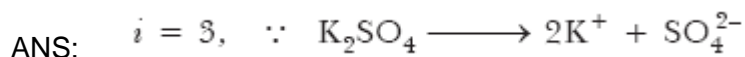SOLUTION

**1** State Raoult's law for a solution containing volatile components. 1

ANS: The vapour pressure of each component is directly proportional to the mole fraction of each component.

**2** What are azeotropes? Give an example. 1

ANS: Azeotropes are constant boiling mixtures which distill out unchanged in their composition, e.g. ethanol and water.

**3** 10 mL of liquid A was mixed with 10 mL of liquid B. The volume of the resulting solution was found to be 19.9 mL. What do you conclude? 1

ANS: It means solution shows –ve deviation from Raoult's law due to increase in force of attraction, volume decreases.

**4** Give reason when 30 mL of ethyl alcohol and 30 mL of water are mixed, the volume of resulting solution is more than 60 mL. 1

ANS: It is because forces of attraction between ethyl alcohol and water are less than ethanol-ethanol and water-water.

**5** Two liquids A and B boil at 145 °C and 190 °C respectively. Which of them has a higher vapour pressure at 80 °C? 1

ANS: 'A' because lower the boiling point, higher will be vapour pressure.

**6** Of 0.1 molal solutions of glucose and potassium chloride respectively, which one will have a higher boiling point? 1

ANS: 0.1 molal KCl solution will have higher boiling point because KCl dissociates into $K^+$ and $Cl^-$ ions, therefore, number of particles will be doubled.

**7** Which has the highest freezing point?
(a) 1 M glucose (b) 1 M NaCl (c) 1 M $CaCl_2$ (d) 1 M $AlF_3$ 1

ANS: (a) 1 M glucose solution has highest freezing point because it has lowest $\Delta T_f$.

**8** Measurement of which colligative property is preferred for determination of molar mass. 1

ANS: Osmotic pressure.

**9** Define osmotic pressure. 1

ANS: It is the extra pressure which must be applied on solution side so as to prevent the flow of solvent molecules from solution through semi-permeable membrane.

**10** What is meant by 'reverse osmosis'? 1

ANS: Reverse Osmosis: If extra pressure is applied on the solution side and exceeds the osmotic pressure, the osmosis can be reversed. That is, pure water can be forced out of the solution to pass through the pores of the membrane in the opposite direction. This is called *reverse osmosis*.

**11** A 10% solution of urea is isotonic with 20% solution of 'x' at same temperature. Calculate molecular weight of x. 1

$$\Rightarrow \quad \frac{10}{60} \times \frac{1000}{100} = \frac{20}{M.wt.\ of\ x}$$

ANS: $M_1 = M_2$, where $M_1$ and $M_2$ are molarities $\Rightarrow$ M.wt. of $x = 120$ g $mol^{-1}$

**12** What is expected value of van't Hoff factor for $K_3[Fe(CN)_6]$. 1

ANS:
$$K_3[Fe(CN)_6] \rightarrow 3K^+ + [Fe(CN)_6]^{3-}$$
$$i = 4$$

13  What would be the value of van't Hoff factor for a dilute solution of $K_2SO_4$ in water?     1

ANS:   $i = 3, \quad \because \quad K_2SO_4 \longrightarrow 2K^+ + SO_4^{2-}$

14  In the determination of molar mass of $A^+B^-$ using a colligative property, what may be the value of van't Hoff factor if the solute is 50% dissociated?     1

ANS:

$$\alpha = \frac{i-1}{n-1} = \frac{i-1}{2-1}$$
$$\Rightarrow \qquad i = 1.5 \qquad [\alpha = 50\% = 0.5, \; n = 2, \; \because \; AB \longrightarrow A^+ + B^-]$$

15  A person suffering from high blood pressure should take less common salt, why?     1

ANS:   Common salt contains $Na^+$ and $Cl^-$ which increase osmotic pressure of blood, therefore, increase blood pressure.

16  When outer shell of two eggs are removed, one of the eggs is placed in pure water and other is placed in saturated solution of NaCl, what will be observed and why?     1

ANS:   The egg placed in pure water will *swell*, whereas the egg placed in saturated solution of NaCl will *shrink*.

17  What is the cause of anoxia?     1

ANS:   Low level of oxygen in the blood and tissues of people living at high altitudes.

18  What is the value of *i* for $Na_2SO_4 \cdot 10\,H_2O$ assuming complete ionisation?     1

ANS:   $i = 3$ for $Na_2SO_4 \cdot 10\,H_2O$ assuming complete ionisation.

19  Why is osmotic pressure of 1 M KCl is higher than that of 1 M urea solution?     1

ANS:   1 M KCl solution dissociates into $K^+$ and $Cl^-$, therefore, its osmotic pressure is higher than that of 1 M solution of urea which does not dissociate.

20  The molecular masses of polymers are determined by osmotic pressure method and nor by measuring other colligative properties. Give two reasons.     2

ANS:   (i) It is measured at room temperature.
(ii) It has appreciable value.

21  Define the following terms:
(i) Mole fraction
(ii) Isotonic solutions     2
(iii) van't Hoff factor
(iv) Ideal solution

ANS:   (i) Mole fraction (x): It is the ratio of number of moles of a particular component to the total number of moles of all the components.

For example, mole fraction of a component A, $\quad x_A = \dfrac{n_A}{n_A + n_B},\quad$ where $n_A$ and $n_B$ are the number of moles of components 'A' and 'B' respectively.
(ii) Isotonic solutions: Two solutions are said to be isotonic when they exert the same osmotic pressure because they have same molar concentration. All intravenous injections must be isotonic with body fluids.
(iii) van't Hoff factor (i): The ratio of the experimental value of a colligative property to the theoretical value (calculated on the basis of normal behaviour of solute) is known as van't Hoff

$$i = \frac{\text{Experimentally determined value of the colligative property}}{\text{Calculated value of the colligative property}}$$

factor.     (iv) Ideal solution: Those solutions which obey Raoult's law are called ideal solutions. When the forces of attraction between A—A, B—B are similar to A—B, then A and B will form ideal solution.

22     State Raoult's Law for a solution containing volatile components. How does Raoult's law become a special case of Henry's Law?    2

ANS:    Raoult's law for volatile components: It states that vapour pressure of each component is directly proportional to its mole fraction.

$p_A = p_A° x_A$ In solution of gas in liquid, one of the component is so volatile that it exists as gas and its solubility is given by Henry's law, $p = K_H .x$
Only difference between Raoult's law and Henry's law is $K_H$ differs from $p_A°$.
Thus, Raoult's law becomes a special case of Henry's law in which $K_H$ becomes equal to $p_A°$.

23     If $N_2$ gas is bubbled through water at 293 K, how many millimoles of $N_2$ gas would dissolve in 1 litre of water? Assume that $N_2$ exerts a partial pressure of 0.987 bar. Given that Henry's law constant for $N_2$ at 293 K is 76.48 kbar.    2

ANS:

$$K_H = \frac{p_{N_2}}{x_{N_2}} = \frac{\text{partial pressure of nitrogen}}{\text{mole fraction of } N_2}$$

$$\Rightarrow \quad x_{N_2} = \frac{p_{N_2}}{K_H} = \frac{0.987 \text{ bar}}{76480 \text{ bar}} = 1.29 \times 10^{-5}$$

1 litre of water contains $\dfrac{1000}{18} = 55.5$ moles of water.

$$\therefore \quad x_{N_2} = \frac{n_{N_2}}{n_{N_2} + n_{H_2O}} = \frac{n_{N_2}}{55.5}$$

$$[\because \quad n_{N_2} \text{ is very very small in comparison to } n_{H_2O}]$$

$$\Rightarrow \quad n_{N_2} = 55.5 \times 1.29 \times 10^{-5}$$
$$= 71.6 \times 10^{-5} = 7.16 \times 10^{-4} \text{ moles}$$
$$= 7.16 \times 10^{-4} \times 10^3 \text{ millimoles}$$
$$= 0.716 \text{ millimole}$$

24     18 g of glucose, $C_6H_{12}O_6$, is dissolved in 1 kg of water in a saucepan. At what temperature will water boil at 1.103 bar? ($K_b$ for $H_2O$ is 0.52 k kg mol$^{-1}$)    2

ANS:

Given: $W_B = 18$ g, $M_B = 180$ g mol$^{-1}$, $W_A = 1$ kg $= 1000$ g, $\Delta T_b = ?$

Now, $\Delta T_b = K_b \times m = K_b \times \dfrac{W_B}{M_B} \times \dfrac{1000}{W_A}$

$= 0.52 \text{ K kg mol}^{-1} \times \dfrac{18}{180} \times \dfrac{1000}{1000} = 0.052 \text{ K}$

Boiling point of water $(T_b°) = 373.15$ K at 1 bar pressure
Boiling point of solution $= \Delta T_b + T_b° = 373.15$ K $+ 0.052$ K $= 373.202$ K.

25     Find the boiling point of a solution containing 0.520 g of glucose ($C_6H_{12}O_6$) dissolved in 80.2 g of water. [Given: $K_b$ for water = 0.52 K/m]    2

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

$$\Rightarrow \quad \Delta T_b = 0.52 \times \frac{0.52}{180} \times \frac{1000}{80.2} = \frac{270.4}{14436} = 0.0187$$

ANS: $\therefore$ Boiling point of solution = 373 + 0.0187 = 373.0187 K

26  The boiling point of benzene is 353.23 K. When 1.80 g of non-volatile solute was dissolved in 90 g of benzene, the boiling point is raised to 354.11 K Calculate the molar mass of solute. $K_b$ for benzene is 2.53 K kg mol$^{-1}$.  2

ANS:  Boiling point of benzene = 353.23 K,
$W_B$ = 1.80 g, $W_A$ = 90 g,
Boiling point of solution = 354.11 K

$$\Delta T_b = T_b - T_b^\circ = 354.11 \text{ K} - 353.23 \text{ K} = 0.88 \text{ K}$$
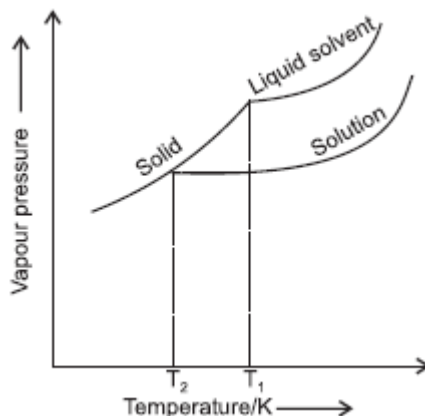
Also, $\quad \Delta T_b = K_b \times m$

$$\Rightarrow \quad \Delta T_b = \frac{W_B}{M_B} \times \frac{1000}{W_A} \times K_b$$

$$\Rightarrow \quad M_B = \frac{1.80 \text{ g}}{0.88 \text{ K}} \times \frac{1000}{90 \text{ g}} \times 2.53 \text{ K kg mol}^{-1} = 57.5 \text{ g mol}^{-1}$$

Therefore, molar mass of solute = 57.5 g mol$^{-1}$.

27  An aqueous solution of solidum chloride freezes below 273 K. Explain the lowering in freezing points of water with the help of a suitable diagram.



2

ANS:  When a non-volatile solute is added to a solvent, its vapour pressure decreases, therefore, at a lower temperature, vapour pressure of solid and solution becomes equal, i.e. depression in freezing point takes place as shown in diagram.

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 kg mol$^{-1}$)  2

$$\Delta T_{b(observed)} = 100.18 \text{ °C} - 100 \text{ °C} = 0.18 \text{ °C}$$

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

$$\Rightarrow \quad \Delta T_{b(calculated)} = 0.512 \times 1 = 0.512$$

$$\therefore \quad i = \frac{\Delta T_{b(observed)}}{\Delta T_{b(calculated)}} = \frac{0.180}{0.512} = 0.35$$

ANS:

29  A 0.561m solution of an unknown electrolyte depresses the freezing point of water by 2.93 °C. What is van't Hoff factor for this electrolyte? The freezing point depression constant ($K_f$) for water is 1.86 °C kg mol$^{-1}$.  2

4

$$m = 0.561, \quad \Delta T_{f(observed)} = 2.93\ °C, \quad i = ?$$

$$K_{f(calculated)} = 1.86\ °C\ kg\ mol^{-1}$$

$$\Delta T_f = K_f \times m = 1.86 \times 0.561 = 1.04346$$

$$i = \frac{\Delta T_{f(obseved)}}{\Delta T_{f(calculated)}} = \frac{2.93}{1.04} = 2.82$$

ANS:

30    The elevation in boiling point of 0.1 molal solution of X in water is 0.1536 °C. What conclusion do you draw about the molecular state of X?
[Given: $K_b$ = 0.512 K kg mol$^{-1}$]    2

$$\Delta T_b = K_b \times m = 0.512 \times 0.1 = 0.0512,$$

$$i = \frac{\text{observed } \Delta T_b}{\text{normal } \Delta T_b} = \frac{0.1536}{0.0512} = 3$$

ANS:      Solute undergoes dissociation in water.
It is a strong electrolyte.

31    Find out the molar mass of X when 100 g of 'X' is dissolved in 500 mL of solution if molarity of solution is 0.5.    2

$$\text{Molarity, } (M) = \frac{W_B}{M_B} \times \frac{1000}{\text{Volume of solution in mL}}$$

$$\Rightarrow \quad 0.5 = \frac{100}{M_B} \times \frac{1000}{500} \quad \Rightarrow \quad M_B = \frac{200}{0.5} = 400\ g\ mol^{-1}.$$

ANS:

32    Define azeotropes. What type of azeotrope is formed by positive deviation from Raoult's law? Give an example.    2

ANS:    Azeotropes are constant boiling mixtures which distill out unchanged in their composition. Minimum boiling azeotropes are formed by solutions showing positive deviation, e.g. cyclohexane and ethanol.

33    (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.    2

ANS:    (i) The resulting solution will show negative deviation from Raoult's law. The temperature of solution will increase.
(ii) The cell will swell and even may burst due to inflow of solvent because of osmosis.

34    Calculate the boiling point of 1 molar solution of solute (Molar mass 74.5 g mol$^{-1}$). The density of solution is 1.04 g mL$^{-1}$ and $K_b$ for water is 0.52 K kg mol$^{-1}$.    2

$$m = \frac{M \times 1000}{1000 \times d - M \times M.Wt}$$

$$= \frac{1 \times 1000}{1000 \times 1.04 - 1 \times 74.5} = \frac{1000}{1040 - 74.5}$$

$$= \frac{1000}{965.5} = 1.0357$$

ANS:      where 'M' is molarity, 'm' is molality, 'd' is density and M.Wt is molecular weight. Now, $\Delta T_b = m \times K_b = 1.0357 \times 0.52 = 0.5385$ ∴ Boiling point of solution = 373 + 0.5385 = 373.5385 K.

35    The freezing point of a solution composed of 5.85 g of NaCl in 100 g of water is –3.348 °C. Calculate the van't Hoff factor 'i' for this solution. $K_f$ (water) = 1.86 K kg mol$^{-1}$.    2

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

$$\Rightarrow \quad 3.348 = i \times 1.86 \times \frac{5.85}{58.5} \times \frac{1000}{100};$$

$$\therefore \quad i = \frac{3.348 \times 10}{10 \times 1.86} = 1.8$$

ANS:

**36** 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?     **2**

ANS:    van't Hoff factor is the ratio of observed colligative property to the normal colligative property:
(i) i > 1 for dissociation. (ii) i < 1 for association.

**37** At 25 °C the saturated vapour pressure of water is 3.165 kPa (23.75 mm Hg). Find the saturated vapour pressure of a 5% aqueous solution of urea (carbamide) at the same temperature. (Molar mass of urea = 60.05 g mol$^{-1}$)    **3**

ANS:

$$\frac{p_A^\circ - p_A}{p_A^\circ} = x_B = \frac{\dfrac{W_B}{M_B}}{\dfrac{W_A}{M_A} + \dfrac{W_B}{M_B}}$$

$$\Rightarrow \quad \frac{3.165\ \text{kPa} - p_A}{3.165\ \text{kPa}} = \frac{\dfrac{W_B}{M_B}}{\dfrac{W_A}{M_A}} \qquad \left[ \because \frac{W_B}{M_B} <<< \frac{W_A}{M_A} \right]$$

Molecular weight of urea = 60.05 g mol$^{-1}$

$$\Rightarrow \quad 1 - \frac{p_A}{3.165} = \frac{\dfrac{5}{60.05}}{\dfrac{95}{18}}$$

$$\Rightarrow \quad 1 - \frac{p_A}{3.165} = \frac{5}{60.05} \times \frac{18}{95} = \frac{18}{1140.95}$$

$$\Rightarrow \quad \frac{p_A}{3.165} = 1 - \frac{18}{1140.95} = \frac{1140.95 - 18.00}{1140.95} = \frac{1122.95}{1140.95}$$

$$\Rightarrow \quad p_A = \frac{3.165 \times 1122.95}{1140.95} = 3.115\ \text{kPa} = 3.12\ \text{kPa}$$

**38** Some ethylene glycol, HOCH$_2$—CH$_2$OH is added to your car's cooling system along with 5 kg of water. If the freezing point of water glycol solution is –15 °C, what is the boiling point of the solution? [K$_b$ = 0.52 K kg mol$^{-1}$, K$_f$ = 1.86 K kg mol$^{-1}$]    **3**

$$\Delta T_f = 0\ °C - (-15\ °C) = 15\ °C$$
$$\Delta T_f = K_f \times m$$
$$\Rightarrow \quad 15\ °C = 1.86 \times m$$

Also, $\quad \Delta T_b = K_b \times m$

$$\Rightarrow \quad \Delta T_b = 0.52 \times m$$

Dividing $(i)$ by $(ii)$ we get

$$\frac{15}{\Delta T_b} = \frac{1.86}{0.52}$$

$$\Delta T_b = \frac{15 \times 0.52}{1.86} = \frac{7.80}{1.86} = 4.19$$

ANS: Boiling point of solution $= 373 + 4.19 = 377.19\ K$

39 What would be the molar mass of a compound if 6.21 g of it dissolved in 24.0 g of chloroform forms a solution that has a boiling point of 68.04 °C. The boiling point of pure chloroform is 61.7 °C and the boiling point elevation constant, $K_b$ for chloroform is 3.63 °C/m.   3

$$\Delta T_b = 68.04\ °C - 61.70\ °C = 6.34\ °C$$

Also, $\quad \Delta T_b = K_b \times \dfrac{W_B}{M_B} \times \dfrac{1000}{W_A} \quad \Rightarrow \quad 6.34 = 3.63\ °C/\,m \times \dfrac{6.21}{M_B} \times \dfrac{1000}{24}$

$$\Rightarrow \quad M_B = \frac{3.63 \times 6.21 \times 1000}{6.34 \times 24} = \frac{22542.3}{152.16} = 148.15\ g\ mol^{-1}.$$

ANS:

40 What mass of ethylene glycol (molar mass = 62.0 g mol$^{-1}$) must be added to 5.50 kg of water to lower the freezing point of water from 0 °C to –10.0 °C? ($K_f$ for water = 1.86 K kg mol$^{-1}$)   3

ANS:

Given: $\quad M_B = 62.0\ g\ mol^{-1},\ W_A = 5.50\ kg,$

$$\Delta T_f = 0\ °C - (-10.0\ °C) = 10.0\ °C,$$

$$K_f = 1.86\ K\ kg\ mol^{-1}$$

Now, $\quad \Delta T_f = K_f \times \dfrac{W_B}{M_B} \times \dfrac{1000}{W_A}$

$$\Rightarrow \quad W_B = \frac{\Delta T_f \times M_B \times W_A}{K_f \times 1000} = \frac{10 \times 62 \times 5500}{1.86 \times 1000} = \frac{3410}{1.86} = 1833.33\ g$$

41 15 g of an unknown molecular substance was dissolved in 450 g of water. The resulting solution freezes at – 0.34 °C. What is the molar mass of the substance? ($K_f$ for water = 1.86 K kg mol$^{-1}$)   3

ANS:

Given: $\Delta T_f = 0.34\ °C,\ K_f = 1.86\ K\ kg\ mol^{-1},\ M_B = ?,\ W_B = 15\ g,\ W_A = 450\ g$

Now, $\quad \Delta T_f = K_f \times \dfrac{W_B}{M_B} \times \dfrac{1000}{W_A}$

$$\Rightarrow \quad 0.34 = 1.86 \times \frac{15}{M_B} \times \frac{1000}{450}$$

$$\Rightarrow \quad M_B = \frac{1.86 \times 15 \times 100}{0.34 \times 45} = \frac{186}{1.02} = 182.35\ g\ mol^{-1}$$

42 A solution of urea in water has a boiling point of 373.128 K. Calculate the freezing point of the same solution. [Given: For water, $K_f = 1.86\ Km^{-1}$, $K_b = 0.52\ Km^{-1}$]   3

$$\Delta T_b = 373.128 \text{ K} - 373.0 \text{ K} = 0.128 \text{ K}$$
$$\Delta T_b = K_b \times m$$
$$\Rightarrow \quad 0.128 = 0.52 \times m$$
$$\Rightarrow \quad m = \frac{0.128}{0.52} = 0.246 \text{ mol/kg}$$

Now, $\Delta T_f = K_f \times m = 1.86 \times 0.246 = 0.457$

ANS: Freezing point $= 273 - 0.457 = 272.543$ K

43    Calculate the mass of compound (molar mass = 256 g mol⁻¹) to be dissolved in 75 g of benzene to lower its freezing point by 0.48 K ($K_f$ = 5.12 K kg mol⁻¹).    3

ANS:

$\Delta T_f = 0.48$ K, $M_B = 256$ g mol⁻¹, $W_B = ?$, $W_A = 75$ g, $K_f = 5.12$ K kg mol⁻¹

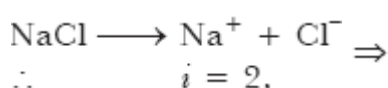Now, $\quad \Delta T_f = K_f \times \dfrac{W_B}{M_B} \times \dfrac{1000}{W_A}$

$\Rightarrow \quad 0.48 = 5.12 \times \dfrac{W_B}{256} \times \dfrac{1000}{75}$

$\Rightarrow \quad W_B = \dfrac{0.48 \times 256 \times 3}{5.12 \times 40} = \dfrac{48 \times 256 \times 100 \times 3}{100 \times 512 \times 40} = \dfrac{48 \times 3}{2 \times 40} = \dfrac{18}{10} = 1.8$ g

44    Calculate the amount of sodium chloride which must be added to one kilogram of water so that the freezing point of water is depressed by 3 K. [Given: $K_f$ = 1.86 K kg mol⁻¹, Atomic mass: Na = 23.0, Cl = 35.5]    3

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

$$\Rightarrow \quad 3 = 2 \times 1.86 \times \frac{W_B}{58.5} \times \frac{1000}{1000}$$

ANS:   $\therefore$ NaCl $\longrightarrow$ Na⁺ + Cl⁻ $\Rightarrow$   $i = 2$,    $W_B = \dfrac{3 \times 58.5}{2 \times 1.86} = \dfrac{175.5}{3.72} = 47.17$ g

45    0.1 mole of acetic acid was dissolved in 1 kg of benzene. Depression in freezing point of benzene was determined to be 0.256 K. What conclusion can you draw about the state of the solute in solution? [Given: $K_f$ for benzene = 5.12 K/m]    3

$$\Delta T_f = K_f \times m$$
$$\Rightarrow \quad \Delta T_f = 5.12 \text{ K} \times 0.1$$
$$\Rightarrow \quad \Delta T_f = 0.512 \text{ K}$$
$$i = \frac{\text{Observed} \, \Delta T_f}{\text{Normal} \, \Delta T_f} = \frac{0.256}{0.512} = \frac{1}{2}$$

ANS: It shows that acetic acid exists as dimer in benzene.

46    0.6 mL of acetic acid ($CH_3COOH$), having density 1.06 g mL⁻¹, is dissolved in 1 litre of water. The depression in freezing point observed for this strength of acid was 0.0205 °C. Calculate the van't Hoff factor and the dissociation constant of acid.    3

$$\Delta T_f = K_f \times m = 1.86 \times \frac{W_B}{M_B} \times \frac{1000}{W_A}$$

$$= 1.86 \times \frac{0.6 \times 1.06}{60} \times \frac{1000}{1000} = 1.86 \times 0.0106 = 0.0197 \text{ K}$$
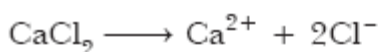
$$i = \frac{\text{Observed } \Delta T_f}{\text{Calculated } \Delta T_f} = \frac{0.0205}{0.0197} = 1.041$$

$$\alpha = \frac{i-1}{n-1} = \frac{1.041-1}{2-1} = 0.041$$

ANS: $$K_a = \frac{C\alpha^2}{1-\alpha} = \frac{0.0106 \times (0.041)^2}{1-0.041} = 1.86 \times 10^{-5}$$

47    Calculate the amount of $CaCl_2$ (molar mass 111 g mol$^{-1}$) which must be added to 500 g of water to lower the freezing point by 2K, assuming $CaCl_2$ is completely dissociated. ($K_f$ = 1.86 K kg mol$^{-1}$) 3

$$CaCl_2 \longrightarrow Ca^{2+} + 2Cl^-$$

$$i = 3, \Delta T_f = 2K, W_B = ?, M_B = 111 \text{ g mol}^{-1}, W_A = 500 \text{ g}$$

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

$$\Rightarrow \qquad 2 = 3 \times 1.86 \times \frac{W_B}{111} \times \frac{1000}{500}$$

ANS: $$\therefore \qquad W_B = \frac{111}{5.58} = 19.89 \text{ g}$$

48    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). (Given; 3 Molar mass of benzoic acid = 122 g mol$^{-1}$, $K_f$ for benzene = 4.9 K kg mol$^{-1}$)

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

$$1.62 = i \times 4.9 \times \frac{3.9}{122} \times \frac{1000}{49}$$

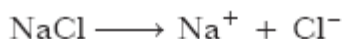$$\Rightarrow \qquad i = \frac{1.62 \times 122 \times 49}{4.9 \times 3.9 \times 1000}$$

$$= \frac{9684.36}{19110} = 0.506$$

ANS:                                         Since 'i' is close to 0.5, therefore, solute associates, i.e. exists as dimer.

49    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 = 3 1.86 K kg mol$^{-1}$)

$$NaCl \longrightarrow Na^+ + Cl^-$$

$$i = 2$$

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

$$\Rightarrow \quad 2 = 2 \times 1.86 \times \frac{W_B}{58.5} \times \frac{1000}{37.2}$$

$$\Rightarrow \quad W_B = \frac{58.5 \times 37.2}{1.86 \times 1000} = \frac{2176.2}{1860} = 1.17\,g$$

ANS:

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**50**  A 5% solution by mass of cane sugar, $C_{12}H_{22}O_{11}$ (molecular weight 342) is isotonic with 0.877% solution of substance 'X'. Find the molecular weight of substance X.　　**3**

ANS:
$$\Pi_{cane\ sugar} = \Pi_X$$

$$\Rightarrow \frac{W_{cane\ sugar}}{M_{cane\ sugar}} = \frac{W_X}{M_X} \quad \Rightarrow \quad \frac{5}{342} = \frac{0.877}{M_X} \quad \Rightarrow \quad M_X = 59.9 \text{ or } 60 \text{ g mol}^{-1}$$

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**51**  6.90 M solution of KOH in water contains 30% by mass of KOH. Calculate density and molality of KOH solution. [K = 39, O = 16, H = 1]　　**3**

$$\text{Molarity } (M) = \frac{\% \text{ by mass} \times d \times 10}{\text{MWt}}$$

$$\Rightarrow \quad 6.9 = \frac{30 \times d \times 10}{56} \quad \Rightarrow \quad d = \frac{6.9 \times 56}{30 \times 10} = \frac{386.4}{300} = 1.288 \text{ g cm}^{-3}$$

$$\text{Molality } (m) = \frac{W_B}{M_B} \times \frac{1000}{W_A} = \frac{30}{56} \times \frac{1000}{70} = \frac{3000}{392} = 7.653 \text{ mol/kg}$$

ANS:

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**52**  State Henry's Law. What is the effect of temperature on the solubility of gas in a liquid?　　**3**

ANS:　Henry's Law: It states 'Partial pressure of gas dissolved in a liquid is directly proportional
$$p_{gas} \propto x_{gas}$$
to its mole fraction'. $\Rightarrow$ $\quad p_{gas} = K_H \times x_{gas}$ where $K_H$ is Henry's Law constant and $x_{gas}$ is mole fraction.
The solubility of a gas in a liquid decreases with increase in temperature.

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**53**  The Henry's Law constant for oxygen dissolved in water is $4.34 \times 10^4$ atm at 25 °C. If the partial pressure of oxygen in air is 0.2 atm, calculate the solubility of oxygen in water at 25 °C.　　**3**

$$p_{O_2} = K_H \times x_{O_2} \Rightarrow 4.34 \times 10^4 \text{ atm} \times x_{O_2} = 0.2 \text{ atm}$$

$$\Rightarrow \quad x_{O_2} = \frac{0.2}{4.34 \times 10^4} = 4.608 \times 10^{-6}$$

$$x_{O_2} = \frac{n_{O_2}}{n_{O_2} + n_{H2O}} \simeq \frac{n_{O_2}}{n_{H_2O}} \quad \Rightarrow \quad 4.608 \times 10^{-6} = \frac{n_{O_2}}{\frac{1000}{18}}$$

$$\Rightarrow \quad n_{O_2} = \frac{4.608 \times 10^{-6} \times 1000}{18} = 2.56 \times 10^{-4} \text{ mol/L}$$

ANS:

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**54**  Calculate the normal boiling point of a sample of sea water containing 3.5% of NaCl and 0.13% of $MgCl_2$ by mass. [Given $K_b$ (water) = 0.52 K kg mol$^{-1}$, Mol. Wt. of NaCl = 58.5 g mol$^{-1}$, $MgCl_2$ = 95 g mol$^{-1}$].　　**3**

ANS: Assuming complete dissociation of NaCl and MgCl$_2$, i.e. 1 mole of NaCl produces 2 moles of species and 1 mole of MgCl$_2$ produces 3 moles of species.

The number of moles of species in water $\left(\dfrac{W_B}{M_B}\right) = \dfrac{2 \times 3.5}{58.5} + \dfrac{3 \times 0.13}{95} = 0.12$.

The mass of water in the solution $(W_A) = 100$ g $- (3.5 + 0.13)$ g $= 96.37$ g

Now, $m = \dfrac{W_B}{M_B} \times \dfrac{1000}{W_A} = 0.12 \times \dfrac{1000}{96.37} = 1.25$ mol/kg.

$\Delta T_b = K_b \times m = 0.52 \times 1.25 = 0.65$ K.

$\therefore$ Boiling point of solution $= 373 + 0.65 = 373.65$ K

**55** An aqueous solution of 3.12 g of BaCl$_2$ in 250 g of water is found to boil at 100.0832 °C. Calculate the degree of dissociation of BaCl$_2$. [K$_b$ (H$_2$O) = 0.52 K/m.]    3

$$\Delta T_b = 100.0832 - 100.0 = 0.0832 \text{ °C,}$$
$$K_b = 0.52 \text{ K kg mol}^{-1},$$
$$W_A = 250 \text{ g, } W_B = 3.12 \text{ g,}$$
$$M_B = 137 + 71 = 208 \text{ g mol}^{-1}$$

Now, $\Delta T_b = iK_b \times \dfrac{W_B}{M_B} \times \dfrac{1000}{W_A}$

$\Rightarrow \quad 0.0832 = i \times 0.52 \times \dfrac{3.12}{208} \times \dfrac{1000}{250}$

$\Rightarrow \quad i = \dfrac{0.0832 \times 208}{4 \times 3.12 \times 0.52} = \dfrac{17.30}{6.489} = 2.66$

Now, $\alpha = \dfrac{i-1}{n-1} = \dfrac{2.66-1}{3-1} = \dfrac{1.66}{2} = 0.83$

$\therefore$ Degree of dissociation $(\alpha) = 83\%$

ANS:

**56** Calculate the freezing point of a 1 molar aqueous solution of KCl. (Density of solution = 1.04 g cm$^{-3}$, K$_f$ = 1.86 K kg mol$^{-1}$, At. Wt. of K = 39 and Cl = 35.5)    3

ANS:

Mass of solution $= 1000 \times 1.04 = 1040$ g

Mass of solute $= 74.5$ g

Mass of solvent $= 1040 - 74.5 = 965.5$ g

$m = \dfrac{W_B}{M_B} \times \dfrac{1000}{W_A} = \dfrac{74.5}{74.5} \times \dfrac{1000}{965.5} = 1.0357$ m

Now, $\Delta T_f = i \times m \times K_f = 2 \times 1.0357 \times 1.86$ [KCl $\rightarrow$ K$^+$ + Cl$^-$; $i = 2$]

$\Rightarrow \quad \Delta T_f = 3.852$ K

Freezing point of solution $= 273$ K $- 3.852$ K $= 269.148$ K

**57** (a) Calculate the molality of sulphuric acid solution in which mole fraction of water is 0.8. [H = 1, S = 32, O = 164]
(b) Calculate molality and mole fraction of solute in a sugar syrup of mass 214.2 g containing 34.2 g of sucrose (MWt of sucrose, C$_{12}$H$_{22}$O$_{11}$ = 342 g mol$^{-1}$).    5

ANS:

(a)
$$x_B = \frac{m}{m + \dfrac{1000}{M_A}} \qquad [x_{H_2O} = 0.8, \; x_{H_2SO_4} = 1 - 0.8 = 0.2]$$

$$\Rightarrow \qquad 0.2 = \frac{m}{m + \dfrac{1000}{18}}$$

$$\Rightarrow \qquad 0.2\,m + \frac{200}{18} = m \quad \Rightarrow \quad 0.8\,m = \frac{200}{18}$$

$$\Rightarrow \qquad m = \frac{200 \times 10}{144} = \frac{2000}{144} = 13.88 \; \text{mol/kg}$$

where $x_B$ = Mole fraction of $H_2SO_4$

$M_A$ = Molar mass of water

$m$ = Molality

(b)  Mass of solvent = Mass of solution − Mass of solute

$$= 214.2 - 34.2 = 180 \text{ g.}$$

$$\therefore \quad \text{Molality } (m) = \frac{W_B}{M_B} \times \frac{1000}{W_A} = \frac{34.2}{342} \times \frac{1000}{180} = \frac{10}{18} = \frac{5}{9} = 0.556 \; \text{mol/kg}$$

$$\text{Mole fraction of solute } (x_B) = \frac{\dfrac{W_B}{M_B}}{\dfrac{W_B}{M_B} + \dfrac{W_A}{M_A}}$$

$$\Rightarrow \qquad \frac{\dfrac{34.2}{342}}{\dfrac{34.2}{342} + \dfrac{180}{18}} = \frac{0.1}{0.1 + 10} = \frac{0.1}{10.1} = \frac{1}{101} = 0.0099$$

58    (a) A sample of water was found to contain dissolved oxygen ($O_2$) to the extent of 5 ppm and hardness due to $Mg^{2+}$ is 15 ppm. Calculate the amount of $O_2$ and number of $Mg^{2+}$ in 1 litre of water (density of water = 1g/mL). (b) What volume of 98% sulphuric acid (d = 1.84 g $cm^{-3}$) and what    5 mass of water must be required to prepare 500 cm3 of 15% solution of $H_2SO_4$ (d = 1.10 g $cm^{-3}$)? [H = 1, S = 32, O = 16 u]

(a) Mass of 1L of water $= 1000\ g = W_A + W_B$

$$\text{ppm (oxygen)} = \frac{W_B}{W_A + W_B} \times 10^6 \Rightarrow 5 = \frac{W_B}{1000} \times 10^6$$

$$\Rightarrow W_B = \frac{5000}{10^6} = 5 \times 10^{-3}\ g$$

$$\text{ppm (hardness)} = \frac{W_B}{W_A + W_B} \times 10^6 \Rightarrow 15 = \frac{W_B}{1000} \times 10^6$$

$$\Rightarrow W_B = \frac{15 \times 1000}{10^6} = 15 \times 10^{-3}\ g = 1.5 \times 10^{-2}\ g$$

$$\text{Number of } Mg^{2+} = \frac{\text{Mass}}{\text{Molar mass}} \times 6.023 \times 10^{23}$$

$$= \frac{1.5 \times 10^{-2}}{24} \times 6.023 \times 10^{23}$$

$$= \frac{90.345}{24} \times 10^{20} = 3.764 \times 10^{20}$$

(b)

$$M_1 = \frac{\% \text{ by mass} \times d \times 10}{MWt} = \frac{98 \times 1.84 \times 10}{98} = 18.4\ M$$

$$M_2 = \frac{\% \text{ by mass} \times d \times 10}{MWt} = \frac{15 \times 1.10 \times 10}{98} = \frac{165}{98} = 1.68\ M$$

$$M_1V_1 = M_2V_2$$

$$\Rightarrow 18.4 \times V_1 = 1.68 \times 500\ cm^3$$

$$\therefore V_1 = \frac{1.68 \times 500}{18.4}cm^3 = \frac{840}{18.4} = 45.65\ cm^3$$

ANS:

**59** (a) State Raoult's law for a solution containing volatile components. Name the solution which follows Raoult's law at all concentrations and temperatures. (b) Calculate the boiling point elevation for a solution prepared by adding 10 g of $CaCl_2$ to 200 g of water. ($K_b$ for water = 0.512 K kg mol$^{-1}$, Molar mass of $CaCl_2$ = 111 g mol$^{-1}$)  5

ANS:   (a) Raoult's law: It states that vapour pressure of each component is directly proportional to its mole fraction when both solute and solvent are volatile.

$$p_A \propto x_A \Rightarrow p_A = p_A^o x_A$$

and $\quad p_B \propto x_B \Rightarrow p_B = p_B^o x_B$   Ideal solution follows Raoult's law at all concentrations and temperatures. (b)

$$CaCl_2 \longrightarrow Ca^{2+} + 2Cl^- ;$$
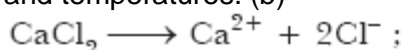
Given; $W_B = 10\ g$, $M_B = 111\ g\ mol^{-1}$; $i = 3$, $K_b = 0.512\ K\ kg\ mol^{-1}$ and $W_A = 200\ g$.

Now, $\quad \Delta T_b = iK_b \times \dfrac{W_B}{M_B} \times \dfrac{1000}{W_A}$

$$\Rightarrow \Delta T_b = 3 \times 0.512 \times \frac{10}{111} \times \frac{1000}{200} = \frac{76.8}{111} = 0.692\ K$$

**60** (a) Define the following terms:
(i) Azeotrope (ii) Osmotic pressure (iii) Colligative properties
(b) Calculate the molarity of 9.8% (w/w) solution of $H_2SO_4$ if the density of the solution is 1.02 g mL$^{-1}$ (Molar mass of $H_2SO_4$ = 98 g mol$^{-1}$)  5

ANS:   (a) (i) Azeotrope: Those solutions which distill out unchanged in their composition are called azeotropes. They are constant boiling mixtures.

(ii) Osmotic pressure: It is an extra pressure which must be applied on solution side so as to stop the flow of solvent molecules into solution when both are separated by a semipermeable membrane.

(iii) Colligative property: The property which depends on the number of particles of solute and not on the nature of solute is called colligative property. (b)

$$\text{Molarity } (M) = \frac{W_B}{M_B} \times \frac{1000}{\text{Volume of solution in mL}}$$

$$= \frac{9.8}{98} \times \frac{1000}{\frac{\text{Mass of solution}}{\text{density of solution}}} = \frac{9.8}{98} \times \frac{1000}{\frac{100}{1.02}} = 1.02 \text{ mol L}^{-1}$$

61      (a) Define the following terms:
(i) Molarity
(ii) Molal elevation constant ($K_b$)
(b) A solution containing 15 g urea (molar mass = 60 g mol$^{-1}$) per litre of solution in water has the same osmotic pressure (isotonic) 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.    5

ANS:     (a) (i) Molarity: It is defined as the number of moles of solute dissolved per litre of solution.
(ii) Molal elevation constant ($K_b$): It is equal to elevation in boiling point when solution is one molal.

$$W_A = 15 \text{ g}, M_A = 60 \text{ g mol}^{-1}, W_B = ?, M_B = 180 \text{ g mol}^{-1}$$

(b) In Isotonic solution,    $M_1 = M_2$

$$\Rightarrow \frac{W_A}{M_A} \times \frac{1000}{\text{volume of solution (in mL)}} = \frac{W_B}{M_B} \times \frac{1000}{\text{volume of solution (in mL)}}$$

$$\Rightarrow \frac{15}{60} \times \frac{1000}{1000} = \frac{W_B}{180} \times \frac{1000}{1000}$$

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

62      (a) What is van't Hoff factor? What possible values can it have if the solute molecules undergo dissociation?
(b) An aqueous solution containing 12.48 g of barium chloride in 1.0 kg of water boils at 373.0832 K. Calculate the degree of dissociation of barium chloride.    5
[Given; $K_b$ for $H_2O$ = 0.52 K m$^{-1}$; Molar mass of $BaCl_2$ = 208.34 g mol$^{-1}$]

14

ANS:

(a) **van't Hoff factor** ($i$) is defined as the ratio of observed colligative property to the normal colligative property.

$$i = \frac{\text{Observed colligative property}}{\text{Normal colligative property}}$$

$i > 1$ for dissociation.

(b) $BaCl_2 \rightleftharpoons Ba^{2+} + 2Cl^-$

$$\Delta T_b = 373.0832 \text{ K} - 373.0 \text{ K} = 0.0832 \text{ K}$$

Now, $\Delta T_b = i \times K_b \times m$

$$\Rightarrow \quad 0.0832 = i \times 0.52 \times \frac{W_B}{M_B} \times \frac{1}{\text{Mass of solvent in kg}}$$

$$\Rightarrow \quad 0.0832 = i \times 0.52 \times \frac{12.48}{208.34} \times \frac{1}{1} \quad \Rightarrow \quad i = \frac{0.0832 \times 208.34}{0.52 \times 12.48} = 2.67$$

$$n = 3, \quad \therefore \quad \alpha = \frac{i-1}{n-1} = \frac{2.67-1}{3-1}$$

$$\Rightarrow \quad \alpha = \frac{1.67}{2} = 0.835 \quad \Rightarrow \alpha = 83.5\%$$

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**63**

(a) Explain the following:
(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$^{-1}$)

5

ANS:     (a) (i) Henry's Law: It states that the solubility of a gas in a liquid is directly proportional to the pressure of the gas. If mole fraction of a gas in the solution is used as a measure of solubility, then it can be defined as the mole fraction of a gas in the solution is directly proportional to the partial pressure of the gas over the solution.

$p = K_H x$,

where '$p$' is partial pressure of gas, '$x$' is mole fraction of the gas and $K_H$ is Henry's law constant.
(ii) Boiling Point Elevation Constant (Molal Boiling Point Elevation Constant): It is equal to elevation in boiling point of 1 molal solution, i.e. 1 mole of solute is dissolved in 1 kg of solvent. The units of $K_b$ is K/m or °C/m or K kg mol$^{-1}$. (b)

$W_B = ?$ $M_B = 36 + 8 + 48 = 92$ g mol$^{-1}$, $W_A = 500$ g,

$$\Delta T_b = 100.42 \text{ °C} - 100 \text{ °C} = 0.42 \text{ °C}$$

Now, $\Delta T_b = K_b \times \dfrac{W_B}{M_B} \times \dfrac{1000}{W_A}$

$$\Rightarrow \quad 0.42 = 0.512 \times \frac{W_B}{92} \times \frac{1000}{500}$$

$$\Rightarrow \quad W_B = \frac{0.42 \times 92}{2 \times 0.512} = \frac{38.64}{1.024} = 37.73 \text{ g}$$

---

**64**

(a) Differentiate between molarity and molality for a solution. How does a change in temperature influence their values?
(b) Calculate the freezing point of an aqueous solution containing 10.50 g of $MgBr_2$ in 200 g of water. (Molar mass of $MgBr_2$ = 184 g) ($K_f$ for water = 1.86 K kg mol$^{-1}$)

5

ANS:     (a) Molality is defined as the number of moles of solute per kg of solvent. It is not affected by temperature. Molarity is defined as the number of moles of solute per litre of solution. It

decreases with increase in temperature. (b)

$$MgBr_2(aq) \longrightarrow Mg^{2+}(aq) + 2Br^-(aq)$$

$$i = 3$$
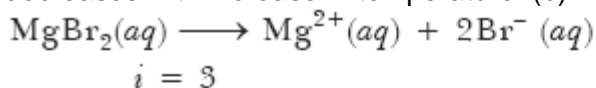
$$\Delta T_f = K_f \times \frac{W_B}{M_B} \times \frac{1000}{W_A} \times i$$

$$= 1.86 \times \frac{10.50}{184} \times \frac{1000}{200} \times 3 = \frac{292.95}{184} = 1.592$$

$\therefore$ Freezing point of solution $= 273 - 1.592 = 271.408$ K

**65**

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

**5**

ANS:     (a) Osmosis: When a solution is separated from the solvent by a semipermeable membrane which allows the passage of solvent molecules but does not allow solute particles to pass through it, there is net flow of solvent molecules from the solvent to the solution which is called *osmosis*.
Osmotic Pressure: Osmotic pressure may be defined as an extra pressure that must be applied to the solution side to prevent the flow of solvent into solution through a semipermeable membrane.

$$NaCl \longrightarrow Na^+ + Cl^-$$

$$i = 2$$
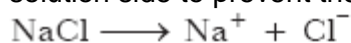
$$\therefore \qquad \Delta T_b = i \times K_b \times \frac{W_B}{M_B} \times \frac{1000}{W_A}$$

$$\Rightarrow \qquad \Delta T_b = 2 \times 0.512 \times \frac{15}{58.44} \times \frac{1000}{250}$$

$$= \frac{2 \times 0.512 \times 15 \times 4}{58.44} = \frac{61.44}{58.44} = 1.05$$

(b)
$\therefore$ Boiling point of solution $= 373 + 1.05 = 374.05$ K

**66**

(a) State the following:
(i) Henry's law about partial pressure of a gas in a mixture.
(ii) Raoult's law in its general form in reference to solutions.
(b) A solution prepared by dissolving 8.95 mg of a gene fragment in 35.0 mL of water has an osmotic pressure of 0.335 torr at 25 °C. Assuming the gene fragment is non-electrolyte, determine its molar mass.

**5**

ANS:     (a) (i) Henry's Law: It states that the partial vapour pressure of a gas in vapour phase is directly proportional to mole fraction of the gas in the solution.

$p = K_H \cdot x$ where KH is Henry's law constant, 'x' is mole fraction of the gas in solution and p is partial vapour pressure of the gas in solution. (ii) Raoult's law for solution of non-volatile solute: The relative lowering of vapour pressure for a solution is equal to the mole fraction of solute when solvent alone is volatile.

$$\frac{p_A^\circ - p_A}{p_A^\circ} = x_B$$

where $p_A^\circ$ is vapour pressure of pure component 'A', $p_A$ is vapour pressure of component 'A' in solution, $x_B$ is mole fraction of solute, $p_A^\circ - p_A$ is lowering of vapour pressure and $\frac{p_A^\circ - p_A}{p_A^\circ}$ is relative lowering of vapour pressure.

(b)
$$\Pi V = nRT$$
$$\Rightarrow \quad \Pi V = \frac{W_B}{M_B} \times R \times T$$
$$\Rightarrow \quad \frac{0.335}{760} \times \frac{35}{1000} = \frac{8.95 \times 10^{-3} \times 0.0821 \times 298}{M_B}$$
$$\Rightarrow \quad M_B = \frac{760 \times 1000 \times 8.95 \times 10^{-3} \times 0.0821 \times 298}{0.335 \times 35} = \frac{166.416 \times 10^3}{11.725}$$
$$= 14.19 \times 10^3 = 1.419 \times 10^4 \text{ g mol}^{-1}$$

67     (a) List any four factors on which the colligative properties of a solution depend.
(b) Calculate the boiling point of one molar aqueous solution (density 1.06 gmL$^{-1}$) of KBr.    5
[Given: $K_b$ for $H_2O$ = 0.52 K kg mol$^{-1}$, Atomic mass: K = 39, Br = 80]

ANS:    (a) (i) Number of particles of solute
(ii) Association or dissociation of solute
(iii) Concentration of solution
(iv) Temperature (b)

$$m = \frac{M \times 1000}{(1000 \times d - M \times M_B)} = \frac{1 \times 1000}{[1000 \times 1.06 - (1 \times 119)]}$$

$$[\because M_B \text{ of KBr} = 39 + 80 = 119 \text{ g mol}^{-1}]$$

$$\Rightarrow \quad m = \frac{1000}{1060 - 119} = \frac{1000}{941}$$

$$\text{KBr} \longrightarrow \text{K}^+ + \text{Br}^-$$

$$i = 2$$

$$\therefore \quad \Delta T_b = i \times K_b \times m = 2 \times 0.52 \times \frac{1000}{941} = \frac{520}{941} \times 2 = 1.10 \text{ K}$$

$$\therefore \text{ Boiling point of solution} = 373 + 1.10 = 374.10 \text{ K}$$

68     (a) Non-ideal solutions exhibit either positive or negative deviations from Raoult's law. What are these deviations and how are they caused?
(b) What mass of NaCl (molar mass = 58.5 g mol$^{-1}$) must be dissolved in 65 g of water to lower    5
the freezing point by 7.50 °C? The freezing point depression constant, $K_f$ for water is 1.86 K kg mol$^{-1}$. Assume van't Hoff factor for NaCl is 1.87.

ANS:    (a) Positive Deviation from Raoult's Law: Those non-ideal solutions, in which partial pressure of each component 'A' and 'B' is higher than that calculated from Raoult's law show positive deviation from Raoult's law, e.g. water and ethanol show positive deviation because the force of attraction between ethanol-water is less than between ethanol-ethanol and waterwater molecules, therefore, vapour pressure is high.
Negative Deviation from Raoult's Law: The partial vapour pressure of component 'A' is found to be less than that calculated from Raoult's law on adding the second component 'B' and when A is

added to B, the partial vapour pressure of component 'B' is found to be less than that calculated from Raoult's law. The total vapour pressure of solution is less than that of ideal solution of same composition. Boiling point of such solution is relatively higher than the boiling points of A and B respectively. This type of deviation from ideal behaviour is known as *negative deviation from Raoult's law*, e.g. chloroform and acetone show negative deviation because the force of attraction between chloroform and acetone is higher than chloroform-chloroform and acetone-acetone molecules, therefore, vapour pressure is low. (b)

$M_B = 58.5 \text{ g mol}^{-1}, W_B = ?, W_A = 65 \text{ g}, \Delta T_f = 7.5\,°C, K_f = 1.86 \text{ K kg mol}^{-1},$
$i = 1.87$

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

$$\Rightarrow \quad W_B = \frac{\Delta T_f \times M_B \times W_A}{K_f \times i \times 1000} = \frac{7.5 \times 58.5 \times 65}{1.86 \times 1.87 \times 1000} = \frac{28518.75}{3478.20} = 8.20 \text{ g}$$

**69** (a) Explain why a solution of chloroform and acetone shows negative deviation from Raoult's law.
(b) Phenol associates in benzene to certain extent to form a dimer. A solution containing 20 g of phenol in 1.0 kg of benzene has its freezing point lowered by 0.69 K. Calculate the fraction of phenol that has dimerised. [Given $K_f$ for benzene = 5.1 Km$^{-1}$]   **5**

ANS: (a) It is due to the formation of H-bonding due to which escaping tendency of molecules and vapour pressure of the solution decrease, and boiling point of the solution increases. Hence, such solution shows negative deviation from Raoult's law. (b)

$\Delta T_f = 0.69 \text{ K}, K_f = 5.1 \text{ K/m}, W_B = 20 \text{ g}, W_A = 1 \text{ kg} = 1000 \text{ g}$

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

$$\Rightarrow \quad 0.69 = i \times \frac{20}{94} \times \frac{1000}{1000} \times 5.1$$

$$\Rightarrow \quad i = \frac{0.69 \times 94}{20 \times 5.1} = \frac{64.86}{102} = 0.635$$

$$\therefore \quad \alpha = \frac{1-i}{1-\dfrac{1}{n}} = \frac{1-0.635}{1-\dfrac{1}{2}} = \frac{0.365}{\dfrac{1}{2}} = 0.730$$

$\alpha$ = degree of association = $0.730 \times 100 = 73\%$

**70** (a) Define the terms osmosis and osmotic pressure. What is the advantage of using osmotic pressure as compared to other colligative properties for the determination of molar masses of solutes in solutions?
(b) A solution prepared from 1.25 g of oil of wintergreen (methyl salicylate) in 90.0 g of benzene has a boiling point of 80.31 °C. Determine the molar mass of this compound. (Boiling point of pure benzene = 80.10 °C and $K_b$ for benzene = 2.53 °C kg mol$^{-1}$)   **5**

ANS: (a) Osmosis: When a solution is separated from the solvent by a semipermeable membrane which allows the passage of solvent molecules but does not allow solute particles to pass through it, there is net flow of solvent molecules from the solvent to the solution which is called *osmosis*.
Osmotic Pressure: Osmotic pressure may be defined as an extra pressure that must be applied to the solution side to prevent the flow of solvent into solution through a semipermeable membrane. Osmotic pressure is determined at room temperature and has appreciable value which can be

easily measured. (b)

Given; $W_B = 1.25$ g, $W_A = 90$ g, $\Delta T_b = 80.31 - 80.10 = 0.21$ °C, $M_B = ?$,
$K_b = 2.53$ °C kg mol$^{-1}$

$$\therefore \qquad \Delta T_b = K_b \times \frac{W_B}{M_B} \times \frac{1000}{W_A}$$

$$\Rightarrow \qquad M_B = \frac{W_B \times 1000}{\Delta T_b \times W_A} \times K_b = \frac{1.25 \times 1000}{0.21 \times 90} \times 2.53$$

$$\Rightarrow \qquad M_B = \frac{3162.5}{18.9} = 167.328 \text{ g mol}^{-1}$$

**71**  (a) Differentiate between molarity and molality of a solution. How can we change molality value to a solution into molarity value.  **5**
(b) What is the mole fraction of the solute in a 1.00 m aqueous solution

ANS:    (a) Molality (m) is the number of moles of the solute dissolved per kg of solvent. Molarity (M) is the number of moles of the solute dissolved per litre of solution. Molality is not affected by temperature, whereas molarity is affected by temperature because volume changes with change in temperature. If we know the density of a solution, 'm' can be changed into M.

$$m = \frac{M \times 1000}{1000 \times d - M \times \text{Molecular weight}}$$ (b)

$$m = 1$$

$$x_B = \frac{m}{m + \frac{1000}{M_A}} \quad \Rightarrow \quad x_B = \frac{1}{1 + \frac{1000}{18}} = \frac{18}{1018} = 0.01768$$

**72**  (a) Assuming complete ionisation, calculate the expected freezing point of solution prepared by dissolving 6.00 g of Glauber's salt, $Na_2SO_4.10H_2O$ in 0.1 kg of $H_2O$. ($K_f$ for $H_2O = 1.86$ K kg mol$^{-1}$) [At. mass of Na = 23, S = 32, O = 16, H = 1 u].  **5**
(b) Two liquids X and Y boil at 110 °C and 130 °C respectively. Which of them has higher vapour pressure at 50 °C ?

ANS:    (a)

$$Na_2SO_4.10H_2O \rightarrow 2Na^+ + SO_4^{2-} + 10H_2O$$
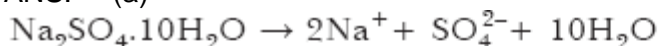
$W_B = 6$ g, $W_A = 0.1$ kg, $i = 3$, $K_f = 1.86$ K kg mol$^{-1}$, $M_B = 46 + 32 + 64 + 180 = 322$ g mol$^{-1}$

$$\Delta T_f = iK_f \times \frac{W_B}{M_B} \times \frac{1}{W_A \text{ in kg}} = 3 \times 1.86 \times \frac{6}{322} \times \frac{1}{0.1} = \frac{334.8}{322}$$

$$= 1.0398 \text{ K}$$    (b) X has

lower boiling point, therefore, it will vaporise easily and will have higher vapour pressure than Y at 50 °C.

**73**  The molality of pure water is
(a) 55.5 (b) 50.5  **1**
(c) 18 (d) 60.5

ANS:    (a) Molality = Number of moles/kg of solvent

$$= \frac{\frac{1000}{18}}{\text{kg of solvent}} = 55.5 \text{ moles/kg}$$

**74**  The number of moles of NaCl in 3 litres of 3M solution is
(a) 1 (b) 3  **1**
(c) 9 (d) 27

ANS: (c) 3M solution means 3 moles in 1 litre.
∴ 9 moles in 3 litre.

75    4L of 0.02 M aqueous solution of NaCl was diluted by adding one litre of water. The molality of the resultant solution is _____. (a) 0.004 (b) 0.008 (c) 0.012 (d) 0.016    1

ANS: (d) $M_1V_1 = M_2V_2$

$0.02 \times 4 = M_2 \times (4 + 1) \Rightarrow M_2 = \dfrac{0.08}{5} = 0.016$

76    Low concentration of oxygen in the blood and tissues of people living at high altitude is due to _____.

(a) low temperature
(b) low atmospheric pressure
(c) high atmospheric pressure
(d) both low temperature and high atmospheric pressure    1

ANS: (b) Low atmospheric pressure will lead to low concentration of oxygen blood.

77    Considering the formation, breaking and strength of hydrogen bond, predict which of the following mixtures will show a positive deviation from Raoult's law?
(a) Methanol and acetone.
(b) Chloroform and acetone.
(c) Nitric acid and water.
(d) Phenol and aniline.    1

ANS: (a) $CH_3OH$ and acetone, on mixing force of attraction will decrease.

78    Which of the following aqueous solutions should have the highest boiling point?
(a) 1.0 M NaOH (b) 1.0 M $Na_2SO_4$
(c) 1.0 M $NH_4NO_3$ (d) 1.0 M $KNO_3$    1

ANS: (b) Because i = 3, $\Delta T_b \propto i$, Boiling point $\propto \Delta T_b$.

79    In comparison to a 0.01 M solution of glucose, the depression in freezing point of a 0.01 M $MgCl_2$ solution is _____.
(a) the same (b) about twice
(c) about three times (d) about six times    1

ANS: (c) It will be nearly 3 times because number of particles in $MgCl_2 \rightarrow Mg^{2+} + 2Cl^-$ are thrice than glucose.

80    An unripe mango placed in a concentrated salt solution to prepare pickle, shrivels because _____.
(a) it gains water due to osmosis.
(b) it loses water due to reverse osmosis.
(c) it gains water due to reverse osmosis.
(d) it loses water due to osmosis.    1

ANS: (d) Concentrated salt solution is hypertonic solution, therefore, fluids inside mango will come out and it shrivels.

81    Which of the following statements is false?
(a) Two different solutions of sucrose of same molality prepared in different solvents will have the same depression in freezing point.
(b) The osmotic pressure of a solution is given by the equation $\prod = CRT$ (where C is the molarity of the solution).
(c) Decreasing order of osmotic pressure for 0.01 M aqueous solutions of barium chloride, potassium chloride, acetic acid and sucrose is
$BaCl_2 > KCl > CH_3COOH >$ sucrose.    1

(d) According to Raoult's law, the vapour pressure exerted by a volatile component of a solution is directly proportional to its mole fraction in the solution.

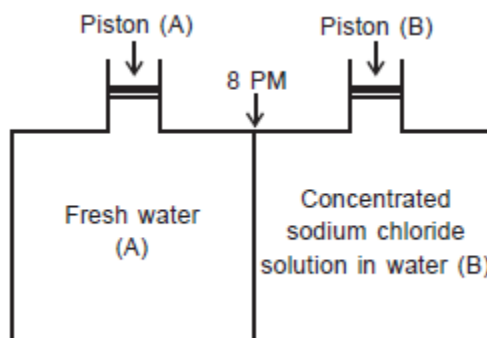ANS: (a) is false because $\Delta T_f$ will depend upon nature of solvent and their $K_f$.

82    The value of Henry's constant $K_H$ is _____.
(a) greater for gases with higher solubility.
(b) greater for gases with lower solubility.
(c) constant for all gases.
(d) not related to the solubility of gases.

1

ANS: (b) Higher the value of $K_H$, lower will be solubility.

83



Consider the figure and mark the correct option. (a) water will move from side (A) to side (B) if a pressure lower than osmotic pressure is applied on piston (B).
(b) water will move from side (B) to side (A) if a pressure greater than osmotic pressure is applied on piston (B).
(c) water will move from side (B) to side (A) if a pressure equal to osmotic pressure is applied on piston (B).
(d) water will move from side (A) to side (B) if pressure equal to osmotic pressure is applied on piston (A).

1

ANS: (b) Reverse osmosis will take place.

84    A solution containing 10 g per $dm^3$ of urea (molar mass 60 g $mol^{-1}$) is isotonic with 5% solution of non-volatile solute, MB of solute is
(a) 300 g $mol^{-1}$ (b) 350 g $mol^{-1}$
(c) 200 g $mol^{-1}$ (d) 250 g $mol^{-1}$

1

ANS: (a) $\dfrac{1}{60} = \dfrac{5}{x}$
$\Rightarrow x = 300$ g $mol^{-1}$
1000 $cm^3$ contains 10 g
100 $cm^3$ contains 1 g, i.e., 1%.

85    Conc. $H_2SO_4$ is 98 % $H_2SO_4$ by mass has d = 1.84 g $cm^{-3}$. Volume of acid required to make one litre of 0.1 M $H_2SO_4$ is
(a) 5.55 mL (b) 10 mL
(c) 20 mL (d) 30 mL

1

(a) $M = \dfrac{98 \times 10 \times 1.84}{98} = 18.4$ M

$\boxed{M_1 V_1 = M_2 V_2}$

$18.4 \times V_1 = 0.1 \times 1000$

ANS: $V_1 = 5.55$ mL

21

**86** What is mole fraction of solute in 1.00 m aqueous solution?
(a) 0.0354 (b) 0.0177
(c) 0.177 (d) 1.770

$$(b) \qquad x_B = \frac{m}{m + \dfrac{1000}{M_A}} = \frac{1}{1 + \dfrac{1000}{18}}$$

$$= \frac{18}{1018} = 0.0177$$

ANS:

**87** When 1 mole of benzene is mixed with 1 mole of toluene (vapour pressure of benzene = 12.8 kPa, Toluene = 3.85 kPa)
(a) The vapour will contain equal amount of benzene and toluene.
(b) Not enough information is given for prediction.
(c) The vapour will contain a higher percentage of benzene.
(d) The vapour will contain higher percentage of toluene.

ANS: (c) It is because benzene has high vapour pressure, it will form more vapours as compared to toluene.

**88** At 100°C, the vapour pressure of a solution of 6.5 g of solute in 100 g of water is 732 mm. If $K_b$ is 0.52 K/m, the boiling point of solution will be
(a) 102°C (b) 103°C
(c) 101°C (d) 100°C

$$(c) \qquad \frac{P_A{}^\circ - P_A}{P_A{}^\circ} = x_B$$

$$\Rightarrow \frac{760 - 732}{760} = x_B$$

$$x_B = \frac{7}{190}$$

$$\Rightarrow \qquad x_B = \frac{m}{m + \dfrac{1000}{M_A}}$$

$$\Rightarrow \qquad \frac{7}{190} = \frac{m}{m + \dfrac{1000}{18}}$$

$$\Rightarrow 7m + \frac{7000}{18} = 190\,m$$

$$\Rightarrow \qquad 183m = \frac{7000}{18}$$

$$\Rightarrow \qquad m = \frac{7000}{3294}$$

$$\Rightarrow \qquad \Delta T_b = K_b \times m = 0.52 \times \frac{7000}{3294} = 1.06$$

ANS: $\qquad$ B.Pt $= 100 + 1.06 = 101°C$

**89** Which of the following is incorrect for an ideal solution?
(a) $\Delta H_{mix} = 0$ (b) $\Delta V_{mix} = 0$
(c) $\Delta P = P_{obs} - P_{calculated} = 0$
(d) $\Delta G_{mix} = 0$

ANS: (d) $\Delta G$ cannot be equal to zero because mixing does not lead to equilibrium.

**90** If molality of dilute solution is doubled, the value of molal depression constant ($K_f$) will be
(a) halved (b) tripled
(c) unchanged (d) doubled

1

ANS: (c) $K_f$ does not depend upon 'm'. It depends upon nature of solvent.

**91** The temperature at which 10% aqueous solution of (W/V) of glucose will show the osmotic pressure of 16.4 atom is (R = 0.082 L atom $K^{-1}$ $mol^{-1}$)
(a) 360°C (b) 180 K
(c) 300 K (d) 360 K

1

$$(d) \qquad \pi V = nRT$$

$$16.4 \times 0.1 = \frac{10}{180} \times 0.082 \times T$$

$$T = \frac{18 \times 16.4 \times 0.1}{0.082} = 360 \text{ K}$$

ANS:

**92** Which has the highest freezing point?
(a) 1 M glucose (b) 1 M NaCl
(c) 1 M $CaCl_2$ (d) 1 M $AlF_3$

1

ANS: (a) 1 M glucose solution has highest freezing point because it has lowest $\Delta T_f$ because i = 1.

**93** Which of the following is correct.
(a) $K_H$ increases with increase in temperature ($K_H$ is Henry's law constant).
(b) Solubility of gas in liquid decreases with increases in temperature.
(c) $K_H$ decreases with increase in temperature.
(d) Solubility of gas in liquid increases with increase in temperature.

1

ANS: (a) and (b) are correct $p_{gas} = K_H \times x_{gas}$
$K_H$ increases with increase in temperature, $x_{gas}$ decreases, i.e., solubility of gas in liquid decreases with increase in temperature.

**94** Benzoic acid, when dissolved in benzene, which of the following is correct.
(a) The benzoic acid will undergo dissociation.
(b) The benzoic acid will undergo association.
(c) Observed molar mass of benzoic acid in benzene will less than normal molar mass.
(d) Observed molar mass of benzoic acid in benzene is more than normal molar mass.

1

(b) and (d) $C_6H_5$—C $\underset{O-H\cdots O}{\overset{O\cdots H-O}{\diagup}}$ C—$C_6H_5$
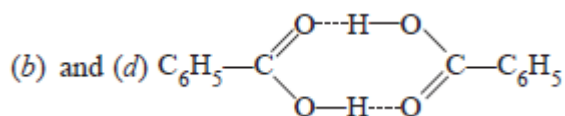
ANS:
Molar mass will be nearly double due to dimerisation.

**95** Relative lowering of vapour pressure is a colligative property because _____.
(a) It depends on the concentration of a non electrolyte solute in solution and does not depend on the nature of the solute molecules.
(b) It depends on number of particles of electrolyte solute in solution and does not depend on the nature of the solute particles.
(c) It depends on the concentration of a non electrolyte solute in solution as well as on the nature of the solute molecules.
(d) It depends on the concentration of an electrolyte or nonelectrolyte solute in solution as well as on the nature of solute molecules.

1

ANS: (a) and (b) colligative property depends upon number of particles of solute in both electrolyte and nonelectrolyte.

**96** Match the items given in Column I with the type of solutions given in Column II.

1

| Column I | Column II |
| --- | --- |

| | |
|---|---|
| (a) Soda water | (i) A solution of gas in solid |
| (b) Sugar solution | (ii) A solution of gas in gas |
| (c) German silver | (iii) A solution of solid in liquid |
| (d) Air | (iv) A solution of solid in solid |
| (e) Hydrogen gas in palladium | (v) A solution of gas in liquid |
| | (vi) A solution of liquid in solid |

ANS:    (a) (v) (b) (iii) (c) (iv) (d) (ii) (e) (i)

97   In the following question a statement of assertion followed by a statement of reason is given.
Choose the correct answer out of the following choices.
(a) Assertion and reason both are correct statements and reason is correct explanation for assertion.
(b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.                                                                                    1
(c) Assertion is correct statement but reason is wrong statement.
(d) Assertion and reason both are incorrect statements.
(e) Assertion is wrong statement but reason is correct statement. Assertion: When methyl alcohol is added to water, boiling point of water increases.
Reason: When a volatile solute is added to a volatile solvent elevation in boiling point is observed.

ANS:    (d) Assertion and reason both are incorrect statements.

98   The process used for desalination of water is _____.                    1

ANS:    reverse osmosis

99   Vapour pressure is _____ proportional to temperature.                    1

ANS:    directly

100   Ethylene glycol is used as _____.                    1

ANS:    antifreeze

101   All intravenous injections must be isotonic with body fluids. [True/False]                    1

ANS:    True.

102   Diabetic patients are likely to have high blood pressure. [True/False]                    1

ANS:    True.

103   Common salt is non-electrolyte. [True/False]                    1

ANS:    False, common salt is electrolyte.

104   Maximum amount of a solid solute that can be dissolved in a specified amount of a given liquid solvent does not depend upon _____.
(a) Temperature (b) Nature of solute                    1
(c) Pressure (d) Nature of solvent

ANS:    (c) Pressure does not affect solubility of solid in liquid.

105   On the basis of information given below mark the correct option. Information:
(A) In bromoethane and chloroethane mixture intermolecular interactions of A–A and B–B type are                    1

nearly same as A–B type interactions.

(B) In ethanol and acetone mixture A–A or B–B type intermolecular interactions are stronger than A–B type interactions.

(C) In chloroform and acetone mixture A–A or B–B type intermolecular interactions are weaker than A–B type interactions.

(a) Solution (B) and (C) will follow Raoult's law.

(b) Solution (A) will follow Raoult's law.

(c) Solution (B) will show negative deviation from Raoult's law.

(d) Solution (C) will show positive deviation from Raoult's law.

ANS: (b) Solution 'A' is ideal solution, will follow Raoult's law.

106     $K_H$ value for Ar(g), $CO_2$(g), HCHO(g) and $CH_4$(g) are 40.39, 1.67, $1.83 \times 10^{-5}$ and 0.413 respectively. Arrange these gases in the order of their increasing solubility. [NCERT Exemplar Problem]

(a) $HCHO < CH_4 < CO_2 < Ar$     1

(b) $HCHO < CO_2 < CH_4 < Ar$

(c) $Ar < CO_2 < CH_4 < HCHO$

(d) $Ar < CH_4 < CO_2 < HCHO$

ANS: (a) Gas with higher $K_H$ has lower solubility.

107     If $P°_A$ = 100 mm, $P°_B$ = 200 mm and mole fraction $x_A$ = 0.4, what will be $y_A$ (mole fraction) in vapour phase?

(a) 0.25 (b) 0.30     1

(c) 0.75 (d) 0.50

$$(a) \quad P_A = P_A° x_A = 100 \times 0.4 = 40 \text{ mm}$$

$$P_B = P_B° x_B$$

$$= 200 (1 - x_A) = 200 (1 - 0.4)$$

$$= 120 \text{ mm}$$

$$y_A = \frac{p_A}{p_A + p_B} = \frac{40}{40 + 120} = \frac{40}{160} = 0.25$$

ANS:

108     Which of the following is maximum boiling azeotropic?

(a) $CH_3COOH + C_5H_5N$ (pyridine)

(b) $H_2O$ + ethanol     1

(c) cyclohexane + ethanol

(d) $H_2O$ + methanol

ANS: (a) is maximum boiling azeotropic due to increase in force of attraction on mixing whereas others are minimum boiling azeotropes.

109     $K_b$ (molal elevation constant) is inversely proportional to [NCERT Exemplar Problem]

(a) boiling point of solvent

(b) $\Delta_{vap}H$ of solvent     1

(c) Molar mas of solvent

(d) all of these

ANS: (b) It is inversely proportional to $\Delta_{vap}H$ of solvent.

110     Out of 1m solution of following dissolved in water. Which one will have lowest freezing point (assuming all are fuel, ionised)

(a) Urea (b) NaCl     1

(c) $Na_2SO_4$ (d) $Al_2(SO_4)_3$

ANS: (d) ∵ Higher $\Delta T_f$, lower will be freezing point and $\Delta T_f \propto$ number of ions.

111 Which of the following will have lowest vapour pressure? (Boiling points are given in brackets)
(a) $H_2O$ (373 K) (b) $CHCl_3$ (334 K)
(c) Anilines (457 K) (d) Benzene (353 K)

1

ANS: (c) Aniline has highest boiling point, therefore, it will have lowest vapour pressure.

112 Henry's law constant of oxygen is $1.4 \times 10^{-3}$ mol $L^{-1}$ $atm^{-1}$ at 298 K. How much oxygen will be dissolved in 100 ml at 298 K when its partial pressure is 0.5 atm?
(a) 1.4 g (b) 3.2 g
(c) 22.4 mg (d) 2.24 mg

1

$$(d) \quad \text{Solubility} = K_H \times p_{gas}$$
$$= 1.4 \times 10^{-3} \times 0.5 \text{ atm} \times 32 \text{ gL}^{-1}$$
$$= 22.4 \times 10^{-3} \text{ gL}^{-1}$$
$$\text{In 100 mL} = \frac{22.4 \times 10^{-3}}{1000} \times 100$$
$$= 22.4 \times 10^{-4} \text{ g} = 22.4 \times 10^{-3} \text{ g}$$
$$= 2.24 \text{ mg}$$

ANS:

113 In isotonic solutions _____.
(a) solute and solvent both are same.
(b) osmotic pressure is same.
(c) solute and solvent may or may not be same.
(d) solute is always same solvent may be different.

1

ANS: (b) and (c) isotonic solution will have same osmotic pressure but solute and solvent may be different.

114 Which of the following binary mixtures will have same composition in liquid and vapour phase?
(a) Benzene-Toluene (b) Water-Nitric acid
(c) Water-Ethanol (d) n-Hexane - n-Heptane

1

ANS: (b) and (c) as they form ideal solution.

115 For a binary ideal liquid solution, the variation in total vapour pressure versus composition of solution is given by which of the curves?



1
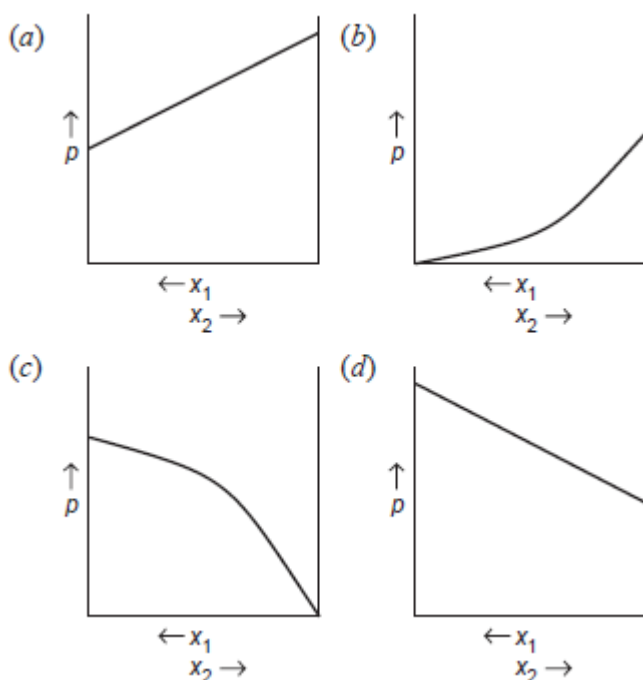
ANS: (a) and (d) are correct.

∵ Vapour pressure is directly proportional to mole fraction in a binary ideal solution.

116    Match the laws given in Column I with expresions given in Column II.

| Column I | Column II |
|---|---|
| (a) Raoult's law | (i) $\Delta T_f = K_f\, m$ |
| (b) Henry's law | (ii) $\Pi = CRT$ |
| (c) Elevation of boiling point | (iii) $p = x_1 p_1^\circ + x_2 p_2^\circ$ |
| (d) Depression in freezing point | (iv) $\Delta T_b = K_b m$ |
| (e) Osmotic pressure | (v) $p = K_H . x$ |

1

ANS: (a) (iii) (b) (v) (c) (iv) (d) (i) (e) (ii)

117    In the following question a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.
(a) Assertion and reason both are correct statements and reason is correct explanation for assertion.
(b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
(c) Assertion is correct statement but reason is wrong statement.
(d) Assertion and reason both are incorrect statements.
(e) Assertion is wrong statement but reason is correct statement.
Assertion: When a solution is separated from the pure solvent by a semipermeable membrane, the solvent molecules pass through it from pure solvent side to the solution side.
Reason: Diffusion of solvent occurs from a region of high concentration solution to a region of low concentration solution.

1

ANS: (e) Assertion and reason both are correct statements  but reason is not correct explanation of assertion. The reason for flow is from higher vapour pressure to lower vapour pressure.

118    The most suitable colligative property to determine molar mass of polymers is _____.    1

ANS: osmotic pressure

119    Water boils _____ 100°C at hill stations.    1

ANS: below

120    Saline water gargles help in sore throat because it is hypertonic solution and NaCl is antiviral agent. [True/False]    1

ANS: True

121    Water is non-volatile solvent. [True/False]    1

ANS: False, water is volatile solvent.