

2

SOLUTIONS AND COLLIGATIVE PROPERTIES

Synopsis

2.1. Solutions

- (1) A solution is a homogeneous molecular mixture of two or more substances, whose composition can be varied within limits.
- (2) Molality, mole fraction and mass percent do not change with temperature since they involve mass.
- (3) Molarity and Normality change with temperature since they involve volumes.
- (4) For a dilute aqueous solution, one molar solution is more concentrated than one molal solution.
- (5) Normality :

Normality indicates the number of gram equivalent of solute present in one litre of the solution.

$$N = \frac{\text{gram equivalent}}{\text{Volume of solution in dm}^3}$$

$$N = \frac{\text{Weight of solute}}{\text{Gram Equivalent Weight} \times \text{Volume of solution in dm}^3}$$

- (6) Equivalent weight/mass (E) :

i. Equivalent weight of Acid :

$$E_{\text{Acid}} = \frac{\text{Formula weight(or) molecular weight}}{\text{Basicity}}$$

Number of replaceable hydrogen of acid is called Basicity.

Examples :

$$E_{\text{HCl}} = \frac{\text{MW}_{\text{HCl}}}{\text{H}^+} = \frac{36.5}{1} = 36.5$$

$$E_{\text{H}_2\text{SO}_4} = \frac{\text{MW}}{\text{Basicity}} = \frac{98}{2} = 49$$

ii) Equivalent weight of Base :

$$E_{\text{Base}} = \frac{\text{Formula weight of Base}}{\text{Acidity of Base}}$$

Number of replaceable hydroxyl group of base is called Acidity.

Example :

$$E_{\text{NaOH}} = \frac{\text{MW}_{\text{NaOH}}}{\text{OH}^-} = \frac{40}{1} = 40$$

$$E_{\text{Ba(OH)}_2} = \frac{\text{MW}}{\text{Basicity}} = \frac{171.33}{2} = 56$$

iii) Equivalent weight of Salt :

$$E_{\text{Salt}} = \frac{\text{Formula weight of salt}}{\text{Total charge of the cation or anion of the salt}}$$

Example :

$$E_{\text{NaCl}} = \frac{\text{FW}_{\text{NaCl}}}{\text{charge}} = \frac{58.5}{1} = 58.5$$

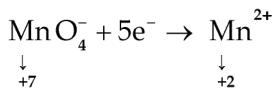
$$E_{\text{Na}_2\text{CO}_3} = \frac{\text{FW}}{\text{charge}} = \frac{106}{2} = 53$$

iii) Equivalent weight of oxidising agent :

$$E_{\text{oxidant}} = \frac{\text{Formula weight of oxidant}}{\text{Electrons gained by oxidant}}$$

Examples :1. KMnO_4 = Potassium permanganate

a) In acid medium :



Change in oxidation number = 7 - 2 = 5
(or) No. of electrons gained = 5

$$E_{\text{KMnO}_4} = \frac{\text{Formula weight of } \text{KMnO}_4}{\text{change in oxidation number}}$$

$$= \frac{158}{5} = 31.6$$

(7) Relationship between different types of concentration :

$$\text{i) } x_{\text{solute}} = \frac{m}{m + \frac{W_{\text{solvent}}}{\text{MW}_{\text{solvent}}}}$$

$$\text{ii) } M = \frac{M \times 1000}{\rho_{\text{solution}} \times 1000 - M (\text{MW}_{\text{solute}})}$$

$$\text{iii) } x_{\text{solute}} = \frac{M (\text{MW}_{\text{solvent}})}{M (\text{MW}_{\text{solvent}} - \text{MW}_{\text{solute}}) + \rho_{\text{solution}}}$$

$$\text{iv) } M = \frac{\% w/w \times \rho_{\text{solution}} \times 10}{\text{MW}_{\text{solute}}}$$

$$\text{v) } N = \frac{\% w/w \times \rho_{\text{solution}} \times 10}{\text{EW}_{\text{solute}}}$$

(8) Dilution law :

When a solution is diluted its molarity decreases and volume increases.

$$M_1 V_1 = M_2 V_2$$

M_1 = Molarity of the solution before dilution

V_1 = Volume of the solution before dilution.

M_2 = Molarity of the solution after dilution.

V_2 = Volume of the solution after dilution.

$(V_2 - V_1)$ = volume of water added

i) Mixing of solution :

When two or more acid solutions or basic solution are mixed then the resulting Molarity or Normality is given by

$$M = \frac{M_1 V_1 + M_2 V_2 + M_3 V_3 + \dots M_n V_n}{V_1 + V_2 + V_3 + \dots V_n}$$

$$N = \frac{N_1 V_1 + N_2 V_2 + N_3 V_3 + \dots N_n V_n}{V_1 + V_2 + V_3 + \dots V_n}$$

ii) When V_a ml of a strong acid of Normality N_a is mixed with V_b ml of a strong base of Normality N_b , then

- a) If $N_a V_a = N_b V_b$, the solution is neutral
- b) If $N_a V_a > N_b V_b$, the solution is acidic

$$\text{Resulting Normality} = \frac{N_a V_a - N_b V_b}{V_a + V_b}$$

iii) If $N_a V_a < N_b V_b$, the solution is basic

$$\text{Resulting Normality} = \frac{N_b V_b - N_a V_a}{V_a + V_b}$$

(9) Formality of a solution (F) indicates the number of gram-formula weight of the solute present in one litre of the solution.

(10) The amount of solute dissolved in 100g of a solvent to form a saturated solution at a given temperature is termed as the solubility of solute.

$$S = \frac{W_2}{W_1} \times 100, \text{ where } W_2 = \text{weight of solute},$$

W_1 = weight of solvent

(11) The enthalpy of dissolution of solute in water is expressed in terms of $\Delta H_{\text{solution}}$

$$\Delta H_{\text{solution}} = \Delta H_{\text{Hydration Energy}} + \Delta H_{\text{Lattice Energy}}$$

(12) Solubility of a gas in liquid is governed by Henry's law $p = K_H x$

Greater the value of K_H at given pressure lower is the solubility of gas in the liquid.

(13) The colligative properties of solutions depend on the total number of solute particles present in the solution.

- Since the electrolytes ionise and give more than one particle per formula unit, in solution, the colligative property of an electrolytic solution undergoing dissociation is always greater than that of a non-electrolyte of the same molar concentration.
- For different solutes of same molar concentration the colligative properties have greater value for the solution which gives more number of particles on ionisation.
- For different molar concentrations of the same solute, the colligative value has greater value for the more concentrated solution.
- For solutions of different solutes having same percentage strength, the colligative property has greater value for the solute with least molecular weight.
- For different solutions of same molar concentration of different non-electrolyte solutes, the colligative properties have the same value for all.

(14) For solutions of different solutes of the same percent strength, the magnitude of the colligative property is more for that solute which gives more number of particles which can be known from the knowledge of ionization behaviour and its molar mass.

For example,

- Amongst the 0.1 M solution of urea, NaCl , BaCl_2 , Na_3PO_4 and $\text{Al}_2(\text{SO}_4)_3$, the vapour pressure and freezing point will be the lowest while boiling point will be highest for $\text{Al}_2(\text{SO}_4)_3$.
- Amongst 0.1 percent solution of urea, glucose and sucrose, vapour pressure and freezing point are the lowest while boiling point is highest for urea.

iii. Amongst 0.1 M glucose solution and 0.15 M urea and 0.2 M sucrose solution, vapour pressure and freezing point are lowest and boiling point is highest for sucrose solution because number of particles/litre of the solution will be highest for sucrose.

(15) Ideal solutions :

- Raoult's law is valid only for **ideal solutions**.
- Ideal Solution is a solution in which the interactions between A and B are of the same magnitude as in the pure components, or is a solution which obeys Raoult's law at all temperatures and concentrations. An ideal solution will show no change in volume or enthalpy on mixing. i.e.

$$\Delta V_{\text{mixing}} = 0$$

$$\Delta H_{\text{mixing}} = 0$$

(16) Non-ideal solutions :

- Non-ideal solution is a solution in which A-B interactions are of different magnitudes than those in pure components,
Thus $\Delta V_{\text{mixing}} \neq 0$ and $\Delta H_{\text{mixing}} \neq 0$.
- These solutions do not obey Raoult's law.
- Non-ideal solutions showing **positive deviation** i.e. the total vapour pressure determined experimentally is higher than that calculated.

E.g. Ethanol and cyclohexane, the intermolecular H-bonding in ethanol is reduced on adding cyclohexane.

Positive deviation solution boils at a lower temperature than expected.

Also

$$\Delta V_{\text{mixing}} = +ve \text{ and } \Delta H_{\text{mixing}} = +ve.$$

Example :

- CHCl_3 and CH_3COCH_3
- CHCl_3 and C_6H_6
- CHCl_3 and $\text{C}_2\text{H}_5\text{OC}_2\text{H}_5$
- CH_3COOH and $\text{C}_6\text{H}_5\text{N}$
- H_2O and HCl
- H_2O and HNO_3
- CH_3COCH_3 and $\text{C}_6\text{H}_5\text{NH}_2$

iv. Non-ideal solutions showing **negative deviation** i.e. the total vapour pressure determined experimentally is lower than calculated from Raoult's law. This is due to stronger interactions than in pure components.

E.g. Chloroform and acetone, show -ve deviation due to new H-bonding between chloroform and acetone molecules. Solution showing -ve deviation boils at a relatively higher temperature than expected.

Also

$$\Delta V_{\text{mixing}} = -\text{ve} \text{ and } \Delta H_{\text{mixing}} = -\text{ve.}$$

Example :

- C_6H_6 and $\text{C}_2\text{H}_5\text{OH}$
- CHCl_3 and $\text{C}_2\text{H}_5\text{OH}$
- C_6H_6 and CH_3COCH_3
- CCl_4 and CHCl_3
- CCl_4 and C_6H_6
- CCl_4 and $\text{C}_6\text{H}_5\text{CH}_3$
- H_2O and CH_3OH
- H_2O and $\text{C}_2\text{H}_5\text{OH}$
- CS_2 and CH_3COCH_3
- C_6H_{14} and $\text{C}_2\text{H}_5\text{OH}$

(17) i. Freezing point depressions are larger than boiling point elevations for the same solution, because for any given solvent $K_f > K_b$. Therefore, it is more convenient to obtain the molar mass of unknown solute by

measuring the freezing point depression rather than the boiling point elevation.

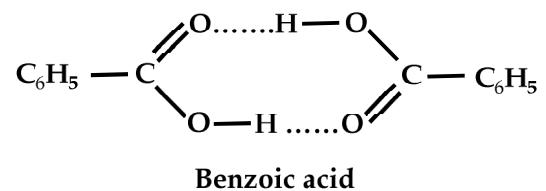
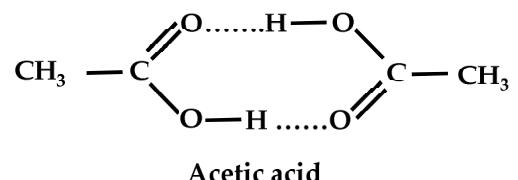
- Rast method for determining the depression in freezing point is an important method. It is based on the fact that depression in freezing point of camphor, if used as a solvent, is 20 times more than the depression, produced by the same amount of solute if water is used as a solvent (K_f of camphor = 40, K_f for water = 1.86). Further, Rast method involves the determination of melting point (which is easier) of camphor and its mixture with the given solute since camphor is solid.
 - Ethylene glycol is commonly added to car radiators to depress the freezing point of water. It is known as **antifreeze**.
 - NaCl or CaCl_2 (anhydrous) are used to clear snow on roads. It depresses the freezing point of water and reduces the temperature at which ice is expected to be formed.
 - Depression in freezing point occurs only when the concentration of the solute is more in the liquid phase than in the solid phase. However, if the concentration of solute is more in the solid phase than in the liquid phase, then there is a corresponding elevation in freezing point (e.g. in case of solid solution system).
- (18) i. The phenomenon of osmosis was first observed by **Abbe Nollet**.
- When outflow of water occurs from a cell, it is called **Exo-osmosis** and when inward flow of water into a cell takes place, it is called **Endo-osmosis**.
 - Gelatinous $\text{Cu}_2[\text{Fe}(\text{CN})_6]$ and gelatinous $\text{Ca}_3(\text{PO}_4)_2$ are artificial semipermeable membranes.
 - Semipermeable membrane of $\text{Cu}_2[\text{Fe}(\text{CN})_6]$ does not work in non-aqueous solutions because it gets dissolved in non-aqueous solvents.

- v. Silica gardens : When small crystals of copper sulphate, nickel sulphate etc. are added to 5% sodium silicate solution, the so called silica garden or chemical garden is produced because of diffusion of metal ions from crystals to form precipitate of metal silicate. These precipitate acts as semipermeable membrane around the crystal. Osmosis takes place and water flows from dilute sodium silicate solution to stronger salt solution. The membrane bursts at its weaker points so as to liberate more metal ions and these ions further give rise to new membrane. As a result, the growth of metal silicates looks like small plants.
- vi. Bursting of red blood cells when placed in water is due to osmosis.
- vii. A 0.91 % solution of pure NaCl is isotonic with human RBC's.
- viii. When a plant cell is placed in a **hypertonic solution**, the fluid from the plant cell comes out and the cell shrinks. This phenomenon is called **plasmolysis** and is due to **osmosis**.
- ix. The colligative property such as osmotic pressure is useful to determine relative molecular masses as compared to elevation of boiling point and depression in freezing point in which relative molecular masses are difficult to determine.
- x. Osmotic pressure method is the best method for determining the molecular masses of polymers since observed value of any other colligative property is too small to be measured with reasonable accuracy.

(19) Association, dissociation and vant hoff factor:

- i. Association generally occurs in the non-aqueous solvents.

Example:- Benzoic acid and acetic acid exist as dimers due to the formation of hydrogen bonds as shown below.



- ii. Dissociation generally occurs in the aqueous solution because in the aqueous solution the high dielectric constant of water helps in the dissociation of the molecules.
- iii. For solutions showing dissociation, the van't Hoff factor $i > 1$.
- iv. For solutions showing association, the van't Hoff factor $i < 1$.
- v. For solutions showing neither dissociation nor association, $i = 1$.

CLASSWORK

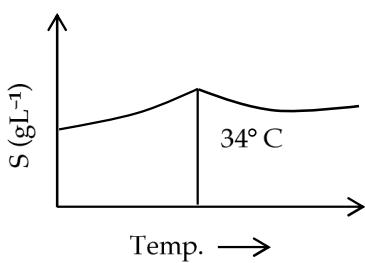
Multiple Choice Questions

1.1 SOLUTIONS :

- (1) Increasing temperature of an aqueous solution causes
 - (a) Decrease in molality
 - (b) Decrease in molarity
 - (c) Decrease in mole fraction
 - (d) Decrease in % w/w.
- (2) The amount of anhydrous Na_2CO_3 (Molecular weight = 106) present in 250 mL of 0.25 M solution is
 - (a) 6.225 g
 - (b) 6.0 g
 - (c) 66.25 g
 - (d) 6.625 g
- (3) 19.6 g of H_2SO_4 is present in 4 litres of a solution. The normality is
 - (a) 0.2
 - (b) 0.1
 - (c) 0.05
 - (d) 0.01
- (4) How many grams of a dibasic acid (Molecular weight = 200) should be present in 100 ml of aqueous solution to give a decinormal solution ?
 - (a) 1 g
 - (b) 10 g
 - (c) 2 g
 - (d) 20 g
- (5) A sugar syrup of weight 214.2 g contains 34.2 g canesugar. The molal concentration is
 - (a) 0.55
 - (b) 55
 - (c) 5.5
 - (d) 0.1
- (6) The molality of a 90% H_2SO_4 solution is
 - (a) 1.8
 - (b) 91.8
 - (c) 48.4
 - (d) 94.6
- (7) Tick the correct statement.
 - (a) For dilute aqueous solutions, molality \approx molarity
 - (b) For dilute aqueous solution molarity < molality
 - (c) Molarity of pure water is 5.55
 - (d) None of these
- (8) 18 grams of glucose is dissolved in 180 g water. The mole fraction of glucose is
 - (a) 0.6428
 - (b) 0.999
 - (c) 0.0099
 - (d) 0.099

- (9) An aqueous solution of urea is 5% in strength. The volume in which 1 g mole of it is dissolved will be
 - (a) 4.8 lit
 - (b) 20 lit
 - (c) 1.2 lit
 - (d) 2.4 lit
- (10) The molarity of a 0.5 N Na_2CO_3 will be
 - (a) 0.5
 - (b) 0.25
 - (c) 0.025
 - (d) 2.5
- (11) Conc. H_2SO_4 has a density of 1.9 g/mL and is 99% H_2SO_4 by weight. The normality of this acid is
 - (a) 19.19
 - (b) 38.38
 - (c) 9.595
 - (d) None of these
- (12) How much of KOH is needed to just neutralise 2000 cm³ of 0.05 N HNO_3 ?
 - (a) 560 g
 - (b) 100 g
 - (c) 56 g
 - (d) 5.6 g
- (13) 5 mL of seminormal H_2SO_4 , 20 mL of 1 N HCl and 40 mL of N/4 HNO_3 are mixed together and the volume made upto 1 dm³. The normality of the solution thus made is
 - (a) 3025
 - (b) 0.0325
 - (c) 0.325
 - (d) 32.5
- (14) The mole fraction of $\text{C}_2\text{H}_5\text{OH}$ (Molecular weight = 46) in 5 molal aqueous ethyl alcohol solution is
 - (a) 0.082
 - (b) 0.82
 - (c) 5
 - (d) $\frac{5}{55.55}$
- (15) The number of iodine atoms present in 1 cm³ of its 0.1 M solution is
 - (a) 6.02×10^{23}
 - (b) 6.02×10^{22}
 - (c) 6.02×10^{19}
 - (d) 1.204×10^{20}
- (16) The number of moles of hydroxide (OH^-) ion in 0.3 litre of 0.005 M solution of $\text{Ba}(\text{OH})_2$ is
 - (a) 0.0075
 - (b) 0.0015
 - (c) 0.0030
 - (d) 0.0050
- (17) 5 ml of 1 N HCl , 20 ml of $\frac{N}{2}$ H_2SO_4 and 30 ml of $\frac{N}{3}$ HNO_3 are mixed together and the final volume is made upto 1 dm³. The normality of the resulting solution is
 - (a) $\frac{N}{5}$
 - (b) $\frac{N}{20}$
 - (c) $\frac{N}{40}$
 - (d) $\frac{N}{50}$

- (18) Hydrochloric acid solution A and solution B have concentration 0.5 N and 0.1 N respectively. The volume of solutions A and B required to make 2 L of 0.2 N hydrochloric acid are
- 0.5 L of A + 1.5 L of B
 - 1.5 L of A + 0.5 L of B
 - 1.0 L of A + 1.0 L of B
 - 0.75 L of A + 1.25 L of B
- (19) A tooth paste has 0.2 g/litre fluoride. Its concentration in ppm will be
- 250
 - 200
 - 400
 - 1000
- (20) The molarity of pure water is
- 55.6
 - 50
 - 100
 - 18
- (21) Out of Molarity (M), molality (m), formality (F) and mole fraction (x), those dependent on temperature are
- M, m
 - F, x
 - m, x
 - M, F
- (22) Solubility curve of $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$ in water with temperature is given as



- (a) Solution process is exothermic
- (b) Solution process is exothermic till 34°C and endothermic after 34°C
- (c) Solution process is endothermic till 34°C and exothermic thereafter
- (d) Solution process is endothermic.
- (23) Duralumin is an alloy of
- aluminium, copper and chromium
 - aluminium, copper, magnesium and manganese.
 - aluminium, magnesium, nickel and copper.
 - aluminium, antimony.

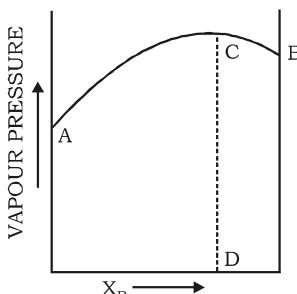
- (24) Babbitt metal is an alloy of
- antimony with tin and copper.
 - aluminium with tin and copper.
 - aluminum bronze.
 - lead with antimony.
- ### 1.2 HENRY'S LAW
- (25) The millimoles of N_2 gas that will dissolve in 1 L of water at 298 K, when it is bubbled through water and has a partial pressure of 0.96 bar will be (Given that at 298 K, $K_H = 76.8 \text{ k bar}$)
- 0.59
 - 0.69
 - 0.79
 - 0.89
- (26) Which of the following correctly represents Henry's law?
- $m = K_H P$
 - $x = K_H P$
 - $P = K_H x$
 - All of these
- (27) The mole fraction of saturated solution is 1.2×10^{-6} . The pressure of the above the solution is ($K_H = 1.44 \text{ k bar}$)
- 0.174 bar
 - 17.4 bar
 - 27.4 bar
 - 0.274 bar
- (28) Air contain O_2 and N_2 in the ratio of 1 : 4. The Henry constant for O_2 and N_2 are $3.30 \times 10^7 \text{ torr}$ and $6.60 \times 10^7 \text{ torr}$ respectively. Ratio of solubility of O_2 and N_2 dissolved in water at atmospheric pressure and room temperature is
- 1 : 4
 - 4 : 1
 - 1 : 2
 - 2 : 1
- (29) Select the correct gas which has less solubility in water
- CO_2
 - NH_3
 - Oxygen
 - HCl
- (30) The Henry's law constant for oxygen is $1.3 \times 10^{-3} \text{ mol dm}^{-3} \text{ atm}^{-1}$. If the partial pressure of oxygen is 0.46 atm, then the concentration of dissolved oxygen at 25°C at 1 atmosphere pressure is
- $5.98 \times 10^{-3} \text{ mol dm}^{-3}$
 - $0.598 \times 10^{-4} \text{ mol dm}^{-3}$
 - $5.98 \times 10^{-4} \text{ mol dm}^{-3}$
 - 598 mol dm^{-3}

1.3 VAPOUR PRESSURE AND RAOULTS LAW

- (31) The vapour pressure of pure liquid A is 70 torr at 27°C. It forms an ideal solution with another liquid B. The mole fraction of B is 0.2 and total vapour pressure of the solution is 84 torr at 27°C. The vapour pressure of pure liquid B at 27°C is
 (a) 14 (b) 56 (c) 140 (d) 70
- (32) 10 cc of a volatile liquid is added to a litre of water. The vapour pressure of water over the solution
 (a) will be equal to that of pure water
 (b) will be less than that of water
 (c) will be greater than that of water
 (d) will be very high
- (33) An aqueous solution of ethanol has vapour pressure
 (a) Same as that of water
 (b) Same as that of ethanol
 (c) More than that of water
 (d) Less than that of water
- (34) The vapour pressure of pure benzene and toluene are 160 and 60 torr respectively. The mole fraction of toluene in vapour phase in contact with equimolar solution of benzene and toluene is
 (a) 0.50 (b) 0.27 (c) 0.16 (d) 0.73

1.4 IDEAL AND NON - IDEAL SOLUTION :

- (35) Which pair from the following will not form an ideal solution ?
 (a) $\text{CCl}_4 + \text{SiCl}_4$ (b) $\text{H}_2\text{O} + \text{C}_4\text{H}_9\text{OH}$
 (c) $\text{C}_2\text{H}_5\text{Br} + \text{C}_2\text{H}_5\text{I}$ (d) $\text{C}_6\text{H}_{14} + \text{C}_7\text{H}_{16}$
- (36) The diagram given below is a vapour pressure-composition diagram for a binary solution of A and B. In the solution, A - B interactions are



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- (a) similar than A - A and B - B interactions
 (b) greater to A - A and B - B interactions
 (c) smaller than A - A and B - B interactions
 (d) unpredictable
- (37) Water and ethanol form non-ideal solution with positive deviation from Raoult's law. This solution will have vapour pressure
 (a) equal to vapour pressure of pure water
 (b) less than vapour pressure of pure water
 (c) more than vapour pressure of pure water
 (d) less than vapour pressure of pure ethanol.
- (38) A binary solution of ethanol and n-heptane is an example of
 (a) Ideal solution
 (b) Non-ideal solution solution with + ve deviation
 (c) Non-ideal solution with-ve deviation
 (d) unpredictable
- (39) 5 ml of acetone is mixed with 100 ml of H_2O . The vapour pressure of water above the solution is
 (a) equal to the vapour pressure of pure water
 (b) equal to the vapour pressure of the solution
 (c) less than the vapour pressure of pure water
 (d) more than the vapour pressure of pure water
- 1.5 LOWERING OF VAPOUR PRESSURE :
 (40) The vapour pressure of pure liquid is 10 torr and at the same temperature, when 1 g of non-volatile solute B is dissolved in 20 g of A, its vapour pressure is reduced to 9.0 torr. If the molecular weight of A is 200, that of B is
 (a) 75 (b) 100 (c) 90 (d) 120
- (41) Two moles of sugar is dissolved in 5 moles of water. The vapour pressure of solution as compared to that of pure water is
 (a) 5 times (b) $\frac{5}{7}$ times
 (c) $\frac{2}{7}$ times (d) 2 times

1.8 OSMOTIC PRESSURE :

- (55) Which substance when coated on clay can act as a semi-permeable membrane?
- Calcium sulphate
 - Nickel phosphate
 - Barium sulphate
 - Copper ferrocyanide
- (56) When blood cell is placed in water containing less than 0.9% salt (mass / volume) than
- blood cell collapses
 - blood cells burst
 - blood cell expands
 - blood cell remain unaffected
- (57) The process of cells by which they absorb solvent when placed in hypotonic solution and get swelled up is called
- Plasmolysis
 - Haemolysis
 - Exosmosis
 - none of these
- (58) When red blood cells are placed in 95% NaCl, they shrink . This is called
- Haemolysis
 - Plasmolysis
 - Endosmosis
 - None of these
- (59) If a sugar beet slice is kept in a strong brine solution, what would happen ?
- Sugar beet will lose water from its cells
 - Sugar beet will lose water from solution
 - Sugar beet will neither absorb nor lose water
 - Sugar beet will dissolve in the solution
- (60) Which of the following colligative properties gives the molecular mass of macromolecules and biomolecules with great accuracy ?
- relative lowering of vapour pressure
 - ebullioscopic method
 - cryoscopic method
 - osmotic pressure

- (61) The osmotic pressure of a solution increases if
- temperature is lowered
 - solution constant is increased
 - No. of solute molecules is increased
 - volume is increased
- (62) A solution containing 20 g of solute dissolved in 500 mL of water shows an osmotic pressure of 600 mm Hg at 15° C. The molecular mass of solute is
- 1000
 - 1200
 - 1400
 - 1800
- (63) A solution containing 8.6 g/lit urea is isotonic with 5 % solution of a solute X. The molar mass of X is
- 349
 - 174.5
 - 430
 - Data insufficient
- (64) A dilute solution of a non-volatile solute has a volume of 0.1×10^{-3} m³ when its osmotic pressure is 1×10^5 Pa. What will be its osmotic pressure if the volume is reduced to 0.05×10^{-3} m³ (at constant temperature) is
- 200 Nm^{-2}
 - $2 \times 10^5 \text{ Nm}^{-2}$
 - $5 \times 10^{-6} \text{ Pa}$
 - None of these
- (65) The osmotic pressure of 0.4% urea solution is 1.66 atm and that of sugar (3.42%) is 2.46 atm. When both the solutions are mixed, the osmotic pressure of the resulting solution is
- 1.64 atm
 - 2.06 atm
 - 2.46 atm
 - 0.82 atm
- (66) The osmotic pressure of a solution of urea at 283 K is 500 mm. When it is diluted and temperature raised to 298 K, its osmotic pressure becomes 105.3 mm. The extent of dilution is about
- 0.2 times
 - 50 times
 - 5 times
 - 3 times
- (67) The relationship between osmotic pressure at 273 k when 10 g glucose (π_1), 10 g urea (π_2) and 10 g sucrose (π_3) are dissolved in 250 ml of water is
- $\pi_1 > \pi_2 > \pi_3$
 - $\pi_3 > \pi_1 > \pi_2$
 - $\pi_2 > \pi_1 > \pi_3$
 - $\pi_2 > \pi_3 > \pi_1$

- (68) The plant cell will shrink when placed in
 (a) water
 (b) a hypotonic solution
 (c) a hypertonic solution
 (d) an isotonic solution
- 1.9 VANT' HOFF FACTOR (i) :
 (69) The Van't Hoff factor for non-electrolytes like urea, sugar etc. of any molar concentration is
 (a) 2 (b) 0.5 (c) 0.2 (d) 1.0
- (70) Tick the correct statement
 (a) 'i' is unity for urea solution
 (b) $i = 2$ for NaCl solution
 (dissociating electrolyte)
 (c) $i < 1$ for benzoic acid (associated molecule)
 (d) All of these
- (71) Benzoic acid dissolved in benzene shows a molecular mass of
 (a) 122 (b) 61 (c) 244 (d) 180
- (72) Which of the following pairs of solutions are isotonic ?
 (a) 1 M Urea and 1 M KCl
 (b) 1 M Urea and 0.01 M glucose
 (c) 1 M KCl and 1 M BaCl_2
 (d) 1 M Urea and 1 M Sucrose
- (73) Which of the following solutions will exhibit the highest osmotic pressure ?
 (a) 1 M Urea solution
 (b) 1 M Glucose solution
 (c) 1 M Alum solution
 (d) 1 M NaCl solution
- (74) Which of the following will have the highest B.P?
 (a) 1 % Urea in water
 (b) 1 % Sucrose in water
 (c) 1 % NaCl in water
 (d) 1 % Glucose in water
- (75) The minimum freezing point is that of
 (a) 0.01 m NaCl
 (b) 0.005 m MgI_2
 (c) 0.005 m $\text{C}_2\text{H}_5\text{OH}$
 (d) 0.001 m MgSO_4
- (76) The freezing point of 1 molal NaCl solution assuming NaCl to be 100% dissociated in water is
 (a) -1.86°C (b) -3.72°C
 (c) $+1.86^\circ\text{C}$ (d) $+3.72^\circ\text{C}$
- (77) KBr is 80% dissociated in solution. The freezing point of a 0.5 molal solution is ($K_f = 1.86^\circ\text{C/m}$)
 (a) 273 K (b) 277 K
 (c) 271.326 K (d) 269 K
- (78) Acetic acid exists in benzene solution in the dimeric form. In an actual experiment, the van't Hoff factor was found to be 0.52. Then the degree of association of acetic acid is
 (a) 0.48 (b) 0.88 (c) 0.96 (d) 0.52
- (79) The value of observed and normal molar masses of acetic acid are 118 and 60 respectively. The Van't Hoff factor is
 (a) 1.97 (b) 0.51 (c) 0.9 (d) 1.6
- (80) Arrange the following in the order of increasing boiling points
 (i) 10^{-4} M NaCl (ii) 10^{-3} M Urea
 (iii) 10^{-3} M MgCl_2 (iv) 10^{-2} M NaCl
 (a) (i) < (ii) < (iii) < (iv)
 (b) (ii) < (i) < (iii) < (iv)
 (c) (ii) < (i) < (iii) < (iv)
 (d) (iv) < (iii) < (i) < (ii)

HOME WORK**Multiple Choice Questions****1.1 SOLUTION :**

- (1) What will be the normality of a solution containing 9.8 g orthophosphoric acid in 1 dm³ of solution? (H = 1, O = 16, P = 31)
- (a) 0.3 (b) 3.0 (c) 1.0 (d) 0.1
- (2) 5 g H₂SO₄ is dissolved in half a litre of the solvent with density 1.29 g/mL. Its molality is
- (a) 0.080 (b) 0.1204 (c) 0.0476 (d) 100
- (3) In a mixture of 4 g hydrogen and 32 g oxygen gas, the mole fraction of hydrogen is
- (a) $\frac{1}{4}$ (b) $\frac{2}{5}$ (c) $\frac{1}{5}$ (d) $\frac{1}{3}$
- (4) A 0.8 M dilute solution has molality (if density of solvent = 1.2 kg/dm⁻³)
- (a) 0.0667 (b) 0.667
(c) 0.8 m (d) None of these
- (5) 100 mL of 0.1 M solution of solute A are mixed with 200 mL of 0.1 M solution of solute B. If A and B are non-reacting substances, the molarity of the final solution will be
- (a) 0.3 M (b) 0.4 M (c) 0.1 M (d) 0.15 M
- (6) The volume of water to be added to 100 cm³ of 0.5 N H₂SO₄ to get decinormal concentration is
- (a) 400 cm³ (b) 500 cm³
(c) 450 cm³ (d) 100 cm³
- (7) Normality of 0.3 M H₃PO₄ is
- (a) 0.6 (b) 0.3 (c) 0.9 (d) 0.1
- (8) Which of the following is not solution?
- (a) Air (b) A gold ring
(c) Smoke (d) Salt solution
- (9) An alloy of copper, manganese and nickel is
- (a) German silver (b) Brass
(c) Manganin (d) Bronze

- (10) Ferromangarous contain iron and _____

- (a) 70-80% Mn (b) 70-90% Mn
(c) 12% Mn (d) 4% Mn

- (11) An alloy of manganese and iron is

- (a) Spiegeleisen (b) Babbitt metal
(c) Manganin (d) Solder

- (12) Amalgams are

- (a) Alloys of mercury with other metal.
(b) Alloy of antimony with tin and copper.
(c) Alloy of manganin.
(d) Alloy of aluminium.

- (13) Lead hardened by the addition of

- (a) Copper (b) Chromium
(c) Antimony (d) Iron

1.2 HENRY'S LAW :

- (14) Solubility of a gas in liquid increases with
- (a) Increase of pressure and increase of temperature
(b) Decrease of pressure and increase of temperature
(c) Increase of pressure and decrease of temperature
(d) Decrease of pressure and decrease of temperature
- (15) The solubility of methane in benzene at 298 K under 760 mm Hg. If K_H = 4.27×10^5 mm Hg is
- (a) 1.78×10^{-4} (b) 1.78×10^{-5}
(c) 1.78×10^{-3} (d) 1.78×10^{-6}
- (16) N₂ exerts a pressure of 0.987 bar. The mole fraction of N₂ is (K_H = 76.48 kbar)
- (a) 7.648×10^{-3} (b) 9.87×10^{-5}
(c) 1.3×10^{-5} (d) 2.6×10^{-5}
- (17) Solubility decreases with the increase in temperature for
- (a) Al₂(SO₄)₃ (b) NaNO₃
(c) Na₂SO₄ (d) KBr

- (18) With the rise in temperature, solubility of NaCl in water

- (a) increase slightly
- (b) increases appreciably
- (c) decreases
- (d) remains constant

- (19) Marine life like fish prefers to stay at lower level and stay away from the upper layer of water because

- (a) temperature at the surface of water is relatively high.
- (b) solubility of oxygen in the upper layer is minimum.
- (c) solubility of oxygen decreases with increase in temperature
- (d) all of these

1.3 VAPOUR PRESSURE & RAULTS LAW :

- (20) For a solution of volatile liquids, the partial vapour pressure of each component is directly proportional to

- (a) Molality
- (b) Molarity
- (c) Mole fraction
- (d) Normality

- (21) If two substances A and B have $P_A^o : P_B^o = 1 : 2$ and have mole fraction in solution 1:2, then mole fraction of A in vapour is

- (a) 0.33
- (b) 0.25
- (c) 0.52
- (d) 0.2

- (22) The determination of the correct molar mass form Raoult's law is applicable to

- (a) An electrolyte in solution
- (b) A non-electrolyte in a dilute solution
- (c) A non-electrolyte in a concentrated solution
- (d) An electrolyte in liquid solvent

- (23) $\frac{P_1^o - P_s}{P_1^o}$, select the correct term which represents given equation

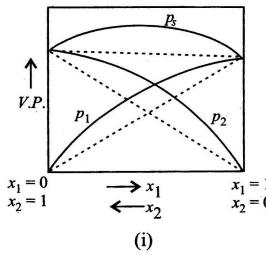
- (a) Raoult's law
- (b) Lowering vapour pressure
- (c) Ideal equation
- (d) Relative lowering vapour pressure

1.4 IDEAL & NON-IDEAL SOLUTION :

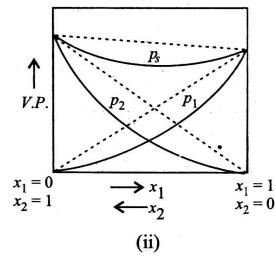
- (24) Benzene and Toluene form a pair of “Ideal Solutions.” In the case of ideal solutions, tick the incorrect statement.

- (a) Ideal Solutions obey Raoult's Law
- (b) $\Delta H_{\text{mixing}} = 0$
- (c) $\Delta V_{\text{mixing}} = 0$
- (d) None of these

- (25) Study the figures given below and mark the correct statement.



(i)



(ii)

- (a) (i) Nitric acid + Water,
- (ii) Acetone + Ethyl alcohol
- (b) (i) Water + Ethyl alcohol,
- (ii) Acetone + Benzene
- (c) (i) Acetone + Ethyl alcohol,
- (ii) Acetone + Chloroform
- (d) (i) Benzene + Chloroform,
- (ii) Acetone + Chloroform

- (26) Two liquids HNO_3 (A) and water (B) shows a negative deviation from Raoult's law when mixed in the ratio of 68% and 32% respectively. It means
- (a) A - B interactions are stronger than A - A and B - B interactions
 - (b) A - B interactions are weaker than A - A and B - B interactions
 - (c) vapour pressure of solution is more than the pure components
 - (d) vapour pressure of solution is less since only one component vaporises.
- (27) When acetone and chloroform are mixed together, hydrogen bonds are formed between them. Which of the following statement is correct about the solution made by mixing acetone and chloroform?
- (a) On mixing acetone and chloroform will form an ideal solution
 - (b) On mixing acetone and chloroform positive deviation is shown since the vapour pressure increases.
 - (c) On mixing acetone and chloroform negative deviation is shown since there is decrease in vapour pressure.
 - (d) At a specific composition acetone and chloroform will form minimum boiling azeotrope.
- (28) Intermolecular forces between n-hexane and n-heptane are nearly same as between hexane and heptane individually. When these two are mixed, which of the following is not true about the solution formed?
- (a) It obeys Raoult's law, i.e. $P_A = x_A P_A^{\circ}$ and $P_B = x_B P_B^{\circ}$
 - (b) ΔH_{mixing} is zero.
 - (c) ΔV_{mixing} is zero.
 - (d) It forms minimum boiling azetrope.

- 1.5 LOWERING OF VAPOUR PRESSURE :**
- (29) The vapour pressure pure liquid A is 0.60 torr. On adding a non-volatile solid B to A, its vapour pressure decreases by 0.20 torr. The mole fraction of solvent A in the solution is
- (a) 0.1
 - (b) 0.33
 - (c) 0.66
 - (d) None of these
- (30) The vapour pressure of water at room temperature is 30 mm Hg. If mole fraction of water is 0.9, the vapour pressure of solution is
- (a) 30 mm Hg
 - (b) 33 mm Hg
 - (c) 27 mm Hg
 - (d) 24 mm Hg
- (31) If 32×10^{-3} kg of an unknown substance and 150.04×10^{-3} kg acetone is used to prepare a solution at 313 K and vapour pressure of pure acetone at this temperature is 0.842 atm. Molar mass of substance is 384.4×10^{-3} kg mol⁻¹, then the vapour pressure of the solution is
(Given that atomic mass: C = 12, H = 1, O = 16)
- (a) 0.800 atm
 - (b) 0.750 atm
 - (c) 0.880 atm
 - (d) 0.815 atm
- (32) The vapour pressure of solvent is decreased by 10 mm of Hg when a non-volatile solute was added to the solvent. The mole fraction of solute in the solution is 0.2. What would be the mole fraction of solvent if decrease in vapour pressure is 20 mm of Hg
- (a) 0.8
 - (b) 0.6
 - (c) 0.4
 - (d) 0.2
- 1.6 ELEVATION OF BOILING POINT :**
- (33) The increase in boiling point of a solution containing 34.2 g sucrose in 100g solvent is 0.1°C . The ebullioscopic constant of the solvent is
- (a) 0.01 K/m
 - (b) 1 K/m
 - (c) 0.1 K/m
 - (d) 10 K/m
- (34) The boiling point of a solution of 0.11 g of a substance in 15 g ether was found to be 0.1°C higher than that of pure ether. If K_b of ether = 2.16, then molecular weight of the substance is nearly
- (a) 148
 - (b) 168
 - (c) 158
 - (d) 178

(35) The elevation in B.P of a solvent by the addition of a non-volatile solute is directly proportional to

- (a) The vapour pressure of pure solvent
- (b) The vapour pressure of solution
- (c) The lowering of vapour pressure in the solution
- (d) The relative lowering of vapour pressure

1.7 DEPRESSION OF FREEZING POINT :

(36) A solution of 1.25 g of a non-electrolyte in 20 g water freezes at 271.94 K. If K_f of water = 1.86 Km^{-1} , the solute has a molecular mass of

- (a) 179.79 (b) 209.6 (c) 207.8 (d) 109.7

(37) The molal depression constant of water is 1.86 Km^{-1} . If 342 g sucrose is dissolved in 1000 g water, the solution will freeze at

- (a) 1.86°C (b) -1.86°C
- (c) -392°C (d) 3.92°C

(38) A solution of urea boils at 100.18°C. If K_f and K_b for water are 1.86 and 0.512 K kg mol^{-1} , the above solution will freeze at

- (a) -6.54°C (b) 0.654°C
- (c) 6.54°C (d) -2.79°C

(39) The amount of urea to be dissolved in 500 c.c of water (K_f = 1.86) to produce a depression of 0.186°C in freezing point is

- (a) 0.3 g (b) 3 g (c) 6 g (d) 9 g

(40) If 15 g of a solute in 100 g of water makes a solution that freezes at -1.0°C, then 30 g of the same solute in 100 g water will make a solution that freezes at

- (a) -0.5°C (b) 0°C
- (c) -2.0°C (d) 2.0°C

(41) K_b and K_f depend on the

- (a) amount of solvent used
- (b) amount of solute used
- (c) nature of solute used
- (d) nature of solvent used

(42) The depression in freezing point in a 1 molal solution is termed as

- (a) Ebulliscopic constant
- (b) Cryoscopic constant
- (c) Molar depression constant
- (d) None of these

(43) A solution containing 6.8 g of non-ionic solute in 100 g of water was found to freeze at -0.930°C. If K_f for water is 1.86, the molar mass of solute is

- (a) 13.6 (b) 34 (c) 68 (d) 136

1.8 OSMOTIC PRESSURE :

(44) Osmosis is a phenomenon in which

- (a) Solvent molecules move from higher concentration to lower concentration of solution.
- (b) Solvent molecules move from lower to higher concentration of solution.
- (c) Solute molecules move from higher to lower concentration.
- (d) Solute molecules move from lower to higher concentration.

(45) A 0.1 M glucose solution and 0.1 M urea solution are placed on the two sides of a semi-permeable membrane which is the correct observation?

- (a) There will be no net movement across the membrane
- (b) Glucose solution will flow into the urea solution
- (c) Urea solution will flow into glucose solution
- (d) Water will flow from urea solution into the glucose solution

(46) A semi-permeable membrane allows the passage of

- (a) Solute molecules only
- (b) Solvent molecules only
- (c) Both solute and solvent molecules
- (d) None of these

- (47) Which involve osmosis?
- (a) Crenation (b) Haemolysis
(c) Plasmolysis (d) All of these
- (48) As a result of osmosis from pure solvent to a solution the volume of the solution
- (a) Increases
(b) Decreases
(c) Neither a nor b
(d) Depends on the solution
- (49) Two solutions are isotonic if
- (a) they have the same boiling point.
(b) they have the same freezing point.
(c) they have the same osmotic pressure.
(d) All of these
- (50) If 1 g glucose is dissolved in 20 g water at 25°C The osmotic pressure of this solution is
- (a) 67.9 atm (b) 135.8 atm
(c) 6.79 atm (d) 6.79 mm Hg
- (51) The osmotic pressure at 273 K of a 5% aqueous solution of urea is
- (a) 1.86 atm (b) 0.186 atm
(c) 18.68 atm (d) 18.68 torr
- (52) A solution containing 250 g of protein per litre is isotonic with a solution containing 0.9 g of glucose per litre. The molecular mass of the protein can be estimated as
- (a) 9000 (b) 250 (c) 50,000 (d) 5,000
- (53) At 25°C, a solution of a non-volatile solute in water has osmotic pressure of 5.0 atm. The strength of the solution in g/lit is (if mol.wt of solute is 100 g)
- (a) 20.4 (b) 40.8 (c) 0.204 (d) 2.04

1.9 VANT HOFF FACTOR :

- (54) Vant hoff's factor is

- (a) $\frac{\text{Observed osmotic pressure}}{\text{Calculated osmotic pressure}}$
- (b) $\frac{\text{Calculated osmotic pressure}}{\text{Observed osmotic pressure}}$
- (c) $\frac{\text{Experimental molecular weight}}{\text{Theoretical molecular weight}}$

- (d) None of these

- (55) The molecular weight of NaCl as per osmotic pressure measurements is

- (a) Same as theoretical value
(b) Higher than theoretical value
(c) Lower than theoretical value
(d) None of these

- (56) If $i > 1$, the experimental value of a colligative property is _____ than

- (a) Greater
(b) Lesser
(c) Same
(d) Depends on the property

- (57) Which of the following salts solution will have the highest osmotic pressure ?

- (a) 1 % KCl
(b) 1 % Urea
(c) 1 % NaCl
(d) All of them will have the same osmotic pressure

- (58) The highest freezing points is that of

- (a) 0.1 M Urea (b) 0.1 M NaCl.
(c) 0.005 M C_2H_5OH (d) 0.001 M MgSO₄

- (59) Which of the following criteria is necessary for two solutions to be isotonic?
- (a) Same molality
 - (b) Same molarity
 - (c) Same solubility of solute
 - (d) All of these
- (60) What is the freezing point of a solution containing 8.1 g HBr in 100 g water assuming the acid to be 90% ionised (K_f for water = 1.86 K kg mol⁻¹)
- (a) 0.85°C
 - (b) -3.53°C
 - (c) 0°C
 - (d) -0.35°C

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CLASS WORK - ANSWER KEY

1 b	2 d	3 b	4 a	5 a	6 b	7 a	8 c	9 c	10 b
11 b	12 d	13 b	14 a	15 d	16 c	17 c	18 a	19 b	20 a
21 d	22 c	23 b	24 a	25 b	26 d	27 a	28 c	29 c	30 c
31 c	32 b	33 c	34 b	35 b	36 c	37 c	38 b	39 c	40 b
41 b	42 b	43 a	44 a	45 c	46 b	47 b	48 b	49 d	50 d
51 b	52 a	53 b	54 d	55 d	56 a	57 b	58 b	59 a	60 d
61 c	62 b	63 a	64 b	65 b	66 c	67 c	68 c	69 d	70 d
71 c	72 d	73 c	74 c	75 a	76 b	77 c	78 c	79 b	80 a

HOME WORK - ANSWER KEY

1 a	2 a	3 d	4 b	5 c	6 a	7 a	8 c	9 c	10 a
11 a	12 a	13 c	14 c	15 c	16 c	17 c	18 a	19 d	20 c
21 d	22 b	23 d	24 d	25 c	26 a	27 c	28 d	29 c	30 c
31 d	32 b	33 c	34 c	35 c	36 d	37 b	38 b	39 b	40 c
41 d	42 b	43 d	44 b	45 a	46 c	47 d	48 a	49 c	50 c
51 c	52 c	53 a	54 a	55 c	56 a	57 c	58 d	59 b	60 b



CLASS WORK**Hints & Explanation**

- (1) (b) Decrease in molarity

Molarity, mole fraction and mass percent do not change with temperature since they involve mass.

Molarity changes with temperature since they involve volume.

- (2) (d) 6.625 g

$$M = \frac{W_{\text{solute}}}{\text{MW}_{\text{solute}} \times V_{\text{solution}} (\text{dm}^3)}$$

$$0.25 = \frac{W_{\text{solute}}}{106 \times (250 \times 10^{-3}) \text{dm}^3}$$

$$W_{\text{solute}} = 0.25 \times 106 \times 0.25$$

$$= \frac{1}{4} \times 106 \times \frac{1}{4}$$

$$= \frac{106}{16}$$

$$= 6.625 \text{ grams}$$

- (3) (b) 0.1

$$N = \frac{W_{\text{solute}}}{E_{\text{solute}} V_{\text{solution}}}$$

$$= \frac{19.6}{\left(\frac{98}{2}\right) \times 4}$$

$$= \frac{19.6}{49 \times 4}$$

$$= \frac{19.6}{196}$$

$$= 0.1$$

- (4) (a) 1 g

$$N = \frac{W_{\text{solute}}}{E_{\text{solute}} \times V_{\text{solution}}}$$

$$0.1 = \frac{W_{\text{solute}}}{\left(\frac{200}{2}\right) (100 \times 10^{-3}) L}$$

$$W_{\text{solute}} = 0.1 \times 100 \times 0.1$$

$$W_{\text{solute}} = 1 \text{ grams}$$

- (5) (a) 0.55

$$M = \frac{W_{\text{solute}}}{\text{M.W}_{\text{solute}} \times (W_{\text{solution}} - W_{\text{solute}}) \text{kg}}$$

$$M = \frac{34.2}{342 \times (214.2 - 34.2) \times 10^{-3}}$$

$$= \frac{0.1}{0.180}$$

$$= \frac{1}{1.8}$$

$$\approx \frac{1}{2}$$

$$\approx 0.55$$

- (6) (b) 91.8

\therefore It is 90% w/w H₂SO₄ aqueous solution

$$W_{\text{solute}} = 90 \text{ g}$$

$$W_{\text{solution}} = 100 \text{ g} = 0.1 \text{ kg}$$

$$W_{\text{solvent}} = 10 \text{ g} = 0.01 \text{ kg}$$

$$\therefore m = \frac{W_{\text{solute}}}{\text{MW}_{\text{solute}} \times W_{\text{solvent}} (\text{kg})}$$

$$\therefore m = \frac{90}{98 \times 0.01}$$

$$\therefore m = \frac{90}{0.98}$$

$$\therefore m = 91.8367$$

- (7) (a) For dilute aqueous solutions, molality \approx molarity

For a dilute aqueous solution, one major solute is more concentrated than one moral solution

Molarity of pure water is 55.55

- (8) (c) 0.0099

$$x_{\text{glucose}} = \frac{n_{\text{glucose}}}{n_{\text{glucose}} + n_{\text{water}}}$$

$$= \frac{\frac{18}{180}}{\frac{18}{180} + \frac{180}{18}}$$

$$= \frac{\frac{1}{10}}{\frac{1}{10} + 10}$$

$$= \frac{0.1}{0.1 + 10}$$

$$= \frac{0.1}{10.1}$$

$$= \frac{1}{101}$$

$$\approx \frac{1}{100} \approx 0.01$$

\therefore The denominator is greater than 100
thus $x_{\text{glucose}} < 0.01$

$$\therefore x_{\text{glucose}} = 0.00999$$

- (9) (c) 1.2 lit

\therefore it is 5% w/w aqueous solution of urea thus,

5 grams of urea = 100 grams of solutions
i.e. 5 g of urea = 100 ml of solutions

\therefore 1 g mole (60 g) of urea = x ml of solutions

$$\therefore 5 \times x = 100 \times 60$$

$$x = \frac{100 \times 60}{5}$$

$$\therefore x = 20 \times 60$$

$$\therefore x = 1200 \text{ ml}$$

$$\therefore x = 1.2 \text{ Litre}$$

- (10) (b) 0.25

$$N = \text{valency factor} \times M$$

$$0.5 = 2 \times M$$

$$M = 0.25$$

- (11) (b) 38.38

$$N = \frac{\% \times \rho_s \times 10}{E}$$

$$N = \frac{99 \times 1.9 \times 10}{\left(\frac{98}{2}\right)}$$

$$\therefore N = \frac{99 \times 19}{49}$$

$$N \approx 2 \times 19$$

$$N \approx 38$$

- (12) (d) 5.6 g

Since monoacidic base is neutralizing monobasic acid

$$\therefore N_{\text{acid}} \times V_{\text{acid}} = N_{\text{Base}} \times V_{\text{Base}}$$

$$\therefore (0.05) (2) \text{dm}^3 = \frac{W_{\text{Base}}}{E.W_{\text{Base}} \times V_{\text{Base}}} \times V_{\text{base}}$$

$$\therefore 0.1 = \frac{W_{\text{Base}}}{56 \times V_{\text{Base}}} \times V_{\text{Base}}$$

$$\therefore W_{\text{Base}} = 5.6 \text{ g}$$

(13) (b) 0.0325

$$N = \frac{N_1 V_1 + N_2 V_2 + N_3 V_3}{V_f}$$

$$= \frac{\frac{1}{2} \times 5 + 1 \times 20 + \frac{1}{4} \times 40}{1 \text{ dm}^3}$$

$$= \frac{2.5 + 20 + 10}{1000 \text{ mL}}$$

$$= 0.0325$$

(14) (a) 0.082

$$x_{C_2H_5OH} = \frac{m}{m + n_{\text{solvent}}}$$

\because it is a 5 molal aqueous solution of C_2H_5OH
it means 5 moles of C_2H_5OH is present in
1000 g of H_2O

$$\text{Thus } n_{\text{solvent}} = n_{H_2O} = \frac{W_{H_2O}}{MW_{H_2O}} = \frac{1000}{18} = 55.55$$

$$\therefore x_{C_2H_5OH} = \frac{5}{5+55.55} = \frac{5}{60.55} = 0.082$$

(15) (d) 1.2044×10^{20}

$$\therefore M = \frac{n_{\text{solute}}}{V_{\text{solution}} (\text{dm}^3)}$$

$$\therefore n_{\text{solute}} = 0.1 \times 10^{-3}$$

$$\therefore n_{\text{solute}} = 10^{-4} \text{ mol}$$

$$\therefore 1 \text{ mole} = 6.022 \times 10^{23} \text{ molecule}$$

$$\therefore 10^{-4} \text{ mol} = x \text{ molecule}$$

$$\therefore x = 6.022 \times 10^{19} \text{ molecule}$$

for Iodine,

$$\therefore 1 \text{ molecule} = 2 \text{ atoms}$$

$$\therefore 6.022 \times 10^{19} \text{ molecule} = "y" \text{ atoms}$$

$$y = 6.022 \times 2 \times 10^{19}$$

$$\therefore y = 12.044 \times 10^{19}$$

$$\therefore y = 1.2044 \times 10^{20} \text{ atoms of Iodine}$$

(16) (c) 0.0030

$$\therefore M = \frac{\text{Moles}}{V_{\text{solution}}}$$

$$\therefore \text{moles of Ba(OH)}_2 = 0.005 \times 0.3 = 0.0015$$



$$1 \text{ mole of Ba(OH)}_2 = 2 \text{ mole of OH}^-$$

$$0.0015 \text{ mole of Ba(OH)}_2 = (0.015 \times 2) \text{ mole of OH}^-$$

$$\therefore \text{moles of OH}^- = 0.0030$$

(17) (c) $N/40$

$$N_f = \frac{N_1 V_1 + N_2 V_2 + N_3 V_3}{V_f}$$

$$N_f = \frac{1 \times 5 + \frac{1}{2} \times 20 + \frac{1}{3} \times 30}{1 \text{ dm}^3}$$

$$N_f = \frac{5 + 10 + 10}{1000 \text{ ml}}$$

$$N_f = \frac{25}{1000}$$

$$N_f = \frac{1}{40}$$

(18) (a) 0.5 L of A + 1.5 L of B

$$N_f = \frac{N_1 V_1 + N_2 V_2}{V_f}$$

$$\text{i.e. } N_f V_f = N_1 V_1 + N_2 V_2$$

$$\therefore (0.2 \times 2) = 0.5 (V_1) + 0.1 (V_2)$$

$$\therefore V_1 + V_2 = 2L$$

$$\therefore 0.4 = 0.5 (V_1) + 0.1 (2 - V_1)$$

$$\therefore 0.4 = 0.5 V_1 + 0.2 - 0.1 V_1$$

$$\therefore 0.4 = 0.4 V_1 + 0.2$$

$$\therefore 0.4V_1 = 0.2$$

$$\therefore V_1 = \frac{1}{2}$$

$$\therefore V_1 = 0.5 \text{ L of A}$$

$$\text{Thus, } V_2 = 2 - V_1$$

$$= 2 - 0.5$$

$$= 1.5 \text{ L of B}$$

(19) (b) 200

$$\frac{W_{\text{solute}}}{V_{\text{solution}}} = 0.2 \text{ g/L} = 2 \times 10^{-4} \text{ g/ml}$$

$$\therefore \text{ppm} = \frac{W_{\text{solute}}}{V_{\text{solution}}} \times 10^6$$

$$\therefore \text{ppm} = 2 \times 10^{-4} \times 10^6$$

$$\therefore \text{ppm} = 200$$

(20) (a) 55.55

Density of pure water = 1 g/ml

it means W = 1g

and V = 1ml = 10^{-3}L

$$\therefore M = \frac{\text{Moles}}{\text{Volume}}$$

$$= \frac{\text{Weight}}{\text{Molar mass} \times \text{Volume}}$$

$$= \frac{1}{18 \times 10^{-3}}$$

$$= \frac{1000}{18}$$

$$= 55.55$$

(21) (d) M, F.

Molarity and formality are dependent on temperature.

(22) (c) Solution process is endothermic till 34°C and exothermic there afterSolubility increases with temp. upto 34°C and then decreases. So the process isendothermic upto 34°C and exothermic there after.

(23) (b) Aluminium, copper, magnesium and manganese

Duralumin is an alloy of aluminium, copper, magnesium and manganese.

It is light and strong as steel

It is used in construction of air crafts.

(24) (a) Antimony with tin and copper

Babbitt metal is an alloy of antimony with tin and copper.

It is antifriction alloy extensively used in machine bearings

(25) (b) 0.69

$$P_{N_2} = (K_H) (x_{N_2})$$

or

$$x_{N_2} = \frac{P_{N_2}}{K_H} = \frac{0.96 \text{ bar}}{76800 \text{ bar}} \\ = 1.25 \times 10^{-5}$$

If moles of N_2 are present in 1 L of water (55.5 moles)

$$x_{N_2} = \frac{n_{N_2}}{n_{N_2} + n_{H_2O}}$$

$$x_{N_2} = \frac{n}{n_{N_2} + 55.5} \approx \frac{n_{N_2}}{55.5}$$

(Neglecting n_{N_2} from denominator since very small)

$$\therefore n_{N_2} = x_{N_2} \times 55.5 \\ = 1.25 \times 10^{-5} \times 55.5 \\ = 69.3 \times 10^{-5} \text{ moles} \\ = 0.693 \text{ millimoles}$$

(26) (d) All of these

All the given expressions represent Henry's law.

(27) (a) 0.174 bar

$$P = (K_H)(x)$$

$$\begin{aligned} P &= (1.44 \times 10^3 \text{ bar}) \times (1.2 \times 10^{-6}) \\ &= 0.174 \text{ bar} \end{aligned}$$

(28) (c) 1 : 2

Ratio of moles of O₂ to N₂ is 1 : 4

$$\text{i.e. } \frac{n_{O_2}}{n_{N_2}} = \frac{1}{4}$$

∴ Partial pressure = Mole fraction × Total pressure

$$\begin{aligned} \therefore P_{O_2} &= \left(\frac{n_{O_2}}{n_{O_2} + n_{N_2}} \right) P_{\text{Total}} \text{ (at 1 bar pressure)} \\ &= \left(\frac{1}{1+4} \right) \times 1 \text{ bar} \end{aligned}$$

$$\therefore P_{O_2} = 0.2 \text{ bar}$$

$$\begin{aligned} \text{Also, } P_{N_2} &= \frac{n_{N_2}}{n_{N_2} + n_{O_2}} \times P_{\text{Total}} \\ &= \frac{4}{4+1} \times 1 \\ &= 0.8 \text{ bar} \end{aligned}$$

According to Henry's law,

$$x_{O_2} = \frac{P_{O_2}}{K_{H(O_2)}} \text{ and } x_{N_2} = \frac{P_{N_2}}{K_{H(N_2)}}$$

$$\frac{x_{O_2}}{x_{N_2}} = \frac{P_{O_2}}{K_{H(O_2)}} \times \frac{K_{H(N_2)}}{P_{N_2}} = \frac{P_{O_2}}{P_{N_2}} \times \frac{K_{H(N_2)}}{K_{H(O_2)}}$$

$$= \frac{0.2}{0.8} \times \frac{6.60 \times 10^7}{3.30 \times 10^7} = \frac{1}{2}$$

$$x_{O_2} : x_{N_2} \Rightarrow S_{O_2} : S_{N_2} = 1 : 2$$

(29) (c) Oxygen

Oxygen molecules are non polar. Therefore it has less solubility in water.

(30) (c) 5.98 × 10⁻⁴ mol dm⁻³

Given = K_H = 1.3 × 10⁻³ mol dm⁻³ atm⁻¹

$$P_{O_2} = 0.46 \text{ atm}$$

$$\therefore S = K_H P$$

$$= 1.3 \times 10^{-3} \times 0.46 \text{ atm}$$

$$= 0.598 \times 10^{-3}$$

$$= 5.98 \times 10^{-4} \text{ mol dm}^{-3}$$

(31) (c) 140

(c) 140

$$P_S = P_A^o x_A + P_B^o x_B$$

$$\therefore 84 = 70 (1 - x_B) + P_B^o (0.2)$$

$$\therefore 84 = 70 (1 - 0.2) + P_B^o (0.2)$$

$$\therefore 84 = 70 \times 0.8 + P_B^o \times 0.2$$

$$\therefore 84 = 56 + P_B^o (0.2)$$

$$\therefore P_B^o (0.2) = 28$$

$$\therefore P_B^o = \frac{28}{0.2} = 140 \text{ torr}$$

(32) (b) Will be less than that of water

The vapour pressure of a liquid solvent is lowered when a solute is dissolved in it to form a solution.

(33) (c) More than that of water

When a volatile solute is added to volatile solvent, the vapour pressure of the solvent decrease but the vapour pressure of the solution increases.

(34) (b) 0.27

$$\begin{aligned} x_{\text{Toluene}} &= \frac{P_T}{P_{\text{Solution}}} \\ &= \frac{P_T^o x_T}{P_T^o x_T + P_B^o x_B} \end{aligned}$$

since solutions are equimolar

∴ mole fraction is also same ($x_T = x_B$)

$$\begin{aligned} x_T &= \frac{P_T^o x_T}{P_T^o x_T + P_B^o x_B} \\ &= \frac{P_T^o}{P_T^o + P_B^o} \\ &= \frac{60}{60 + 100} \\ &= \frac{60}{220} = \frac{6}{22} \\ &\approx \frac{6}{24} = \frac{1}{4} \\ &= 0.25 \approx 0.27 \end{aligned}$$

(35) (b) $\text{H}_2\text{O} + \text{C}_4\text{H}_9\text{OH}$

Ideal solution is one in which the interaction between A and B are of same magnitude as in the pure components.

(36) (c) smaller than A-A and B-B interactions

The vapour pressure composition diagram is of solution A and B is showing positive deviation where the interaction of A-B is lesser than A-A and B-B interaction, and thus leads to increase in vapour pressure of solvent.

(37) (c) more than vapour pressure of pure water

(38) (b) Non-ideal solution with + ve deviation

Refer synopsis (Point no. 16)

(39) (c) less than the vapour pressure of pure water

Refer Q. No. 32

(40) (b) 100

$$\frac{P_1^o - P_s}{P_1^o} = \frac{W_2}{W_1} \frac{\text{MW}_1}{\text{MW}_2}$$

A = 1 and B = 2

$$\therefore \frac{10 - 9}{10} = \frac{1 \times 200}{20 \times \text{MW}_B}$$

$$\therefore \frac{1}{10} = \frac{10}{\text{MW}_B}$$

$$\therefore \text{MW}_B = 100$$

(41) (b) $\frac{5}{7}$ times

$$\frac{P_1^o - P_s}{P_1^o} = x_2 = \frac{n_2}{n_1 + n_2}$$

$$\frac{P_1^o - P_s}{P_1^o} = \frac{2}{5+2}$$

$$\therefore 1 - \frac{P_s}{P_1^o} = \frac{2}{7}$$

$$\therefore \frac{P_s}{P_1^o} = 1 - \frac{2}{7} = \frac{5}{7}$$

(42) (b) 65.25 grams

$$\frac{P_1^o - P_s}{P_1^o} = \frac{W_2/\text{MW}_2}{W_1/\text{MW}_1 + W_2/\text{MW}_2}$$

$$\frac{640 - 600}{640} = \frac{2.175 / \text{MW}_2}{2.175 / \text{MW}_2 + \frac{39}{78}}$$

$$\frac{40}{640} = \frac{2.175 / \text{MW}_2}{2.175 / \text{MW}_2 + 0.5}$$

$$\frac{1}{16} \left(\frac{2.175}{\text{MW}_2} + 0.5 \right) = \frac{2.175}{\text{MW}_2}$$

$$\frac{0.1359}{\text{MW}_2} + 0.03125 = \frac{2.175}{\text{MW}_2}$$

$$\frac{2.175}{\text{MW}_2} - \frac{0.1359}{\text{MW}_2} = 0.03125$$

$$\begin{aligned}\therefore \text{MW}_2 &= \frac{(2.175 - 0.1359)}{0.03125} \\ &= \frac{2.0391}{0.03125} \\ &= 65.25 \text{ grams}\end{aligned}$$

(43) (a) 141.93 mm Hg

$$\frac{P_1^o - P_s}{P_1^o} = \frac{W_2}{W_1} \frac{\text{MW}_1}{\text{MW}_2}$$

$$\frac{143 - P_s}{143} = \frac{0.5 \times 154}{(\rho_1 V_1) \times 65}$$

$$\frac{143 - P_s}{143} = \frac{77}{(1.58 \times 100) \times 65}$$

$$\therefore 143 - P_s = \frac{77 \times 143}{158 \times 65}$$

$$\therefore 143 - P_s = 1.072$$

$$\therefore P_s = 143 - 1.072$$

$$\therefore P_s = 141.928 \text{ mm Hg}$$

(44) (a) 180

$$\frac{P_1^o - P_s}{P_1^o} = \frac{W_2 / \text{MW}_2}{W_1 / \text{MW}_1 + W_2 / \text{MW}_2}$$

$$\therefore \frac{3000 - 2985}{3000} = \frac{15 / \text{MW}_2}{100 / 18}$$

$(W_1 / \text{MW}_1 = n_1 = \text{is neglected})$

$$\text{MW}_2 = 180$$

(45) (c) Boiling point

Boiling point is defined as the temperature at which the vapour pressure of liquid is equal to atmospheric pressure.

(46) (b) 100.256°C

$$K_b = 5.13 \text{ }^\circ\text{C} 100\text{g/mol}$$

$$\therefore \text{But } K_b = K \text{ kg/mol}$$

$$\therefore K_b = 0.513 \text{ }^\circ\text{C kg/mol}$$

$$\Delta T_b = \frac{K_b \cdot n_{\text{solute}}}{W_{\text{Solvent}}}$$

$$T_b - T_b^o = \frac{0.513 \times 0.1}{0.2}$$

$$T_b - T_b^o = 0.256$$

(solvent is water $\therefore T_b^o = 100 \text{ }^\circ\text{C}$)

$$T_b^o = 100.256 \text{ }^\circ\text{C}$$

(47) (b) 373.25 K

$$T_{b_{\text{urea}}} - T_{b^o} = \frac{K_b W_{\text{urea}}}{MW_{\text{urea}} W_{\text{solvent}}} \quad \text{--- (i)}$$

$$T_{b_{\text{glucose}}} - T_{b^o} = \frac{K_b W_{\text{glucose}}}{MW_{\text{glucose}} W_{\text{solvent}}} \quad \text{--- (ii)}$$

Dividing eq (ii) by (i)

$$T_{b_{\text{glucose}}} - T_{b^o} = \frac{K_b \times 6}{180 \times W_{\text{solvent}}}$$

$$373.25 - T_{b^o} = \frac{K_b \times 2}{60 \times W_{\text{solvent}}}$$

$$\therefore \frac{T_{b_{\text{glucose}}} - T_{b^o}}{373.25 - T_{b^o}} = \frac{6 \times 60}{180 \times 2}$$

$$\therefore T_{b_{\text{glucose}}} - T_{b^o} = 373.25 - T_{b^o}$$

$$\therefore T_{b_{\text{glucose}}} = 373.25 \text{ K}$$

(48) (b) halved

$$\Delta T_b = \frac{K_b W_{\text{solute}}}{MW_{\text{solute}} W_{\text{solvent}}}$$

$$\text{Case 1 : } \Delta T_b = \frac{K_b W}{MW W}$$

$$\text{Case 2 : } \Delta T_{b'} = \frac{K_b (2W)}{MW(4W')}$$

$$\frac{\Delta T_b}{\Delta T_{b'}} = \frac{1}{2} \times \frac{4}{1}$$

$$\therefore \Delta T_{b'} = \frac{1}{2} \Delta T_b$$

(49) (d) 100.3 °C

Refer Q. No. 47

(50) (d) 8

$$M_{\text{solute}} = \frac{K_f W_{2(\text{Solute})}}{\Delta T_f W_{1(\text{Solute})}}$$

$$= \frac{6.8 \times 25.6}{0.68 \times 1} = 256$$

$$\text{Atomicity} = \frac{\text{mol.wt}}{\text{At. wt}} = \frac{256}{32} = 8$$

(51) (b) 17.1

\therefore urea solution is 3%

$$\therefore W_{\text{urea}} = 3g$$

$$W_{\text{solution}} = 100g$$

$$\therefore \Delta T_f = \frac{K_f W_{\text{solute}}}{MW_{\text{solute}} W_{\text{solvent}}}$$

For canesugar :

$$\Delta T_f = \frac{K_f W}{342 \times W'}$$

For urea :

$$\Delta T_f = \frac{K_f (3)}{60 \times W'}$$

\therefore Freezing point is same

$$\frac{W}{342} = \frac{3}{60}$$

$$W = \frac{342 \times 3}{60} \\ = 17.1 \text{ grams}$$

(52) (a) below 0°C

The freezing point of a liquid solvent is decreased when a solute is dissolved in it to form a solution.

(53) (b) -3.72°C

For 1st solution :

$$T_f = -1.86, T_f^o = 0^\circ C$$

$$m_1 = 0.1 m$$

$$\therefore \Delta T_{f1} = T_f^o - T_f = 0 - (-1.86) \\ = 1.86^\circ C$$

$$\therefore \Delta T_f = k_f m$$

$$\therefore 1.86 = k_f (0.1) \quad \dots(i)$$

For 2nd solution :

$$m_2 = 0.3 m$$

For new solution :

$$T_{f3} = ? \quad m_3 = ?$$

$$m_3 = \frac{m_1 V_1 + m_2 V_2}{V_1 + V_2}$$

(volumes are same)

$$m_3 = \frac{0.1 V + 0.3 V}{2V}$$

$$= \frac{0.4}{2} = 0.2 m$$

$$m_3 = 0.2 m$$

$$\Delta T_{f3} = k_f m_3$$

$$\therefore T_f^o - T_f = k_f (0.2)$$

$$-T_f = 1.86 \times 0.2$$

$$T_f = -k_f \times 0.2 \quad \dots(ii)$$

comparing eq. (ii) by (i)

$$\frac{T_f}{1.86} = \frac{-0.2}{0.1}$$

$$T_f = -1.86 \times 2$$

$$= -3.72^\circ\text{C}$$

- (54) (d) Reduction in freezing point

As ethylene glycol depresses the freezing point of water.

- (55) (d) Copper ferrocyanide

Copper ferrocyanide is an example of semi permeable membrane.

- (56) (a) blood cell collapses

Blood cells placed in water containing less than 0.9% salt (mass/volume) collapses due to loss of water by osmosis.

- (57) (b) Haemolysis

When a cell is placed in hypertonic solution, it shrinks is called exo-osmosis or plasmolysis and when a cell is placed in hypotonic solution, it swells is called endosmosis or haemolysis.

- (58) (b) Plasmolysis

Refer Q. No. 57

- (59) (a) Sugar beet will lose water from its cells

Refer Q. No. 57

- (60) (d) Osmotic pressure

Osmotic pressure method is the best method for determining the molecular masses of polymers since observed value of any other colligative property is too small to be measured with reasonable accuracy.

- (61) (c) No. of solute molecules is increased

$$\pi V = nRT$$

$$\pi \propto \frac{1}{\text{Volume}}$$

$\pi \propto$ No. of solute molecule is increased

$\pi \propto$ emperature

- (62) (b) 1200

$$\pi V = \frac{W_{\text{solute}}}{MW_{\text{solute}}} RT$$

$$(600 \text{ mm}) (500 \text{ ml}) = \frac{20}{MW_{\text{solute}}} \times 0.082$$

$$(\text{Lit atm}/\text{K mol}) \times 288 (\text{K})$$

$$\frac{600}{760} (\text{atm}) (0.5 \text{ L}) = \frac{20}{MW} \times 0.082 (\text{Lit atm}/\text{K mol}) \times 288 \text{ K}$$

$$MW = \frac{20 \times 0.082 \times 288 \times 760}{600 \times 0.5}$$

$$MW = 1196.54 \text{ gram mol}^{-1}$$

- (63) (a) 349

urea solution : 8.6 g/lit

$$W_{\text{urea}} = 8.6 \text{ g}$$

$$V_{\text{solution}} = 1000 \text{ ml}$$

solution x : 5%

$$W_x = 5 \text{ g}$$

$$V_{\text{solution}} = 100 \text{ ml}$$

\therefore the solution is isotonic

$$n_{\text{urea}} = n_x$$

(if volumes are equal)

$$\therefore W_x = 50 \text{ g per } 1000 \text{ ml}$$

$$\therefore n_{\text{urea}} = n_x$$

$$\frac{W_{\text{urea}}}{MW_{\text{urea}}} = \frac{W_x}{MW_x}$$

$$\frac{8.6}{60} = \frac{50}{MW_x}$$

$$\begin{aligned} \text{MW}_x &= \frac{50 \times 60}{8.6} \\ &= 348.83 \text{ gram mol}^{-1} \end{aligned}$$

(64) (b) $2 \times 10^5 \text{ Nm}^{-2}$

$$\pi V = nRT$$

$$\text{Case 1 : } (1 \times 10^5) (0.1 \times 10^{-3}) = nRT$$

$$\text{Case 2 : } (\pi_2) (0.05 \times 10^{-3}) = nRT$$

$$\therefore nRT = \text{constant}$$

$$\therefore 10^5 \times 10^{-4} = \pi_2 \times 5 \times 10^{-5}$$

$$\therefore \pi_2 = \frac{10}{5 \times 10^{-5}}$$

$$\therefore \pi_2 = 2 \times 10^5 \text{ Nm}^{-2}$$

(65) (b) 2.06 atm

The osmotic pressure of resulting solution, π is.

$$\pi = \frac{\pi_1 + \pi_2}{2} \text{ (is equal volume)}$$

$$\pi = \frac{1.66 + 2.46}{2}$$

$$\pi = \frac{4.12}{2}$$

$$\pi = 2.06 \text{ atm}$$

(66) (c) 5 times

$$\pi V = nRT$$

$$\text{Case I : } (500 \text{ mm}) V = n R (283 \text{ K})$$

$$\text{Case II : } (105.3 \text{ mm}) V' = n R (298 \text{ K})$$

$$\frac{(500) V}{(105.3) V'} = \frac{283}{298}$$

$$\frac{V'}{V} = \frac{500 \times 298}{105.3 \times 283}$$

$$\frac{V'}{V} = 5$$

(67) (c) $\pi_2 > \pi_1 > \pi_3$

Colligative property is inversely proportional to the molecular mass, smaller is molecular mass of solute greater is the osmotic pressure.

(68) (c) a hypertonic solution

Refer Q. No. 57

(69) (d) 1.0

The Van't Hoff factor for non - electrolyte is always equal to 1.

(70) (d) All of these

The Van't Hoff factor for non - electrolyte is always equal to 1

The Van't Hoff factor for dissociating electrolyte is greater than 1 and for associating electrolyte is less than 1.

(71) (c) 244

Refer synopsis (Point No. 19)

(72) (d) 1 M Urea and 1 M Sucrose

Two solutions are isotonic if their concentrations are same.

(73) (c) 1 M Alum solution

For different solutes of same molar concentration the colligative properties have greater value for the solution which gives more number of particles on ionisation.

(74) (c) 1% NaCl in water

Refer Q. No. 73

(75) (a) 0.01 m NaCl

For minimum freezing point product of the to be more concentration and 'i' has

(76) (b) -3.72°C

$$\begin{aligned} \Delta T_f &= i \times K_f \times m \\ &= 2 \times 1.86 \times 1 \end{aligned}$$

$$T_f^\circ - T_f = 3.720 \quad (\because T_f^\circ = 0^\circ \text{ C})$$

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

(77) (c) 271.326 K

$$\infty = \frac{i - 1}{n^1 - 1}$$

$$0.8 = \frac{i - 1}{2 - 1}$$

$$i = 1.8$$

$$T_f^0 - T_f = i K_f m.$$

$$273 - T_f = 1.8 \times 1.86 \times 0.5$$

$$273 - T_f = 1.674$$

$$T_f = 273 - 1.674$$

$$T_f = 271.326 \text{ K}$$

(78) (c) 0.96

For association,

$$i = 1 - x + \frac{x}{n}$$

Where x = degree of association n = type of polymerization

$$\therefore 0.52 = 1 - x + \frac{x}{2}$$

$$\therefore 0.52 = 1 - \frac{x}{2}$$

$$\therefore 1.04 = 2 - x$$

$$\therefore x = 2 - 1.04$$

$$\therefore x = 0.96$$

(79) (b) 0.51

$$i = \frac{\text{MW}_{\text{theoretical}}}{\text{MW}_{\text{observed}}}$$

$$i = \frac{60}{118}$$

$$i = 0.5084$$

(80) (a) (i) < (ii) < (iii) < (iv)

Greater the product of "concentration and i ", greater is the boiling point.

HOME WORK

Hints & Explanation

(1) (a) 0.3

$$N = \frac{W_{\text{solute}}}{E_{\text{solute}} V_{\text{solution}} (\text{dm}^3)}$$

$$N = \frac{9.8}{(98/3)(1)}$$

$$N = 0.3$$

(2) (a) 0.080

$$m = \frac{W_{\text{solute}}}{M.W_{\text{solute}} \times W_{\text{solvent}} (\text{kg})}$$

$$\therefore 0.1 = \frac{W_{\text{solute}}}{M.W_{\text{solute}} (\rho_{\text{Solvent}} \times V_{\text{Solvent}}) (\text{kg})}$$

$$= \frac{5}{98(1.29 \times 500)10^{-3}}$$

$$\approx \frac{5}{100 \times 1.29 \times 500 \times 10^{-3}}$$

$$= \frac{1}{12.9} = 0.07752 \approx 0.08$$

(3) (d) $\frac{1}{3}$

$$x_{\text{Hydrogen}} = \frac{n_{\text{hydrogen}}}{n_{\text{hydrogen}} + n_{\text{oxygen}}}$$

$$= \frac{4/2}{4/2 + 32/32}$$

$$= \frac{1/2}{1/2 + 1}$$

$$= \frac{1/2}{3/2} = \frac{1}{3}$$

(4) (b) 0.667

Since it is 0.8 M solution

$$\therefore n_{\text{solute}} = 0.8 \text{ and}$$

$$V_{\text{solution}} = 1 \text{ dm}^3$$

\therefore The solution is dilute

$$V_{\text{solution}} = V_{\text{solvent}} = 1 \text{ dm}^3$$

(neglecting volume occupied by solute)

$$\therefore m = \frac{n_{\text{solute}}}{W_{\text{solvent}} \text{ in kg}}$$

$$\therefore m = \frac{0.8}{\rho_{\text{solvent}} \times V_{\text{solvent}}}$$

$$\therefore m = \frac{0.8}{1.2 \left(\frac{\text{Kg}}{\text{dm}^3} \right) \times 1(\text{dm}^3)}$$

$$\therefore m = \frac{0.8}{1.2}$$

$$\therefore m = \frac{2}{3}$$

$$\therefore m = 0.667$$

(5) (c) 0.1 M

$$M_f = \frac{M_1 V_1 + M_2 V_2}{V_f}$$

$$\therefore = \frac{100 \times 0.1 + 200 \times 0.1}{300}$$

$$M_f = \frac{10+20}{300} = \frac{30}{300}$$

$$M_f = 0.1$$

(6) (a) 400 cm³

$$N_1 V_1 = N_2 V_2$$

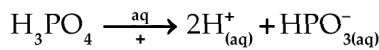
$$0.5 \times 100 = 0.1 \times v_2$$

$$v_2 = 500 \text{ cm}^3$$

Volume of water to be added = (500 - 100) cm³

$$= 400 \text{ cm}^3$$

(7) (a) 0.6

 H_3PO_3 is a dibasic acid

$$\therefore \text{Normality} = \text{Molarity} \times \text{Basicity} \\ = 0.3 \times 2 = 0.6 \text{ N}$$

(8) (c) Smoke

Smoke is an heterogeneous mixture.

(9) (c) manganin

(10) (a) 70-80% Mn

(11) (a) Spiegeleisen

(12) (a) Alloys of mercury with other metal.

Alloys of mercury with other metals are called amalgams. This property is used for extracting metals from the ores. Silver and gold from the ores, dissolve in mercury to form liquid amalgams. Gold and silver are recovered by distilling off mercury.

(13) (c) Antimony

Lead is hardened by addition of 10-20% antimony is used for bearings, bullets and sharpner.

(14) (c) Increase of pressure and decrease of temperature

Solubility of gas in a liquid increases with increase of pressure (i.e. Henry's law, $S = K_H P$)

According to Charle's law volume of a given mass of a gas increases with increase of temperature. Therefore, volume of a given mass of dissolved gas in solution also increases with increase of temperature, so that it becomes impossible for the solvent in solution to accommodate gaseous solute in it and gas bubbles out. Hence solubility of gas in liquid decreases with increase of temperature.

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(15) (c) $p = K_H \times x$

Where x = mole fraction or solubility of methane

$$x = \frac{P}{K_H} = \frac{760}{4.27 \times 10^5} \\ = 177.98 \times 10^{-5} \\ = 1.7798 \times 10^{-3}$$

(16) (c) $P_{N_2} = K_H \times x_{N_2}$

$$\therefore x_{N_2} = \frac{P_{N_2}}{K_H} = \frac{0.987 \text{ bar}}{76480 \text{ bar}} = 1.29 \times 10^{-5}$$

(17) (c) Na_2SO_4

Solubility of Na_2SO_4 decreases with increase of temperature.

(18) (a) increase slightly

(19) (d) All of these

Due to high temperature at upper level, solubility decreases.

(20) (c) Mole fraction

From Raoult's law

$$P = P^\circ x$$

P = Partial vapour pressure of component in solution

P° = Pure vapour pressure of component

x = Mole fraction of component

(21) (d) 0.2

$$x_A = \frac{P_A^\circ x_A}{P_{\text{Solution}}}$$

$$\therefore \frac{P_A^\circ}{P_B^\circ} = \frac{1}{2} \quad \text{and} \quad \frac{x_A}{x_B} = \frac{1}{2}$$

$$\therefore P_B^\circ = 2P_A^\circ \text{ and}$$

$$x_B = 2x_A$$

$$x_A = \frac{P_A^0 x_A}{P_A^0 x_A + 2 P_B^0 x_B}$$

$$\begin{aligned} \therefore x_A &= \frac{P_A^0 x_A}{P_A^0 x_A + 2 P_A^0 x_A} \\ &= \frac{1}{5} \\ &= 0.2 \end{aligned}$$

- (22) (b) A non-electrolyte in a dilute solution Raoult's law is applicable to
 (i) Dilute solutions
 (ii) Solution of non-volatile solute
 (iii) Solution of non-electrolyte solute

- (23) (d) Relative lowering vapour pressure

$$\frac{P_1^0 - P_s}{P_1^0} = \text{Relative lowering of vapour pressure}$$

- (24) (d) None of these

Refer synopsis (Point No. 15)

- (25) (c) (i) Acetone + Ethyl alcohol,
 (ii) Acetone + Chloroform

Graph (i) shows positive deviation from Raoult's law and Graph (ii) shows negative deviation from Raoult's law.

Refer synopsis (Point No. 16)

- (26) (a) A - B interactions are stronger than A - A and B - B interactions

Refer synopsis (Point No. 16)

- (27) (c) On mixing acetone and chloroform
 Negative deviation is shown since there is decrease in vapour pressure.

Refer synopsis (Point No. 16)

- (28) (d) It forms minimum boiling azeotrope

Refer synopsis (Point No. 16)

- (29) (c) 0.66

$$x_{\text{solute}} = \frac{P_1^0 - P_s}{P_1^0}$$

$$1 - x_{\text{Solvent}} = \frac{P_1^0 - P_s}{P_1^0} = \frac{0.20}{0.60} = \frac{2}{6} = \frac{1}{3}$$

$$\therefore x_{\text{solvent}} = 1 - \frac{1}{3} = \frac{2}{3} = 0.667$$

- (30) (c) 27 mm Hg

$$P_s = P_1^0 x_1$$

$$\therefore P_s = 30 \times 0.9$$

$$\therefore P_s = 27 \text{ mm Hg}$$

- (31) (d) 0.815 atm

$$\frac{P_1^0 - P_s}{P_1^0} = \frac{W_2 \text{ MW}_1}{W_1 \text{ MW}_2}$$

$$\therefore \frac{0.842 - P_s}{0.842} = \frac{32 \times 10^{-3} \times 58 \times 10^{-3}}{150 \times 10^{-3} \times 384.4 \times 10^{-3}}$$

$$\therefore \frac{0.842 - P_s}{0.842} = 0.0321$$

$$\therefore 0.842 - P_s = 0.027$$

$$\therefore P_s = 0.842 - 0.027$$

$$\therefore P_s = 0.815 \text{ atm}$$

- (32) (b) 0.6

Case I :

$$\therefore \frac{P_1^0 - P_s}{P_1^0} = x_2$$

$$\therefore \frac{10}{P_1^0} = 0.2$$

$$\therefore P_1^0 = \frac{10}{0.2} = 50$$

Case II :

$$\frac{P_1^0 - P_s}{P_1^0} = 1 - x_1$$

$$\therefore \frac{20}{50} = 1 - x_1$$

$$\therefore x_1 = 1 - \frac{20}{50}$$

$$\therefore x_1 = \frac{30}{50}$$

$$\therefore x_1 = 0.6$$

(33) (c) 0.1 K/m

$$T_b - T_b^0 = \frac{K_b W_{\text{solute}}}{MW_{\text{solute}} W_{\text{solvent}} (\text{Kg})}$$

$$\therefore 0.1 = \frac{K_b \times 34.2}{342 \times 0.1}$$

$$\therefore K_b = 0.1 \text{ Km}^{-1}$$

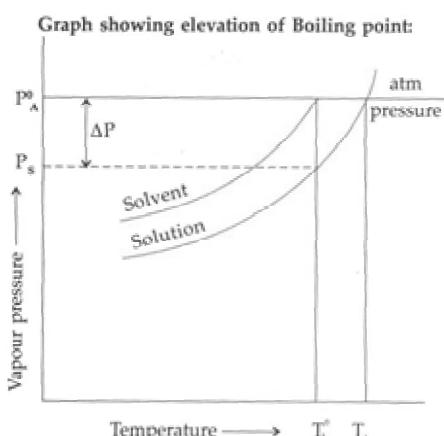
(34) (c) 158

$$T_b - T_b^0 = \frac{K_b W_{\text{solute}}}{MW_{\text{solute}} W_{\text{solvent}} (\text{Kg})}$$

$$\therefore 0.1 = \frac{2.16 \times 0.11}{MW_{\text{solute}} \times 15 \times 10^{-3}}$$

$$\therefore MW_{\text{solute}} = 158.4 \text{ gram mol}^{-1}$$

(35) (c) The lowering of vapour pressure in the solution



(36) (d) 109.7

$$T_f^0 - T_f = \frac{K_f W_{\text{solute}}}{MW_{\text{solute}} W_{\text{solvent}} (\text{Kg})}$$

$$\therefore (273 - 271.94) = \frac{1.86 \times 1.25}{MW_{\text{solute}} \times 20 \times 10^{-3}}$$

$$\therefore MW_{\text{solute}} = \frac{2.325}{1.06 \times 20 \times 10^{-3}}$$

$$= 109.6 \text{ gram mol}^{-1} \approx 109 \text{ gram mol}^{-1}$$

(37) (b) -1.86°C

$$T_f^0 - T_f = \frac{K_f W_{\text{solute}}}{MW_{\text{solute}} W_{\text{solvent}} (\text{Kg})}$$

$$\therefore 0^\circ \text{C} - T_f = \frac{1.86 \times 342}{342 \times 1}$$

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

(38) (b) 0.654°C

$$\therefore T_b - T_b^0 = K_b m$$

$$\therefore 100.18 - 100 = 0.512 \times m \quad \text{(i)}$$

$$\therefore T_f^0 - T_f = K_f m$$

$$\therefore 0^\circ \text{C} - T_f = 1.86 \times m \quad \text{(ii)}$$

Dividing (ii) by (i)

$$\frac{-T_f}{0.18} = \frac{1.86}{0.512}$$

$$\therefore T_f = -0.6539^\circ \text{C} \approx 0.654^\circ \text{C}$$

(39) (b) 3 g

$$T_f^0 - K_f = \frac{K_f W_{\text{solute}}}{MW_{\text{solute}} W_{\text{solvent}} (\text{Kg})}$$

$$\therefore 0.186 = \frac{1.86 \times W_{\text{solute}}}{60 \times 0.5}$$

$$\therefore W_{\text{solute}} = 3 \text{ grams}$$

(40) (c) -2.0°C

$$T_f^o - T_f = \frac{K_f}{\text{MW}_{\text{solute}}} \frac{W_{\text{solute}}}{W_{\text{solvent}}} (\text{Kg})$$

Case 1 :

$$0^{\circ}\text{C} - (-1^{\circ}\text{C}) = \frac{K_f (15)}{\text{MW}_{\text{solute}} (0.1)}$$

Case 2 :

$$0^{\circ}\text{C} - T_f = \frac{K_f \times 30}{\text{MW}_{\text{solute}} \times (0.1)}$$

Dividing case 2 by case 1

$$\frac{-T_f}{1^{\circ}\text{C}} = \frac{30/0.1}{15/0.1}$$

$$-T_f = 2^{\circ}\text{C}$$

$$T_f = -2^{\circ}\text{C}$$

(41) (d) nature of solvent used

K_b and K_f depends upon the nature of solvent used.

(42) (b) cryoscopic constant

Cryoscopic constant is defined as the depression in freezing point produced by one molal solution.

(43) (d) 136

$$T_f^o - T_f = \frac{K_f}{\text{MW}_{\text{solute}}} \frac{W_{\text{solute}}}{W_{\text{solvent}}} (\text{Kg})$$

$$\therefore 0^{\circ}\text{C} - (-0.930^{\circ}\text{C}) = \frac{1.86 \times 6.8}{\text{MW}_{\text{solute}} \times 0.1}$$

$$\therefore \text{MW}_{\text{solute}} = \frac{1.86 \times 6.8}{0.93 \times 0.1}$$

$$= 136 \text{ gram mol}^{-1}$$

(44) (b) solvent molecules move from lower to higher concentration of solution

Osmosis is the phenomenon in which the solvent molecules moves from region of lower concentration of solute to that of higher concentration of solute, as a result the volume of solution increases.

(45) (a) There will be no net movement across the membrane

Since the two solutions are isotonic there is no movement of solvent across the semi permeable membrane.

(46) (c) Both solute and solvent molecules

A semi permeable membrane allows the movement of solvent molecules only and not the solute particle.

(47) (d) All of these

All the terms are example of osmosis.

(48) (a) Increases

Refer Q. No. 44

(49) (c) they have the same osmotic pressure

$$\pi = CRT$$

For two solution,

$$\text{if } C_1 = C_2$$

$$T_1 = T_2$$

$$\therefore \pi_1 = \pi_2$$

(50) (c) 6.79 atm

$$\pi V = \frac{W_{\text{solute}}}{\text{MW}_{\text{solute}}} RT$$

$$= \frac{1 (9) \times 0.082(\text{Lit atm K}^{-1} \text{mol}^{-1}) \times 298(\text{K})}{180(9 \text{ mol}^{-1})(20 \times 10^{-3} \text{L})}$$

$$= 6.78 \text{ atm}$$

$$0^\circ\text{C} - T_f = 1.9 \times 1.86 \times \frac{W_{\text{Solute}}}{\text{MW}_{\text{Solute}} W_{\text{Solvent}}}$$

$$-T_f = 3.534 \times \frac{8.1}{81 \times 0.1}$$

$$T_f = -3.534^\circ\text{C}$$

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Points to remember

1 Strength of solution = $\frac{\text{Mass of solute in grams}}{\text{Volume of solution in litres}}$

$$\% w/w = \frac{W_2}{W_1 + W_2} \times 100 \quad M = \frac{W_2}{MW_2 \times V_s} \quad N = \frac{W_2}{E_2 \times V_s}$$

$$m = \frac{W_2}{MW_2 \times W_1 (\text{kg})} \quad ppm = \frac{w_2}{w_1 \times w_2} \times 10^6$$

Note : 1 represents solvent, 2 represents solute and s represents solution.

2 Mole fraction of 1, $x_1 = \frac{n_1}{n_1 + n_2}$

Mole fraction of 2, $x_2 = \frac{n_2}{n_1 + n_2}$

$$\text{Also } x_1 + x_2 = 1$$

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3 Normality of acid = Molarity \times Basicity

4 Normality of base = Molarity \times Acidity

5 Dilution formula :

$$N_1 V_1 = N_2 V_2 \text{ or } M_1 V_1 = M_2 V_2$$

6 Henry's Law, $P = K_H x$

where, P = vapour pressure or particle pressure of the gas,

x = mole fraction of the component

K_H = Henry's law constant

7 Raoult's Law

(i) If both components are volatile $P_s = P_1^o x_1$ and $P_2 = P_2^o x_2$

$$P_s = P_1 + P_2 = P_1^o x_1 + P_2^o x_2$$

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(ii) If only solvent (A) is volatile vapour pressure of solution, $P_s = P_1^0 X_1$

Mole fraction of A in vapour phase, $y_A = \frac{P_A}{P_A + P_B}$ (If solution is less than 5%)

8 Relative lowering of vapour pressure

$$\frac{P_1^0 - P_s}{P_1^0} = x_2 = \frac{n_2}{n_1 + n_2}$$

For dilute solution, $n_1 + n_2 \approx n_1$

$$\frac{P_1^0 - P_s}{P_1^0} = \frac{n_2}{n_1} = \frac{W_2 \text{ MW}_1}{W_1 \text{ MW}_2}$$

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9 Elevation in boiling point

$$\Delta T_b = K_b m = \frac{K_b W_2}{M W_2 W_1}$$

10 Depression in freezing point

$$\Delta T_f = K_f = \frac{W_2}{M W_2 W_1}$$

11 Osmotic pressure

$$\pi = CRT = \frac{n}{V} RT \quad \text{and} \quad M W_2 = \frac{W_2 RT}{\pi V}$$

$R = 0.0821 \text{ L atm K}^{-1} \text{ mol}^{-1}$ (where P is in atm and V is in L)

$= 8.314 \text{ K K}^{-1} \text{ mol}^{-1}$ (where P is in N m⁻² or pascals and V is in m³)

For isotonic solutions, $\pi_1 = \pi_2$

12 Van't Hoff factor

Van't Hoff factor, $i = \frac{\text{Observed value of colligative property}}{\text{Calculated value of colligative property}}$

$$= \frac{\text{Calculated molar mass}}{\text{Observed molar mass}}$$

For dissociation, $i > 1$; For association, $i < 1$.

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13 For solution undergoing association or dissociation,

$$\frac{\Delta P}{P_1^o} = i x_2$$

$$\Delta T_b = i K_b m$$

$$\Delta T_f = i K_f m$$

$$\pi = i CRT$$

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13 Degree of dissociation (α) = $\frac{i-1}{n-1}$

14 Degree of association (x) :

$$i = 1 - x + \frac{x}{n}$$

Where i = Van't Hoff factor

x = degree of association

n = degree of polymerization ($n = 2$ for dimerization, $n = 3$ for trimerization and etc).

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EVALUATION PAPER - SOLUTIONS AND COLLIGATIVE PROPERTIES

Time : 30 Min.

Marks : 25

- (10) Density of a 2.05 M solution of acetic acid in water is 1.02 g/mL. The molality of the solution is
(a) 1.14 mol kg⁻¹ (b) 3.28 mol kg⁻¹ (c) 2.28 mol kg⁻¹ (d) 0.44 mol kg⁻¹
- (11) A mixture of ethyl alcohol and propyl alcohol has a vapour pressure of 290 mm at 300 K. The vapour pressure of propyl alcohol is 200 mm. If the mole fraction of ethyl alcohol is 0.6, its vapour pressure (in mm) at the same temperature will be
(a) 350 (b) 300 (c) 700 (d) 360
- (12) A non ideal solution was prepared by mixing 30 mL chloroform and 50 mL acetone. The volume of mixture will be
(a) > 80 ml (b) < 80 ml (c) = 80 ml (d) ≥ 80 ml
- (13) A binary liquid solution is prepared by mixing n-heptane and ethanol. Which one of the following statements is correct regarding the behaviour of the solution
(a) the solution formed is an ideal solution
(b) the solution is non-ideal, showing +ve deviation from Raoult's Law
(c) the solution is non-ideal, showing -ve deviation from Raoult's Law
(d) n-heptane shows +ve deviation while ethanol shows -ve deviation from Raoult's Law
- (14) Pressure cooker reduces cooking time for food because
(a) heat is more evenly distributed in the cooking space
(b) boiling point of water involved in cooking is increased
(c) the higher pressure inside the cooker crushes the food material
(d) cooking involves chemical changes helped by a rise in temperature
- (15) The molal boiling point constant for water is 0.513°C kg mol⁻¹. When 0.1 mole of sugar is dissolved in 200 ml of water, the solution boils at
(a) 100.513°C (b) 100.0513°C (c) 100.256°C (d) 101.0.25°C
- (16) The elevation in boiling point of a solution of 13.44 g of CuCl₂ in 1 kg of water using the following information will be
(Molecular weight of CuCl₂ = 134.4 and K_b = 0.52 K molal⁻¹)
Assume CuCl₂ as strong electrolyte
(a) 0.16 (b) 0.05 (c) 0.1 (d) 0.2
- (17) Which one of the following statements is FALSE
(a) The correct order of osmotic pressure for 0.01 M aqueous solution of each compound is BaCl₂ > CH₃COOH > KCl > sucrose.
(b) The osmotic pressure π of a solution is given by the equation $\pi = MRT$ where M is the molarity of the solution
(c) Raoult's law states that the vapour pressure of a component over a solution is proportional to its mole fraction
(d) Two sucrose solutions of same molality prepared in different solvents will have the same freezing point depression

- (18) Which of the following has minimum freezing point
 (a) 0.1 M $K_2Cr_2O_7$ (b) 0.1 M NH_4Cl (c) 0.1 M $BaSO_4$ (d) 0.1 M $Al_2(SO_4)_3$
- (19) Which of the following pair of solutions are expected to be isotonic at the same temperature
 (a) 0.2 M Urea and 0.2 M $NaCl$ (b) 0.1 M Urea and 0.2 M $MgCl_2$
 (c) 0.1 M $NaCl$ and 0.1 M Na_2SO_4 (d) 0.1 M $Ca(NO_3)_2$ and 0.1 M Na_2SO_4
- (20) Which of the following aqueous solutions has the highest boiling point
 (a) 0.1 M KNO_3 (b) 0.1 M Na_3PO_4 (c) 0.1 M $BaCl_2$ (d) 0.1 M K_2SO_4
- (21) Hydrochloric acid solution A and B have concentration of 0.5 N and 0.1 N respectively. The volumes of solutions A and B required to make 2 litres of 0.2 N HCl are
 (a) 0.5 litre of A + 1.5 litre of B (b) 1.5 litre of A + 0.5 litre of B
 (c) 1.0 litre of A + 1.0 litre of B (d) 0.75 litre of A + 1.25 litre of B
- (22) The mole fraction of water in 20% aqueous solution (By weight) of H_2O_2 is
 (a) $\frac{77}{68}$ (b) $\frac{68}{77}$ (c) $\frac{20}{80}$ (d) $\frac{80}{20}$
- (23) The volume of water to be added to 10 ml of 10 N HCl solution to make it decinormal is
 (a) 1000 ml (b) 9990 ml (c) 99 ml (d) 9,990 ml
- (24) Out of Molarity (M), molarity (m), formality (F) and mole fraction (x), those dependent on temperature are
 (a) M, m (b) F, x (c) m, x (d) M, F
- (25) 'i' of centimolar solution of $K_3[Fe(CN)_6]$ is 3.333. Calculate the percent dissociation of $K_3[Fe(CN)_6]$.
 (a) 33.33 (b) 0.78 (c) 78 (d) 23.33

EVALUATION PAPER - SOLUTION AND COLGATIVE PROPERTIES ANSWER KEY

1 d	2 c	3 a	4 c	5 c	6 d	7 a	8 b	9 a	10 c
11 a	12 b	13 b	14 b	15 c	16 a	17 d	18 d	19 d	20 b
21 a	22 b	23 b	24 b	25 c					

