1. SOLUTIONS

SYNOPSIS

I. TYPES OF SOLUTIONS, MOLARITY, NORMALITY, MOLALITY, MOLE FRACTION

* Molarity, $\frac{w}{GMW}\times\frac{1000}{V}$; w = wt. of the solute in grams and V = volume of the solution in millilitres

* $M=\frac{10(\%w/v)}{GMW}$ (or) $M=\frac{(10)(d)(\%w/w)}{GMW}$, where d is density in grams per ml.

* Number of gram-equivalents $=\frac{weight}{GEW}$; Equivalent weight $=\frac{\text{Molecular weight}}{n}$

* Normality, $N=\frac{w}{GEW}\times\frac{1000}{V}$; $N=\frac{10(\%w/v)}{GEW}$ (or) $N=\frac{(10)(d)(\%w/w)}{GEW}$

When a solution is diluted, its normality decreases. V_1N_1(before dilution) = V_2N_2 (after dilution)

* Normality of the mixture when two solutions of same solute are mixed. $N=\frac{N_1V_1+N_2V_2}{V_1+V_2}$

* Molality (m) $=\frac{w_1\times1000}{GMW\times w_2}$ where w_1 is weight of solute, w_2 is weight of solvent in grams.

* Mole fraction of the solute = $X_{solute}=\frac{n_1}{n_1+n_2}$; Mole fraction of the solvent = $X_{solvent}=\frac{n_2}{n_1+n_2}$

where n_1 and n_2 are number of moles of solute and solvent.

For a binary solution, $X_{solute}+X_{solvent}=1$.

II. VAPOUR PRESSURE, RAOULT'S LAW, IDEAL & NON-IDEAL SOLN, HENRY'S LAW, AZEOTROPIC MIXTURE

Vapour Pressure : The pressure exerted by the vapour of liquid which is in equilibrium with it at a given temperature.

* Vapour pressure is not a surface phenomena.

* Vapour pressure increases with increase in temperature. $X_{(l)}\rightleftharpoons X_{(g)}$; $K_p = P_x(g)$

$\ln\frac{K_{p_2}}{K_{p_1}}=\ln\frac{p_2}{p_1}=\frac{\Delta H_{vap.}}{R}\left(\frac{1}{T_1}-\frac{1}{T_2}\right)$; where $\Delta H_{vap.}$ is molar enthalpy of vaporisation (J/mol or cal/mol)

Raoult's Law

i) Liquid solution containing non volatile solute :

Vapour pressure of liquid solution $\propto$ mole fraction of solvent in liq. solution

$p_{solution}\propto X_{solvent}$; $p_{solution}=p^0_{solvent}.X_{solvent}$

Where $p^0_{solvent}$ = Vapour pressure of pure liquid solvent, $X_{solvent}$ = Mole fraction of solvent.

For binary liquid solution ; $X_{solute}+X_{solvent}=1$

Relative lowering of vapour pressure $=\frac{p^0-p}{p^0}=X_{solute}$

ii) Vapour Pressure of Solution containing volatile solute (B) and volatile solvent (A):

The equilibrium vapour pressure of a volatile component is linearly proportional to the mole fraction of that component in liquid phase.

A solution contains volatile solute (B) and volatile solvent (A) :

$P_A = P_A^0 X_A$ and $P_B = P_B^0 X_B$; $P = P_A^0 X_A + P_B^0 X_B$

Where, P_A and P_B are partial vapour pressure of A and B at given temperature.

P_A = vapour pressure of pure A ; P_B^0 = vapour pressure of pure B.

X_A = mole fraction of A in liquid phase ; X_B = mole fraction of B in liquid phase.

Y_A = mole fraction of A in vapour phase ; Y_B = mole fraction of B in vapour phase.

Partial vapour pressure of 'A' = mole fraction of 'A' in vapour phase x total vapour pressure.

$P_A = Y_A P$ and $P_B = Y_B P$; $P_A X_A = Y_A P$ and $P_B X_B = Y_B P$; $X_A + X_B = 1$

$$\frac{Y_A P}{P_A^0} + \frac{Y_B P}{P_B^0} = 1; \frac{Y_A}{P_A^0} + \frac{Y_B}{P_B^0} = \frac{1}{P}; \; Y_A = \frac{P_A^0 X_A}{P_A^0 X_A + P_B^0 X_B}; Y_B = \frac{P_B^0 X_B}{P_A^0 X_A + P_B^0 X_B}$$

Ideal Solutions

The solutions which obey Raoult's Law are called ideal solutions. For ideality :

$F_{solute.....solvent} \simeq F_{solute.....solute}$ (F = Intermolecular attractive interactions) $\simeq F_{solvent.....solvent}$

$\Delta H_{mix} = 0; \Delta V_{mix} = 0$; $\Delta S_{mix} > 0; \Delta G_{mix} < 0$

Examples : Benzene & Toluene, Hexane & Heptane, C_2H_5Br & C_2H_5I

Non-ideal solutions : The mixture which do not follow Raoult's Law will be known as non-ideal solutions.

Types of Real or Non-ideal Solutions

* Non-ideal solution with positive deviation.

$P_{T,exp} > (P_A^0 X_A + P_B^0 X_B)$

$A.....B < \begin{matrix} A.....A \\ A.....B \end{matrix}$

$\Delta H_{mix} = +ve$

$\Delta V_{mix} = +ve$

$\Delta S_{mix} = +ve$

$\Delta G_{mix} = -ve$

Ex. $H_2O + CH_3OH$, $H_2O + C_2H_5OH$

$CHCl_3 + CCl_4$

* Non-ideal solution with negative deviation.

$P_{T,exp} < (P_A^0 X_A + P_B^0 X_B)$

$A.....B < \begin{matrix} A.....A \\ A.....B \end{matrix}$

$\Delta H_{mix} = -ve$

$\Delta V_{mix} = -ve$

$\Delta S_{mix} = +ve$

$\Delta G_{mix} = -ve$

Ex. $H_2O + CH_3COOH$, $CHCl_3 + CH_3COCH_3$

$H_2O + HNO_3$

Azeotropic Solutions: During distillation, the mole fraction of more volatile component in vapour state is higher than that in liquid state. This makes distillation possible. However, some solutions for particular compositions of which the mole fraction of components in liquid and vapour state is same. Thus, no distillation is possible for the mixture and it is termed as **azeotropic mixture**.

Azeotropes are binary mixtures having the same composition in liquid and vapour phase and boil at a constant temperature. The solutions which show a large positive deviation from Raoult's law form minimum boiling azeotrope at a specific composition. The solutions which show a large negative deviation from Raoult's law form maximum boiling azeotrope at a specific composition.

Completely Immiscible Liquids : When they are distilled, they distil in the ratio of their vapour pressure at that temperature.

$P = P_A^0 + P_B^0$; For vapour of pure liquid we can apply : $P_A^0 V = n_A RT$ and $P_B^0 V = n_B RT$

So, $\frac{P_A^0}{P_B^0} = \frac{n_A}{n_B}$; When A and B are distilled wt. ratio is given as $\frac{w_B}{w_A} = \frac{P_B^0 . M_B}{P_A^0 . M_A}$

III. COLLIGATIVE PROPERTIES, R.L.V.P., ΔT_b, ΔT_f, VANT'S HOFF'S FACTOR

Colligative Properties : Colligative Properties depend on the number of solute particle irrespective to their nature.

* **Normal Colligative Properties :** When neither association nor dissociation of solute particles take place.

(i) Relative lowering of Vapour Pressure :

$$\frac{P^0 - P}{P^0} = X_{solute} = \frac{n}{n+N}$$ Where, n = mole of solute, N = mole of solvent

$$\frac{P^0 - P}{P^0} = \frac{n}{N}; \left(\frac{P^0 - P}{P^0}\right) = \frac{m}{m + \frac{1000}{\text{M.W. of solvent}}}$$

Ostwald-Walker Method

Loss in wt of solution containers αP

Loss in wt of solvent containers $\alpha(P^0 - P)$

gain in wt of dehydrating agent αP^0

$$\frac{P^0 - P}{P^0} = \frac{\text{Loss in weight of solvent}}{\text{Gain in weight of dehydrating agent}}$$

(ii) Elevation in Boiling Point :

$\Delta T_b = K_b m$ Where $\Delta T_b = T_b - T_b^0$

K_b = Boiling point elevation constant or ebullioscopic constant or ebullioscopic constant

$K_b = \frac{RT_b^{0^2}}{1000 L_v}$; L_v = Latent heat of vapourisation per gram

$K_b = \frac{MRT_b^{0^2}}{1000 \Delta H_{vap}}$

ΔH_{vap} = enthalpy of vapourisation per mole

M = molar mass of solvent (in g/mol) ; T_b^0 = Boiling point of solvent

(iii) Depression in Freezing point :

$\Delta T_f = K_f m$ where $\Delta T_f = T_f - T_f^0$

K_f = Freezing point depression constant or cryoscopic constant or cryoscopic constant

$K_f = \frac{RT_f^{0^2}}{1000 L_f}$

L_f = Latent heat of fusion per gram

$K_f = \frac{MRT_f^{0^2}}{1000 \Delta H_{fus}}$

ΔH_{Fus} = enthalpy of fusion per mole

M = molar mass of solvent (in g/mol)

T_f^0 = freezing point of solvent

(iv) Osmotic Pressure (π) : For dilute solutions $\pi = CRT = h\rho g$, where C is the total molar concentration of all the free species present in the solution, h is the height developed by the column of the concentrated solution and ρ is the density of the solution in the column.

On the basis of osmotic pressure, the solutions can be classified in three classes.

* **Isotonic solutions:** Two solutions having same osmotic pressures are called isotonic solutions. (This implies $C_1 = C_2$ at same temperature).

* **Hypertonic and hypotonic solution :** When two solutions are being compared, then the solution with higher osmotic pressure is termed as **hypertonic**. The solution with lower osmotic pressure is termed as **hypotonic**.

* **Abnormal Colligative Properties :** When solute particle associated or dissociated in solvent.

$$i = \text{Vant Hoff factor} = \frac{\text{Acutal moles of solute}}{\text{Moles of solute without dissociation or association}}$$

$$= \frac{\text{Observed or experimental colligative properties}}{\text{Theoretical or calculated colligative properties}}$$

(i) Relative lowering of vapour pressure : $\frac{P^0 - P}{P^0} = \frac{i.n_{solute}}{i.n_{solute} + n_{solvent}}$

(ii) Elevation of boiling point : $\Delta T_b = i.K_b m$

(iii) Depression of freezing point : $\Delta T_f = i.K_f m$

(iv) Osmotic pressure : $\pi = i.CRT$

For dissociation : $i = 1 + (n-1)\alpha$; For association : $i = 1 + \left(\frac{1}{n} - 1\right)\alpha$

Degree of dissociation $\alpha = \frac{i-1}{n-1}$; Degree of association $\alpha = \frac{1-i}{1-1/n}$

Where n = Total number of particles of solute after dissociation or association.

Henry's Law

This law deals with dissolution of gas in liquid i.e., mass of any gas dissolved in any solvent per unit volume is proportional to pressure of gas in equilibrium with liquid.

(i) $m = k \times P$

Where m = mass of gas dissolved per unit volume, k = proportionality constant, P = pressure of gas.

(ii) $P = K_H.X_{gas}$, Where P = Pressure of gas, K_H = Henry's constant, X_{gas} = Mole fraction of gas

LECTURE SHEET

EXERCISE-I

(Types of Solutions, Molarity, Normality, Molality, Mole fraction)

LEVEL-I (MAIN)

Straight Objective Type Questions

1. If air is taken as a binary solution, the solvent is

   1) N_2 2) O_2 3) CO_2 4) H_2

2. The physical change among the following is

   1) burning of coal 2) burning of sulphur

   3) dissolution of Glucose in water 4) burning of white phosphorus

3. Homogeneous system among the following is

   1) milk 2) sand in water 3) urea in water 4) benzene in water

4. The units of Molarity are

   1) gms. lit^{-1} 2) moles. lit^{-1} 3) equivalents. lit^{-1} 4) moles. kg^{-1}

5. To half the molarity of a solution the following should be adopted

   1) weight of the solute to be doubled 2) weight of the solvent to be doubled

   3) volume of the solvent to be doubled 4) volume of the solution to be doubled

6. **(A) :** Molarity of a solution decreases with an increase of temperature.
(R) : As temperature increases volume of the solution increases.
1) Both (A) and (R) are true and (R) is the correct explanation of (A)
2) Both (A) and (R) are true and (R) is not the correct explanation of (A)
3) (A) is true but (R) is false
4) (A) is false but (R) is true

7. The units of Normality are
1) moles. lit^{-1} 2) moles. Kg^{-1} 3) equivalents. lit^{-1} 4) equivalents. Kg^{-1}

8. The following is not a fixed quantity
1) atomic weight of an element
2) equivalent weight of an element (or) compound
3) molecular weight of a compound
4) formula weight of a substance

9. At 25^0C for a given solution M = m, then at 50^0C the correct relationship is
1) M = m 2) M > m 3) M < m 4) M = 2M

10. The units of molality are
1) moles. lit^{-1} 2) moles. ml^{-1} 3) moles. Kg^{-1} 4) g. equivalents Kg^{-1}

11. **(A) :** Molality is independent of temperature.
(R) : There is no volume factor in the expression of molality.
1) Both (A) and (R) are true and (R) is the correct explanation of (A)
2) Both (A) and (R) are true and (R) is not the correct explanation of (A)
3) (A) is true but (R) is false
4) (A) is false but (R) is true

12. The number of Glucose molecules present in 10 ml of decimolar solution is
1) 6.0×10^{20} 2) 6.0×10^{19} 3) 6.0×10^{21} 4) 6.0×10^{22}

13. The number of ions present in 1 ml of 0.1M $CaCl_2$ solution is
1) 1.8×10^{20} 2) 6.0×10^{20} 3) 1.8×10^{19} 4) 1.8×10^{21}

14. 100 ml of an aqueous solution contains 6.023×10^{21} solute molecules. The solution is diluted to 1 lit. The number of solute moleculespresent in 10ml of the dilute solution is
1) 6.0×10^{20} 2) 6.0×10^{19} 3) 6.0×10^{18} 4) 6.0×10^{17}

15. 0.1 gram mole of urea is dissolved in 100g. of water. The molality of the solution is
1) 1 m 2) 0.01 M 3) 0.01 m 4) 1.0 M

16. 6 g. of Urea is dissolved in 90 g. of water. The mole fraction of solute is
1) 1/5 2) 1/50 3) 1/51 4) 1/501

Numerical Value Type Questions

17. The number of millimoles of H_2SO_4 present in 5 litres of 0.2N H_2SO_4 solution is

18. 200 ml of 1M H_2SO_4, 300 ml 3M HCl and 100 ml of 2M HCl are mixed and made upto 1 litre. The proton concentration in the resulting solution is

19. The Normality of 0.98% (w/v) H_2SO_4 solution is

LEVEL-II (ADVANCED)

Straight Objective Type Questions

1. Which of the following differs from the others?
a) ruby b) elektron c) bell metal d) amalgam

2. H_2SO_4 is labelled as 9.8% by weight. Specific gravity of H_2SO_4 is 1.8. The volume of the acid to be taken to prepare 1000 ml of 0.18M solution is
   a) 10ml b) 100ml c) 740 ml d) 360 ml

3. The volume of decamolar aqueous solution of HCl is required to prepare $2dm^3$ of 5M HCl sol. is
   a) 0.5L b) 1L c) 2L d) 3L

4. The molality of 2% (W/W) NaCl solution nearly
   a) 0.02m b) 0.35 m c) 0.25 m d) 0.45 m

5. The mole percentage of oxygen in a mixture of 7 gm of Nitrogen and 8 gm of oxygen is
   a) 8 b) 16 c) 21 d) 50

6. The volumes of 1M HCl and 5M HCl to be mixed to get 2 lit of 2M HCl are
   a) 1 lit and 1 lit b) 1.5 lit and 0.5 lit c) 1.25 lit and 0.75 lit d) 1.33 lit and 0.66 lit

7. A solution weighing 'a' gm has molality 'b'. The molecular mass of solute. If the mass of solute is 'c' gm will be
   a) $\frac{c}{b}\cdot\frac{1000}{(a-c)}$ b) $\frac{b}{a}\cdot\frac{1000}{(a-b)}$ c) $\frac{b}{c}\cdot\frac{1000}{(a-c)}$ d) $\frac{c}{a}\cdot\frac{1000}{(b-a)}$

8. 10 millimoles of a diacidic base exactly neutralises 100 ml of an acid. Then the N of that acid is
   a) 0.2 N b) 0.1 N c) 0.4 N d) 0.5N

9. 100 mL of H_2SO_4 solution having molarity 1M and density 1.5g/ml is mixed with 400 ml of water. Calculate final molarity of H_2SO_4 solution, if final density is 1.25 g/ml :
   a) 4.4 M b) 0.145 M c) 0.52 M d) 0.227 M

10. Wood's metal contains 50.0% bismuth, 25.0% lead, 12.5% tin and 12.5% cadmium by weight. What is the mole fraction of tin? (Atomic weights : Bi = 209, Pb = 207, Sn = 119, Cd = 112)
    a) 0.202 b) 0.158 c) 0.176 d) 0.221

11. The density of a 56.0% by weight aqueous solution of 1-propanol ($CH_3CH_2CH_2OH$) is 0.8975 g/cm^3. What is the mole fraction of the compound?
    a) 0.292 b) 0.227 c) 0.241 d) 0.276

12. Three sols. X, Y, Z of HCl are mixed to produce 100 mL of 0.1 M sol.. The molarities of X, Y and Z are 0.07 M, 0.12 M and 0.15 M respectively. What respective vol. of X, Y and Z should be mixed?
    a) 50 ml, 25 ml, 25 ml b) 20 ml, 60 ml, 20 ml
    c) 40 ml, 30 ml, 30 ml d) 55 ml, 20 ml, 25 ml

More than One correct answer Type Questions

13. The characterstic property of solution is
    a) formation of solution is physical change
    b) solute and solvent in the solution can be separated by filtration
    c) solute and solvent in the solution can be separated by distillation
    d) solution can be represented with a chemical formula

14. In a solution 49 gm of H_2SO_4 is dissolved in 2 litre of solution. The concentration of solution may be
    a) 0.5 M b) 0.25 M c) 0.5 N d) 0.25 N

15. 5.3% (w/v) Na_2CO_3 solution and 6.3% (w/v) $H_2C_2O_4\ 2H_2O$ solution have same
    a) molality b) molarity c) normality d) mole fraction

16. Which of the following concentration terms is added by a change of in temperature?
a) Molarity b) Molality c) Normality d) Specific Gravity

Linked Comprehension Type Questions

Passage:

1.24M aqueous solution of KI has density 1.15 g/cm^3

17. Percentage composition of solute in the solution is
a) 17.89 b) 27.89 c) 37.89 d) 47.89

18. Molality of this solution is
a) 2.61 b) 1.31 c) 4.12 d) 3.12

19. Normality of this solution is
a) 0.62 b) 1.24 c) 2.48 d) 3.72

Matrix Matching Type Questions

20.

Column-I	Column-II
A) Molarity	p) Number of gram formula mass of solute dissolved per litre of solution
B) Molality	q) Number of moles of solute dissolved per kg of solvent
C) Formality	r) Depends on Temperature
D) Strength of solution	s) Number of moles of solute dissolved per litre of solution

21.

Column-I	Column-II
A) Mole fraction	p) mole/kg
B) Molality	q) Depends on temperature
C) Molarity	r) No units
D) Formality	s) Independent on temperature

Integer Type Questions

22. What volume of liquid (in lit) will contain 10moles? If molar mass of liquid is 280 and its density is 1.4 gm/ml?

23. 200ml of 1M HCl is mixed with 300ml of 6M HCl and the final solution is diluted to 1000ml. Calculate molar concentration of [H$^+$] ion.

EXERCISE-II

(Vapour Pressure, Raoult's Law, Ideal & Non-ideal solutions, Henry's Law, Azeotropic Mixture)

LEVEL-I (MAIN)

Straight Objective Type Questions

1. Which one of the following gases has the lowest value of Henry's Law constant?
1) N_2 2) He 3) CO_2 4) O_2

2. The solubility of $N_2(g)$ in water exposed to the atmosphere, when the partial pressure of 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

3. As temperature increases, vapour pressure of a liquid
1) increases linearly 2) decreases linearly
3) increases exponentially 4) decreases exponentially

4. Rate of evaporation depends upon
   a) Nature of liquid
   b) Surface area of the liquid
   c) Temperature
   d) Flow of air current over the surface
   The correct answer is
   1) a, b only 2) b, c only 3) a, b, and c only 4) a, b, c and d

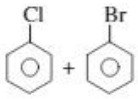
5. **(A)** : At boiling point of the liquid vapour pressure equal to atmospheric pressure
   (R) : Volume of a solution increases by increasing the temperature.
   1) Both (A) and (R) are true and (R) is the correct explanation of (A)
   2) Both (A) and (R) are true and (R) is not the correct explanation of (A)
   3) (A) is true but (R) is false 4) (A) is false but (R) is true

6. **(A)** : Sea water boils at higher temperature than distilled water.
   (R) : Addition of non volatile solute to a solvent lowers the vapour pressure

7. **(A)** : A pressure cooker reduces cooking time.
   (R) : The boiling point of water inside the cooker is increased.

8. A solution that obeys Raolult's law is called
   1) normal solution 2) non-ideal solution 3) ideal solution 4) saturated solution

9. At 20^0C, the vapour pressure of diethyl ether is 442mm. When 6.4 g. of a non-volatile solute is dissolved in 50g. of ether, the vapour pressure falls to 410 mm. The Molecular weight of the solute is
   1) 150 2) 130.832 3) 160 4) 180

10. Among the following the azeotropic mixture is
    1) $CCl_4 + CHCl_3$ 2) $C_6H_{14} + C_7H_{16}$ 3) $C_2H_5Br + C_2H_5Cl$ 4) 

11. An azeotropic solution of two liquids has a boiling point lower than either of them when it
    1) shows negative deviation from Raoult's law 2) shows no deviation from Raoult's law
    3) shows positive deviation from Raoult's law 4) is saturated

Numerical Value Type Questions

12. 6 g. of urea is dissolved in 90 g. of boiling water. The vapour pressure of the solution is ___ mm.

13. The vapour pressure of pure water at 25^0C is 30 mm. The vapour pressure of 10% (W/W) glucose solution at 25^0C is ____ mm.

14. The wt. of urea to be dissolved in 100g. of water to decrease the vapour pressure of water by 5% is ____ g

15. The vapour pressure of a pure liquid A is 40 mm of Hg at 310K. The vapour pressure of this liquid in a solution with liquid B is 32 mm of Hg. x_A in the solution, if it obeys Raoult's law, is :

LEVEL-II (ADVANCED)

Straight Objective Type Questions

1. **(A)** : If one component obeys Raoult's law over a certain range of composition, the other component would not obey Henry's law in that range
   (R) : Raoult's law is a special case of Henry's law.
   a) Both (A) and (R) are true and (R) is the correct explanation of (A)
   b) Both (A) and (R) are true and (R) is not the correct explanation of (A)
   c) (A) is true but (R) is false d) (A) is false but (R) is true

2. 139.18 g of glucose is added to 178.2 g of water the vapour pressure of water for this aqueous solution at 100^0 C is
   a) 700.7 torr b) 759 torr c) 7.6 torr d) 76 torr

3. The relative lowering of vapour pressure of 0.2 molal solution in which the solvent is Benzene is
   a) 15.6×10^{-4} b) 15.6×10^{-3} c) 15.6×10^{-1} d) 0.05

4. Vapour pressure of an aqueous solution is 2% less than that of the solvent. The molality of the solution is
   a) 2m b) 1.5 m c) 1.13 m d) 0.2 m

5. The amount of Glucose to be dissolved in 500 g. of water so as to produce the same lowering in vapour pressure as that of 0.2 molal aqueous urea solution
   a) 9 g. b) 18 g. c) 36 g. d) 1.8 g.

6. A Current of dry air was first passed through the bulb containing solution of 'A' in water and then through the bulb containing pure water. The loss in mass of a solution bulb is 1.92g gm Where as that in pure water bulb is 0.08g, then mole fraction of 'A' is
   a) 0.86 b) 0.2 c) 0.96 d) 0.04

7. The vapour pressure of a mixure of 1 mole of liquid 'A' and 3 mole of liquid 'B' is 550 mm of Hg. When one mole of liquid 'B' is further added, the vapour pressure of the solution increases by 10 mm of Hg. The vapour pressure of pure liquid A and B are respectively in mm of Hg.
   a) 400, 600 b) 200, 800 c) 500, 600 d) 600, 800

8. The vapour pressure of pure benzene and toulene are 160 Torr and 60 Torr respectively. The mole fraction of benzene in vapour phase in contact with equimolar solution of benzene and toulene would be
   a) 0.50 b) 8/3 c) 0.73 d) 0.27

9. The plot of $1/x_A$ versus $1/y_A$ (where x_A and y_A are the mole fraction of A in liquid and vapour phases, respectively) is linear with slope and intercept respectively are given as (y-axis = $1/y_A$, x-axis = $1/x_A$)
   a) $P_A^0/P_B^0, (P_A^0 - P_B^0)/P_B^0$ b) $P_A^0/P_B^0, (P_B^0 - P_A^0)/P_B^0$
   c) $P_B^0/P_A^0, (P_A^0 - P_B^0)/P_A^0$ d) $P_B^0/P_A^0, (P_B^0 - P_A^0)/P_B^0$

10. An azeotropic solution of two liquids has a boiling point higher than either of the boiling points of the liquids when it
    a) shows negative deviation from Raoult's law b) shows positive deviation from Raoult's law
    c) shows no deviation from Raoult's law d) is saturated

11. Solution (A) is ideal and solution (B) is non-ideal with –ve deviation, which of the following are correct?
    a) $\Delta H_{mix} = 0, \Delta V_{mix} = 0$ for A b) ΔS_{mix} is zero for both A, B
    c) ΔH_{mix} is positive, ΔV_{mix} is negative for B d) ΔH_{mix} is negative, ΔV_{mix} is positive for B

More than One correct answer Type Questions

12. At a given temperature, correct statements:
    a) Vapour pressure of a sol. containing nonvolatile solute is proportional to mole fraction of solvent
    b) Lowering of vapour pressure of solution containing nonvolatile solute is proportaional to mole fraction of solute
    c) Relative lowering of vapour pressure is equal to mole fraction of solute
    d) Vapour pressure of a sol. containing nonvolatile solute is proportional to mole fraction of solute

13. Which of the following statements are correct?
    a) the boiling point of a solution is greater than that of pure solvent
    b) the temperature where the V.P. of liquid equals to atmospheric pressure is called its boiling point
    c) the V.P. of pure solvent is less than the vapour pressure of solution containing non volatile solute.
    d) the T of liquid remained in the container after evaporation is more than that before the evaparation

14. For a solution containing nonvolatile solute, the relative lowering of vapour pressure is 0.2, If total moles present in the solution are 5 then select the correct relations
    a) $x_{solute} = 0.2$ b) $n_{solute} = 1$ c) $n_{solvent} = 4$ d) $x_{solvent} = 0.8$

15. Which of the following show deviation from Raoult's law?
    a) C_2H_5OH & H_2O b) HNO_3 & H_2O
    c) $CHCl_3$ & CH_3COCH_3 d) C_6H_6 & $C_6H_5CH_3$

16. 4 mole of pure liquid A ($P_A^0 = 80mm of Hg$) and 6 mole of pure liquid B ($P_B^0 = 100mm of Hg$) are mixed. The vapour pressure of the resulting solution is found to be 90 mm of Hg then
    a) It is an ideal solution
    b) The solution shows negative deviation from Raoult's law
    c) The solution is formed by the absorption of heat
    d) The solution will boil at higher temperature than expected

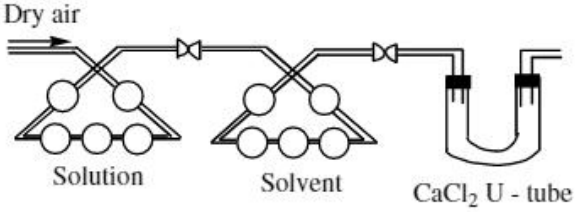
17. Which of the following confirm minimum boiling point azeotropic mixture?
    a) $CCl_4 + CHCl_3$ b) $CH_3COOH + C_5H_5N$
    c) $CH_3COCH_3 + CHCl_3$ d) $C_2H_5OH + H_2O$

18. At certain temperature a solution 3 moles of liquid A(p^0 = 500 torr) and 1 mol of liquid B(p^0 = 340 torr) has a vapour pressure of 435 torr, we can conclude that
    a) a solution of 50 mL of A and 50 mL of B must have a volume of 100 mL.
    b) the solution shows negative deviation from Raoult's law
    c) on mixing the two liquids heat must be given out so as to obtain solution at the same temperature
    d) entropy of mixing is zero.

Linked Comprehension Type Questions

Passage-I :

A current of dry air is passed through the above apparatus containing two sets of bulbs. One set of bulbs is filled with the solution and second with the solvent. Finally that is attached with a U-tube containing $CaCl_2$, which is very efficient in absorbing the water vapour. Passing of dry air through all these three causes some change in weight.



19. Loss in weight (W_1) of solution is proportional to

a) the weight of air passed in
b) the vapour pressure of solution
c) the vapour pressure of pure solvent
d) the weight of solute

20. Loss in weight (W_2) of solvent (water) is proportional to

a) the vapour pressure of solution
b) the vapour pressure of pure solvent
c) the difference $P^0_{solvent} - P_{solution}$
d) the mol fraction of solute

21. Gain in weight (W_3) of U-tube containing $CaCl_2$ is proportional to

a) the vapour pressure of solution
b) the vapour pressure of pure solvent
c) the difference $P^0_{solvent} - P^0_{solution}$
d) the mol fraction of solute

Passage-II:

Vapour Pressue of a mixture of benzene and toluene is given by $P = 179X_B + 92$, Where X_B is molefraction of benzene.

22. Vapour pressure of the solution obtained by mixing 936 g of benzene and 736 gm of toluene

a) 199.4 mm
b) 271 mm
c) 280 mm
d) 289 mm

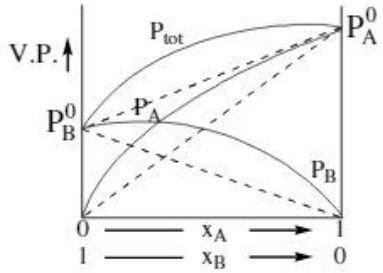
23. If Vapours are removed and condensed into liquid then what will be the ratio of mole fraction of benzene and toluene in first condensate

a) 2.8
b) 1.5
c) 3.5
d) 4.5

24. This condensed liquid again brought to the same temperature then what will be the mole fraction of benzene in vapour phase

a) 0.07
b) 0.93
c) 0.65
d) 4.5

Passage-III :



25. Consider some facts and select the correct facts.

I) This is observed when A....B attractions are greater than average of A....A and B....B attraction.
II) $\Delta H_{mix} = +ve$, $\Delta V_{mix} = +ve$
III) Boiling point is smaller than expected such that vaporisation is increased
IV) Mixture is called Azeotropic mixture

a) I, II, III
b) II, III, IV
c) I, III, IV
d) I, II, III, IV

26. Total vapour pressure of mixture of 1 mole of volatile component A(P^0_A=100mm Hg) and 3 mole of volatile component B(P^0_B = 60 mm Hg) is 75 mm. For such case

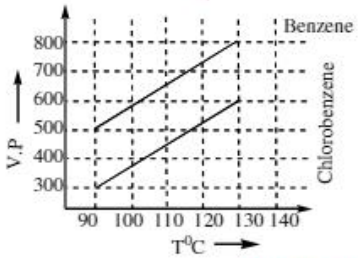
a) There is +ve deviation from Raoult's law
b) Boiling point has been lowered
c) Force of attraction between A and B is smaller than that between A and A or between B and B
d) All the above statements are correct

Matrix Matching Type Questions

27.

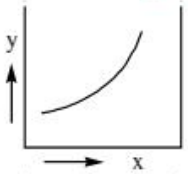
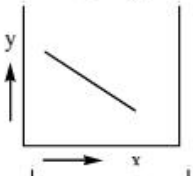
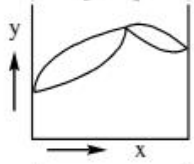
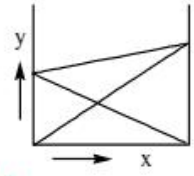
Column-I	Column-II
A) Lowering of vapour pressure	p) $\frac{P^o - P}{P^o}$
B) Relative lowering of vapour pressure	q) $\frac{P^o - P}{P^o} = \frac{w}{m} x \frac{M}{W}$
C) Raoult's law	r) $P^o - P$
D) Ideal solution	s) Obeying Raoults law
	t) Boiling point

28. Using V.P Vs temp graph match the following : $\left(X_{chlorobenzene} = \frac{1}{3}, X_{Benzene} = \frac{2}{3}\right)$



Column-I	Column-II
A) P at 90^0	p) 0.23
B) $X_{chlorobenzene}$ in vapour phase	q) 0.73
C) $X_{benzene}$ in vapour phase at 130^0C	r) 733.33
D) P at 130^0C	s) 433.33

29.

Column-I (graph)	Column-II (suitable variables)
A) 	p) Vapour pressure vs. composition
B) 	q) Boiling point of non-ideal mixture vs. composition
C) 	r) log(V.P.) vs. (temperature)$^{-1}$
D) 	s) Vapour pressure vs. temperature.

30.

Column-I	Column-II
A) n-hexane, n-heptane	p) Dimerisation
B) CO_2, H_2O	q) ionisation
C) C_6H_5COOH, Benzene	r) Roults law (obey)
D) C_6H_5COOH, H_2O	s) Henrys law (obeys)

Integer Type Questions

31. P_A = 320 torr, when x_A = x torr If x_A = x + 0.1; P_A = 440 then P^o_A= 200x; find x.

32. P^o_A = 10torr; 1g of B is dissolved in 20g of A, its vapour pressure reduced to 9.0torr. If M.W of A is 200, M.W of B is 30x. x is

EXERCISE-III

(ΔT_b, ΔT_f, π, Van't Hoff's factor)

LEVEL-I (MAIN)

Straight Objective Type Questions

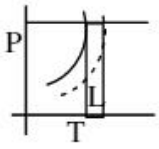
1. During depression of freezing point in a solution the following are in equilibrium
   1) Liquid solvent, Solid solvent
   2) Liquid solvent, Solid solute
   3) Liquid solute, Solid Solute
   4) Liquid solute, Solid solvent

2. The molal elevation constant is the ratio of the elevation in boiling point to
   1) Molarity
   2) Molality
   3) Mole fraction of solute
   4) Mole fraction of solvent

3. Molality of an aqueous solution that produces an elevation of boiling point of 1.00 K at 1 atm pressure. (K_b for water = 0.512 K. kg. mol^{-1})
   1) 0.512 M
   2) 0.195 m
   3) 1.95 m
   4) 5.12 M

4. Which of the following is a colligative property?
   1) vapour pressure of a liquid
   2) boiling point
   3) freezing point
   4) relative lowering of vapour pressure of a sol.

5. The phase diagrams for the pure solvent (solid lines) and the solution (non-volatile solute, dashed line) are recorded below.
   The quantity indicated by 'L' in the figure is



   1) Δp
   2) ΔT_f
   3) $K_b.m$
   4) $K_f.m$

6. An aqueous solution containing one gram of urea boils at 100.25°C. The aqueous solution containing 3gm of glucose in the same volume will boil at
   1) 100°C
   2)100.25°C
   3) 100.5°C
   4) 100.75°C

7. Y g of a non-volative Organic substance of molecular mass M is dissolved in 250g benzene Molal elevatioin constant of bezene is k_b. Elevation in its B.P is given by
   1) $\frac{M}{K_bY}$
   2) $\frac{4K_bY}{M}$
   3) $\frac{K_bY}{4M}$
   4) $\frac{K_bY}{M}$

8. The solution containing 6.8g of non-ionic solute in 100g of water was found to freeze at –0.93°C. If K_f for water is 1.86, the molar Mass of solute is
1) 13.6 2) 68 3) 34 4) 136

9. Solution S_1 contains 3g of urea per litre and solution S_2 contains 9g glucose per litre. At 298 K, the osmotic pressure of
1) S_1 is greater than that S_2 2) S_1 is less than that of S_2
3) Both the solution is same 4) Both the solution is 1 atm

10. The Osmotic pressure of solution containing 4.0g of solute (molar mass 246) per litre at 27°C is ($R = 0.082L\ atm\ k^{-1}\ mol^{-1}$) :
1) 0.1 atm 2) 0.2 atm 3) 0.4 atm 4) 0.8 atm

11. Which of the following colligative properties can provide molar mass of proteins (or polymers or colloids) with greater precision?
1) Relative lowering of vapour pressure 2) Elevation of boiling point
3) Depression in freezing point 4) Osmotic pressure

12. The degree of dissociation (α) of a weak electrolyte A_xB_y is related to Van't Hoff factor (i) by the expression
1) $\alpha = \frac{i-1}{(x+y-1)}$ 2) $\alpha = \frac{i-1}{x+y+1}$ 3) $\alpha = \frac{x+y-1}{i-1}$ 4) $\alpha = \frac{x+y+1}{i-1}$

13. If α is the degree of dissociation of Na_2SO_4, the Vant Hoff factor (i) used for calculating the molecular mass is
1) $1+\alpha$ 2) $1-\alpha$ 3) $1+2\alpha$ 4) $1-2\alpha$

14. Relative lowering of vapour pressure is maximum for
1) 0.1m urea 2) 0.1m NaCl 3) 0.1m $MgCl_2$ 4) 0.1m $Al_2(SO_4)_3$

15. Boiling point is least for
1) 0.1m urea 2) 0.2m urea 3) 0.1m NaCl 4) 0.2m $MgCl_2$

16. **(A)** : Vapour pressure of 0.5M sugar solution is more than 0.5M KCl solution
(R) : Lowering of vapour pressure is directly proportional to the number of particles present in the solution.
1) Both (A) and (R) are true and (R) is the correct explanation of (A)
2) Both (A) and (R) are true and (R) is not the correct explanation of (A)
3) (A) is true but (R) is false 4) (A) is false but (R) is true

17. Solution A, B, C and D are respectively 0.1M Glucose, 0.05M NaCl, 0.05M $BaCl_2$ and 0.1M AlF_3. Which one of the following pairs are isotonic?
1) A & C 2) B & C 3) A & B 4) A & D

18. Solution A contains 7g/L $MgCl_2$ and solution B contains 7g/L of NaCl. At room temperature, the osmotic pressure of
1) solution A is greater than B 2) both have same osmotic pressure
3) solution B is greater than A 4) Can't determine

19. Which has the highest boiling point?
1) 0.1M Na_2SO_4 2) 0.1M $C_6H_{12}O_6$ 3) 0.1M $MgCl_2$ 4) 0.1M $Al(NO_3)_3$

20. 0.004M Na_2SO_4 is isotonic with 0.01M glucose. Degree of dissociation of Na_2SO_4 is :
1) 75% 2) 50% 3) 25% 4) 85%

21. When mercuric iodide is added to the aqueous solution of potassium iodide, the
1) freezing point is raised 2) freezing point does not change
3) freezing point is lowered 4) boiling point does not change

Numerical Value Type Questions

22. A solution prepared by dissolving 0.8gm of naphthalene in 100g of CCl_4 has a boiling point elevation of 0.4°C. A 1.24 g of an unknown solute in same amount of CCl_4 produced boiling point elevation of 0.62°C, then molar mass of unknown solute is

23. The molal freezing point constant for water is 1.85 K.kg $mole^{-1}$. The freezing point of 0.1m NaCl solution is ___ °C

24. Average osmotic pressure of human blood is 7.4 atm at 27°C, then total concentration of various solutes is

25. Consider equimolal aqueous solutions of $NaHSO_4$ and NaCl with ΔT_b and ΔT_b^1 as their respective boiling point elevations. The value of $\underset{V\to\infty}{Lt} \frac{\Delta T_b}{\Delta T_b^1}$ will be

26. 0.6 molar $MgCl_2$ and 1.2 molar sucrose sol. are isotonic then the percentage degree of dissociation of $MgCl_2$ is

27. Lowering of vapour pressure of 1.00 m solution of a non-volatile solute in a hypothetical solvent of molar mass 40g at its normal boiling Points is ___ torr.

LEVEL-II (ADVANCED)

Straight Objective Type Questions

1. For a dilute solution containing 2.5 g of non-volatile non-electrolyte solute in 100 g of water, the elevation in boiling point at 1 atm pressure is 2°C. Assuming concentration of solute is much lower than the concentration of solvent, the vapour pressure (mm of Hg) of the solution is (take K_b = 0.76 kg mol^{-1})
a) 724 b) 740 c) 736 d) 718

2. Molal depression constant for water is 1.86 K.Kg.$mole^{-1}$. The freezing point of a 0.05 molal solution of a non electrolyte in water is
a) -1.86^0C b) -0.93^0C c) -0.093^0C d) 0.93^0C

3. The relationship between osmotic pressure at 273K when 10g glucose (P_1), 10g urea (P_2) and 10 g sucorse (P_3) are dissoved in 250 ml of water is
a) $P_1 > P_2 > P_3$ b) $P_3 > P_1 > P_2$ c) $P_2 > P_1 > P_3$ d) $P_2 > P_3 > P_1$

4. If 0.1 M solution of glucose and 0.1 M solution of urea are placed on two sides of a semi-permeable membrane to equal heights, then it will be correct to say that
a) Glucose will flow towards urea solution
b) There will be no net movement across membrane
c) Urea will flow towards glucose solution
d) Water will flow from urea solution to glucose

5. **Set-I** **Set-II**

i) RBC in 0.5% NaCl solution A) Swells

ii) RBC in 1% NaCl solution B) Shrinks

iii) egg (outer shell removed in water)

iv) egg (outer shell removed in NaCl solution)

Incorrect match is

a) i - A b) ii - B c) iii - A d) iv - A

6. Which of the following statement is false?

a) Raoult's law states that vapour pressure of a component over a solution is proportional to its mole fraciton.

b) Osmotic pressure is given by the expression π= MRT where, M is molarity.

c) The correct order of osmotic pressures of 0.01 M aqueous solution of each compound is $BaCl_2$ > KCl> CH_3COOH > Sucrose.

d) Two sucrose solutions of same molarity prepared in different solvents will have same freezing point depressions.

7. Equimolar solutions of electrolytes in the same solvent have

a) Same B.P. but different F.P. b) Same F.P. but different B.P.

c) Same boiling and same freezing points d) Different boiling and different freezing point

8. Which of the following salt will have same value of Van't Hoff's factor [i] as that of $K_4[Fe(CN)_6]$

a) $Al_2(SO_4)_3$ b) NaCl c) $Al(NO_3)_3$ d) Na_2SO_4

9. Blood is isotonic with

a) 0.16 M NaCl b) Conc.NaCl c) 50% NaCl d) 30% NaCl

10. The Osmotic presure of blood is 8.21 atm at 37^0C. How much glucose is used per lit for an intravenous injection that is to isotonic with blood.

a) 180 gm b) 342 gm c) 58.06 gm d) 55.55 gm

11. If M_{normal} is the normal molecular mass and α is the degree of ionsation of $k_3[Fe(CN)_6)]$, then the abnormal molecular mass of the complex in the solution will be

a) $M_{normal}\,(1+2\alpha)^{-1}$ b) $M_{normal}\,(1+3\alpha)^{-1}$ c) $M_{normal}\,(1+\alpha)^{-1}$ d) equal to M_{normal}

12. 1.0 molal aqueous solution of an electrolyte X_3Y_2 is 25% ionized. The Boiling point of the solution is (k_b of H_2O = 0.52 K kg mol^{-1})

a) 375.5 K b) 374.04 K c) 377.12 K d) 373.25 K

13. pH of a 0.1M monobasic acid is found to be 2. Hence, its osmotic pressure at a given temp.

a) 0.1RT b) 0.11RT c) 1.1RT d) 0.01RT

14. 4g of Substance A, dissolved in 100g H_2O depressed the freezing point of water by 0.1^0C. While 4g of another substance B, depressed the f.pt by 0.2^0C. What is the relation between molecular weights of A and B.

a) $M_A = 4M_B$ b) $M_A = M_B$ c) $M_A = 0.5\,M_B$ d) $M_A = 2M_B$

15. The osmotic pressure of solution containing non-volatile, non-electrolyte solute is 7.6 atm at 27^0C then the boiling point of the same solution is (Assume that molality and molarity are same)

a) 126.25^0 b) 50.8^0 c) 100.16^0 d) 200.32^0

More than One correct answer Type Questions

16. In the depression of freezing point experiment, correct statements are:
    a) The vapour pressure of the solution is less than that of pure solvent
    b) The vapour pressure of the solution is more than that of pure solvent
    c) Only solute molecules solidify at the freezing point
    d) Only solvent molecules solidify at the freezing point

17. Cryoscopic constant value depends on
    a) molar mass of solvent in the solution
    b) molar mass of solute in the solution
    c) the enthalpy of vapourisation of solvent
    d) freezing point of solvent

18. When a solution containing nonvolatile solute is diluted with water
    a) Its vapour pressure increases
    b) Its osmotic pressure decreases
    c) Its boiling point decreases
    d) Its freezing point increases

Linked Comprehension Type Questions

Passage-I :

The addition of 3 gm of substance to 100 gm CCl_4 (M = 154 gm mol^{-1}) raises the boiling point of CCl_4 by 0.6°C. K_b (CCl_4) is 5.03d kg mol^{-1} k, k_f (CCl_4) is 31.8 kg mol^{-1} k and density of solution is 1.64 gm/ml.

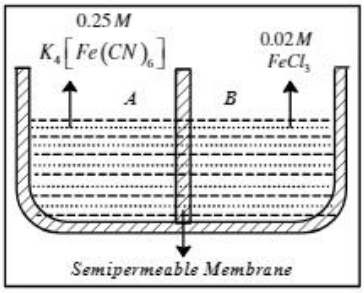
19. Calculate the depression in freezing point
    a) 3.79°C b) 0.018°C c) 4.65°C d) 251.5°C

20. The Osmotic pressure at 298K is :
    a) 3.79 atm b) 0.018 atm c) 4.65 atm d) 251.5 atm

21. The molar mass of the substance is :
    a) 37.9 b) 18 c) 46.5 d) 251.5

Passage-II :

$FeCl_3$ on reaction with $K_4[Fe(CN)_6]$ in aqueous solution gives a blue colour. These two solutions are separated by a semipermeable membrane as shown in the figure. Both the solutions are sufficiently dilute & osmosis will take place as there is a difference in concentration of the solutions. Imagine the experiment is carried out at 27°C. The osmotic flow will take place in one direction and not in both.



22. Which of the following observations may be recorded after a while?
    a) No change in colour in either of the compartments
    b) Blue colour appears in compartment A
    c) Blue colour appears in compartment B
    d) Blue colour appears in both A and B

23. In the given experiment, with passage of time, the concentrations are expected to change as
    a) Concentration of $FeCl_3$ Decreases
    b) Concentration of $K_4[Fe(CN)_6]$ Increases
    c) Concentration of $FeCl_3$ Increases
    d) Concentration of Both Remain Unchanged

24. The osmotic pressure (π) of $FeCl_3$ Solution can be expressed as
    a) 6 R b) 18 R c) 24 R d) 5 R

Passage-III :

$CoCl_3 . xNH_3$ is a complex compound obtained by dissolving $CoCl_3$ in ammonia. The complex compound is denoted at $[Co(NH_3)_{6-x}]Cl_{3-x}$ (soluble 100% ionisable). The chlorides shown inside the square brackets are not ionisable.

The salt ionises as $[Co(NH_3)_{6-x}Cl_x]Cl_{3-x} \rightarrow [Co(NH_3)_{6-x}Cl_x]^{+(3-x)} + (3-x)Cl^-$

25. 0.1M "$CoCl_3.nNH_3$" solution has same osmotic pressure as 0.1M glucose solution. What is 'n' ?
a) 2 b) 3 c) 4 d) 5

26. 0.1m $CoCl_3.xNH_3$ solution is found to boil at 100.104^{0}C (Kb of water = 0.52KKg mol^{-1}) what x? ('α' of salt = 1)
a) 2 b) 3 c) 4 d) 5

27. 66% of chloride content of the complex $CoCl_3.nNH_3$ can be precipitated by excess of aq.$AgNO_3$. What is the Van't hoff factor of the complex for 50% ionisation?
a) 2 b) 3 c) 4 d) 2.5

Matrix Matching Type Questions

28.

Column-I	Column-II
A) π_1 : 0.1M NaCl; π_2 : 0.1M urea	p) π_1 is Isotonic to π_2
B) π_1 : 0.1M NaCl; π_2 : 0.1M Na_2SO_4	q) No net migration of solvent across the membrane
C) π_1 : 0.1M NaCl; π_2 : 0.1M KCl	r) π_1 is hypertonic to π_2
D) π_1 : 0.1M $CuSO_4$; π_2 : 0.1M sucrose	s) π_1 is hypotonic to π_2

29.

Column-I	Column-II
A) 0.1M $Al_2(SO_4)_3$	p) Solution with highest boiling point
B) 0.1MAlPO$_4$	q) Van't Hoff factor is greater than 1
C) 0.1 M urea	r) Solution with lowest osmotic pressure
D) 0.1 M $MgCl_2$	s) Solution with lowest freezing point

30. Match with isotonic solutions.

Column-I	Column-II
A) 6% w/v urea (M=60) aqueous solution	p) 0.5M K_2SO_4(aq) solution ($\alpha = 1$)
B) 5.85% w/v NaCl	q) 0.1M $K_3[Fe(CN)_6]$ (aq) solution ($\alpha = 1$)
C) 0.2 M NH_4Cl aq. solution ($\alpha = 1$)	r) 36% w/v glucose (aq) solution
D) 0.2 M $K_3[Fe(CN)_6]$ aq solution ($\alpha = 1$)	s) 18% w/v glucose(aq) solution

Integer Type Questions

31. 718.2 g of sucrose is dissolved in 1 kg of water. If '100+x' is the difference between the melting and boiling point of the solutions, then report the value of 'x'.

32. The boiling point of an aqueous solution is found to be 100. 28^{0}C. Then the freezing point of the same solution is $-x^0$C. What is the value of 'x' ?

33. A solution of a non-volatile solute in ethanol (B.P of ethanol = 78.4^{0}C) has a vapour pressure of 730mm of Hg at 78.4^{0}C. To what temperature, the above solution must be heated have the pressure of 760mm of Hg? K_b of ethanol = 1.22 k Kg mol^{-1}. Express temperature of 10x. x is __

34. For $[CrCl_3xNH_3]$, elevation in boiling point of one molal solution is double of one molal urea solution. Hence, the value of x (assuming complete dissociation) is ___

35. Mole fraction of solute in some solution is 1/n. If 50% of solute molecules dissociate into two parts and remaining 50% get dimerised, new mole fraction of solvent becomes 4/5. Find value of n.

KEY SHEET (LECTURE SHEET)

EXERCISE-I

LEVEL-I

1) 1 2) 3 3) 3 4) 2 5) 4 6) 1 7) 3 8) 2
9) 3 10) 3 11) 1 12) 1 13) 1 14) 2 15) 1 16) 3
17) 500 18) 1.5 19) 0.2

LEVEL-II

1) a 2) b 3) b 4) b 5) d 6) b 7) a 8) a
9) d 10) c 11) d 12) d 13) ac 14) bc 15) bcd 16) acd
17) a 18) b 19) b 20) A-rs; B-q; C-pr; D-r
21) A-rs; B-ps; C-q; D-q 22) 2 23) 2

EXERCISE-II

LEVEL-I

1) 3 2) 2 3) 3 4) 4 5) 2 6) 1 7) 1 8) 3
9) 2 10) 1 11) 3 12) 744.8 13) 29.67 14) 16.66 15) 0.8

LEVEL-II

1) d 2) a 3) b 4) c 5) b 6) d 7) a 8) c
9) c 10) a 11) a 12) abc 13) ab 14) abcd 15) abc 16) bd
17) ad 18) bc 19) b 20) c 21) b 22) a 23) d 24) b
25) b 26) d 27) A-r; B-p; C-q; D-s 28) A-s; B-p; C-q; D-r
29) A-s; B-r; C-q; D-p 30) A-r; B-s; C-p; D-q
31) 6 32) 3

EXERCISE-III

LEVEL-I

1) 1 2) 2 3) 3 4) 4 5) 3 6) 2 7) 2 8) 4
9) 3 10) 3 11) 4 12) 1 13) 3 14) 4 15) 1 16) 1
17) 3 18) 3 19) 4 20) 1 21) 1 22) 128 23) –0.37 24) 0.3
25) 1.5 26) 50 27) 29.23

LEVEL-II

1) a 2) c 3) c 4) b 5) d 6) d 7) d 8) a
9) a 10) c 11) b 12) b 13) b 14) d 15) c 16) ad
17) acd 18) abcd 19) a 20) c 21) d 22) a 23) c 24) c
25) b 26) c 27) a 28) A-r; B-s; C-pq; D-r
29) A-pqs; B-q; C-r; D-q 30) A-s; B-r; C-q; D-p 31) 5 32) 1
33) 8 34) 4 35) 6

PRACTICE SHEET

EXERCISE-I

(Types of Solutions, Molarity, Normality, Molality, Mole fraction)

LEVEL-I (MAIN)

Straight Objective Type Questions

1. A mixture of salt and water can be separated by
   1) filtration 2) decantation
   3) crystallisation 4) kept long standing

2. Occlusion of Hydrogen on Palladium is an example for ____ type solution
   1) gas in solid 2) solid in gas
   3) gas in liquid 4) liquid in gas

3. **Column-I**
   A) Gaseous solution
   B) Liquid solution
   C) Solid solution
   D) Colloidal solution

   Column-II
   1) German silver
   2) Milk
   3) Sand in water
   4) Aqueous Alcoholic solution
   5) Air

	A	B	C	D
1)	5	4	1	2
2)	1	3	2	5
3)	4	2	5	1
4)	2	3	1	4

4. A one molal solution is one that contains
   1) 1 g. of the solute in 1000 g. of solvent 2) 1g. mole of solute in 1000 ml of solution
   3) 1 g. mole of solute in 22.4 lits of solution 4) 1g. mole of solute in 1000 g. of solvent

5. 11.1 g. of $CaCl_2$ is present in 100 ml of the aqueous solution. The chloride ion concentration is
   1) 1M 2) 2M 3) 0.5M 4) 0.2M

6. 100 ml each of 1M $AgNO_3$ and 1M NaCl are mixed. The nitrate ion conc. in the resulting sol. is
   1) 1M 2) 0.5M 3) 0.75M 4) 0.25 M

7. Three solutions of HCl having normality 12N, 6N and 2N are mixed to obtain a solution of 4N which among the following volume ratio is correct for the above three solutions
   1) 1:1:5 2) 1:2:6 3) 2:1:9 4) 1:2:4

8. Which of the following aqueous solutions is more concentrated [Assume the density of the solution as 1g/ml]
   1) 1M Glucose 2) 1m Glucose 3) 0.5m Glucose 4) 0.5M Glucose

9. The mole fraction of solvent in 0.1 molal aqueous solution is
   1) 0.9982 2) 0.0017 3) 0.017 4) 0.17

10. A 6.9 M solution of KOH in water contains 30% by mass of KOH. Calculate the density of the solution
    1) 1.288 2) 1.153 3) 2.213 4) 1.166

Numerical Value Type Questions

11. A 20%(W/W) solution of NaOH is 5 M. The density of the solution is

12. You are given 500 ml of 2NHCl and 500 ml of 5N HCl what will be the maximum volume of 3M HCl that you can make from these two solutions.

13. How many kilograms of wet NaOH containing 10% water are required to prepare 60 litre of a 0.5 M Solution?

14. Calculate the molarity of chloride ions in a solution when 3 litre of 4M NaCl and 4 litre of 2M $CoCl_2$ are mixed and diluted to 10 litre.

LEVEL-II (ADVANCED)

Straight Objective Type Questions

1. A sample of H_2SO_4 is labelled as 9.8% by weight. Its specific gravity is 1.8g/cc. Volume of this solution required to prepare 180 ml of 0.2 molar H_2SO_4 solution is
   a) 20 ml b) 40 ml c) 10 ml d) 50 ml

2. 10.6 g of a substance of molecular weight 106 was dissolved in 100 ml. 10 ml of this solution was pipetted out into a 1000 ml flask and made up to the mark with distilled water. The molarity of the resulting solution is
   a) 1 M b) 10^{-2} M c) 10^{-3}M d) 10^{-4} M

3. The concentration of a 100 ml sol. containing 'x' grams of Na_2CO_3 is yM. The values of x and y are
   a) 2.12, 0.05 b) 1.06, 0.2 c) 1.06, 0. 1 d) 2.12, 0.1

4. 100 ml of ethyl alcohol [d = 0.92 g/ml] and 900 ml of water [d = 1 g/ml] are mixed to form 1 lit solution. The Molarity and molality of the resulting solution are
   a) 2M and 2m b) 2M and 2.415m c) 2.2M and 1.1m d) 2M and 1m

5. Aqueous NaOH solution is labelled as 10% by weight mole fraction of the solute in it is
   a) 0.05 b) 0.0476 c) 0.052 d) 0.52

6. The maximum allowable level of Nitrates in drinking water as set by U.S. is 45mg NO_3^- ions per dm^3, the level in ppm is
   a) 15 b) 30 c) 45 d) 60

7. Molarity and molality of a solution of an liquid (mol. wt. = 50) in aqueous solution is 9 and 10 respectively. What is the density of solution?
   a) 1 g/cc b) 0.95 g/cc c) 1.05 g/cc d) 1.35 g/cc

8. An aqueous solution of ethanol has density 1.025 g/ml and it is 2 M. What is the molality of this solution?
   a) 1.79 b) 2.143 c) 1.951 d) none of these

9. 0.2 mole of HCl and 0.2 mole of barium chloride were dissolved in water to produce a 500 ml solution. The molarity of the Cl^- ions is :
   a) 0.06 M b) 0.09 M c) 1.2M d) 0.80M

10. Calculate the molality of 1 L solution of 80% H_2SO_4 (w/V), given that the density of the solution is 1.80 g mL^{-1}.
    a) 8.16 b) 8.6 c) 1.02 d) 10.8

11. Which of the following solution is more concentrated?
    a) 0.3% H_3PO_4 b) 0.3M H_3PO_4 c) 0.3m H_3PO_4 d) 0.3N H_3PO_4

12. Molarity of 1m aqueous NaOH solution [density of the solution is 1.02 g/ml]
a) 1M b) 1.02 M c) 1.2 M d) 0.98 M

13. A gaseous mixture contain four gases A, B, C and D. The mole fraction of 'B' is 0.5. The mole fraction of 'A' is
a) 0.525 b) 0.375 c) 0.625 d) 0.732

14. We have 100 ml of 0.1 M KCl solution to make it 0.2 M
a) evaporate 50 ml H_2O b) evaporate 50 ml solution
c) add 0.1 Mole KCl d) add 0.01 Mole KCl

15. Fluoxymesterone, $C_{20}H_{29}FO_3$, is an anabolic steroid. A 500 ml solution is prepared by dissolving 10.0 mg of the steroid in water, 1.0 ml portion of this solution is diluted to a final volume of 1.00 L. What is the resulting molarity?
a) 1.19×10^{-10} b) 1.19×10^{-7} c) 5.95×10^{-8} d) 2.38×10^{-11}

16. Concentrated HNO_3 is 63% HNO_3 by mass and has a density of 1.4 g/ml. How many millilitres of this solution are required to prepare 250 mL of a 1.20 M HNO_3 solution?
a) 18.0 b) 21.42 c) 20.0 d) 14.21

17. A certain public water supply contains 0.10 ppb (part per billion) of chloroform ($CHCl_3$). How many molecules of $CHCl_3$ would be obtained in 0.478 mL drop of this water? (assumed d=1 g/ml)
a) $4 \times 10^{-3} \times N_A$ b) $10^{-3} \times N_A$ c) $4 \times 10^{-10} \times N_A$ d) None of these

More than One correct answer Type Questions

18. Regarding molarity, which of the following statements are correct
a) units of molarity gm-moles kg^{-1} b) molarity of dibasic acid is half of its normality
c) $\frac{\text{Normality} \times \text{GEW}}{\text{GMW}}$ d) Molarity always equals to its molality

19. Correct expressions among the following are : (ρ-density of solution; M-molarity of solution, M_2-Molar mass of solute; m-molality ; X_2-Mole fraction of solute)
a) $m = \frac{1000M}{1000\rho - MM_2}$ b) $X_2 = \frac{mM_1}{1000 + mM_1}$ c) $X_2 = \frac{MM_1}{M(M_1 - M_2) + \rho}$ d) $m = \frac{\rho - MM_2}{M}$

20. 30 mL of CH_3OH (d = 0.8 g/cm^3) is mixed with 60 ml of C_2H_5OH (d = 0.92 g/cm^3) at 25^{0}C to form a solution of density 0.88 g/cm^3. Select the correct option :
a) Molarity and molality of resulting solution are 6.33 and 13.59 respectively
b) The mole fraction of solute and molality are 0.385 and 13.59 respectively
c) Molarity and % change in volume are 13.59 and zero respectively
d) Mole fraction of solvent and molality are 0.615 and 13.59 respectively

21. Solutions containing 23g HCOOH is/are:
a) 46 g of 70% $\left(\frac{w}{V}\right)$ HCOOH ($d_{solution}$ = 1.40 g/ml)
b) 50 g of 10M HCOOH ($d_{solution}$ = 1 g/ml)
c) 50 g of 25% $\left(\frac{w}{w}\right)$ HCOOH d) 46g of 5 M HCOOH ($d_{solution}$ = 1 g/ml)

Matrix Matching Type Questions

22.

Column-I	Column-II
A) Amount of urea to be dissolved in 500 ml of 0.1 M solution	p) 3 gr solute
B) 1 lit of 0.05 M propanol solution contains	q) 0.05 mole solute
C) 10 gr of glucose in 100 gm of water	r) Mole fraction = 0.0089 of solute
D) Pure water of density 1 gm/mol	s) Molality = 55.5

Integer Type Questions

23. 29.2% w/w HCl stock solution has a density of 1.25 gm/ml. The molecular weight of HCl is 36.5 g/mole. The volume of stock solution required to prepare a 200 ml solution of 0.4 M HCl is

EXERCISE-II

(Vapour Pressure, Raoult's Law, Ideal & Non-ideal solutions, Henry's Law, Azeotropic Mixture)

LEVEL-I (MAIN)

Straight Objective Type Questions

1. The Henry's law constant for solubility of N_2 gas in water at 298k is 1.0×10^5 atm. The mole fraction of N_2 in air is 0.8. The number of moles of N_2 from air dissolved in 10moles of water at 298k and 5 atm pressure is:

1) 4×10^{-4} 2) 4.0×10^{-5} 3) 5.0×10^{-4} 4) 4.0×10^{-6}

2. According to Henry's Law, the partial presure of gas (P_g^l) is directly, propotional to molefraction of gas in dissolved state, i.e., $P^l_{gas} = K_H.X_{gas}$. Which are Correct.

1) K_H is charecteristic constant for a given gas solute system
2) Higher is the value of K_H, lower is solubility of gas for a given partial pressure of gas
3) K_H has temperature in dependence
4) all of these

3. **(A) :** In a pressure cooker, the water is brought to boil. The cooker is then removed from the stove, Now on removing the head of the pressure cooker, the water starts boiling again.

(R) : The impurties in water bring down its boiling point.

1) Both (A) and (R) are true and (R) is the correct explanation of (A)
2) Both (A) and (R) are true and (R) is not the correct explanation of (A)
3) (A) is true but (R) is false 4) (A) is false but (R) is true

4. A liquid is in equilibrium with its vapour at its boiling point, on the average, the molecules in the two phases have equal

1) Inter molecular forces 2) Potential energy
3) Temperature 4) Kinetic energy

5. **(A) :** For two solutions, 0.1m aqueous solution of glucose and 0.1 m urea in benzene, the lowering of vapour pressure is same.

(R) : Vapour pressure is always lowered when non–volatile solute is added to water.

1) Both (A) and (R) are true and (R) is the correct explanation of (A)
2) Both (A) and (R) are true and (R) is not the correct explanation of (A)
3) (A) is true but (R) is false 4) (A) is false but (R) is true

6. The vapour pressure of an aqueous solution of sucrose at 373 K is found to be 750 mm Hg. The molality of the solution at the same temperature will be :
1) 0.26 2) 0.65 3) 0.74 4) 0.039

7. Water boils at lower temperature on high altitudes because
1) atmospheric pressure is high there
2) atmospheric pressure is lower there
3) water is weakly Hydrogen bonded there
4) water in pure form is found there

8. In Ostwald's dynamic method, the loss in weight in solvent bulb is directly proportional to :
1) P 2) P^0 3) $P^0 - P$ 4) $\frac{P^0 - P}{P^0}$

9. The vapour pressure of a solution of 5g of a non-electrolyte in 100g water at a particular temperature is 2950Pa and that of pure water at the same temperature is 3000Pa. The molar mass of the solute is
1) 54 g mol^{-1} 2) 119 g mol^{-1} 3) 179 g mol^{-1} 4) 229 g mol^{-1}

10. Consider a binary mixture of volatile liquids. If at $X_A = 0.4$ the Vapour pressure of solution is 580 torr than the mixture could be ($P_A^0 = 300$ torr, $P_B^0 = 800$ 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}

11. Which of the following show not deviation from raoult's law?
1) $C_2H_5OH + H_2O$ 2) HNO_3 & H_2O 3) $CHCl_3$ & CH_3COCH_3 4) C_6H_6 & $C_6H_5CH_3$

Numerical Value Type Questions

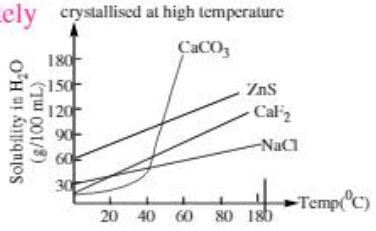
12. At 300 K 40 ml of O_3 dissolves in 100 g of water at 1 atm. What mass of O_3 dissolved in 400 g of water at a pressure of 4 atm at 300 K.

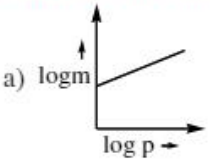
13. O_2 is bubbled through water at 293K, assuming that O_2 exerts a partial pressure of 0.98 bar, the solubility of O_2 in $gm.L^{-1}$ is (Henry's law constant = 34 k bar)

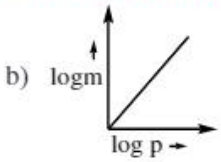
LEVEL-II (ADVANCED)

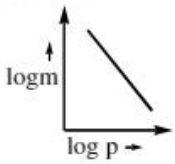
Straight Objective Type Questions

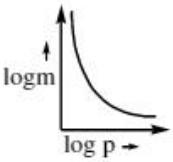
1. In the given plot, which compound would be the most approximately to be easily purified by recrystallisation from water?
a) NaCl
b) $CaCO_3$
c) CaF_2
d) ZnS



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

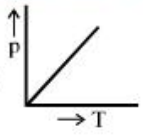
b) 

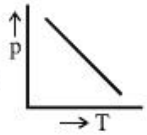
c) 

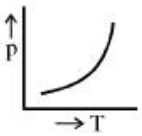
d) 

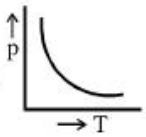
3. Partial pressure needed to dissolve 21 mg of CO_2 in 100 gr of water at 298K is (K_H for CO_2 is 2.937 KPa m^3 mol^{-1})
a) 14 KPa b) 7 KPa c) 121 KPa d) 79 KPa

4. The graph obtained by taking vapour pressure (P) of a liquid on y-axis and temperature (T) on x-axis will be

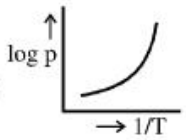
a) 

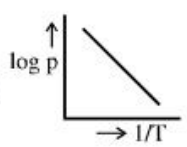
b) 

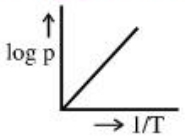
c) 

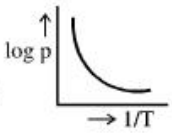
d) 

5. Which of the following represents the graph between log p (on Y-axis) and 1/T (on X-axis)?

a) 

b) 

c) 

d) 

6. Which combination of vapour pressure, intermolecular forces and ΔH_{vap} (latent heat of vaporisation) is matched correctly.

	Vapour Pressure	Intermolecular	ΔH_{vap}
a)	High	Weak	Small
b)	High	Strong	Large
c)	Low	Weak	Large
d)	Low	Strong	Small

7. The vapour pressure of a solution having 2.0g of a solute X (molar mass 32 g mol^{-1}) in 100 g of CS_2 (vapour pressure 854 Torr) is 848.9 Torr. The molecular formula of the solute is

a) X b) X_2 c) X_4 d) X_8

8. Two beakers 1 and 2 containing 0.15 moles of naphthalene ($C_{10}H_8$) in 100gm of benzene and 31gm of glucose in 100gm of benzene respectively, are placed under a tightley sealed bell-jar at 298k. Calculate the weight fraction of naphthalene at equilibrium by assuming ideal behaviour

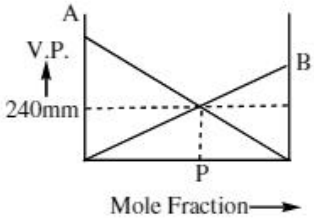
a) 0.70 b) 0.085 c) 0.35 d) 0.17

9. Three solutions are prepared by adding 'w' g of 'A' into 1kg of water, 'w' g of B into 1kg of water and 'w' g of c into 1kg of water (A, B, C are non electrolytic). Dry air is passed from these solutions in sequence ($A \rightarrow B \rightarrow C$). The loss in weight of A was found to be 2 gm while solution B gained 0.5gm and solution C lost 1gm then the relation between molar masses of A, B and C is :

a) $M_A : M_B : M_c = 1 : 2 : 3$ b) $P_{SA} : P_{SB} : P_{SC} = 5 : 3 : 1$

c) $M_A > M_B > M_C$ d) $M_C > M_A > M_B$

10. Which of the following statement regarding A, B and the solution of A and B is incorrect? (From the graph given)



a) Vapour pressure of A in pure state is greater than that of B in pure state at same temperature

b) Vapour pressure of solution at P is 480mm of Hg

c) Molefraction of B at P may be 0.60

d) At point P_1 the molefraction of A in the Vapour Phase which is in equilibrium with the solution is 0.6

11. At 25^0c, Vapour Pressure of Pure benzene and pure toluene are 93.4 and 26.9 torr respectively. A solution is prepared by mixing 60g benzene and 40g of toluene. What pressure should be maintained in the flask containing this solution so that it start boiling at 25^0 C.

a) 0.693mm b) 6.93 mm c) 69.327 mm d) 693.27 mm

12. Two liquids A and B have vapour pressure in the ratio $P_A^0 : P_B^0 = 1:3$ at a certain temperature. Assume A and B form an ideal solution and the ratio of mole fractions of A to B in the vapour phase is 4:3. Then the mole fraction of B in the solution at the same temperature is :
a) 1/5 b) 2/3 c) 4/5 d) 1/4

13. Given vapour pressure of Benzaldehyde is 400 torr at 154^0C and its normal BP is 179^0 C, what is its molar enthalpy of vaporisation, ΔH_{vap} ?
a) 67.9 KJ mol^{-1} b) 10.3 KJ mol^{-1} c) 41.2 KJ mol^{-1} d) 56.4 KJ mol^{-1}

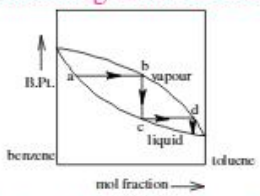
More than One correct answer Type Questions

14. A binary liquid solution of n-heptane and ethyl alcohol is prepared. Which of the following statements correctly represents the behaviour of this liquid solution?
a) The solution formed is an ideal solution
b) The solution formed is nonideal solution with positive deviation from Raoult's law
c) The solution formed is nonideal solution with negative deviation from Raoult's law
d) The solution is formed with the absorption of heat

15. Which of the following solutions exhibit positive deviation from Raoult's law
a) $H_2O + C_2H_5OH$ b) $C_6H_6 + C_2H_5OH$ c) $H_2O + HCl$ d) $CHCl_3 + (CH_3)_2CO$

16. Vapour pressure of water decreases from one atmosphere to one bar by dissolving glucose. (1 atm = 1.01 bar). Which statement(s) is(are) correct ? (P_{bar} = 1atm).
a) The solution contains approximately 1% of glucose by moles
b) The solution is nearly 9% w/w
c) The external pressure must be reduced by nearly 1% to boil the solution
d) The prepared solution boils at 100^0C

17. A graph is plotted with temperature of a solution containing benzene and toluene as a function of mole fraction. Choose the correct options.
a) a $\rightarrow$ b represents evaporation
b) b $\rightarrow$ c represents condensation
c) c $\rightarrow$ d represents evaporation
d) c $\rightarrow$ d represents condensation



18. One mole of a liquid A(vapour pressure = 300mm Hg) and 2 moles of a liquid B(Vapour pressure = 360mm Hg) are mixed. The mole fraction of A in the vapour mixture if found to be 5/17. Which of the following is correct?
a) $(\Delta H)_{mix} > 0$ b) $(\Delta S)_{mix} > 0$ c) $(\Delta V)_{mix} = 0$ d) $(\Delta G)_{mix} > 0$

Linked Comprehension Type Questions

Passage-I :

In a mixture of closely related liquids (such as benzene and toluene), the Raoult law states that the ratio p_A is proportional to the mole fraction of A in the liquid, $P_A = P^\circ_A x_A$. Mixtures that obey the law throughout the composition ranges from pure A to pure B are called ideal solutions. In ideal solution the solute also obeys Raoult's law. Then the total pressure is given by $P_{total} = P^0_A x_A + P^0_B x_B$

19. Each of the following solution obeys Raoult's law except
a) n-hexane + n-heptane b) Methanol + Ethanol
c) carbon tetrachloride + carbon disulphide d) chloroform + Acetone

20. For the solution which obeys Raoult's law, which of the following is incorrect?

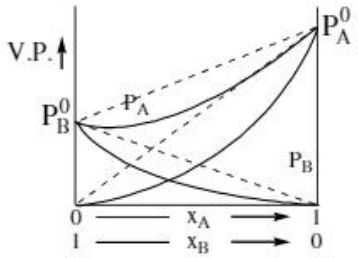
a) $\Delta V_{mix} = 0$ b) $\Delta H_{mix} = 0$ c) $\Delta S_{mix} = 0$ d) $P_{total} = P^0_A x_A + P^0_B x_B$

21. Benzene and toluene forms nearly an ideal solutions in which the mole fraction of the benzene is 0.4. If v.p. of pure benzene is 40 mmHg and toluene is 30 mmHg at a given temperature, then what is the mole fraction of toluene in the vapour phase?

a) 0.6 b) 0.47 c) 0.53 d) 0.74

Passage-II :

Answer the questions given below which are based on the following diagram.



22. Solution containing compounds A and B shows this type of deviation from ideal behaviour when

Attraction A .... B	ΔH_{mix}	ΔV_{mix}	B.P.
a) Larger than average of A...A, B...B attraction	+ve	+ve	larger than expected
b) As in (a)	–ve	–ve	As in (a)
c) Smaller than average of A...A, B...B attraction	+ve	+ve	Smaller than expected
d) As in (c)	–ve	–ve	As in (c)

23. This type of deviation is also expected in the following mixture

a) $C_2H_5OH + C_6H_{12}$ b) $C_2H_5Br + C_2H_5Cl$

c) $C_6H_5CN + C_2H_5CN$ d) $C_2H_5 - O - C_2H_5 + CHCl_3$

Matrix Matching Type Questions

24.

Column-I	Column-II
A) $P^o_A = 200$; $P^o_B = 300$	p) P = 250; $X_A = 0.5$
B) $P^o_A = 300$; $P^o_B = 200$	q) P = 275; $X_A = 0.25$
C) $P^o_A = 100$; $P^o_B = 400$	r) P = 264; $X_A = 0.33$
D) $P^o_A = 400$; $P^o_B = 100$	s) P = 290; $X_A = 0.1$

25. Solubitlity of a solid solute into water increases as the temperature is raised. Match the process listed in Column-I with the changes in appropriate properties listed in Column-II. (m = molality)

Column-I	Column-II
A) Gas + Water $\rightarrow$ solution	p) $\Delta H > 0$, $\Delta S > 0$
B) Solid + Water $\rightarrow$ solution	q) $\Delta H = 0$, $\Delta m = 0$
C) Saturated solution + solid solute	r) $\Delta H < 0$, $\Delta m < 0$
D) Super saturated solution + solid solute	s) $\Delta H < 0$, $\Delta S < 0$

26.

Column-I (Examples of Solution)	Column-II (Types of Solution)
A) Acetone + Aniline	p) +ve deviation from ideal behaviour
B) Water + CH_3OH	q) –ve deviation from ideal behaviour
C) Benzene + toluene	r) Ideal solution
D) n-Hexane + n-heptane	s) Colloids

27.

Column-I (Preparation of a)	Column-II (Always true)
A) Binary liquid mixture with stronger interaction than in constituent liquids	p) $(\Delta P)_{mixing} < 0$ (Where P is V.P.)
B) Binary liquid mixture with weaker interaction than in constituent liquids	q) $(\Delta G)_{mixing} < 0$
C) Binary of a nonvolatile electrolyte in a solvent (true solution)	r) $(\Delta H)_{mixing} < 0$
D) Mixture of a nonvolatile electrolyte in a solvent (true solution)	s) $(\Delta S)_{mixing} > 0$ 22)

Integer Type Questions

28. Vapour pressure of pure liquid solvent A is 0.8 atm when a non-volatile substance B is added to the solvent its vapur pressure drops to 0.6 atm. Calculate how many times the mole fraction of A to that of B.

29. A sample of air is saturated with benzene (v.p = 100mm Hg) at 298K, 750mm Hg pressure. If it is isothermally compressed to 1/3rd of initial volume, the final pressure is 410x. x is

EXERCISE-III

(ΔT_b, ΔT_f, π, Van't Hoff's factor)

LEVEL-I (MAIN)

Straight Objective Type Questions

1. Elevation in b.p of a molar glucose solution (d = 1.2 g mL^{-1}) is :
   1) $0.98K_b$ 2) K_b 3) $1.20\ K_b$ 4) $1.02K_b$

2. For an ideal solution containing a nonvolatile solute, which of the following expressions is correctly represented?
   1) $\Delta T_f = K_f m$ with $K_f = M_1RT_0^2/\Delta H_{fusion}$ 2) $\Delta T_f = K_f m$ with $K_f = RT_0^2/M_1 \Delta H_{fusion}$
   3) $\Delta T_f = K_f m$ with $K_f = M_1T_0^2/R\ \Delta H_{fusion}$ 4) $\Delta T_f = K_f m$ with $K_f = \Delta H_{fusion}/M_1RT_0^2$

3. A Thermometer designed by Beckman is useful to measure the absolute values of
   1) B.P. 2) F.P. 3) elevation of B.P 4) M.P.

4. The boiling point elevation constant for toluene is 3.32 K kg mol^{-1}. The normal boiling point of toluene is 110.7°C. The enthalpy of vaporization of the toluene would be nearly:
   1) 17.0kJ mol^{-1} 2) 34.0kJ mol^{-1} 3) 51.kJ mol^{-1} 4) 68.0 kJ mol^{-1}

5. After removing the hard shell of an egg by dissolving in dil. HCl, a semipermeable membrane is visible. If such an egg is kept in a saturated solution of common salt the size of the egg will :
   1) shrink 2) grow
   3) remain the same 4) first shrink and then grow larger

6. A 5% solution of cane sugar is isotonic with 0.5% of X. The molecular weight of substance X is
1) 34.2 2) 119.96 3) 95.58 4) 126.98

7. At 10°C, the osmotic pressure of urea sol. was formed to be 500 mm. The sol. is diluted 'x' times and the temp. raised to 25°C when the osmotic pressure was noticed to be 105.3mm, then 'x' is
1) 3 2) 4 3) 5 4) 12

8. At 273K, $100Cm^3$ of a solution containing 3gm of an unidentified solute exhibits an osmotic pressure of 2.24atm, then molar mass of the solute is
1) $88gmol^{-1}$ 2) $188gmol^{-1}$ 3) $300gmol^{-1}$ 4) $388gmol^{-1}$

9. The osmotic pressure of the solution obtained by mixing $200cm^3$ of 2% (mass-volume) solution of urea with $200cm^3$ of 3.42% solution of sucrose at 20°C is
1) 4 bar 2) 1.2 bar 3) 5.2 bar 4) 15.4 bar

10. Correct order of osmotic pressure of the following solution is
A) 34.2 gm L^{-1} of glucose B) 60 gm L^{-1} of urea
C) 90 gm L^{-1} of glucose D) 58.5 gm L^{-1} of NaCl
1) A < B < C < D 2) A < C < B < D 3) A < D < B < C 4) A < C < D < B

11. A complex of iron and cynanide ions is 100% ionised at 1m (molal). If its elevation in b.p. is 2.08^0, ($K_b = 0.52^0 mol^{-1}Kg$), then the complex is:
1) $K_3[Fe(CN)_6]$ 2) $Fe(CN)_2$ 3) $K_4[Fe(CN)_6]$ 4) $Fe(CN)_4$

12. Ratio of $\Delta T_b / K_b$ of 6% AB_2 and 9% A_2B (AB_2 and A_2B both are non-electrolytes) is 1molal in both cases. Hence atomic masses of A and B are respectively:
1) 60, 90 2) 40, 40 3) 44.65, 9.6 4) 40, 10

13. Which of the following statements is FALSE ?
1) Two sucrose solutions of same molality prepared in different solvents will have the same freezing point depression
2) The osmotic pressure (π) of solution is given by the equation π = MRT, where M is the molarity of the solution
3) The correct order of osmotic pressure of 0.01 M aqueous solution of each compound is $BaCl_2 > KCl > CH_3COOH >$ sucrose
4) Raoult's law states that the vapour pressure of a component over a solution proportional to its mole fraction

14. Arrange the following w.r.t their B.P.
I) 0.2 m ethylene glycol II) 0.12M K_2SO_4
III) 0.1m $MgCl_2$ IV) 0.12m KBr
1) I < IV < III < II 2) III < II < IV < I 3) II < IV < III < I 4) II < III < IV < I

15. A complex is represented as $COCl_3XNH_3$. Its 0.1 molal solution in water shows $\Delta T_f = 0.558K$. K_f for H_2O is 1.86K molality^{-1}. Assuming 100% ionization of complex and co-ordination number of Co is six, calculate formula of complex:
1) $[Co(NH_3)_6]Cl_3$ 2) $[Co(NH_3)_5Cl]Cl_2$ 3) $[Co(NH_3)_4Cl_2]Cl$ 4) $[CoCl_6]NH_3$

Numerical Value Type Questions

16. A decimolar solution of $K_4[Fe(CN)_6]$ at 300K is 50% dissociated, then, osmotic pressure of the solution is

17. The freezing point (in °C) of a solution containing 0.1 g of $K_3(Fe(CN)_6$ (Mol.wt, 329) in 100g of water (K_f = 1.86 K kg mol^{-1}) is ____ × 10^{-2}

18. In winter season at some places the temperature falls to –0.36^{0}C. The amount of ethylene glycol to be added to 300 gr of water to avoid the freezing is

19. Glucose is added to one litre water to such an extent that $\Delta T_f / k_f$ becomes equal to 1/1000, the weight of glucose added is :

LEVEL-II (ADVANCED)

Straight Objective Type Questions

1. A solution containing 25.6gm of sulphur dissolved in 1000gm of naphthalene gave a freezing point lowering of 0.680, then molecular formula of sulphur is (K_F for naphthalene = 6.8K kg mol^{-1})
   a) S_2 b) S_4 c) S_6 d) S_8

2. A radiator of motor vehicle was filled with 8.2L of water to which 2L of methanol (d=0.8gm/ml) were added, the lowest temp. at which the vehicle can be parked without a danger of getting water in the radiator to freeze is (K_f for water = 1.86 Km^{-1})
   a) –9.5°C b) –5.6°C c) –6.6°C d) –4.3°C

3. Van't Hoff's factor for 0.01M aqueous solution acetic acid is 1.04, the pH of that solution is
   a) 3.4 b) 6.4 c) 9.6 d) 10.6

4. Relative decrease in vapour pressure of an aqueous solution containing 2 moles $[Cu(NH_3)_3Cl]Cl$ in 3 moles H_2O is 0.50. On reaction with $AgNO_3$, this solution will form
   a) 1 mol AgCl b) 0.25 mol AgCl c) 0.5 mol AgCl d) 0.40 mol AgCl

5. The freezing point of 1 molal $CaCl_2$ aq.solution is –3.62^{0}C, (K_f = 1.86unit). The percentage ionisation of $CaCl_2$ is
   a) 94.6% b) 23.65 % c) 47.3% d) 69.73%

6. When a solution containing "W" g of urea in 1kg of water is cooled to –0.372^{0}C, 200g of ice is separated. If K_f for water is 1.86 k kg mol^{-1}. W is _____
   a) 4.8 b) 12 c) 9.6 d) 6

7. The depression in freezing poing is 0.93^{0}C then the osmotic pressure of aqueous solution of the given non-electrolyte at 27^{0}C is
   a) 12.3 atm b) 1.23 atm c) 6.15 atm d) 2.46 atm

8. Moles of K_2SO_4 to be dissolved in 12 mol water to lower its vapour pressure by 10 mm of Hg at a temperature at which vapour pressure of pure water is 50mm is:
   a) 3 mol b) 2 mol c) 1 mol d) 0.5 mol

9. Acetic acid dimerises in benzene during the determination of the freezing point, the molecular weight of acetic acid is found to be 108. Then the degree of association of acetic acid in benzene during this experiment is
   a) 89% b) 76% c) 44.5% d) 67.3%

10. A volatile solute AB is dissolved in water, in which mole fraction of water is 5/6. If 50% of molecules of AB get dissociated into A and B and remaining 50% get dimerised into $(AB)_2$. Then relative lowering of vapour pressure will
    a) Increase by 20% b) Increase by 25%
    c) Remain same because mass of solute is unchanged
    d) Remain same because no.of solute particles will not change

11. 3.24 g of $Hg(NO_3)_2$ [M-Wt = 324] dissolved in 1000g of water constitutes a solution having freezing point of 0.0558^0C while 21.68g of $HgCl_2$ (molar mass = 271) in 2000g of water constitutes a solution with a freezing point of -0.0744^0C. The K_f for water is 1.86 $\frac{K\,kg}{mol}$. About the state of ionisation of these two solids in water it can be inferred that
    a) $Hg(NO_3)_2$ and $HgCl_2$ both are completely ionized
    b) $Hg(NO_3)_2$ is fully ionized but $HgCl_2$ is fully unionized
    c) $Hg(NO_3)_2$ and $HgCl_2$ both are completely unionized
    d) $Hg(NO_3)_2$ is fully unionized but $HgCl_2$ is fully ionized

12. A solution containing 4.0 g of PVC in 2 litre of dioxane (industrial solvent) was found to have an osmotic pressure 3.0×10^{-4} atm at 27^0C The molecular mass of the polymer will be:
    a) 1.6×10^4 b) 1.6×10^5 c) 1.6×10^3 d) 1.6×10^2

More than One correct answer Type Questions

13. The osmotic pressure of a solution containing non-volatile, non-electrolyte solution is 7.6 atm at 27^0C. (Assume that molality and molarity are same)
    a) Molarity of the solution is 0.308M
    b) boiling point of the solution is 100.32^0C
    c) Freezing poing of the solution is -0.573^0C
    d) At 27^0C, the solution is isotonic with 10%(W/V) aqueous urea solution.

14. 9.5 g of $MgCl_2$ is dissolved in 100 g of water. The freezing point of the solution is -4.836^0C Then.
    a) Degree of dissociation of $MgCl_2$ is 80%
    b) The boiling piont of the solution is 100.96^0C
    c) Vant Hoff factor is 2.6
    d) Osmatic pressure of the solution considering molality and molarity are same is 24.63 atm at 27^0C.

15. Which of the following statements are correct for Van't Hoff's factor 'i' for a solution of weak electrolyte $A_X B_Y$.
    a) $i = 1-\alpha + X\alpha + Y\alpha$
    b) $i > 1$ at normal dilution
    c) 'i' increases more rapidly with dilution and attains a limiting value of (x + y) at infinite dilution
    d) the increase in 'i' with dilution is due to increase in molatiry of solution with dilution.

16. Which of the following has same Van't Hoff factor?
    a) KCl, 50% ionised b) K_2SO_4, 40% ionised
    c) $FeCl_3$, 30% ionised d) $SnCl_4$, 20% ionised

17. Among 0.1M NH_2CONH_2, 0.05M Na_3PO_4, 0.2 M NaCl and 0.075M $Al_2(SO_4)_3$ solutions (assume all electrolytes are completely ionized, neglect hydrolysis of anion).
    Correct statement(s) is/are
    a) The vapour pressure and freezing point are the lowest for $Al_2(SO_4)_3$
    b) The vapour pressure and freezing point are the highest for urea
    c) The elevation in boiling point is the highest for NaCl
    d) The depression in freezing point is the highest for NaCl

18. In which of the following reactions after 100% completion, the colligative property of the final solution is increased by "greater than 40%" than that of initial solution?
(Note: All salts $\alpha = 1$ except $Hg(CN)_2$. Precipitates removed, Ignore trace ions, Ignore volume changes, No limting reagent)

a) $\underset{(aq)}{AgNO_3} + \underset{(added)}{NaCl} \rightarrow AgCl\downarrow + \underset{(aq)}{NaNO_3}$

b) $BaCl_2 + \underset{(added)}{Na_2SO_4} \rightarrow BaSO_4\downarrow + \underset{(aq)}{2NaNO_3}$

c) $\underset{(aq)}{Hg(NO_3)_2} + \underset{(added)}{2KCN} \rightarrow \underset{(aq)\ (\alpha=q)}{Hg(CN)_2} + \underset{(aq)}{2KNO_3}$

d) $\underset{(aq)}{2Na_3PO_4} + \underset{(added)}{3BaCl_2} \rightarrow Ba_3(PO_4)_2\downarrow + 6NaCl$

19. "1m of $MgCl_2$" and 2m of urea, aqueous solutions are found to boil at same temperature. Hence we can say

a) $MgCl_2$ is 50% ionised
b) $MgCl_2$ is 66.6% ionised
c) Both solutions have same vapour pressure
d) Both solutions freeze at same temperature

Linked Comprehension Type Questions

Passage-I :

The freezing point of 0.2 molal solution of acetic acid in benzene is 277.65. Freezing point of pure benzene is 278.4 K and heat of fusion of benzene is 10.042kJ/mol. If molarity of solution is equal to molality, and acetic acid is found in equilibrium with its dimmer, then answer the following based on this data

20. K_f for benzene is

a) 3K × molality^{-1} b) 2K × molality^{-1} c) 5K × molality^{-1} d) 10K × molality^{-1}

21. The degree of association of acetic acid should be

a) 0.60 b) 0.5 c) 0.92 d) 0.75

22. Calculate the equilibrium constant for dimerisation of acetic acid

a) 10 b) 5 c) 20 d) 40

Passage-II :

A dilute solutions "x" moles of A in 1kg of solvent with molal elevation constant k_b. The solution dimerises in the solution. $2A \rightleftharpoons A_2$ (α be degree of association)

23. The Van't Haff factor will be :

a) $i = 1 - 2\alpha$ b) $i = 1 - \frac{\alpha}{2}$ c) $i = 1 + \frac{\alpha}{2}$ c) $i = 1 + \alpha$

24. The molecular weight observed will be :

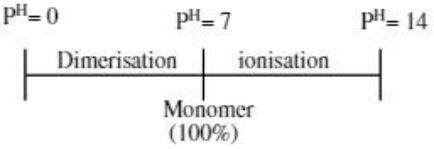
a) greater than actual molecular weight
b) lower than actual molecular weight
c) equal to the actual molecular weight
d) cannot be predicted by the given data

25. The degree of association is equal to :

a) $\alpha = \frac{(k_b x - \Delta T_b)}{\Delta T_b . 2}$ b) $\alpha = \frac{2(k_b x - \Delta T_b)}{K_b x.}$ c) $\alpha = 2 + \frac{2\Delta T_b}{k_b x}$ d) $\alpha = \frac{\Delta T_b}{2k_b x}$

Passage-III :

An organic compound (Mol.wt = 100) exist in "Monomeric form" in its neutral aqueous solution at 25^0C with every one unit decrease in P^H the substance dimerises by 50% extent out of the present monomers. With every one unit increase in P^H it ionises into two ions by 50% extent. (Ignore impact of H^+)



26. What is the molecular weight of the substance at P^H = 9 determined by colligatie methods?
a) 57.1 b) 62.8 c) 44.5 d) 79.2

27. At what P^H the molecular weight of the substance is determined to be 133.3 through colligative property experiments ?
a) 6 b) 5.3010 c) 4.690 d) 4

28. At P^H = 8, at 1 atm., for 1 molal aq.solution (K_b = 0.52unit), here, T_b = ?
a) 100.52^0C b) 100.26^0C c) 100.78^0C d) 101.04^0C

Matrix Matching Type Questions

29.

Column-I	Column-II
A) Ostwald-Walker	p) Osmotic pressure
B) Cotrell's method	q) Depression of F.P
C) Rast's camphor method	r) Elevation of B.P
D) Berkeley and Hartley's method	s) Lowering of vapour pressure

30.

Column-I (Solute)	Column-II (Van't Hoff Factor, i)
A) $AlCl_3$ if $\alpha = 0.8$	p) i = 3.4
B) $BaCl_2$ if $\alpha = 0.9$	q) i = 2.8
C) Na_3PO_4 if $\alpha = 0.9$	r) i = 3.8
D) $K_4[Fe(CN)_6]$ if $\alpha = 0.7$	s) i = 3.7

31.

Column-I	Column-II
A) Elevation of B.P.	p) Colligative property
B) Osmotic pressure	q) Ebullioscopic constant
C) Relative lowering in V.P.	r) Berkeley-Heartley method
D) Depression of F.P.	s) Ostwald and walker method

32.

Column-I (aqueous solution)	Column-II ('property' among the list A)
A) 0.1m $K_4[Fe(CN)_6]$($\alpha = 1$)	p) Highest vapour pressure of solution
B) 0.2m $[K_4[Hg(CN)_2Fe(CN)_6]$	q) Least colligative property
C) 1m glucose	r) Highest boiling point
D) 0.5m $MgCl_2$(α =0.75)	s) Highest Vant Hoff factor

Integer Type Questions

33. 50 g of ethylene glycol is dissolved in 170.3 g of water at -9.3^0C. The amount of water seperated as ice is _____g.

34. An aqueous solution of urea has freezing point of -0.604^0C At 27^0C. The osmotic pressure of the same solution is _____atm. (Assume molality and molarity are same).

35. 0.1 M KI and 0.2 M $AgNO_3$ are mixed in 3 : 1 volume ratio. The depression in freezing point of the resulting solution will be 0.1 x (Assume kf of H_2O = 2Kg/mol).

36. At 20^0C, the osmotic pressure of urea solution is 400 mm. The solution is diluted and the temperature is raised to 35^0C, when the osmotic pressure is found to be 105.3 mm. Determine the extent of dilution _____

37. 17.4% (mass/Vol) K_2SO_4 solution at 27^0C is isotonic to 5.85% (mass/Vol) NaCl solution at 27^0C. If NaCl is 100% ionised, the % ionisation of K_2SO_4 in aqueous solution is $x \times 10$ then the value of x is

38. ΔH_{vap} of the process, $A_{(l)} \rightleftharpoons A_{(vap)}$ is 460.6 Cal mol^{-1}. The normal boiling point of the A is 50 K. When pressure is increased to 10 atm, how many times its boiling point is increased?

39. The freezing point of an aqueous solution of containing 0.19 mol of KCN in 1 kg of water was found to be -0.704^0C. On adding 0.095 mol of $Hg(CN)_2$ to the above solution, the freezing point of the solution was found to be -0.530^0C. If the complex formation takes place according to the following equation: $Hg(CN)_2 + nKCN \rightleftharpoons K_n[Hg(CN)_{n+2}]$. The Van't Hoffs factor for the complex is

KEY SHEET (PRACTICE SHEET)

EXERCISE-I

LEVEL-I

1) **3** 2) **1** 3) **1** 4) **4** 5) **2** 6) **2** 7) **2** 8) **1**

9) **1** 10) **1** 11) **1** 12) **750** 13) **1.33** 14) **2.8**

LEVEL-II

1) **a** 2) **b** 3) **c** 4) **b** 5) **b** 6) **c** 7) **d** 8) **b**

9) **c** 10) **a** 11) **b** 12) **d** 13) **b** 14) **d** 15) **c** 16) **b**

17) **a** 18) **bc** 19) **ab** 20) **bd** 21) **ab**

22) **A-pq; B-pq; C-r; D-s** 23) **8**

EXERCISE-II

LEVEL-I

1) **1** 2) **4** 3) **3** 4) **4** 5) **4** 6) **3** 7) **2** 8) **3**

9) **1** 10) **1** 11) **4** 12) **4.8** 13) **0.05**

LEVEL-II

1) **b** 2) **a** 3) **a** 4) **c** 5) **b** 6) **a** 7) **d** 8) **d**

9) **d** 10) **d** 11) **c** 12) **a** 13) **c** 14) **bd** 15) **ab** 16) **abc**

17) **abc** 18) **bcd** 19) **d** 20) **c** 21) **b** 22) **b** 23) **d**

24) **A-pqrs; B-p; C-p; D-p** 25) **A-s; B-p; C-q; D-r**

26) **A-q; B-p; C-r; D-r** 27) **A-pqrs; B-qs; C-qs; D-pqs**

28) **3** 29) **5**

EXERCISE-III

LEVEL-I

1) **1** 2) **1** 3) **3** 4) **2** 5) **1** 6) **1** 7) **3** 8) **3**
9) **3** 10) **2** 11) **1** 12) **3** 13) **1** 14) **1** 15) **2** 16) **7.38**
17) **–2.72** 18) **3.6** 19) **0.18**

LEVEL-II

1) **d** 2) **a** 3) **a** 4) **a** 5) **c** 6) **c** 7) **a** 8) **a**
9) **a** 10) **b** 11) **b** 12) **b** 13) **ac** 14) **ac** 15 **abc** 16) **bd**
17) **bcd** 18) **cd** 19) **acd** 20) **c** 21) **b** 22) **b** 23) **b** 24) **a**
25) **b** 26) **c** 27) **a** 28) **c** 29) **A-s; B-r; C-q; D-p**
30) **A-p; B-q; C-s; D-r** 31) **A-pq; B-pr; C-ps; D-p**
32) **A-s; B-rs; C-pq; D-r** 33) **9** 34) **8** 35) **3** 36) **4** 37) **5**
38) **2** 39) **3**

ADDITIONAL PRACTICE EXERCISE

LEVEL-I (MAIN)

Straight Objective Type Questions

1. An ideal solution contains two volatile liquids $A(p^o = 100\,torr)$ and $B(p^o = 200 torr)$. If mixture contain 1mole of A and 4 mole of B then total vapour pressure of the distillate is:
   1) 150 2) 180 3) 188.88 4) 198.88

2. What is the osmotic pressure of 0.2 M $HX_{(aq)}$ solution at 300 K ? (given $Ka(HX = 8 \times 10^{-5})$)
   1) 4.926 atm 2) 0.5024 atm 3) 5.024 atm 4) none

3. Equal volumes of 0.1 M urea and 0.1 M glucose are mixed. The mixture will have
   1) lower osmotic pressure 2) same osmotic pressure
   3) higher osmotic pressure 4) none

4. Freezing point of the following equilibrium liquid solvent $\rightleftharpoons$ solid solvent is
   1) $\frac{\Delta H - \Delta G}{T\Delta S}$ 2) $\frac{\Delta H}{\Delta S}$ 3) $\frac{\Delta G}{\Delta S}$ 4) $\frac{\Delta S}{\Delta H}$

5. The osmotic pressure of a phenol solution in an organic solvent is determined to be 20% less than expected, it is due to
   1) Phenol is 20% ionised 2) Phenol is 20% dimerised
   3) Phenol is 40% dimerised 4) Phenol is 80% dimerised

6. Elevation in b.p. of a 0.5 molar glucose solution $(d = 1.2 gmL^{-1})$ is:
   1) $0.45K_b$ 2) K_b 3) $1.20K_b$ 4) $1.02K_b$

7. Select correct statement:
   1) B.P. of molal NaCl solution is twice that of 1 molal sucrose solution
   2) B.P. elevation of 1 molal glucose solution is half of the 1 molal KCl solution
   3) B.P. is a colligative property 4) All of the above

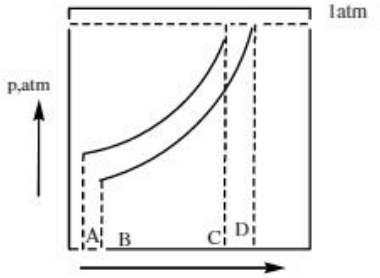
8. Elevation in b.p of an aqueous urea solution is 0.52^0. ($K_b = 0.52^0 mol^{-1}kg$). Hence, mole-fraction of urea in this solution is :

1) 0.982 2) 0.0567 3) 0.943 4) 0.018

9. A complex of iron and cyanide ions is 100% ionised at 1m (mol). If its elevation in b.p. is 2.08^0, ($K_b = 0.52^0 mol^{-1}kg$), then the complex is :

1) $K_3[Fe(CN)_6]$ 2) $Fe(CN)_2$ 3) $K_4[Fe(CN)_6]$ 4) $Fe(CN)_4$

10. What is the normal boiling point of the solution represented by the phase diagram?



1) A 2) B 3) C 4) D

11. During depression of freezing point in a solution, the following are in equilibrium

1) Liquid solvent, solid solute 2) Liquid solvent, solid solvent
3) Liquid solute, solid solute 4) Liquid solute, solid solvent

12. Absolute alcohol is prepared from rectified spirit by :

1) fractional distillation 2) steam distillation
3) azeotropic distillation 4) vaccum distillation

13. Two liquids A and B have vapour pressures 500 and 200 torr respectively at a certain temperature. In an ideal solution of the two, the mole fraction of A in vapour state, at which two liquids have equal partial pressures is

1) 0.5 2) 0.2 3) 0.286 4) 0.714

14. Two moles of a liquid A($p_A^o = 100$ torr) and 3 moles of liquid B($p_B^o = 150$ torr) from a solution having vapour pressure of 120 torr. Based upon this observation one can conclude :

1) Interactions between like molecules > those between unlike molecules
2) Interactions between like molecules < those between unlike molecules
3) Interactions between like molecules = those between unlike molecules
4) $\Delta S_{mixing} = 0$

15. Which of the following pairs of solutions are expected to be isotonic, temperature being the same?

1) 0.1 M glucose and 0.1 M $C_6H_5NH_3Cl$ 2) 0.1 M NaCl and 0.05 M $BaCl_2$
3) 0.1 M Na_2SO_4 and 0.1 MKNO_3 4) 0.1 M $BaCl_2$ and 0.075 M $FeCl_3$

16. Assuming degree of ionization to be unity in each case, which of the following equimolal solutions would freeze at the lowest temperature?

1) $[Pt(NH_3)_6]Cl_4$ 2) $[Pt(NH_3)_5Cl]Cl_3$ 3) $[Pt(NH_3)_4Cl_2]Cl_2$ 4) $[Pt(NH_3)_3Cl_3]Cl$

17. The boiling point of 0.1 m $K_4[Fe(CN)_6]$ is expected to be (K_b for water = 0.52K kg mol^{-1})
1) 100.52^{0}C 2) 100.10^{0}C 3) 100.26^{0}C 4) 102.6^{0}C

18. 0.004M Na_2SO_4 is isotonic with 0.01 M glucose. Degree of ionization of Na_2SO_4 is
1) 25% 2) 50% 3) 75% 4) 85%

19. Decomposition of non-volatile solute (A) into another non-volatile solute B and C. When dissolved in water follows first order kinetic as : $A(s) \xrightarrow{H_2O} 2B(s) + C(s)$
If initially two moles of A is dissolved in 360 g of H_2O and left for decomposition at constant temperature (25°C). then P_s in the given table is (assuming A, B, and C are miscible in water):

S.No.	Time	The vapour pressure of solution
1.	12hr	20mm Hg
2.	80hr	P_s

Vapour pressure of H_2O at 25°C is 24 mm Hg. (log2 = 0.30)
1) 15 mm Hg 2) 18.75 mm Hg 3) 24 mm Hg 4) 19.2 mm Hg

LEVEL-II

LECTURE SHEET (ADVANCED)

Integer Type Questions

1. A mixture of two immiscible liquids nitrobenzene and water boiling at 99^{0}C has a partial vapour pressure of water 733 mm and that of nitrobenzene 27 mm. Calculate the ratio of weights of water to nitrobenzene in the distillate

2. At a certain temperature pure liq. A & liq B have vapour pressures 10 torr and 37 torr respectively. For a certain ideal Solution of A, B the Vapour is in equilibrium with the liquid. Molefraction of A in the solution is 0.346. Then $\frac{P_B}{P_A}$ in the solution is.

3. The Vapour pressure of ethyl alcohol and methyl alcohol are 45 mm and 90mm. An ideal solution is formed at the same temperature by mixing 46g of C_2H_5OH with 40g of CH_3OH. Total vapour pressure of the solution is approximately x cm. x is _____.

4. An aqueous solution containing 5% by weight of urea and 10% by weight of glucose. What will be the ΔT_f of the solution (K_f for H_2O is 1.86^{0}K-molal)

5. A mixture of an organic liquid A and water distilled under one atmospheric pressure at 99.2^{0}C. How many grams of steam will be condensed to obtain 1.0g of liquid A in the distillate? (Vapour pressure of water at 99.2^{0}C is 739mm Hg. Molecular Weight of A = 123).

6. 29.2% (w/w) HC*l* stock solution has a density of 1.25 g ml^{-1}. The molecular weight of HC*l* is 36.5 g mol^{-1}. The volume (mL) of stock solution required to prepare a 200 ml solution of 0.4 M HC*l* is

7. Weight of solute (M.wt 60) that is required to dissolve in 180g water to reduce the vapour pressure to 4/5th of pure water is 50x g. x is

8. An aqueous sol: containg 10g of mixture of urea and glucose boils at 100.58^{0}C. Addition of a further 6.0g glucose to the above solution causes it to boil at 100.77^0 C mass percentage of urea in the original mixture is 7y then y = ?

9. The boiling point of an aqueous solution is found to be 100. 28^0C. Then the freezing point of the same solution is $-x^0$C. What is the value of 'x' ?

10. A decimolar solution of potassium ferrocyanide is 50% dissociated at 300k. It's Osmotic pressure is 7.482×10^x Nm^{-2}. Find x ?

11. A storage battery contains a solution of H_2SO_4 38% by weight. Van't Hoff factor if the ΔT_f is 29.08 (K_f = mol^{-1} kg) can be written as $x - 0.5$. Find x ?

12. 0.5 molal NaCl and 0.8 molal urea solutions are formed to be isotonic at 27^0 C then the degree of dissociation of NaCl under these conditions is reported as $x \times 10\%$. What is the value of 'x' ?

13. The boiling point of an aqueous solution of non volatile & non electrolytic solute is 100.15^0C.How many times the solution is diluted by water to get freezing point of resultant solution as -0.272^0C given K_b and K_f of water are 0.512 and 1.86 k kg mol^{-1}.

14. Vant Hoff factor for Hg_2Cl_2 assuming 100% ionisation is

15. The freezing point of a solution containing 28.335 cm^3 of ethylene glycol in 50 gm water is found to be $-34°$C. Assuming ideal behaviour, calculate the density of ethylene glycol in g/ml. K_f for water 1.86 k kg mol^{-1}.

16. An aqueous solution of 0.01 gr of a polymer in 10ml of water at 293K shows a 5.22 cm rise in the level (density of solution = 1gr/cc). If molecular weight of polymer is (4.67×10^y) then y = ?

17. Vapour pressure of pure liquid solvent A is 0.8 atm. When a non-volatile substance B is added to the solvent its vapour drops to 0.6 atm. Calculate how many times the mole fraction of A is to that of B.

18. Dissolution of 1.28 g of sulphur in 50 g of CS_2 causes the freezing point of solvent to be lowered by 0.010^0. If the sulphur molecule could be represented by S_x then x = ____ (K_f = 0.1 $KKgmol^{-1}$)

PRACTICE SHEET (ADVANCED)

Straight Objective Type Questions

1. HCl is labelled as 3.65% (w/v) 10ml of the solution is diluted to 1 lit. The proton concentration in the resulting solution is

   a) 10^{-3} M b) 2.5×10^{-2} M c) 7.5×10^{-2} M d) 10^{-2} M

2. A current of dry air was bubbled through a bulb contaning 30 g of an organic compound in 200 g of water, then through a bulb at the same temparature, containing water and finally through a tube contaning anhydrous $CaCl_2$, the loss in mass of bulb containing water was 0.03 g and gain in mass of $CaCl_2$ tube was 2g, then molecular mass of organic compound is

   (Hint: $\frac{P^o - P}{P^o} = \frac{\text{Loss in mass of solvent bulb}}{\text{Gain in mass of } CaCl_2 \text{ tube}}$)

   a) 180 b) 530.7 c) 280.7 d) 140.7

3. Equal masses of a solute are dissolved in equal amount of two solvents A and B respective molecular masses being M_A and M_B. The relative lowering of vapour pressure of solution in solvent A is twice that of the solution in solvent B. If the solutions are dilute, M_A and M_B are related as

   a) $M_A=M_B$ b) $2M_A=M_B$ c) $M_A=2M_B$ d) $M_A=4M_B$

4. The solubility of oxygen in water is 1.25×10^{-3} M at a pressure of 1atm and 298K. Solubility of atmospheric oxygen at sea level and the same temp will be:
a) 1.25×10^{-3} M b) 2.5×10^{-3} M c) 2.5×10^{-4} M d) 1.00×10^{-3} M

5. Determine Vapour pressure of water at 50^0C. If enthalpy of vaporisation of water is 40.6 KJ/mol
a) 10 cm b) 0.132 atm c) 100.15 mm d) 1.32 atm

More than One correct answer Type Questions

6. Azeotropic mixture of water and HCl boils at 381.5 K by distilling the mixture it is possible to obtain
a) pure HCl only b) neither HCl
c) nor water d) both water and HCl in pure state

7. $\underset{(solid)}{HgI_2} + \underset{(aq)}{2KI} \rightarrow K_2\underset{(aq)}{[HgI_4]}$ (100%)yield)
If exactly sufficient HgI_2 solid is dissoved in an aqueous potassium iodide solution, which of the following may be observed? (all substances are completely ionised)
a) The elevation in boiling point of water in the solution drops by 25%
b) Freezing point of the solution increased by 25%
c) 'ΔT_f' of KI solution decreases by 25%
d) Freezing point of the solution decreases by 25%

8. Which of the following are not true ?
a) Addition of HgI_2 solid to aqKI solution increases the B.Pt.
b) Addition of litre solid $AgNO_3$ to KCl solution decreases freezing point
c) Addition of litre solid NaOH to HCN solution increases the B.Pt.
d) 0.1M NaCl freezes at a lower temperature than 0.2M NaCl solution

9. Which of the following are not valid Van't hoff factors ?
a) 2.2 during ionisation of MX b) 1.6 during ionisation of MX_2
c) 0.3 during dimerisation of A d) 5.6 during ionisation of $K_4[Fe(CN)_6]$

10. Which of the following give lower abnormal molecular weight than ideal in a colligative experiment ?
a) NaCl b) Glucose c) $MgCl_2$ d) urea

Integer Type Questions

11. What is the maximum possible van't hoff factor of $COCl_3.xNH_3$ (assume all ammonia is co-ordinated)

12. 0.1m K_2SO_4 ionises to $10x$% to boil at same temperature as 0.2m glucose. What is x ?

13. 1 mol of each $MgCl_2$, NaCl and glucose are dissolved in 3kg of water. NaCl is completely ionised and $MgCl_2$ is '$10x$'% ionised. If the solution boils at 100.867^0C. What is x ? $K_b = 0.52 Kkgmol^{-1}$

14. $x \times 10^{-2}$ molar $K_4[Fe(CN)_6]$ with 100% ionisation shows an osmotic pressure of 2.46atm at 27^0C. What is x?

15. If HgI_2 is stoichiometrically dissolved in a KI solution to get $K_2[HgI_4]$ complex the osmotic pressure is decreased by $5x$%. what is x ?

16. Stoichiometric quantity of $AgNO_3$ solid is added to a KCl solution $10x$% variation is expected in the elevation in boiling point. What is x ?

17. An aqueous solution of urea has freezing point of -0.604^0C at 27^0C. The π of the same solution is ____ atm (assume m = M)

18. 2 g of a non-electrolyte solute dissolved in 200 g of water shows an elevation of boiling point of 0.026^0C. K_b of water is 0.52K. mole^{-1} Kg then the molecular weight of solute is $x \times 100$. What is the value of 'x'?

KEY SHEET (ADDITIONAL PRACTICE EXERCISE)

LEVEL-I (MAIN)

1) **3**	2) **3**	3) **2**	4) **2**	5) **1**	6) **1**	7) **2**	8) **4**	9) **1**	10) **4**
11) **2**	12) **1**	13) **1**	14) **2**	15) **4**	16) **1**	17) **3**	18) **3**	19) **2**	

LEVEL-II

LECTURE SHEET (ADVANCED)

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

PRACTICE SHEET (ADVANCED)

1) **d**	2) **a**	3) **c**	4) **a**	5) **bc**	6) **bc**	7) **abc**	8) **abd**	9) **acd**	10) **ac**
11) **4**	12) **5**	13) **5**	14) **2**	15) **5**	16) **0**	17) **8**	18) **2**		