

TEACHERS FORUM[®]



QUESTION BANK

(SOLVED)

KERALA STATE

+2 CHEMISTRY

CONTENTS

Board Question Paper with Solutions - 2023 March	005 - 010
Board Question Paper with Solutions - 2022 March	011 - 018
Board Question Paper with Solutions - 2021 March	019 - 030
Board Question Paper with Solutions - 2020 March	031 - 037
Board Question Paper with Solutions - 2019 March	038 - 045
01. SOLUTIONS	046 - 058
02. ELECTROCHEMISTRY	059 - 069
03. CHEMICAL KINETICS	070 - 083
04. THE D- AND F- BLOCK ELEMENTS	084 - 093
05. COORDINATION COMPOUNDS	094 - 104
06. HALOALKANES AND HALOARENES	105 - 113
07. ALCOHOLS, PHENOLS AND ETHERS	114 - 126
08. ALDEHYDES, KETONES AND CARBOXYLIC ACIDS	127 - 141
09. AMINES	142 - 152
10. BIOMOLECULES	153 - 164

1

SOLUTIONS

PREVIOUS YEARS' QUESTIONS AND ANSWERS

1. A solution contains 15 g urea (molar mass = 60 g mol⁻¹) per litre of solution in water has the same osmotic pressure as a solution of glucose (molar mass = 180 g mol⁻¹) in water. Calculate the mass of glucose present in one litre of its solution. **(2018)**

Ans. Here the two solutions have same osmotic pressure. So they are isotonic.

$$\text{So } \pi_1 = \pi_2$$

$$\text{We know that } \pi = \frac{nRT}{V}$$

$$\text{Therefore, } \pi_1 = \frac{n_1RT}{V}$$

$$\text{and } \pi_2 = \frac{n_2RT}{V}$$

Since $\pi_1 = \pi_2$, it follows that $n_1 = n_2$ (at constant temperature and volume)

$$\text{or, } \frac{w_1}{M_1} = \frac{w_2}{M_2} \quad \Rightarrow \quad \frac{15}{60} = \frac{w_2}{180}$$

$$w_2 = \frac{15}{60} \times 180 = 45 \text{ g}$$

ie., Mass of glucose = 45 g

2. An element crystallises as FCC with density 2.8 g cm⁻³. Its unit cell having edge length 4 × 10⁻⁸ cm. Calculate the molar mass of the element. (Given N_A = 6.022 × 10²³ mol⁻¹).

Ans. Here d = 2.8 g/cm³, a = 4 × 10⁻⁸ cm, z = 4 (since fcc) and N_A = 6.022 × 10²³ **(2018)**

$$\text{We know that, } d = \frac{zM}{N_A a^3}$$

$$\text{So, } M = \frac{d \cdot N_A a^3}{z} = \frac{2.8 \times 6.022 \times 10^{23} \times (4 \times 10^{-8})^3}{4} = 26.97 \text{ g}$$

3. (a) Henry's law is related to solubility of a gas in liquid

(i) State Henry's law

(ii) Write any two applications of Henry's law.

(b) 1000 cm³ of an aqueous solution of a protein contains 1.26 gm of a protein. The osmotic pressure of such a solution at 300 K is found to be 2.57 × 10⁻³ bar. Calculate molar mass of the protein. (R = 0.083 L bar mol⁻¹ K⁻¹) **(2017)**

Ans. (a) (i) Henry's law states that at constant temperature, the solubility of a gas in a liquid is directly proportional to the pressure of the gas.

- (ii) 1. In the preparation of soda water the bottle is sealed at high pressure.
2. As Bends in Scuba divers.

(b) Given $V = 1000 \text{ cm}^3 = 1 \text{ L}$, $w_2 = 1.26 \text{ g}$, $\pi = 2.57 \times 10^{-3} \text{ bar}$, $T = 300 \text{ K}$, $R = 0.083 \text{ LbarK}^{-1}\text{mol}^{-1}$

$$M_2 = \frac{w_2 RT}{\pi V} = \frac{1.26 \times 0.083 \times 300}{2.57 \times 10^{-3} \times 1} = 12.2077 \times 10^3 \text{ g/mol}$$

4. (a) Number of moles of the solute per kilogram of the solvent is

- (a) Mole fraction (b) Molality (c) Molarity (d) Molar mass

(b) The extent to which a solute is dissociated or associated can be expressed by Van't Hoff factor. Substantiate the statement.

(c) The vapour pressure of pure benzene at a certain temperature is 0.850 bar. A non-volatile, non-electrolyte solid weighing 0.5 g when added to 39 g of benzene (molar mass 78 mol⁻¹) vapour pressure become 0.845 bar. What is the molar mass of the solid substance? **(2016)**

Ans. (a) (b) Molality

(b) If the value of $i < 1$, association of solute occurs and if it is greater than 1, dissociation occurs.

(c) The relative lowering in vapour pressure, $\frac{\Delta P}{P_1^0} = \frac{w_2 \times M_1}{w_1 \times M_2}$

$$\text{Molar mass of solute, } M_2 = \frac{w_2 \times M_1 \times P_1^0}{w_1 \times \Delta P} = \frac{0.5 \times 78 \times 0.85}{39 \times 0.005} = 170 \text{ g/mol}$$

5. Osmotic pressure is a colligative property.

(a) What is osmotic pressure?

(b) 1.00 g of a non-electrolyte solute dissolved in 50 g of benzene lowered the freezing point of benzene by 0.40K. The freezing point depression constant of benzene is 5.12 K kg/mol. Find the molar mass of the solute. **(2016)**

Ans. (a) Osmotic pressure is defined as the excess pressure that must be applied on solution side to stop osmosis.

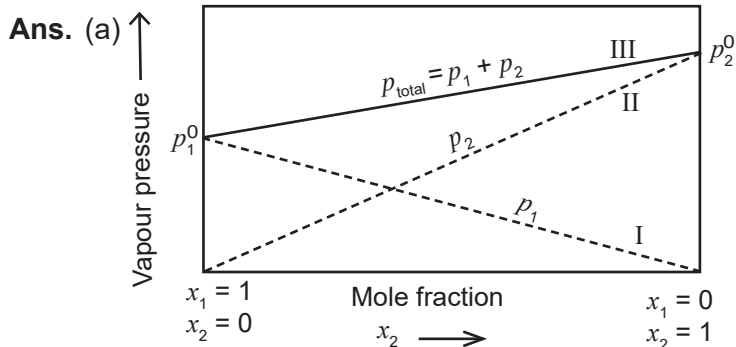
(b) Given $K_f = 5.12 \text{ K kg mol}^{-1}$, $W_2 = 1.00 \text{ g}$, $W_1 = 50 \text{ g}$, $\Delta T_f = 0.40 \text{ K}$

$$M_2 = \frac{K_f \times W_2 \times 1000}{\Delta T_f \times W_1} = \frac{5.12 \text{ K kg mol}^{-1} \times 1.00 \text{ g} \times 1000 \text{ g}^{-1}}{0.04 \text{ K} \times 50 \text{ g}} = 256 \text{ g mol}^{-1}$$

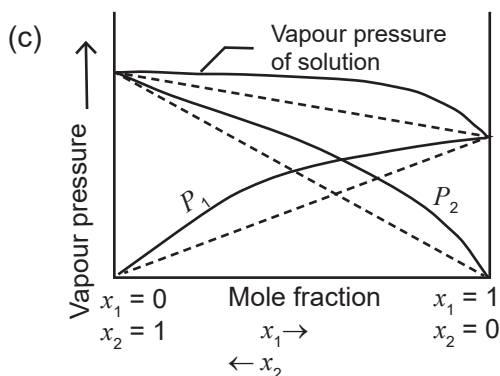
6. (a) Draw a vapour pressure curve, by plotting vapour pressure against mole fraction of an ideal solution of two components A and B. Indicate partial vapour pressure of A and B (P_A and P_B) and the total vapour pressure (P_{Total}).

(b) What is an ideal solution?

(c) Modify the above plot for non-ideal solution showing positive deviation. (Draw the above plot once again and modify.) **(2015)**



(b) These are solutions which obey Raoult's law over the entire range of concentration.



7. (a) Among the following, which is not a colligative property?

- | | |
|-----------------------|-----------------------------------|
| (i) Osmotic pressure | (ii) Elevation of boiling point |
| (iii) Vapour pressure | (iv) Depression of freezing point |

(b) (i) 200 cm³ of aqueous solution of a protein contains 1.26 g of protein. The osmotic pressure of the solution at 300 K is found to be 8.3 x 10⁻² bar.

Calculate the molar mass of protein. (R = 0.083 LbarK⁻¹mol⁻¹)

(ii) What is the significance of Van't Hoff factor?

[2015]

Ans. (a) (iii) Vapour pressure

(b) (i) Molar mass of the protein, $M_2 = \frac{WRT}{\pi V}$

$$= \frac{1.26 \text{ g} \times 0.083 \text{ L bar K}^{-1} \text{ mol}^{-1} \times 300 \text{ K}}{8.3 \times 10^{-2} \text{ bar} \times 0.200 \text{ L}} = 189000 \text{ g mol}^{-1}$$

(ii) The van't Hoff factor accounts for the extent of dissociation or association of solute particles in solution.

$$i = \frac{\text{Total no. of moles of particles after association/dissociation}}{\text{No. of moles of particles before association/dissociation}}$$

In the case of association, value of 'i' is less than unity while dissociation 'i' is greater than unity. If i = 1 there is no association or dissociation of the solute particles in solution.

8. Molarity (M), molality (m) and mole fraction (x) are some methods for expressing concentration of solutions.

(a) Which of these are temperature independent?

(b) Define mole fraction?

(c) A mixture contains 3.2g methanol (molecular mass = 32u) and 4.6g ethanol (molecular mass = 46u).

Find the mole fraction of each component.

[2014]

Ans. (a) Molality and Mole fraction are temperature independent.

(b) **Mole fraction (x)** : It is defined as the ratio of the number of moles of a particular component to the total number of moles of solution.

$$\text{Mole fraction of a component} = \frac{\text{Number of moles of the component}}{\text{Total number of moles of all the components}}$$

(c) Number of moles of methanol = $\frac{3.2 \text{ g}}{32 \text{ g mol}^{-1}} = 0.1$

Number of moles of ethanol = $\frac{4.6 \text{ g}}{46 \text{ g mol}^{-1}} = 0.1$

Mole fraction methanol = $\frac{0.1}{0.2} = 0.5$

Mole fraction of ethanol = $\frac{0.1}{0.2} = 0.5$

9. Osmotic pressure is a colligative property and it is proportional to the molarity of the solution.

(a) What is osmotic pressure?

(b) Molecular mass of NaCl determined by osmotic pressure measurement is found to be half of the actual value. Account for it?

(c) Calculate the osmotic pressure exerted by a solution prepared by dissolving 1.5 g of a polymer of molar mass 185000 in 500ml of water at 37°C. (R = 0.0821 L atm/K/mol)

[2014]

Ans. (a) It is the minimum excess pressure to be applied on the solution side to prevent osmosis.

(b) It is due to dissociation of NaCl to Na⁺ and Cl⁻ ions. If there is 100% dissociation, the number of particles doubles (van't Hoff factor, i = 2) and thereby the colligative property also doubles. Hence, the observed molecular mass will be half of the actual value since colligative property is inversely related to molar molecular mass.

(c) Osmotic pressure, $\pi = \frac{W_2 RT}{M_2 V} = \frac{1.5 \text{ g} \times 0.0821 \text{ L atm K}^{-1} \text{ mol}^{-1} \times 310 \text{ K}}{185000 \times 0.5 \text{ L}} = 0.00041 \text{ atm}$

10. Liquid solutions can be classified into ideal and non-ideal solutions on the basis of Raoult's law.

(a) State Raoult's law.

(b) What are ideal solutions?

(c) Write any two properties of ideal solutions.

(d) What type of deviation is shown by a mixture of chloroform and acetone? Give reason. **[2013]**

Ans. (a) It states that for a solution of volatile liquids, the partial vapour pressure of each component in the solution is directly proportional to its mole fraction.

(b) Ideal solutions are solutions which obey Raoult's law over the entire range of concentration.

(c) $\Delta H_{\text{mix}} = 0$ and $\Delta V_{\text{mix}} = 0$

(d) In case of negative deviation from Raoult's law, solute-solvent interactions are stronger than solute-solute interaction and solvent-solvent interaction. So number of molecules escaped to vapour phase decreases and hence the vapour pressure of the solution decreases. E.g. solution of phenol and aniline, chloroform and acetone etc.

11. Elevation of boiling point is a colligative property.

(i) What are colligative properties?

(ii) Elevation of boiling point (ΔT_b) is directly proportional to molality (m) of solution. Thus $\Delta T_b = K_b \cdot m$, K_b is called the molal elevation constant. From the above relation derive an expression to obtain molar mass of the solute.

(iii) The boiling point of benzene is 353.23 K. When 1.80 g of a non-volatile solute was dissolved in 90 g of benzene, the boiling point is raised to 354.11K. Calculate the molar mass of the solute. K_b for benzene is 2.53 K kg mol⁻¹. **[2013]**

Ans. (i) Colligative properties are those properties which depend only upon the number of solute particles but not on their nature are called colligative properties.

(ii)
$$\Delta T_b = K_b \cdot m$$

We know that molality $m = \frac{W_B \times 1000}{M_B \times W_A}$

Therefore $\Delta T_b = \frac{K_b \cdot W_B \times 1000}{M_B \cdot W_A}$

i.e., $M_B = \frac{1000 \cdot K_b \cdot W_B}{\Delta T_b \cdot W_A}$

(iii) The elevation in boiling point, $(\Delta T_b) = 354.11\text{K} - 353.23\text{K} = 0.88\text{K}$

$$M_B = \frac{1000 \times K_b \times W_B}{\Delta T_b \times W_A} = \frac{1000 \times 2.53 \text{ K kg mol}^{-1} \times 1.8 \text{ g}}{0.88 \text{ K} \times 90 \text{ g}} = 58\text{g/mol}$$

\therefore Molar mass of Solute (M_B) = 58g/mol

12. Colligative properties are properties of solution which depend on the number of solute particles in the solution.

(i) Write the names of four important colligative properties.

(ii) The value of van't Hoff factor 'i', for aqueous KCl solution is close to 2, while that

for ethanoic acid in benzene is nearly 0.5. Give reason.

[2012]

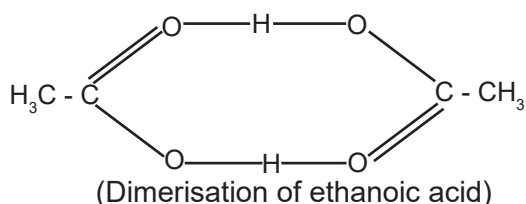
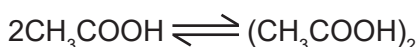
Ans. (i) The important colligative properties are: Relative lowering of Vapour pressure, Elevation of Boiling point, Depression of Freezing point and Osmotic Pressure.

(ii) This is caused by dissociation in the case of KCl and association in the case of acetic acid

KCl in aqueous solution undergoes dissociation as : $\text{KCl} \rightarrow \text{K}^+ + \text{Cl}^-$

Thus if complete ionisation occurs the number of particles in solution becomes double and hence van't Hoff factor (i) for aqueous KCl solution is close to 2.

In the case of ethanoic acid (acetic acid) association (dimerisation) occurs in benzene through intermolecular hydrogen bonding, Thus, if complete association occurs the number of particles in solution becomes half and hence van't Hoff factor (i) for ethanoic acid in benzene is nearly 0.5



13. Vapour pressure of a solution is different from that of pure solvent.

(i) Name the law which helps us to determine partial vapour pressure of a volatile component in a solution.

(ii) State the above law.

(iii) Vapour pressure of chloroform (CHCl_3) and dichloromethane (CH_2Cl_2) at 298K are 200 mm of Hg and 415 mm of Hg respectively. Calculate the vapour pressure of solution prepared by mixing 24g of chloroform and 17g of dichloromethane at 298K.

[2012]

Ans. (i) Raoult's law

(ii) A quantitative relationship between the vapour pressure and mole fraction of solute in a solution was first given by a French chemist F.M Raoult and it is known as Raoult Law. It states that for a solution of volatile liquids, the partial vapour pressure of each component in the solution is directly proportional to its mole fraction.

$$(iii) \quad \text{No. of moles of } \text{CHCl}_3 = \frac{24}{119.5} = 0.2$$

$$\text{No. of moles of } \text{CH}_2\text{Cl}_2 = \frac{17}{85} = 0.2$$

$$\text{Mole fraction of } \text{CH}_2\text{Cl}_2 = \frac{0.2}{0.2 + 0.2} = 0.5$$

$$\chi_{\text{CHCl}_3} = 1 - 0.5 = 0.5$$

$$P_{\text{Total}} = P_A^0 \chi_A + P_B^0 \chi_B$$

$$P_{\text{Total}} = P_A^0 (1 - \chi_B) + P_B^0 \chi_B \quad (\text{But } \chi_B = 1 - \chi_B)$$

$$\begin{aligned}
 &= P_A^0 + (P_B^0 - P_A^0) \chi_B \\
 &= 200 + (415 - 200) 0.5 \\
 &= 200 + (215) \times 0.5 = 307.5 \text{ mm of Hg}
 \end{aligned}$$

Additional Questions and Answers

1. How does change in temperature changes the molarity and molality values?

Ans. As the temperature increases, volume increases and molarity decreases whereas molality does not change with any change in temperature.

2. Calculate the volume of water which could be added to 20 ml of 0.65 m HCl to dilute the solution to 0.2 m?

Ans.

$$\begin{aligned}
 M_1 V_1 &= M_2 V_2 \\
 V_2 &= \frac{M_1 V_1}{M_2} = \frac{0.625M \times 20\text{ml}}{0.2 M} = 65 \text{ ml.}
 \end{aligned}$$

Vol of water to be added to 20 ml = $V_2 - V_1 = 65\text{ml} - 20\text{ml} = 45 \text{ ml.}$

3. A solution is prepared by dissolving 11g glucose in 200 cm³ water at 30^o C.

What is the mass Percentage of glucose in solution? The density of water 30^oC is 0.996 g/cm³ ?

Ans.

$$\text{Density} = \frac{\text{mass}}{\text{volume}} = 0.996 \text{ g/cm}^3$$

$$0.996 = \frac{\text{mass}}{200\text{cm}^3}$$

$$\text{Mass} = 0.996 \times 200 = 199.2 \text{ g}$$

$$\begin{aligned}
 \text{Mass\% of glucose} &= \frac{\text{mass volume}}{\text{mass of water} + \text{mass of glucose}} \times 100 \\
 &= \frac{11}{199.2 + 11} \times 100 = 5.23 \%
 \end{aligned}$$

4. Find the molality and molarity of a 15% solution of H₂SO₄ when its density is 1.10 gcm³ & molar mass = 98 amu.

Ans.

$$\text{Volume} = \text{mass/density} = 100 \text{ g}/1.10 \text{ g/cm}^3 = 90.9 \text{ cm}^3.$$

$$\text{Molarity} = \frac{\text{no. of moles of H}_2\text{SO}_4}{\text{volume of solution}} \times 1000 = \frac{(15/98)}{90.9} \times 1000 = 1.68 \text{ m}$$

$$\text{Molality} = \frac{\text{no. of moles solute}}{\text{mass of solvent in kg}} = \frac{(15/98)}{85 \text{ kg}} \times 1000 = 1.8 \text{ m}$$

5. Calculate the % composition in terms of mass of a solution obtained by mixing 300g of a 25% & 400 g of a 40% solution by mass?

Ans. mass of solute in 400g of 40% = $\frac{40}{100} \times 400 = 160\text{g.}$

$$\text{Total mass of solute} = 160 + 75 = 235\text{g}$$

Total mass of solution = 400+300 = 700g

$$\text{Mass\% of solute} = \frac{\text{mass of solute}}{\text{Total mass of solution}} \times 100 = \frac{235}{700} \times 100 = 33.57\%$$

Mass % of solvent = 100 – 33.57 = 66.43%

6. The density of 85% phosphoric acid is 1.70 g/cm³. What is the volume of a solution that contains 17g of phosphoric acid?

Ans. 85g phosphoric acid is present in 100g of solution.

17g of phosphoric acid is present in $\frac{100}{85} \times 17 = 20\text{g}$ of solution

$$\text{Volume of 17g of 85\% acid} = \frac{\text{mass}}{\text{density}} = \frac{20\text{g}}{1.70\text{g/cm}^3} = 11.8 \text{ cm}^3.$$

7. What is the effect of pressure on solubility of a gas?

Ans. The solubility of a gas increases with increases of pressure.

8. Carbon tetrachloride and water are immiscible whereas alcohol and water are miscible. Explain on the basis of molecular structures of these compounds.

Ans. Carbon tetrachloride is a non-polar compound whereas water is a polar compound. They do not interact with each other and carbon tetrachloride cannot dissolve in water whereas alcohol and water are completely miscible due to high polarity.

9. State Henry's Law.

Ans. Henry's Law states that the partial pressure of the gas in vapour phase is proportional to the mole fraction of the gas in solution.

10. State Raoult's Law.

Ans. Raoult's Law states that for a solution of volatile liquids, the partial vapour pressure of each component in the solution is directly proportional to its mole fraction.

11. What are the factors on which vapour pressure depends?

Ans. The factors on which vapour pressure depends are –

1) Temperature of the liquid. 2) Nature of the liquid.

12. The vapour pressure of solvent gets lowered, when a non- volatile solute is added to it. Why?

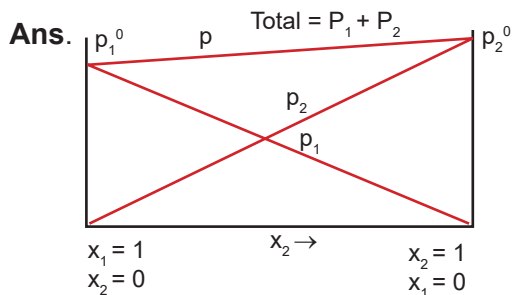
Ans. When a non-volatile solute is added to a solvent, the surface area for escape of solvent molecules decreases and vapour pressure gets lowered.

13. Name two ways by which vapour pressure of a liquid can be lowered.

Ans. The two ways by which vapour pressure can be lowered are –

1) By decreasing the temperature. 2) By adding a non- volatile solute.

14. Plot a graph between vapour pressure and mole fraction of a solution obeying Raoult's Law at constant temperature?



15. Define the term colligative properties?

Ans. The property which depends upon amount of solute and not upon the nature of solute are called colligative properties.

16. Name different colligative properties?

Ans. (a) Relative lowering of vapour pressure. (b) Elevation in boiling point.
(c) Depression in freezing point (d) Osmotic pressure.

17. A mixture of chlorobenzene and bromobenzene is a nearly an ideal solution but a mixture of chloroform and acetone is not Explain?

Ans. Chlorobezene & bromobenzene both have similar structure and polarity. Therefore the various interactions (solute – solute, solvent – solvent & solute – solvent) are same whereas in chloroform and acetone initially there is no hydrogen bonding but after mixing solute solvent interactions (H –bond) become stronger and solution deviates from ideal behaviour.

18. What are the possible deviations from ideal behaviors?

Ans. There are two types of deviation from ideal behaviour – positive and negative deviations.

19. Give one example of each deviation?

Ans. Positive deviation – ethanol and acetone. Negative deviation – chloroform and acetone.

20. Define the term azeotrope?

Ans. A solution at certain concentration when continues to boil at constant temperature without change in its composition in solution & in vapour phase is called an azeotrope.

21. The vapour pressure of CS₂ at 5000C is 854 mm of Hg .A solution of 2.0g sulphur in 100g of CS₂ has a vapour pressure of 848.9 mm of Hg .Calculate the formula of sulphur molecule.

Ans. $P_A^{\circ} = 854 \text{ mm}$, $P_A = 848.9 \text{ mm}$, $W_B = 2.0\text{g}$, $M_A = 12 + 2(32) = 76 \text{ g/mol}$

$$\frac{P_A^{\circ} - P_A}{P_A^{\circ}} = X_B = \frac{W_B}{M_B} / \frac{W_A}{M_A} \quad M_B = W_B \times \frac{W_A}{M_A} \times \frac{P_A^{\circ}}{P_A^{\circ} - P_A}$$

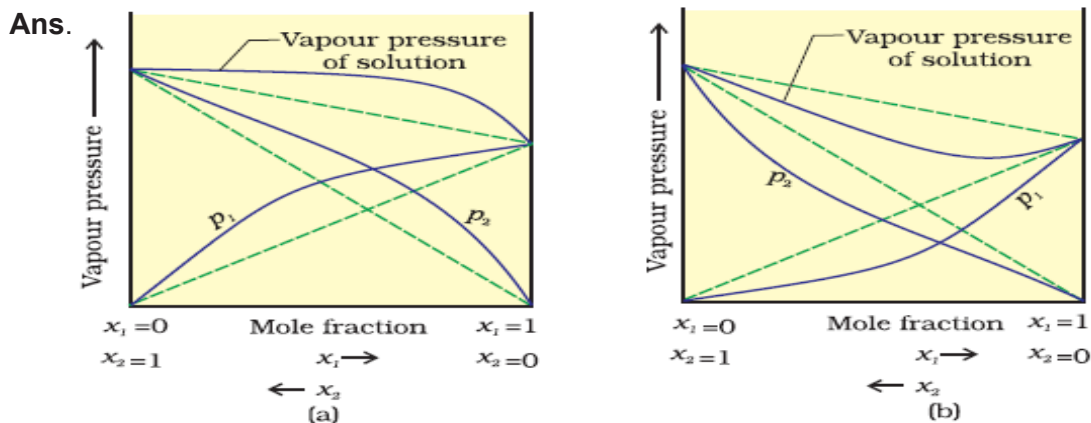
$$= 2 \times \frac{100}{76} \times \frac{854}{854 - 848.9} = 254.5\text{g/mol}.$$

Let the formula = S_x

$$X \times 32 = 254.5 \text{ g/mol}$$

$$X = \frac{254.5}{32} = 7.95 \approx 8 \quad \text{Formula} = S_8.$$

22. Draw the graphs of both deviations from ideal behaviours?



23. Why is the boiling point elevated when a non – volatile solute is dissolved in a liquid?

Ans. When a non – volatile solute is added the vapour pressure decreases and the solution is elevated to a higher temperature, increasing the boiling point.

24. How is boiling point changed when mass of solvent is doubled?

$$\text{Ans. } \Delta T_b = K_b \frac{W_{\text{solute}}}{W_{\text{solvent}}} \times \frac{1000}{M_{\text{solute}}}$$

When the amount of solvent is doubled, ΔT_b is halved.

25. How is osmotic pressure of a solution related to its concentration?

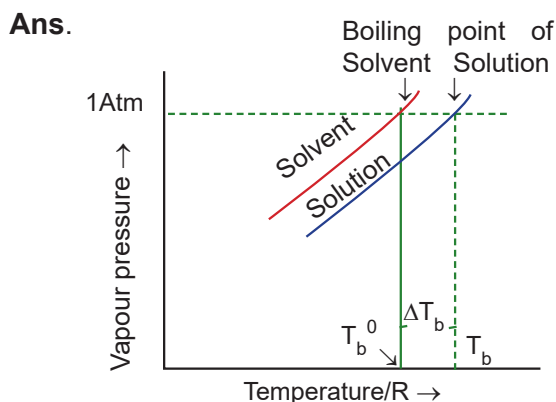
Ans. Osmotic pressure, $\pi = CRT$

C = concentration, R = gas constant, T= temperature

26. Calculate the osmotic pressure of 0.25 M solution of urea at 37°C. R = 0.083 L bar/ mol/k.

$$\text{Ans. } T = 37^\circ\text{C} = 310\text{k}, T_1 = CRT = \frac{n}{V} RT = 0.25 \times 0.083 \times 310 = 6.43 \text{ bar.}$$

27. Show graphically the depression in freezing point on adding a non volatile solute?



28. When does the measurement of colligative property leads to abnormal molecular mass?

Ans. When the solute undergoes either association or disassociation abnormal molar mass is obtained.

29. Give various expressions for van't Hoff factor?

Ans.
$$i = \frac{\text{Normal Molar Mass}}{\text{Abnormal molar mass}} = \frac{\text{Observed colligative property}}{\text{Calculated colligative property}}$$

$$= \frac{\text{Total no. of moles of particles after association/dissociation}}{\text{Total no. of moles of particles before association/dissociation}}$$

30. How are the various colligative properties modified after consideration of van't Hoff factor?

Ans. a) $\frac{P_1^0 - P_1}{P_1^0} = i X_2$ b) $\Delta T_b = i K_b \cdot m$ c) $\Delta T_f = i K_f \cdot m$ d) $\pi = i CRT$

31. The boiling point elevation of 0.6 g acetic acid in 100g benzene is 0.1265k. What conclusion can you draw about the state of solute in solution? Molar elevation constant for benzene is 2.53 deg per molar?

Ans. Molality of acetic acid = $\frac{0.6}{60} \times \frac{1000}{100} = 0.10 \text{ m.}$

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

$$\therefore M = \frac{\Delta T_b}{K_b} = \frac{0.1265}{2.53} = 0.050 \text{ m.}$$

$$i = \frac{0.050}{0.10} = 0.50 \quad \text{Since } i = \frac{1}{2}, \text{ acetic acid exist as dimer in solution.}$$

32. When is the value of i less than unity?

Ans. When the solute under goes association in solution, i is less than unity.

33. The molecular mass of a solute is 120 g/mol and van't Hoff factor is 4. What is its abnormal molecular mass?

Ans. Abnormal molecular mass = $\frac{\text{Normal Molecular Mass}}{i} = \frac{120}{4} = 30\text{g/mol.}$

34. Derive the relationship between relative lowering of vapour pressure and mole fraction of the volatile liquid.

Ans. Let us assume a binary solution in which the mole fraction of the solvent be x_1 and that of the solute be x_2 , p_1 be the vapour pressure of the solvent and p_1^0 be the vapour pressure of the solvent in pure state.

According to Raoult's Law: $p_1 = x_1 p_1^0 \dots\dots\dots (1)$

The decrease in vapour pressure of the solvent (Δp_1) is given by:

$\Rightarrow \Delta p_1 = p_1^0 - p_1$

$\Rightarrow \Delta p_1 = p_1^0 - p_1^0 x_1$ [using equation (1)]

$$\Rightarrow \Delta p_1 = p_1^0 (1 - x_1)$$

Since we have assumed the solution to be binary solution, $x_2 = 1 - x_1$

$$\Rightarrow \Delta p_1 = p_1^0 x_2$$

$$\Rightarrow x_2 = \Delta p_1 / p_1^0$$

35. Define the following terms : (i) Colligative properties (ii) Molality (m)

Ans. (i) Properties that are independent of nature of solute and depend on number of moles of solute only.

(ii) Number of moles of solute dissolved per kg of the solvent.

36. What are colligative properties ? Write the colligative property which is used to find the molecular mass of macromolecules.

Ans. Properties that depend on the number of solute particles irrespective of their nature relative to the total number of particles present in the solution.

Osmotic Pressure.

37. Why does a solution containing non-volatile solute have higher boiling point than pure solvent ? Why is the elevation of boiling point a colligative property ?

Ans. Because of addition of non - volatile solute, vapour pressure of the solution lowers down.

Because it depends on molality, $\Delta T_b \propto m$

38. State Henry's law. Write its one application. What is the effect of temperature on solubility of gases in liquid ?

Ans. Henry's law states that the mole fraction of gas in the solution is proportional to the partial pressure of the gas over the solution.

Applications: Solubility of CO₂ gas in soft drinks

Solubility of gas in liquid decreases with increase in temperature.

39. Write two differences between a solution showing positive deviation and a solution showing negative deviation from Raoult's law.

Ans.

Positive deviation	Negative deviation
Observed vapour pressure is greater than expected vapour pressure.	Observed vapour pressure is less than expected vapour pressure.
A-B interaction < A—A & B—B	A—B interaction > A—A & B—B

40. (i) Write the colligative property which is used to find the molecular mass of macromolecules.

(ii) In non-ideal solution, what type of deviation shows the formation of minimum boiling azeotropes ?