TEACHERS FORUM®

QUESTION BANK

(solved)

Based on CBSE Previous years' question papers

Class XII

CHEMISTRY

SUBJECT EXPERTS

CONTENTS

1 SOLUTIONS

1 MARKS

1. For two statements given - one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (i), (ii), (iii) and (iv) as given below :

   (i) Both Assertion (A) and Reason (R) are correct, statements, and Reason (R) is the correct explanation of the Assertion (A).

   (ii) Both Assertion (A) and Reason (R) are correct statements, but Reason (R) is not the correct explanation of the Assertion (A).

   (iii) Assertion (A) is correct, but Reason (R) is incorrect statement.

   (iv) Assertion (A) is incorrect, but Reason (R) is correct statement.

   Assertion (A): Osmotic pressure is a colligative property. **(2020)**

   Reason (R): Osmotic pressure is directly proportional to molarity.

Ans. (ii)

2. $Pb(NO_3)_2$ on reacting gives a brown gas which undergoes dimerization on cooling? Identify the gas. **(2016)**

Ans. NO_2

2 MARKS

3. Why does a solution containing non-volatile solute have a higher boiling point than pure solvent ? Why is elevation of boiling point a colligative property ? **(2019)**

Ans. Because on addition of non-voilatile solute, vapour pressure of solution lowers down and therefore in order to boil solution, temperature has to be raised.
Because it depends on molality.

4. (a) Out of 0·1 molal aqueous solution of glucose and 0.1 molal aqueous solution of KCl, which one will have higher boiling point and why ? **(2019)**

   (b) Predict whether van't Hoff factor, (i) is less than one or greater than one in the following :

   (i) CH_3COOH dissolved in water (ii) CH_3COOH dissolved in benzene

Ans. (a) 0.1 molal KCl ; Because KCl undergoes dissociation whereas glucose does not.

(b) (i) Van't Hoff factor i > 1 (ii) Van't Hoff factor i < 1

5. Give reasons : **(2019)**

   (a) Cooking is faster in pressure cooker than in cooking pan.

(b) Red Blood Cells (RBC) shrink when placed in saline water but swell in distilled water.

Ans. (a) Due to increase of pressure in cooker, boiling point of water increases.

(b) RBC looses water in saline water and absorb water in distilled water due to osmosis.

6. State Raoult's law for a solution containing volatile components. Write two characteristics of the solution which obeys Raoult's law at all concentrations. **(2019)**

Ans. For a solution of volatile liquids, the partial vapour pressure of each component of the solution is directly proportional to its mole fraction present in solution.

(i) $\Delta_{max} H = 0$ (ii) $\Delta_{max} V = 0$

(iii) The components have nearly same intermolecular force of attraction

7. Calculate the freezing point of a solution containing 60 g of glucose in 250 g of water. (Molar mass = 180 g mol^{-1}) (K_f of water = 1·86 K kg mol^{-1}) **(2018)**

Ans.

$$\Delta T_f = K_f m$$

$$= \frac{w_2 \times 1000}{M_2 \times w_1}$$

$$= \frac{1.86 \times 60 \times 1000}{180 \times 250} = 2.48 \text{ K}$$

$$\Delta T_f = T_f^0 - T_f$$

$$2.48 = 273.15 - T_f$$

$$\Rightarrow T_f = 270.67 \text{ K}$$

8. Why a mixture of Carbon disulphide and acetone shows positive deviation from Raoult's law? What type of azeotrope is formed by this mixture? **(2018)**

Ans. Intermolecular forces of attraction between carbon disulphide and acetone are weaker than the pure components.

Minimum boiling azeotrope at a specific composition.

9. Derive the relationship between relative lowering of vapour pressure and mole fraction of the volatile liquid. **(2017)**

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^o be the vapour pressure of the solvent in pure state.

According to Raoult's Law:

$p_1 = x_1 p_1^0$ .... (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, $x_2 = 1 - x_1$

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

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

10. Define the following terms :

(i) Colligative properties (ii) Molality (m) **(2017)**

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.

11. What are colligative properties ? Write the colligative property which is used to find the molecular mass of macromolecules. **(2017)**

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.

13. Will the elevation in boiling point be same if 0.1 mol of Sodium chloride or 0.1 mol of sugar is dissolved in 1L of water? Explain. **(2016)**

Ans. No, the elevation in boiling point is not the same.

Elevation in boiling point is a colligative property which depends on the number of particles. NaCl is an ionic compound which dissociates in solution to give more number of particles whereas sugar is made up of molecules and thus does not dissociate.

14. State Henry's law. Write its one application. What is the effect of temperature on solubility of gases in liquid ? **(2016)**

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 CO_2 gas in soft drinks

Solubility of gas in liquid decreases with increase in temperature.

15. (i) Gas (A) is more soluble in water than Gas (B) at the same temperature. Which one of the two gases will have the higher value of K_H (Henry's constant) and why?

(ii) In non - ideal solution, what type of deviation shows the formation of maximum boiling zeotropes? **(2016)**

Ans. (i) Gas B. Higher the value of K_H lower is the solubility of gas.

(ii) Negative deviation from Raoult's law

16. Write two differences between a solution showing positive deviation and a solution showing negative deviation from Raoult's law. **(2016)**

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

17. (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 ? **(2016)**

Ans. (i) Osmotic pressure (ii) Positive deviation from Raouls' law

18. Derive the relationship between relative lowering of vapour pressure and molar mass of the solute. **(2015)**

Ans. As per Raoult's law pA = $x_A\, p_A^o$

$$P_A = p_A^o(1 - x_B) = p_A^o - p_A^o x_B$$

$$p_A^o - p_A = p_A^o\, x_B$$

$$(p_A^o - p_A) / p_A^o = x_B$$

$$\Delta p / p_A^o = X_B = w_B\, M_A / M_B\, w_A$$

$$\therefore \quad M_B = \frac{w_B\, M_A}{(\Delta p / pA^o)\, w_A}$$

19. What is meant by positive deviations from Raoult's law ? Give an example. What is the sign of $\Delta_{mix}H$ for positive deviation ? **(2015)**

Ans. When vapour pressure of solution is higher than that predicted by Raoult's law, it is called positive deviation.

Eg. ethanol-acetone

$\Delta_{mix}H$ is positive

20. Define azeotropes. What type of azeotrope is formed by positive deviation from Raoult's law ? Give an example. **(2015)**

Ans. (a) Azeotropes are binary mixtures having the same composition in the liquid and vapour phase and boil at a constant temperature.

(b) Minimum boiling azeotrope

eg - ethanol + water

21. (i) Why are aquatic species more comfortable in cold water than in warm water ?

(ii) What happens when we place the blood cell in saline water solution (hypertonic solution) ? Give reason. **(2015)**

Ans. (i) As solubility of gases decreases with increase of temperature, less oxygen is available in summer in the lakes.

(ii) They will shrink. It is due to osmosis.

22. What do you understand by depression of freezing point ? Derive the relationship between depression of freezing point and molar mass of the solute. **(2015)**

Ans. $\Delta T_f = T_f^0 - T_f$

The decrease in freezing point of a solvent due to the dissolution of a non-volatile solute in it is called depression in freezing point.

$$\Delta T_f = K_f m$$

$$\Delta T_f = K_f \times \frac{W_2 / M_2}{W_1 / 1000}$$

$$M_2 = \frac{K_f . w_2 \times 1000}{W_1 . \Delta T_f}$$

23. What is meant by negative deviation from Raoult's law ? Give an example. What is the sign of $\Delta_{mix}H$ for negative deviation ? **(2015)**

Ans. When solute- solvent interaction is stronger than pure solvent or solute interaction.

Eg: chloroform and acetone

$\Delta_{mix}H$ = negative

24. Define azeotropes. What type of azeotrope is formed by negative deviation from Raoult's law ? Give an example. **(2015)**

Ans. Azeotropes –binary mixtures having same composition in liquid and vapour phase and boil at constant temperature.

Maximum boiling azeotropes

eg: HNO_3 (68%) and H_2O(32%)

25. (i) On mixing liquid X and liquid Y, volume of the resulting solution decreases. What type of deviation from Raoult's law is shown by the resulting solution ? What change in temperature would you observe after mixing liquids X and Y ?

(ii) What happens when we place the blood cell in water (hypotonic solution) ? Give reason. **(2015)**

Ans. (i) Negative deviation, temperature will increase.

(ii) Blood cell will swell due to osmosis, water enters into the cell.

26. How is the vapour pressure of a solvent affected when a non-volatile solute is dissolved in it ? **(2015)**

Ans. Vapour pressure of a solvent decreases

This is due to fraction of surface area gets covered by non-volatile solute particles.

27. Differentiate between molarity and molality of a solution. How can we change molality

value of a solution into molarity value ? **(2015)**

Ans. Molality - It is defined as the number of moles of the solute per kg of the solvent.

Molarity: Molarity (M) is defined as number of moles of solute dissolved in one litre (or one cubic decimetre) of solution

By converting weight of solvent into volume of solution using density

28. A 1.00 molal aqueous solution of trichloroacetic acid (CCl_3COOH) is heated to its boiling point. The solution has the boiling point of 100.18°C. Determine the van't Hoff factor for trichloroacetic acid. (K_b for water = 0.512 K kgmol^{-1}) **(2012)**

Ans. $\Delta T_b = iK_bm$ $(100.18 - 100)^0C = i \times 0.512K \text{ kg mol}^{-1} \times 1m$

$0.18 \text{ K} = i \times 0.512K \text{ kg mol}^{-1} \times 1m$

$i = 0.35$

29. Define the followingterms: **(2012)**

(i) Mole fraction (ii) Isotonic solutions (iii) Van't Hoff factor (iv) Ideal solution

Ans. (i) Mole fraction is the ratio of number of moles of one component to the total number of moles in a mixture.

(ii) Two solutions having same osmotic pressure at a given temperature are called Isotonic Solutions.

(iii) Van't Hoff factor is expressed as:

$$i = \frac{\text{normal molar mass}}{\text{abnormal molar mass}}$$

(iv) The solution which obeys Raoult's law under all conditions is known as an ideal solution.

30. State the following:

(i) Raoult's law in its general form in reference to solutions.

(ii) Henry's law about partial pressure of a gas in a mixture. **(2011)**

Ans. (i) Raoult's law states that for a solution of volatile liquids, the partial vapour pressure of each component in the solution is directly proprtional to its mole fraction.

(ii) Henry's lawstates that at a constant temperature, the solubility of a gas in a liquid is directly proportional to the pressure of the gas over the solution.

31. Differentiate between molality and molarity of a solution. What is the effect of change in temperature of a solution on its molality and molarity? **(2009)**

Ans. Molality (m) is the number of moles of the solute per kilogram (kg) of the solvent whereas Molarity is the number of moles of solute present in one litre (or one cubic decimeter) of solution.

Molality is independent of temperature whereas Molarity is function of temperature because volume depends on temperature and the mass does not or Molarity decreases with increase in temprature

32. State Henry's law correlating the pressure of a gas and its solubility in a solvent and mention two applications for the law. **(2008)**

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

Applications :

(i) To increase the solubility of CO_2 in soft drinks and soda water, the bottle is sealed under high pressure.

(ii) Scuba divers must cope with high concentrations of dissolved Nitrogen with breathing air at high pressure underwater.To avoid this air is diluted with He.

(iii) At high altitudes the partial pressure of oxygen is less than that at the ground level. Low blood oxygen causes anoxia.

33. State Raoult's law for solutions of volatile liquid components. Taking a suitable example, explain the meaning of positive deviation from Raoult's law. **(2008)**

Ans. Raoult's law states that for a solution of volatile liquids, the partial vapour pressure of each component in the solution is directly proprtional to its mole fraction. When the solute-solvent interaction is weaker than those between the solute-solute and solvent-solvent molecules then solution shows positive deviation from Raoults law hence the partial pressure of each component is greater. ex. mixture of ethanol and acetone or carbondisulphide and acetone behave in this manner.

34. Define the term 'osmotic pressure'. Describe how the molecular mass of a substance can be determined on the basis of osmotic pressure measurement. **(2008)**

Ans. The extra pressure applied on the solution side that just stops the flow of solvent to solution through semi-permeable membrane is called osmotic pressure of the solution. Here r is the osmotic pressure and R is the gas constant.

$$\pi = (n_2/V)\ RT$$

$$\pi V = \frac{w_2\ RT}{M_2}$$

$$\text{or } M_2 = \frac{w_2\ RT}{\pi V}$$

Thus knowing the quantities w_2, T, ð and V we can calculate the molar mass of the solute.

3 MARKS

35. A solution containing 8 g of substance in 100 g of diethyl ether boils at 36.86°C whereas pure ether boils at 35.60°C. **(2019)**

Determine the molar mass of the solute. [For ether Kb = 2.02 K kg mol^{-1}]

Ans. $\Delta T_b = T°_b - T_b$

$$= \frac{K_b\, w_2 \times 1000}{M_2 \times w_1}$$

$$= \frac{2.02 \text{ K Kg mol}^{-1} \times 8\text{g} \times 1000}{1.26 \text{ K} \times 100 \text{ g}}$$

$$M_2 = 128.25 \text{ mol l}^{-1}$$

36. A solution 0.1 M of Na_2SO_4 is dissolved to the extent of 95%. What would be its osmotic pressure at 27°C ? (R = 0.0821 L atm K^{-1} mol^{-1}) **(2019)**

Ans.

$$\alpha = 0.95$$

$$\alpha = \frac{i - 1}{n - 1}$$

$$0.95 = \frac{i - 1}{3 - 1}$$

i = 2.9 (Or any other method for calculation of i)

$$\pi = i\,CRT = 2.9 \times 0.1 \times 0.0821 \times 300 = 7.143 \text{ atm.}$$

37. A solution containing 1.9 g per 100 mL of KCl (M = 74·5 g mol^{-1}) is isotonic with a solution containing 3 g per 100 mL of urea (M = 60 g mol^{-1}). Calculate the degree of dissociation of KCl solution. **(2019)**

Assume that both the solutions have same temperature.

Ans.

$$\pi_1 \text{ (urea)} = \pi_2 \text{ (KCl)}$$

$$C_1RT = i\,C_2RT$$

$$\frac{n_1}{v_1} = i\,\frac{n_2}{v_2} \quad (v_1 = v_2)$$

$$\frac{3}{60} = i \times \frac{1.9}{74.5}$$

$$i = 1.96$$

$$\alpha = \frac{i - 1}{n - 1} = \frac{1.96 - 1}{2 - 1}$$

$$= 0.96 \text{ or } 96\%$$

38. A 4% solution(w/w) of sucrose (M = 342 g mol^{-1}) in water has a freezing point of 271.15 K. Calculate the freezing point of 5% glucose (M = 180 g mol^{-1}) in water.

(Given : Freezing point of pure water = 273.15 K) **(2019)**

Ans.

$$\Delta T_f = K_f\, m$$

$$K_f = \Delta T_f \times \frac{M_2 \times W_1}{W_2 \times 1000} = \frac{2 \times 342 \times 96}{4 \times 1000} = 16.4 \text{ K}$$

$$\Delta T_f = K_f\, m'$$

$$K_f = \frac{W_2 \times 1000}{M_2 \times W_1} = \frac{16.4 \times 5 \times 1000}{95 \times 180} = 4.8 \text{ K}$$

$$\Delta T_f = T_f^{\circ} - T_f$$

$$4.8 = 273.15 - T_f$$

$$T_f = 268.35 \text{ K}$$

39. Give reasons for the following : **(2018)**

(a) Measurement of osmotic pressure method is preferred for the determination of molar masses of macromolecules such as proteins and polymers.

(b) Aquatic animals are more comfortable in cold water than in warm water.

(c) Elevation of boiling point of 1 M KCl solution is nearly double than that of 1 M sugar solution.

Ans. (a) 1) As compared to other colligative properties, its magnitude is large even for very dilute solutions.

2) Pressure measurement is around the room temperature and the molarity of the solution is used instead of molality.

(b) Because oxygen is more soluble in cold water or at low temperature.

(c) Due to dissociation of KCl / KCl (aq) $\rightarrow K^+ + Cl^-$, i is nearly equal to 2

40. Calculate the freezing point of an aqueous solution containing 10.5 g of Magnesium bromide in 200 g of water, assuming complete dissociation of Magnesium bromide.

(Molar mass of Magnesium bromide = 184 g mol^{-1}, K_f for water = 1.86 K kg mol^{-1}).

Ans. **(2018)**

$$\text{Moles for } MgBr_2 = \frac{10.5}{184}\ 0.0571 \text{ mol}$$

$$\text{Molality} = \frac{0.0571}{200} \times 1000 = 0.2855 \text{ m}$$

$$i = 3$$

$$\Delta T_f = i\,K_f\,m$$

$$= 3 \times 1.86 \times 0.2855 = 1.59 \text{ K}$$

$$\text{Freezing point} = 273 - 1.59 = 271.41\text{K}$$

41. Calculate the mass of a non-volatile solute (molar mass40 g/mol) which should be dissolved in 114 g octane to reduce its vapour pressure to 80%. **(2017)**

Ans. If vapour pressure of pure liquid is = P_0

80% of pure liquid $P_s = 80 \times P_0/100 = 0.8P_0$

$P_S = P_0 \times X_{solute}$

mass of solute = x gram, And mass of solvent = 114g

Molar mass of solute = 40 g/mol

Molar mass of solvent (octane C_8H_{18}) = 114g/mol

Number of moles of solute = x/40 = 0.025x

Number of moles of solvent = 114/114 = 1 moles

Mole fraction of solvent = 1/(1 + 0.025x)

$0.8P_0 = P_0 \times 1/(1 + 0.025x)$

Cross multiply we get, $(1 + 0.025x)0.8P_0 = P_0$

Divide by $0.8\ P_0$ we get, $1 + 0.025x = 1.25$

Subtract 1 both side we get, $0.025x = 0.25$

Now divide by 0.025 we get, x = 10g

42. At 300 K, 36 g of glucose, $C_6H_{12}O_6$ present per litre in its solution has an osmotic pressure of 4.98 bar. If the osmotic pressure of another glucose solution is 1.52 bar at the same temperature, calculate the concentration of the other solution. **(2017)**

Ans. $\pi V = CRT$

4.98 = 36/180 x R x 300 = 60 R .... (i)

1.52 = C x R x 300 .... (ii)

Divide (ii) by (i), C = 0.061M

43. A 10% solution (by mass) of sucrose in water has freezing point of 269.15 K. Calculate the freezing point of 10% glucose in water, if freezing point of pure water is 273.15 K.

Given : (Molar mass of sucrose = 342 g mol^{-1}, Molar mass of glucose = 180 g mol^{-1})

Ans. $\Delta T_f = K_f\ m$ **(2017)**

Here, $m = w_2 \times 1000 / M_2 X M_1$

$273.15 - 269.15 = K_f \times 10 \times 1000 / 342 \times 90$

$\Rightarrow K_f = 12.3$ K kg/mol

$\Delta T_f = K_f\ m = 12.3 \times 10 \times 1000 / 180 \times 90 = 7.6$ K

$T_f = 273.15 - 7.6 = 265.55$ K

44. A solution of glucose (Molar mass = 180 g mol^{-1}) in water has a boiling point of 100·20°C. Calculate the freezing point of the same solution. Molal constants for water K_f and K_b are 1·86 K kg mol^{-1} and 0·512 K kg mol^{-1} respectively. **(2017)**

Ans. Given : T_b of glucose solution = 100.20°C

$\Delta T_b = K_b.m$

m = 0.20/ 0.512 = 0.390 mol/kg

$\Delta T_f = K_f\ .\ m$

$\Delta T_f = 1.86$ K kg/mol x 0.390 mol/kg = 0.725 K

Freezing point of solution = 273.15K – 0.725 = 272.425K

45. 3.9 g benzoic acid dissolved in 49 g of benzene shows a depression in freezing point of 1.62 K. Calculate the van't Hoff factor and predict the nature of solute (associated/ dissociated).

[Given : Molar mass of Benzoic Acid = 122 g mol^{-1}, K_f (H_2O) = 1·86 K kg mol^{-1}] **(2017)**

Ans. $\Delta T_f = i\ K_f\ m$

Here, $m = w_2 \times 1000/\ M_2 X M_1$

$$1.62 = \frac{i \times 1.86 \text{ K kg/mol} \times 3.9 \text{ g} \times 1000}{122 \text{ g/mol} \times 49}$$

$$i = \frac{1.62 \times 122 \times 49}{1.86 \times 3.9 \times 1000} = 1.33$$

As i > 1, the solute particles gets dissociated.

46. Calculate the boiling point of a 1M aqueous solution (density 1.04 g mL^{-1}) of Potassium chloride (K_b for water = 0.52 K kg mol^{-1}, Aromic masses:K=39u, Cl 39.9u)

Assume, Potassium chloride is completely dissociated in solution **(2016)**

Ans. Molar mass of KCl = 39 + 35.5 = 74.5 g mol^{-1}

As KCl dissociates completely, number of ions produced are 2.

Therefore, van't Hoff factor, i = 2

Mass of KCl solution = 1000 x 1.04 = 1040 g

Mass of solvent = 1040 – 74.5 = 965.5 g = 0.9655 kg

$$\text{Molality of the solution} = \frac{\text{No.of moles of solute}}{\text{Mass of solvent in kg}} = \frac{1 \text{ mol}}{0.9655 \text{ kg}} = 1.0357 \text{ m}$$

$\Delta T_b = i \times K_b \times m = 2 \times 0.52 \times 1.0357 = 1.078^0C$

Therefore, boiling point of solution = 100 + 1.078 = 101.078^0C

47. Calculate the freezing point of solution when 2 g of Na_2SO_4(M = 142 g mol^{-1}) was dissolved in 50 g of water, assuming Na_2SO_4 undergoes complete ionization.
(K_f for water = 1.86 K kg mol^{-1}) **(2016)**

Ans. $\Delta T_f = iK_f m$

For complete ionisation of Na_2SO_4, i = 3

$$\Delta T_f = T_f^\circ - T_f = 3 \times 1.86 \text{ K kg mol}^{-1} \times \frac{2\text{g}}{142\text{g mol}^{-1}} \times \frac{1000 \text{ g kg}^{-1}}{50 \text{ g}}$$

$\Delta T_f = 1.57 = 271.43K$

48. Calculate the boiling point of solution when 4g of $MgSO_4$ (M = 120 g mol^{-1}) was dissolved in 100 g of water, assuming $MgSO_4$ undergoes complete ionization.
(K_b for water = 0.52 K kg mol^{-1}) **(2016)**

Ans. i = 2

$$\Delta T_b = i\,K_b.m$$

$$= i \times K_b \times \frac{w_2 \times 1000}{M \times W_1}$$

$$= 2 \times 0.52 K\ kg\ mol^{-1} \times \frac{4\ g \times 1000\ g/kg}{120\ g/mol \times 100\ g}$$

$$= \frac{2 \times 0.52}{3} = 0.346\ K$$

Boiling point of water = 373.15 K

$$T_b = T_b^o + \Delta T_b = 373.15\ K + 0.346\ K = 373.496\ K$$

49. Calculate the freezing point of a solution when 3 g of $CaCl_2$(M = 111 mol^{-1}) was dissolved in 100 g of water, assuming $CaCl_2$ undergoes Complete ionization. (K_f for water = 1.86 K kg mol^{-1}) **(2016)**

Ans. $\Delta T_f = i \times k_f \times m$

$$\Delta T_f = i \times k_f \times \frac{W_B}{M_B} \times \frac{1000}{W_A}$$

$$\Delta T_f = 3 \times 1.86 \times \frac{3}{111} \times \frac{1000}{100} = 1.50\ k$$

$$\Delta T_f = T^0_f - T_f$$

$$T_f = T^0_f - \Delta T_f = 273.15 - 1.50 = 271.65\ K$$

50. Calculate the boiling point of solution when 2g of Na_2SO_4 (M = 142 g mol $^{-1}$) was dissolved in 50 g of water, assuming Na_2SO_4 undergoes complete ionization. **(2016)**

(K_b for water = 0.52 K kg mol^{-1})

Ans. $\Delta T_b = i\,\frac{K_b W_b \times 1000}{M_b \times W_a}$

$$\Delta T_b = \frac{3 \times 0.52 \times 2 \times 1000}{142 \times 50} = 0.439\ K$$

$$\Delta Tb = T_b - T_b^0$$

$$T_b = 0.439 + 373 = 373.439K$$

51. When 1.5 g of a non-volatile solute was dissolved in 90 g of benzene, the boiling point of benzene raised from 353.23 K to 353.93 K. Calculate the molar mass of the solute. (K_b for benzene = 2.52 K kg mol^{-1}) **(2015)**

Ans. $\Delta T_b = K_b\, m$

$$\Delta T_b = K_b \left(\frac{W_B \times 1000}{M_B \times W_A}\right)$$

$$353.93 - 353.23 = \frac{2.52 \times 1.5 \times 1000}{M_B \times 90}$$

$$M_B = \frac{2.52 \times 1.5 \times 1000}{0.7 \times 90} = 60.0\ g\ mol^{-1}.$$

52. 3.9 g of benzoic acid dissolved in 49 g of benzene shows a depression in freezing point of 1.62 K. Calculate the van't Hoff factor and predict the nature of solute (associated or dissociated). **(2015)**

(Given : Molar mass of benzoic acid = 122 g mol^{-1}, K_f for benzene = 4.9 K kg mol^{-1})

Ans.

$$\Delta T_f = i\,K_f\,m$$

$$\Delta T_f = i\,K_f\,mb\,\frac{m_b \times 1000}{M_b \times m_a}$$

$$1.62\text{ K} = i \times 4.9\text{K kg mol}^{-1} \times \frac{3.9\text{ g}}{122\text{ gmol}^{-1}} \times \frac{1000}{49\text{ kg}}$$

$$\Rightarrow i = 0.506$$

As i < 1 , therefore solute gets associated.

53. Vapour pressure of water at 20°C is 17.5 mm of Hg. Calculate the vapour pressure of water at 20°C when 15 g of glucose (molar mass = 180 g mol^{-1}) is dissolved in 150 g of water. **(2015)**

Ans.

$$\frac{P_1^0 - P_1}{P_1^0} = \frac{w_2 \times M_1}{M_2 \times w_1}$$

$$\frac{17.5 - P_1}{17.5} = \frac{15/180}{\frac{15}{180} + \frac{150}{18}}$$

$$= \frac{15}{1515} = 0.01$$

$$17.5 - P_1 = 0.01 \times 17.5$$

$$17.5 - 0.175 = P_1$$

$$P_1 = 17.325 \text{ mm of Hg}$$

54. Calculate the mass of NaCl (molar mass = 58·5 g mol^{-1}) to be dissolved in 37·2 g of water to lower the freezing point by 2°C, assuming that NaCl undergoes complete dissociation. (K_f for water = 1·86 K kg mol^{-1}) **(2015)**

Ans.

$$\Delta T_f = i.\,K_f\,m = i\,K_f\,\frac{w_B \times 1000}{M_B \times w_A}$$

$$2\text{K} = \frac{2 \times 1.86\text{K kg/mol} \times w_B \times 1000}{58.5\text{g/mil} \times 37.2\text{ g}}$$

$$\Rightarrow w_B = 1.17\text{ g}$$

55. A solution is prepared by dissolving 10 g of non-volatile solute in 200 g of water. It has a vapour pressure of 31.84 mm Hg at 308 K. Calculate the molar mass of the solute. (Vapour pressure of pure water at 308 K = 32 mm Hg) **(2015)**

Ans.

$$\frac{p^0 - p}{p^0} = \frac{w_s \times M\text{ solvent}}{M_s \times W\text{ solvent}}$$

$$(32 - 31.84)/32 = 10 \times 18/\ Ms \times 200$$

$$\Rightarrow M_s = 180\text{ g/mol}$$

56. Some ethylene glycol, $HOCH_2CH_2OH$, is added to your car's cooling system along with 5 kg of water. If the freezing point of water-glycol solution is – 15.0°C, what is the boiling point of the solution ?

(K_b = 0.52 K kg mol^{-1} and K_f = 1.86 K kg mol^{-1} for water) **(2015)**

Ans. $$m\ HOCH_2CH_2OH = \frac{\Delta T_f}{K_f} = \frac{15.0°C}{1.86°\ C/m} = 8.06m$$

$$\Delta T_b = K_b\ m\ HOCH_2CH_2OH$$

$$= (0.52°C/m)\ (8.06m) = 4.19°C$$

$$T_b = 100.00°C + 4.19°C = 104.19°C$$

57. Calculate the amount of KCl which must be added to 1 kg of water so that the freezing point is depressed by 2K. (K_f forwater = 1.86 K kg mol^{-1}) **(2012)**

Ans. Since one mole of KCl gives 2 mole particles, the value of i = 2

$$\Delta T_f = 2\ K,\ K_f = 1.86\ kg\ mol^{-1}$$

Applying equation, $\Delta T_f = iK_f\ m$

$$m = \frac{\Delta T_f}{iK_f} = \frac{2}{2 \times 186} = 0.54\ mol\ kg^{-1}.$$

Therefore, 0.54 mole of KCl should be added to one kg of water.

Molar mass of KCl = 39 + 35.5 = 74.5 g

Amount of KCl = 0.54 x 74.5g = 40.05 g

58. A solution prepared by dissolving 8.95mg of a gene fragment in 35.0mL. of water has an osmotic pressure of 0.335 torr at 25°C.Assuming that the gene fragment is a non-electrolyte, calculate its molar mass. **(2011)**

Ans. π = CRT

$$M_2 = \frac{w_2\ R\ T}{\pi\ V}$$

$$M_2 = \frac{8.95 \times 10^{-3}g \times 0.0821L\ atm\ mol^{-1}\ K^{-1} \times 298K \times 760 \times 1000}{0.335\ atm \times 35\ L}$$

M_2 = 14193.3 g mol^{-1} or 1.42 x 10^4g mol^{-1}

59. 100 mg of a protein is dissolved in just enough water to make 10.0 mL of solution. If this solution has an osmotic pressure of 13.3 mm Hg at 25°C, what is the molar mass of the protein? **(2009)**

(R = 0.0821 L atm mol^{-1} K^{-1} and 760 mm Hg = 1 atm.)

Ans. π = CRT

$M_2 = \frac{w_2 R T}{\pi V}$

$M_2 = \frac{100 \times 10^{-3} g \times 0.0821 L\ atm\ mol^{-1} K^{-1} \times 298 K \times 760 \times 1000}{13.3\ atm \times 10\ L}$

M_2 = 13980g mol^{-1} or 1.4 x 10^4 g mol^{-1}

60. A solution containing 8 g of a substance in 100 g of diethyl ether boils at 36.86° C, whereas pure ether boils at 35.60° C. Determine the molecular mass of the solute.

(For ether K_b = 2.02 K kg mol^{-1}) **(2008)**

Ans. ΔT_b = (36.86 – 35.60)^{0}C = 1.26^{0}C or 1.26 K

No. of moles of solute = $\frac{8\ g}{M}$

Molality of Glucose solution = $\frac{8\ g}{M} \times \frac{1000}{100\ kg}$

$\Delta T_b = K_b m$

$1.26 K = 2.02 K\ kg\ mol^{-1} \times \frac{8\ g}{M} \times \frac{1000}{100\ kg}$

M = 128.25 g mol^{-1}

Where M is molar mass of the solute

61. Calculate the temperature at which a solution containing 54 g of glucose, $C_6H_{12}O_6$, in 250 g of water will freeze. [K_f for water = 1.86 K kg mol^{-1}] **(2008)**

Ans. $\Delta T_f = K_f m$

No. of moles of glucose = $\frac{54\ g}{180\ g\ mol^{-1}}$

Molality of Glucose solution = $\frac{54\ mol}{180} \times \frac{1000}{250\ kg}$ = 1.20 mol kg^{-1}

$\Delta T_f = K_f m$ = 1.86 K kg mol^{-1} x 1.20 mol kg^{-1} = 2.23 K

Temp. at which solution freezes = (273.15 – 2.23)K = 270.77K or -2.23^{0}C /

5 MARKS

62. (a) A solution contains 5.85 g NaCl (Molar mass = 58.5 g mol^{-1}) per litre of solution. It has an osmotic pressure of 4.75 atm at 27°C. **(2020)**

Calculate the degree of dissociation of NaCl in this solution.

(Given : R = 0.082 L atm K^{-1} mol^{-1})

(b) State Henry's law. Why is air diluted with helium in the tanks used by scuba divers?

Ans. (a) Given:

Weight of NaCl given = 5.85g

molecular mass of NaCl = 58.5g/mol

Osmatic pressure = 4.75 atm

Temperature T = 27 °C = (27 + 273) K = 300 K

We know that, π = iCRT, C = $\frac{5.85}{58.5 \times 1}$ M

$$4.75 = \frac{i \times 5.85}{58.5/1} \times 0.082 \times 300$$

$$i = \frac{4.75 \times 58.5}{5.85 \times 0.082 \times 300} = 1.93$$

For dissociation,

$$i = 1 + \alpha\,(n - 1) \qquad \text{Here } n = 2$$

$$1.93 = 1 + (2 - 1)\,\alpha$$

$$1 + \alpha = 1.93$$

$$\alpha = 1.93 - 1 = 0.93 \text{ or } 93\%$$

(b) Henry's law: At a constant temperature, the solubility of a gas in a liquid is directly proportional to the partial pressure of the gas present above the surface of liquid or solution.

Air diluted with helium in the tanks used by scuba divers to avoid bends, as well as, the toxic effects of high concentrations of nitrogen in the blood because of increase in pressure underwater and decreasing pressure towards the water surface.

63. (a) When 19.5 g of F – CH_2 – COOH (Molar mass = 78 g mol^{-1}) is dissolved in 500 g of water, the depression in freezing point is observed to be 1°C. Calculate the degree of dissociation of F – CH_2 – COOH. [Given : K_f for water = 1.86 K kg mol^{-1}] **(2020)**

(b) Give reasons :

(i) 0.1 M KCl has higher boiling point than 0.1 M Glucose.

(ii) Meat is preserved for a longer time by salting.

Ans. mass of solute = 19.5g

molar mass of solute (F - CH_2 – COOH) = 78 $gmol^{-1}$

mass of solvent = 500 g ; K_f = 1.86 k Kg mol^{-1}

depression in freezing point = 1° C

degree of dissociation of solute = ?

No. of moles of solute = $\frac{19.5}{78}$ = 0.25

molality is the no. of moles of solute in 1 Kg of Solvent

molality = $\frac{0.25}{\frac{500}{1000}}$ = 0.50 m

Calculated depression in freezing point ;

ΔT_f = $K_f \times m = 1.86 \times 0.50 = 0.93$ K

$$i = \frac{\text{Observed freezing point}}{\text{Calculated freezing point}} = \frac{1.0}{0.93} = 1.0753$$

Let, C is the initial conc. of fluoroacetic acid and α be its degree of dissociation.

$CH_2FCOOH \longrightarrow CH_3\ FCOO^- + H^+$

C (1 - a)   C a   Ca

Total no. of moles = C(1 - a) + Ca + Ca = C (1 + a)

1.0753 = 1 + a

a = 0.0753

(b) (i) KCl dissociates in the solution and forms ions K^+ and Cl^- and glucose does not dissociate. Since boiling point is a colligative property and depends on number of particles. Therefore, 0.1 M KCl has higher boiling point than 0.1 M glucose.

(ii) Meat is preserved for a longer time by salting to protect it against bacterial action.

64. (a) A solution is prepared by dissolving 5·0 g of a non-volatile solute in 95 g of water. It has a vapour pressure of 23·375 mm of Hg at 25^0C. Calculate the molar mass of the solute. Vapour pressure of pure water at 25^0C is 23·75 mm of Hg. **(2018)**

(b) Give reasons for the following :

(i) Osmotic pressure is considered to be a colligative property.

(ii) Molality is a better option to express concentration in comparison to molarity.

Ans. (a)

$$\frac{P_1^0 - P_1}{P_1^0} = \frac{w_2 \times M_1}{M_1 \times w_2}$$

$$\frac{23.75 - 23.375}{23.75} = \frac{5 \times 18}{M_2 \times 95}$$

$$\Rightarrow \quad M_2 = 60 \text{ g/mol}$$

(b) (i)The value of osmotic pressure at a given temperature is directly proportional to the number of moles of the solute.

(ii) Molality of a solution does not change with temperature as it involves mass.

65. (a) Calculate the amount of $CaCl_2$ (molar mass = 111 g mol^{-1}) which must be added to 500 g of water to lower its freezing point by 2 K, assuming $CaCl_2$ is completely dissociated. (K_f for water = 1·86 K kg mol^{-1}) **(2018)**

(b) (i) What happens when blood cells are placed in distilled water ?

(ii) Why is increase in temperature observed on mixing chloroform with acetone?

Ans. $\Delta T_f = i K_f w_2 \times 1000 / M_2 \times w_1$ -------------- (1)

$i = 3$

$$(1) \Rightarrow 2 = 3 \times 1.86 \times \frac{w_2 \times 100}{111 \times 500}$$

$$\Rightarrow w_2 = \frac{2 \times 111 \times 500}{3 \times 1.86 \times 1000} = 19.89 \text{ g}$$

b)(i) Due to osmosis, water enters into the cell due to which the blood cells swell and even burst.

(ii) On mixing, chloroform and acetone molecules develop hydrogen bonding resulting in release of energy, so the temperature rises.

66. (a) A 10% solution (by mass) of sucrose in water has a freezing point of 269·15 K. Calculate the freezing point of 10% glucose in water if the freezing point of pure water is 273·15 K. Given :

(Molar mass of sucrose = 342 g mol^{-1}, Molar mass of glucose = 180 g mol^{-1})

(b) Define the following terms :

(i) Molality (m)

(ii) Abnormal molar mass **(2017)**

Ans. (a) $\Delta T_f = K_f\, m$

Here , $m = w_2 \text{ x } 1000 / M_2 \text{ X } M_1$

$\Rightarrow 273.15 - 269.15 = K_f \text{ x } 10 \text{ x} 1000 / 342 \text{ x } 90$

$\Rightarrow K_f = 12.3$ K kg/mol

$\Delta T_f = K_f\, m = 12.3 \text{ x } 10 \text{ x} 1000 / 180 \text{ x } 90 = 7.6$ K

$T_f = 273.15 – 7.6 = 265.55$ K

(b) (i) Number of moles of solute dissolved in per kilogram of the solvent.

(ii) Abnormal molar mass: If the molar mass calculated by using any of the colligative properties to be different than theoretically expected molar mass.

67. (a) 30 g of urea (M = 60 g mol^{-1}) is dissolved in 846 g of water. Calculate the vapour pressure of water for this solution if vapour pressure of pure water at 298 K is 23·8 mm Hg.

(b) Write two differences between ideal solutions and non-ideal solutions. **(2017)**

Ans. (a) $(P_A^0 - P_A) / P_A^0 = (w_B \text{ x } M_A)/(M_B \text{ x } w_A)$

$$\frac{23.8 - P_A}{23.8} = (30 \times 18)/ 60 \times 846$$

$23.8 - P_A = 23.8 \times [(30 \times 18)/ 60 \times 846]$

$$23.8 - P_A = 0.2532$$

$$\Rightarrow P_A = 23.55\ mm\ Hg$$

(b)

Ideal solution	Non ideal solution
(a) It obeys Raoult's law over the entire range of concentration.	(a) Does not obey Raoult's law over the entire range of concentration.
(c) $\Delta_{mix} H = 0$	(c) $\Delta_{mix} H$ is not equal to 0.
(c) $\Delta_{mix} V = 0$.	(c) $\Delta_{mix} V$ is not equal to 0.

68. (a) Calculate the freezing point of solution when 1.9 g of $MgCl_2$(M = 95 g mol^{-1}) was dissolved in 50 g of water, assuming $MgCl_2$ undergoes complete ionization.

(K_f for water = 1.86 K kg mol^{-1})

(b) (i) Out of 1 M glucose and 2 M glucose, which one has a higher boiling point and why ?

(ii) What happens when the external pressure applied becomes more than the osmotic pressure of solution ? **(2016)**

Ans. (a) $\Delta T_f = i \dfrac{K_f\, w_b \times 1000}{M_b \times W_A}$

$\Delta T_f = 3\times (1.86 \times 1.9/95\times 50) \times 1000 = 2.23K$

$T_f - \Delta T_f = 273.15 - 2.23$

$\Rightarrow \quad T_f = 270.92$ K

(b) (i) 2M glucose ; More Number of particles / less vapour pressure

(ii) Reverse Osmosis

69. (a) When 2.56 g of sulphur was dissolved in 100 g of CS_2, the freezing point lowered by 0.383 K. Calculate the formula of sulphur (S_x).

[K_f for CS_2 = 3.83 K kg mol^{-1}, Atomic mass of Sulphur = 32 g mol^{-1}]

(b) Blood cells are isotonic with 0.9% sodium chloride solution. What happens if we place blood cells in a solution containing

(i) 1.2% sodium chloride solution ?

(ii) 0.4% sodium chloride solution ? **(2016)**

Ans. (a) $\Delta T_f = \dfrac{K_f\, wb \times 1000}{M_b \times W_A}$

$0.383 = (3.83\times 2.56/M\times 100) \times 1000$

$\Rightarrow$ M = 256

S × x = 256

$32 \times x = 256 \Rightarrow x = 8$

(b) (i) Shrinks (ii) swells

70. (a) Calculate the boiling point of solution when 2 g of Na_2SO_4 (M = 142 g mol^{-1}) was dissolved in 50 g of water, assuming Na_2SO_4 undergoes complete ionization.

(K_b for water = 0.52 K kg mol^{-1})

(b) Define the following terms :

(i) Colligative properties (ii) Ideal solution **(2016)**

Ans. (a) $\Delta T_b = i\, K_b\, m$

$$\Delta T_b = i \frac{K_b\, W_b \times 1000}{M_b \times W_a}$$

$$T_b - T_b^0 = \frac{3 \times 0.52k \text{ kg/mol} \times 2 \times 1000 \text{ g kg}^{-1}}{142 \text{ g/mol} \times 50\text{g}}$$

$T_b - 373 \text{ K} = 0.44\text{K}$

$\Rightarrow T_b = 373.44 \text{ K} = 100.44^oC$

(b) (i) Properties of dilute solutions that depend on the number of particles of solute but not on nature of the solute particles are called colligative properties.

(ii) The solutions which obey Raoult's law over the entire range of concentration are known as ideal solutions.

71. (a) What is van't Hoff factor? What types of values can it have if in forming the solution the solute molecules undergo

(i) Dissociation? (ii) Association?

(b) How many mL of a 0.1 M HCl solution are required to react completely with 1 g of a mixture of Na_2CO_3 and $NaHCO_3$ containing equimolar amounts of both ?

(Molar mass : Na_2CO_3 = 106 g, $NaHCO_3$ = 84 g) **(2015)**

Ans. (a) $i = \frac{\text{Normal molar mass}}{\text{Abnormal molar mass}}$

$$i = \frac{\text{Total number of moles of particles after association/dissociation}}{\text{Number of moles of particles before association/dissociation}}$$

(i) For dissociation, i > 1

(ii) For association, i < 1

(b) $Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$

$NaHCO_3 + HCl \rightarrow NaCl + H_2O + CO_2$

A mixture of 1 mol Na_2CO_3 and 1 mol $NaHCO_3$ reacts with 3 mol of HCl

1 mol Na_2CO_3 and 1 mol $NaHCO_3$ = 106 + 84 = 190 g

190g mixture reacts completely with 3 mol HCl

Mol of HCl that will reacts with 1g $= \frac{3 \text{ mol}}{190 \text{ g}} \times 1\text{g} = \frac{3}{190} \text{ mol} = \frac{3 \times 10^3}{190} \text{ m mol}$

We know that, Molality x volume (ml) = no. of m mole

$$\text{i.e., } 0.1 \times V_{HCl} = \frac{3 \times 10^3}{190}$$

$$V_{HCl} = \frac{3 \times 10^3}{190 \times 0.1} = 157.9 \text{ mL}$$

72. (a) Define

(i) Mole fraction (ii) Molality (iii) Raoult's law

(b) Assuming complete dissociation, calculate the expected freezing point of a solution prepared by dissolving 6.00 g of Glauber's salt, $Na_2SO_4.10\ H_2O$ in 0.100 kg of water.

(K_f for water = 1.86 K kg mol^{-1}, Atomic masses:Na = 23,S = 32,O = 16,H = 1)

Ans. (a) (i) It is defined as the number of moles of the component to the total number of moles of all the components.

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

(ii) It is defined as the number of moles of the solute per kg of the solvent.

$$\text{Molality (m)} = \frac{\text{Moles of solute}}{\text{Mass of solvent in kg}}$$

(iii) According to Raoult's law, the partial pressure of a volatile component or gas is directly proportional to its mole fraction in solution.

(b) Molar mass of $Na_2SO_4.10H_2O$

$$= 2 \times 23 + 32 + 16 \times 4 + 10 \times 2 + 16 \times 10 = 322\text{g mol}^{-1}$$

No. of mol $Na_2\ SO_4.10H_2O$ dissolved in 01.10kg of water

$$= \frac{6.00 \text{ g}}{322 \text{ g mol}^{-1}} = \frac{6}{322} \text{ mol}$$

Since there is complete dissociation, van't Hoff factor, i = 3

$\Delta T_f = i K_f m = i \times K_f \times n_b/w_A$

$$= \frac{3 \times (1.86 \text{ kg mol}) \times \frac{6}{322}\text{mol}}{0.10 \text{ kg}} = 1.04 \text{ K}$$

Freezing point = 273.15K -1.04K = 272.11K

73. (a) Define the following terms:

(i) Mole fraction (ii) Ideal solution

(b) 15.0 g of an unknown molecular material is dissolved in 450 g ofwater.The resulting solution freezes at 0.34°C.What is the molar mass of the material? (K_f for water = 1.86 K kg mol^{-1}) **(2012)**

Ans. (a) (i) The Ratio of number of moles of one component to the total number of moles of solution./ or mathematical expression.

(ii) The Solution which follows Raoult's law over the entire range of concentrations.

(b) W_B = 15 g W_A = 450 g

$\Delta T_f = 0.34^0C$ K_f = 1.86 Kkg/mol M_B = ?

$$M_B = \frac{1000 \times K_f \times W_B}{\Delta T_f \times W_A}$$

$$= \frac{1000 \times 1.86 K\ kg\ mol^{-1} \times 15 g}{0.34 K \times 450\ g}$$

= 182.35 g / mol

74. (a) Explain the following: **(2012)**

(i) Henry's law about dissolution of a gas in a liquid

(ii) Boiling point elevation constant for a solvent

(b) A solution of glycerol ($C_3H_8O_3$) in water was prepared by dissolving some glycerol in 500 g of water. This solution has a boiling point of 100.42°C. What mass of glycerol was dissolved to make this solution? (K_b for water = 0.512 K kg mol^{-1})

Ans. (a) (i) The partial pressure of the gas above the liquid is directly proportional to the mole fraction of the gas dissolved in the liquid.

(ii) Boiling Point Elevation Constant: It is equal to elevation in boiling point of 1 molal solution, i.e., 1 mole of solute is dissloved in 1 kg of solvent.

(b) W_B = ? W_A = 500 g $\Delta T_b = 100.42^0C - 100^0C = 0.42^0C$ or 0.42K

K_b = 0.512 Kkg/mol M_B = 92g/mol

$$\Delta T_b = K_b \frac{W_B \times 1000}{M_B \times W_A \text{ (in grams)}}$$

$$W_B = \frac{\Delta T_b \times M_B \times W_A \text{ (in grams)}}{1000 \times K_b}$$

$$= \frac{042K \times 92g\ mol^{-1} \times 500\ kg}{1000 \times 0.512K\ kg\ mol^{-1}} = 37.73\ g$$

75. (a) Differentiate between molarity and molality for a solution.How does a change in temperature influence their values? **(2011)**

(b) Calculate the freezing point of an aqueous solution containing 10.50g of $MgBr_2$ in 200 g of water. (Molar mass of $MgBr_2$ = 184 g, Kf for water = 1.86 K $kgmol^{-1}$)

Ans. (a) Molality (m) is the number of moles of the solute per kilogram(kg) of the solvent whereas Molarity is the number of moles of solute present in one litre (or one cubic decimeter) of solution at a particular temperature.

Molality is independent of temperature whereas Molarity is function of temperature because volume depends on temperature and the mass does not or Molarity decreases with increase of temperature.

(b) $\Delta T_f = 7.5^0C$, $\Delta T_f = iK_fm$

$$T_f^0 - T_f = 3 \times 1.86^oC \text{ kg mol}^{-1} \times \frac{10.50g}{184 \text{ gmol}^{-1}} \times \frac{1000}{200kg}$$

$0^0C - T_f = 1.59^0C$

$T_f = -1.59^0C$ or 271.41 K

76. (a) Define the terms osmosis and osmotic pressure. Is the osmotic pressure of a solution a colligative property? Explain. **(2011)**

(b) Calculate the boiling point of a solution prepared by adding 15.00 g of NaCl to 250.0 g of water. (K_b for water = 0.512 K kg mol^{-1}, Molar mass of NaCl = 58.44 g)

Ans. (a) The flow of solvent motecules from solution of low concentration to higher con centration through semipermeable membrane is called osmosis.

The hydrostatic pressure that has to be applied on the solution to prevent the entry of the solvent into the solution through the semipermeable membrane is called the Osmotic Pressure.

Yes, osmotic pressure is a colligative property as it depends upon the number of particles of the solute in a solution.

(b) $\Delta T_b = iK_b m$

$$T_b - T_b^0 = 2 \times 0.512K \text{ kg mol}^{-1} \times \frac{15 \text{ g}}{58.44 \text{ gmol}^{-1}} \times \frac{1000}{250 \text{ kg}}$$

$T_b - 373 \text{ K} = 1.05 \text{ K}$

$T_b = 374.05$ K or 101.05^0C

ENTRANCE CORNER

1. The solubility of N_2 in water .The vapour pressure of water (in torr) for this aqueous solution is 0.01 g L^{-1} .The solubility (in g L^{-1}) at 750 torr partial pressure is

(a) 0.0075 (b) 0.005 (c) 0.02 (d) 0.015 **(2016)**

2. The vapour pressure of acetone at 20 °C is 185 torr .When 1.2 g of non-volatile substance was dissolved in 100 g of acetone at 20 °C, its vapour pressure was 183 torr.The molar mass (g mol^{-1}) of the substance is

(a) 128 (b) 488 (c) 32 (d) 64 **(2015)**

3. Determination of the molar mass of acetic acid in benzene using freezing point depression is affected by **(2015)**

(a) dissociation (b) association (c) partial ionization (d) complex formation

4. Of the following 0.10m aqueous solutions,which one will exhibit the largest freezing point depression ?

(a) KCl (b) $C_6H_{12}O_6$ (c) $Al_2(SO_4)_3$ (d) K_2SO_4 **(2014)**

5. The density of a solution prepared by dissolving 120 g of urea (mol.mass =60μ) in 1000g of water is 1.15 g/mL.The molarity of this solution is

(a) 1.78 M (b) 1.02M (c) 2.05 M (d) 0.50 M **(2012)**

6. A 5.2 molal aqueous solution of methyl alcohol ,CH_3OH, is supplied .What is the mole fraction of methyl alcohol in the solution

(a) 0.100 (b) 0.190 (c) 0.086 (d) 0.050 **(2012)**

7. The van't Hoff factor, *i* for a compound which undergoes dissociation in one solvent and association in other solvent is respectively **(2011)**

(a) less than one and less than one

(b) greater than one and less than one

(c) greater than one and greater than one

(d) less than one and greater than one

8. If sodium sulphate is considerd to be completely dissociated into cations and anions in aqueous solution, the change in freezing point of water (ΔT_f), when 0.01 mol of sodium sulphate is dissolved in 1kg of water, is (K_f= 1.86 Kkg mol-1)

(a) 0.0186 K (b) 0.0372 K (c) 0.0558 K (d) 0.0744 K **(2010)**

9. At 80°C ,the vapour pressure of pure liquid A is 520 mm of Hg and that of pure liquid B is 1000 mm of Hg .If a mixtrure solution of A and B boils at 80°C at 1 atm pressure the amount of A in the mixture is (1 atm= 760 mm of Hg) **(2008)**

(a) 50 mol percent (b) 52 mol percent (c) 34 mol percent (d) 48 mol percent

10. During osmosis, flow of water through a semipermeable membrane is

(a) from solution having higher concentration only

(b) from both sides of semipermeable membrane with equal flow rates

(c) from both sides of semipermeable membrane with unequal flow rates

(d) from solution having lower concentration only **(2006)**

11. A solution of acetone in ethanol

(a) shows a negative deviation from Raoult's law

(b) shows a positive deviation from Raoult's law

(c) behaves like a near ideal solution

(d) obeys Raoult's law **(2006)**

12. The mole fraction of solute in one molal aqueous solution is

(a) 0.027 (b) 0.036 (c) 0.018 (d) 0.009 **(2005)**

13. Equimolal solutions in the same solvent have

(a) same boiling point but different freezing point

(b) same freezing point but different boiling point

(c) same boiling and same freezing points

(d) different boiling and different freezing points **(2005)**

14. Benzene and toluene form nearly ideal solutions at 20^0C ,the vapour pressure of benzene is 75 torr and that of toluene is 22 torr.The partial vapour pressure of benzene at 20^0C for a solution containing 78 g of benzene and 46 g of toluene in torr is

(a) 50 (b) 25 (c) 37.5 (d) 53.5 **(2005)**

15. Which of the following liquid pairs shows a positive deviation from Raoult's law ?

(a) Water -Hydrochloric acid (b) Benzene-methanol

(c) Water-nitric acid (d) Acetone-chloroform **(2004)**

16. If liquids A and B from an ideal solution,the

(a) enthalpy of mixing is zero

(b) entropy of mixing is zero

(c) free energy of mixing is zero

(d) free energy as well as the entropy of mixing are each zero **(2003)**

17. In mixture A and B components show -ve deviation as

(a) $\Delta V_{mix} > 0$

(b) $\Delta H_{mix} < 0$

(c) A - B interaction is weaker than A -A and B -B interaction

(d) A - B interaction is stronger than A -A and B - B interaction **(2002)**

18. Freezing point of an aqueous solution is (-0.186)°C .Elevation of boiling point of the same solution is K_b = 0.512°C K_f=1.86°C ,find the increase in boiling point .

(a) 0.186°C (b) 0.0512 °C (c) 0.092°C (d) 0.2372°C **(2002)**

19. Pure water can be obtained from sea water by **(2001)**

(a) centrifugation (b) plasmolysis (c) reverse osmosis (d) sedimentation

20. The vapour pressure of benzene at a certain temperature is 640 mmHg .A non-volatile and non-electrolyte solid, weighing 2.175 g is added to 39.08g of benzene .If the vapour pressure of the solution is 600 mm Hg , what is the molecular weight of solid substance ?

(a) 49.50 (b) 59.60 (c) 69.40 (d) 79.82 **(1999)**

21. The volume strength of 1.5 NH_2O_2 solution is

(a) 4.8 (b) 5.2 (c) 8.4 (d) 8.8 **(1997)**

22. According to Raoult's law ,relative lowering of vapour pressure of a solution is equal to

(a) moles of solute (b) moles of solvent

(c) mole fraction of solute (d) mole fraction of solvent **(1995)**

23. Which one is a colligative property? **(1992)**

(a) Boiling point (b) Vapour pressure

(c) Osmotic pressure (d) Freezing point

24. Blood cells retain their normal shape in solutions which are **(1991)**

(a) hypotonic to blood (b) isotonic to blood

(c) hypertonic to blood (d) equinormal to blood

25. An ideal solution is formed when its components **(1988)**

(a) have no volume change on mixing

(b) have no enthalpy change on mixing

(c) have both the above characteristics

(d) have high solubility

ANSWERS

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

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