2- 2019]**

(1) Intermolecular attractive force between A-A and B-B are stronger than those between A-B.

(2) Δ_{mix} H = 0 at constant T and P.

(3) Δ_{mix} V = 0 at constant. T and P.

(4) Intermolecular attractive forces between A-A and B-B are equal to those between A-B.

PART - II : AIIMS QUESTION (PREVIOUS YEARS)

1. **Assertion :** The molecular weight of acetic acid determined by depression in freezing point method in benzene and water was found to be different.
Reason : Water is polar and benzene is non-polar. **[AIIMS 05]**
(1) If both assertion and reason are true and reason is the correct explanation of assertion.
(2) If both assertion and reason are true but reason is not the correct explanation of assertion.
(3) If Assertion is true but reason is false.
(4) If Assertion & reason both are false.

2. A 5% solution (by mass) of cane sugar in water has freezing point of 271 K and freezing point of pure water is 273.15 K The freezing point of a 5% solution (by mass) of glucose in water is : **[AIIMS 06]**
(1) 271 K (2) 273.15 K (3) 269.07 K (4) 277.23 K

3. **Assertion :** If red blood cells were removed from the body and placed in pure water, pressure inside the cells increases.
Reason : The concentration of salt content in the cells increases. **[AIIMS 06]**
(1) If both assertion and reason are true and reason is the correct explanation of assertion.
(2) If both assertion and reason are true but reason is not the correct explanation of assertion.
(3) If Assertion is true but reason is false.
(4) If Assertion & reason both are false.

4. **Assertion :** The water pouch of instant cold pack for treating athletic injuries breaks when squeezed and NH_4NO_3 dissolves lowering the temperature. **[AIIMS 06]**
Reason : Addition of non-volatile solute into solvent result into depression of freezing point of the solvent.
(1) If both assertion and reason are true and reason is the correct explanation of assertion.
(2) If both assertion and reason are true but reason is not the correct explanation of assertion.
(3) If Assertion is true but reason is false.
(4) If Assertion & reason both are false.

5. 0.01 M solution of KCl and $BaCl_2$ are prepared in water. The freezing points of KCl is found to be –2ºC. What is the freezing point of $BaCl_2$ to be completely ionised ? **[AIIMS 08]**
(1) – 3ºC (2) + 3ºC (3) – 2ºC (4) – 4ºC

6. Which of the following azeotropic solutions has the boiling point less than boiling point of the constituents
A and B ? **[AIIMS 09]**
(1) $CHCl_3$ and CH_3COCH_3 (2) CS_2 and CH_3COCH_3
(3) CH_3CH_2OH and CH_3COCH_3 (4) CH_3CHO and CS_2

7. The order of boiling points of four equimolar aqueous solutions is C < B < A < D. The correct order of their freezing points is **[AIIMS 09]**
(1) D < C < B < A (2) D > C < B < A (3) D < B > A < C (4) D > A < B < C

8. **Assertion :** A non volatile solution is mixed in a solution then elevation in boiling point and depression in freezing point both are 2 K. **[AIIMS 11]**
Reason : Elevation in boiling point and depression in freezing point both depend on melting point of nonvolatile solute.

(1) If both assertion and reason are true and reason is the correct explanation of assertion.
(2) If both assertion and reason are true but reason is not the correct explanation of assertion.
(3) If Assertion is true but reason is false.
(4) If Assertion & reason both are false.

9. 12g of urea is dissolved in a 1 litre of water and 68.4g of surcose of dissolved in 1 litre of water. The lowering of vapour pressure of first case is : **[AIIMS 12]**
(1) equal to second (2) greater than second
(3) less than second (4) double that of second

10. **Assertion :** Lowering of vapour pressure is directly proportional to osmotic pressure of the solution.
Reason : Osmotic pressure is a colligative property. **[AIIMS 12]**
(1) If both assertion and reason are true and reason is the correct explanation of assertion.
(2) If both assertion and reason are true but reason is not the correct explanation of assertion.
(3) If Assertion is true but reason is false.
(4) If Assertion & reason both are false.

11. At a particular temperature, the vapour pressures of two liquids A and B are respectively 120 and 180 mm of mercury. If 2 moles of A and 3 moles of B are mixed to form an ideal solution, the vapour pressure of the solution at the same temperature will be (in mm of mercury) **[AIIMS 13]**
(1) 156 (2) 145 (3) 150 (4) 108

12. The freezing point of equimolal aqueous solution will be highest for **[AIIMS 13]**
(1) $C_6H_5NH_3^+Cl^-$ (2) $Ca(NO_3)_2$ (3) $La(NO_3)_2$ (4) $C_6H_{12}O_6$

13. **Assertion**: If one component of a solution obeys Raoult's law over a certain range of composition, the other component will not obey Henry's law in that range.
Reason: Raoult's law is a special case of Henry's law. **[AIIMS 13]**
(1) If both assertion and reason are true and reason is the correct explanation of assertion.
(2) If both assertion and reason are true but reason is not the correct explanation of assertion.
(3) If Assertion is true but reason is false.
(4) If both assertion and reason are false.

14. A solution containing 10 g per dm^3 of urea (molecular mass = 60 g mol^{-1}) is isotonic with a 5% solution of a non volatile solute.
The molecular mass of this non volatile solute is : **[AIIMS 07, 14]**
(1) 300 g mol^{-1} (2) 350 g mol^{-1} (3) 200 g mol^{-1} (4) 250 g mol^{-1}

15. 100 mL of liquid A was mixed with 25 mL of liquid B. to give non-ideal solution of A-B The volume of this mixture will be **[AIIMS 15]**
(1) 75 mL (2) 125 mL exact
(3) Fluctuating between 75 mL to 125 mL (4) Close to 125 mL but not exceed than 125 mL

16. **Assertion**: Osmotic pressure of 0.1 N urea solution is less than that of 0.1 M NaCl solution.
Reason: Osmotic pressure is not a colligative property. **[AIIMS 15]**
(1) If both assertion and reason are true and reason is the correct explanation of assertion.
(2) If both assertion and reason are true but reason is not the correct explanation of assertion.
(3) If Assertion is true but reason is false.
(4) If both assertion and reason are false.

17. Which has the highest boiling point ? **[AIIMS 16]**

(1) 0.1 M $Na_2 SO_4$ (2) 0.1 M $C_6H_{12}O_6$(glucose) (3) 0.1 M $MgCl_2$ (4) 0.1 M $Al(NO_3)_3$

18. The freezing point of a solution containing 0.2 g of acetic acid in 20.0 g benzene is lowered by 0.45ºC. The degree of association of acetic acid in benznen is (Assume acetic acid dimerises in benzene and K_f for benzene = 5.12 K kg mol^{-1}) **[AIIMS 16]**
($M_{observed}$ of acetic acid = 113.78)
(1) 94.5% (2) 54.9% (3) 78.2 % (4) 100 %

19. We have three aqueous solutions of NaCl labelled as (A), (B) and (C) with concentration of 0.1 M, 0.01 M and 0.001 M, respectively. The value of van't Hoff factor of these solutions will be in order **[AIIMS 17]**
(1) $i_A < i_B < i_C$ (2) $i_A > i_B > i_C$ (3) $i_A = i_B = i_C$ (4) $i_A < i_B > i_C$

20. What is freezing point of solution containing 8.1 g of HBr in 100 g of water, assuming the acid tobe 90 % ionised. (K_f for water = 1.86 kg mol^{-1} and molar mass of HBr = 81) **[AIIMS 17]**
(1) – 0.35ºC (2) – 1.35ºC (3) – 2.35ºC (4) –3.35ºC

21. **Assertion (A)** : $\triangleq H_{mixing}$ and $\triangleq V_{mixing}$ for non-ideal solution with +ve deviation is zero. **[AIIMS 17]**
Reason (R) : A—B interaction is more than that between A—A and B—B
(1) If both assertion and reason are true and reason is the correct explanation of assertion.
(2) If both assertion and reason are true but reason is not the correct explanation of assertion.
(3) If Assertion is true but reason is false.
(4) If both assertion and reason are false.

22. When 45 gm solute is dissolved in 600 gm water freezing point lower by 2.2 K, calculate molar mass of solute (K_f = 1.86 K kg mol^{-1}) **[AIIMS 18]**
(1) 63.4 (2) 80 gm (3) 90 gm (4) 21 gm

23. What happen at increasing pressure at constant temperature **[AIIMS 18]**
(1) Rate of Haber process decrease
(2) Solubility of gas increase in liquid
(3) Solubility of solid increases in liquid
(4) $2C_{(s)} + CO_{2(g)} \longrightarrow 2CO_{(g)}$ reaction move forward

24. 1 gm of polymer having molar mass 1,60,000 gm dissolve in 800 ml water, so calculate osmotic pressure in pascal at 27°C (R = 8.314 J/K mole) **[AIIMS 18]**
(1) 0.78 (2) 0.90 (3) 0.50 (4) 1.20

PART - III : JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

1. Benzene and toluene form nearly ideal solutions. At 20ºC, the vapour pressure of benzene is 75 torr and that of toluene is 22 torr. The partial vapour pressure of benzene at 20 ºC for a solution containing 78 g of benzene and 46 g of toluene in torr is : **[AIEEE-2005]**
(1) 50 (2) 25 (3) 37.5 (4) 53.5

2. If α is the degree of dissociation of Na_2SO_4, the vant Hoff's factor (i) used for calculating the molecular mass is : **[AIEEE-2005]**

(1) $1 + \alpha$ (2) $1 - \alpha$ (3) $1 + 2\alpha$ (4) $1 - 2\alpha$.

3. Density of a 2.05 M solution of acetic acid in water is 1.02 g/mL. The molality of the solution is **[AIEEE-2006]**

(1) 3.28 mol Kg^{-1} (2) 2.28 mol Kg^{-1} (3) 0.44 mol Kg^{-1} (4) 1.14 mol Kg^{-1}

4. A mixture of ethyl alcohol and propyl alcohol has a vapour pressure of 290 mm at 300 K. The vapour pressure of propyl alcohol is 200 mm. If the mole fraction of ethyl alcohol is 0.6, its vapour pressure (in mm) at the same temperature will be : **[AIEEE-2007]**

(1) 700 (2) 360 (3) 350 (4) 300

5. A 5.25% solution of a substance is isotonic with a 1.5% solution of urea (molar mass = 60g mol^{-1}) in the same solvent. If the densities of both the solutions are assumed to be equal to 1.0 g cm^{-3}, molar mass of the substance will be **[AIEEE-2007]**

(1) 105.0 g mol^{-1} (2) 210.0 g mol^{-1} (3) 90.0 g mol^{-1} (4) 15.0 g mol^{-1}

6. The vapour pressure of water at 20ºC is 17.5 mm Hg. If 18 g of glucose ($C_6H_{12}O_6$) is added to 178.2 g of water at 20°C, the vapour pressure of the resulting solution will be : **[AIEEE-2008]**

(1) 15.750 mm Hg (2) 16.500 mm Hg (3) 17.325 mm Hg (4) 17.675 mm Hg

7. At 80ºC , the vapour pressure of pure liquid 'A' is 520 mm Hg and that of pure liquid 'B' is 1000 mm Hg. If a mixture solution of 'A' and 'B' boils at 80º C and 1 atm pressure, the amount of 'A' in the mixture is (1 atm = 760 mm Hg) **[AIEEE-2008]**

(1) 34 mol percent (2) 48 mol percent (3) 50 mol percent (4) 52 mol percent

8. A binary liquid solution is prepared by mixing n-heptane and ethanol. Which one of the following statement is correct regarding the behaviour of the solution? **[AIEEE-2009]**

(1) The solution is non-ideal, showing +ve deviation from Raoult's Law.
(2) The solution in non-ideal, showing –ve deviation from Raoult's Law.
(3) n-heptane shows +ve deviation while ethanol shows –ve deviation from Raoult's Law.
(4) The solution formed is an ideal solution.

9. If sodium sulphate is considered to be completely dissociated into cations and anions in aqueous solution, the change in freezing point of water (ΔT_f), when 0.01 mole of sodium sulphate is dissolved in 1 kg of water, is (K_f = 1.86 K kg mol^{-1}) **[AIEEE-2010]**

(1) 0.0372 K (2) 0.0558 K (3) 0.0744 K (4) 0.0186 K

10. K_f for water is 1.86 K kg mol^{-1}. If your automobile radiator holds 1.0 kg of water, how may grams of ethylene glycol ($C_2H_6O_2$) must you add to get the freezing point of the solution lowered to –2.8ºC ? **[AIEEE 2012]**

(1) 72 g (2) 93 g (3) 39 g (4) 27 g

11. Consider separate solution of 0.500 M C_2H_5OH(aq), 0.100 M $Mg_3(PO_4)_2$(aq), 0.250 M KBr(aq) and 0.125 M Na_3PO_4(aq) at 25°C. Which statement is **true** about these solution, assuming all salts to be strong electrolytes ? **[AIEEE 2014]**

(1) They all have the same osmotic pressure.

(2) 0.100 M $Mg_3(PO_4)_2$(aq) has the highest osmotic pressure.

(3) 0.125 M Na_3PO_4(aq) has the highest osmotic pressure.

(4) 0.500 M C_2H_5OH(aq) has the highest osmotic pressure.

12. The vapour pressure of acetone at 20ºC is 185 torr. When 1.2 g of a non-volatile substance was dissolved in 100 g of acetone at 20ºC, its vapour pressure was 183 torr. The molar mass (g mol^{-1}) of the substance is: **[JEE(Main) 2015]**

(1) 32 (2) 64 (3) 128 (4) 488

13. 18 g glucosse ($C_6H_{12}O_6$) is added to 178.2 g water. The vapor pressure of water (in torr) for this aqueous solution is. **[JEE(Main) 2016]**

(1) 76.0 (2) 752.4 (3) 759.0 (4) 7.6

14. The freezing point of benzene decreases by 0.45ºC when 0.2 g of acetic acid is added to 20 g of benzene. If acetic acid associates to form a dimer in benzene, percentage association of acetic acid in benzene will be : (K_f for benzene = 5.12 K kg mol^{-1}) **[JEE(Main) 2017]**

(1) 80.4% (2) 74.6% (3) 94.6% (4) 64.6%

15. For 1 molal aqueous solution of the following compounds, which one will show the highest freezing point ? **[JEE(Main) 2018]**

(1) $[Co(H_2O)_4Cl_2]Cl.2H_2O$ (2) $[Co(H_2O)_3Cl_3].3H_2O$

(3) $[Co(H_2O)_6]Cl_3$ (4) $[Co(H_2O)_5Cl]Cl_2.H_2O$

16. A solution containing 62 g ethylene glycol in 250 g water is cooled to –10ºC. If K_f for water is 1.86 K kg mol^{-1}, the amount of water (in g) separated as ice is: **[JEE(Main) 2019]**

(1) 16 (2) 32 (3) 48 (4) 64

17. Which one of the following statements regarding Henry's law is not correct? **[JEE(Main) 2019]**

(1) Different gases have different K_H (Henry' law constant) values at the same temperature.

(2) The value of K_H increases with increase of temperature and K_H is function of the nature of the gas

(3) The partial pressure of the gas in vapour phase is proportional to the mole fraction of the gas in the solution.

(4) Higher the value of K_H at a given pressure, higher is the solubility of the gas in the liquids.

18. Liquids A and B form an ideal solution in the entire composition range. At 350 K, the vapor pressures of pure A and pure B are 7×10^3 Pa and 12×10^3 Pa, respectively. The composition of the vapor in equilibrium with a solution containing 40 mole percent of A at this temperature is : **[JEE(Main) 2019]**

(1) $x_A = 0.28$; $x_B = 0.72$ (2) $x_A = 0.76$; $x_B = 0.24$

(3) $x_A = 0.37$; $x_B = 0.63$ (4) $x_A = 0.4$; $x_B = 0.6$

19. Elevation in the boiling point for 1 molal solution of glucose is 2 k. The depression in the freezing point for 2 molal solution of glucose in the same solvent is 2 k. the relation between k_b and K_f is : **[JEE(Main) 2019]**

(1) $K_b = 0.5K_f$ (2) $K_b = K_f$ (3) $K_b = 1.5\ K_f$ (4) $k_b = 2\ k_f$

20. K_2HgI_4 is 40% ionised in aqueous solution. The value of its van't Hoff factor (i) is : **[JEE(Main) 2019]**

(1) 1.8 (2) 1.6 (3) 2.0 (4) 2.2

21. The freezing point of a diluted milk sample is found to be –0.2°C, while it should have been –0.5°C for pure milk. How much water has been added to pure milk to make the diluted sample ?

[JEE(Main) 2019]

(1) 1 cup of water to 3 cups of pure milk (2) 1 cup of water of 2 cups of pure milk

(3) 2 cups of water to 3 cups of pure milk (4) 3 cups of water to 2 cups of pure milk

22. Molecules of benzoic acid (C_6H_5COOH) dimerise in benzene. 'w' g of the acid dissolved in 30 g of benzene shows a depression in freezing point equal to 2 K. If the percentage association of the acid to form dimer in the solution is 80, then w is : **[JEE(Main) 2019]**

(Given that K_f = 5 kg mol^{-1}, Molar mass of benzoic acid = 122 g mol^{-1})

(1) 2.4 g (2) 1.8 g (3) 1.0 g (4) 1.5 g

23. Freezing point of a 4% aqueous solution of X is equal to freezing point of 12% aqueous solution of Y. If molecular weight of X is A, then molecular weight of Y is : **[JEE(Main) 2019]**

(1) 4A (2) 2A (3) 3A (4) A

Answers

EXERCISE - 1

SECTION (A)

1.	(3)	**2.**	(2)	**3.**	(1)	**4.**	(3)	**5.**	(1)	**6.**	(2)	**7.**	(3)
8.	(2)	**9.**	(4)	**10.**	(4)	**11.**	(1)						

SECTION (B)

1.	(2)	**2.**	(3)	**3.**	(2)	**4.**	(2)	**5.**	(2)

SECTION (C)

1.	(4)	**2.**	(4)	**3.**	(4)	**4.**	(2)	**5.**	(4)	**6.**	(2)	**7.**	(3)
8.	(2)	**9.**	(3)	**10.**	(3)	**11.**	(1)						

SECTION (D)

1.	(1)	**2.**	(2)	**3.**	(3)	**4.**	(3)	**5.**	(3)	**6.**	(3)	**7.**	(1)
8.	(4)	**9.**	(3)										

SECTION (E)

1.	(2)	**2.**	(3)	**3.**	(4)	**4.**	(3)	**5.**	(4)	**6.**	(3)	**7.**	(3)
8.	(3)	**9.**	(2)	**10.**	(4)	**11.**	(2)	**12.**	(2)	**13.**	(2)	**14.**	(2)
15.	(4)	**16.**	(2)	**17.**	(4)	**18.**	(4)						

SECTION (F)

1.	(3)	**2.**	(1)	**3.**	(4)	**4.**	(2)	**5.**	(1)	**6.**	(4)	**7.**	(2)
8.	(3)	**9.**	(4)	**10.**	(3)	**11.**	(2)	**12.**	(3)	**13.**	(4)		

SECTION (G)

1.	(2)	**2.**	(4)	**3.**	(2)	**4.**	(4)	**5.**	(2)	**6.**	(4)	**7.**	(2)
8.	(2)	**9.**	(2)	**10.**	(1)								

SECTION (H)

1.	(3)	**2.**	(1)	**3.**	(4)	**4.**	(1)	**5.**	(1)	**6.**	(2)	**7.**	(3)
8.	(1)	**9.**	(3)										

SECTION (I)

1.	(4)	**2.**	(1)	**3.**	(1)	**4.**	(3)	**5.**	(3)	**6.**	(1)	**7.**	(1)
8.	(3)	**9.**	(1)	**10.**	(4)	**11.**	(4)	**12.**	(4)				

SECTION (J)

1.	(3)	**2.**	(1)	**3.**	(2)	**4.**	(4)	**5.**	(2)

EXERCISE - 2

1.	(2)	**2.**	(3)	**3.**	(3)	**4.**	(3)	**5.**	(3)	**6.**	(3)	**7.**	(2)
8.	(4)	**9.**	(3)	**10.**	(1)	**11.**	(2)	**12.**	(3)	**13.**	(2)	**14.**	(3)
15.	(1)	**16.**	(3)	**17.**	(1)	**18.**	(1)	**19.**	(4)	**20.**	(2)	**21.**	(3)
22.	(1)	**23.**	(2)										

EXERCISE - 3

PART-I

1.	(3)	**2.**	(4)	**3.**	(4)	**4.**	(4)	**5.**	(2)	**6.**	(1)	**7.**	(4)
8.	(1)	**9.**	(4)	**10.**	(1)	**11.**	(2)	**12.**	(3)	**13.**	(4)	**14.**	(4)
15.	(4)	**16.**	(3)	**17.**	(3)	**18.**	(3)	**19.**	(4)	**20.**	(1)	**21.**	(1)
22.	(1)	**23.**	(4)	**24.**	(3)	**25.**	(4)	**26.**	(2)	**27.**	(1)		

PART-II

1.	(1)	**2.**	(3)	**3.**	(3)	**4.**	(2)	**5.**	(1)	**6.**	(3)	**7.**	(3)
8.	(4)	**9.**	(1)	**10.**	(2)	**11.**	(1)	**12.**	(4)	**13.**	(2)	**14.**	(1)
15.	(4)	**16.**	(3)	**17.**	(4)	**18.**	(1)	**19.**	(3)	**20.**	(4)	**21.**	(4)
22.	(1)	**23.**	(2)	**24.**	(1)								

PART-III

1.	(1)	**2.**	(3)	**3.**	(2)	**4.**	(3)	**5.**	(2)	**6.**	(3)	**7.**	(3)
8.	(1)	**9.**	(2)	**10.**	(2)	**11.**	(1)	**12.**	(2)	**13.**	(2 / Bonus)		
14.	(3)	**15.**	(2)	**16.**	(4)	**17.**	(4)	**18.**	(1)	**19.**	(4)	**20.**	(1)
21.	(4)	**22.**	(1)	**23.**	(3)								