UNIT 2

SOLUTIONS

Points to Remember

1. The component that is having more number of moles is known as solvent. Solvent determines the physical state of the solution. Water is an universal solvent.

2. Mole fraction (X) is a unitless quantity.

3. Molality (*m*) and mole fraction are temperature independent quantities whereas molarity decreases with increase in temperature.

4. As the temperature increases Henry's law constant, K_H increases so the lower is the solubility of the gas in the liquid.

5. 11.7% w/w Helium is added to air used by scuba divers due to its low solubility in the blood.

6. Raoult's law becomes a special case of Henry's law in which K_H becomes equal to P_A^0, *i.e.,* vapour pressure of pure solvent.

7. Azeotropes having the same composition in liquid and vapour phase and boil at a constant temperature and therefore can't be distilled.

8. Azeotropes arise due to very large deviation from Raoult's law. Maximum boiling azeotropes form when solutions exhibit negative deviation from Raoult's law whereas minimum boiling azeotropes form when solutions exhibit positive deviation from Raoult's law.

9. Relative lowering in vapour pressure is a colligative property but lowering in vapour pressure is not.

10. Van't Hoff factor (*i*) is the ratio of the observed value of the colligative property in solution to the theoretically calculated value of the colligative property.

    (a) A non-volatile solute undergoes dissociation, then $i > 1$.

    (b) A non-volatile solute undergoes association, then $i < 1$.

Some Important Formulae

1. Mole fraction (X)

If the number of moles of A and B are n_A and n_B respectively, the mole fractions of A and B will be

$$X_A = \frac{n_A}{n_A + n_B} \text{ and } X_B = \frac{n_B}{n_A + n_B}$$

$$X_A + X_B = 1$$

2. Molarity (M) $= \dfrac{\text{Moles of solute}}{\text{Volume of solution in litres}} \text{mol L}^{-1}$

3. Molality (*m*) $= \dfrac{\text{Moles of solute}}{\text{Mass of solvent in kilograms}} \text{mol kg}^{-1}$

4. Parts per million (ppm)

$$= \frac{\text{Number of parts of the compound}}{\text{Total number of parts of all components of the solution}} \times 10^6$$

5. Raoult's law for a solution of volatile solute in volatile solvent :

$$p_A = p_A^0 X_A$$

$$p_B = p_B^0 X_B$$

Where p_A and p_B are partial vapour pressures of component 'A' and component 'B' respectively in solution. p_A^0 and p_B^0 are vapour pressures of pure components 'A' and 'B' respectively.

6. Raoult's law for a solution of non-volatile solute and volatile solvent :

$$\frac{p_A^0 - p_A}{p_A^0} = iX_B \; ; \; i\frac{n_B}{n_A} = i\frac{W_B \times M_A}{M_B \times W_A} \text{ (for dilute solutions)}$$

Where X_B is mole fraction of solute, *i* is van't Hoff factor and $\dfrac{p_A^0 - p_A}{p_A^0}$ is relative lowering of vapour pressure.

7. Elevation in boiling point (ΔT_b) :

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

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

K_b = molal boiling point elevation constant

m = molality of solution

T_b = Boiling point of solution

T_b^0 = Boiling point of solvent

8. Depression in freezing point (ΔT_f) :

$\Delta T_f = i.K_f m$

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

K_f = molal freezing point depression constant

m = molality of solution

T_f^0 = Freezing point of solvent

T_f = Freezing point of solution

9. Osmotic pressure (π) of a solution :

$\pi V = i\, nRT$ or $\pi = i\, CRT$

where π = osmotic pressure in bar or atm

V = volume in litres

i = van't Hoff factor

C = molar concentration in moles per litres

n = number of moles of solute

T = Temperature on Kelvin scale

$R = 0.083$ L bar mol^{-1} K^{-1}

$R = 0.0821$ L atm mol^{-1} K^{-1}

10. Van't Hoff factor (i)

$$= \frac{\text{Number of particles in solution after association or dissociation}}{\text{Number of particles actually dissolved in solution}}$$

$$i = \frac{\text{Observed colligative property}}{\text{Theoretically calculated colligative property}}$$

$$i = \frac{\text{Normal molar mass}}{\text{Abnormal molar mass}}$$

$i > 1$ For dissociation of solute

$i < 1$ For association of solute

$i = 1$ For ideal solution undergoing no association or dissociation

11. Relationship between relative lowering in vapour pressure elevation in b.p.

$$\frac{\Delta p}{p_A^0} = i\frac{\Delta T_b}{K_b} M_A \times 1000$$

Here, Δp is lowering in vapour pressure, p_A^0 is vapour pressure of pure solvent, i is van't Hoff, ΔT_b is elevation in boiling point, K_b is molal elevation constant and M_A is molar mass of solvent.

VERY SHORT ANSWER TYPE QUESTIONS (1 Mark)

Q. 1. What is Van't Hoff factor ?

Ans. It is the ratio of normal molecular mass to observed molecular mass. It is denoted as i.

i = normal molecular mass/observed molecular mass

= no. of particles after association or dissociation/no. of particles before

Q. 2. What is the Van't Hoff factor in $K_4[Fe(CN)_6]$ and $BaCl_2$?

Ans. 5 and 3

Q. 3. Why the molecular mass becomes abnormal ?

Ans. Due to association or dissociation of solute in given solvent.

Q. 4. Define molarity. How it is related with normality ?

Ans. N = M × Basicity or acidity

Q. 5. How molarity is related with percentage and density of solution ?

Ans. $M = P \times d \times 10/M.M_2$.

Q. 6. What role does the molecular interaction play in the solution of alcohol and water ?

Ans. Positive deviation from ideal behaviour.

Q. 7. What is van't Hoff factor ? How is it related with :

(a) degree of dissociation **(b) degree of association**

Ans. (a) $\alpha = i - 1/n - 1$ (b) $\alpha = i - 1/1/n - 1$

Q. 8. Why NaCl is used to clear snow from roads ?

Ans. It lowers freezing point of water.

Q. 9. Why the boiling point of solution is higher than pure liquid ?

Ans. Due to lowering in vapour pressure.

Q.10. Out of 1 M and 1 m aqueous solution which is more concentrated ?

Ans. 1 M as density of water is 1 gm/ml.

Q.11. Henry law constant for two gases are 21.5 and 49.5 atm, which gas is more soluble ?

Ans. K_H is inversely proportional to solubility.

Q.12. Define azeotrope. Give an example of maximum boiling azeotrope.

Q.13. Calculate the volume of 75% of H_2SO_4 by weight (d = 1.8 gm/ml) required to prepare 1 L of 0.2 M solution.

Hint :

$$M_1 = P \times d \times 10/98$$

$$M_1V_1 = M_2V_2$$

$$= 14.5 \text{ ml}$$

Q.14. Why water cannot be completely separated from aqueous solution of ethyl alcohol ?

Ans. Due to formation of azeotrope at (95.4%).

Q.15. What is the molarity of pure water ?

Ans. 55.5

Q.16. Calculate the moles of PO_4^{-3} present in 4L of 10^{-5} $MCa_3(PO_4)_2$.

Ans. 8×10^{-5}

Q.17. Why anhydrous salts like NaCl or $CaCl_2$ are used to clear snow from roads on hills ?

Hint : They depress freezing point of water.

Q.18. What is the effect on boiling and freezing point of a solution on addition of NaCl ?

Hint : Boiling point increases and freezing point decreases.

Q.19. Out of M and *m*, which is better concentration term and why ?

Hint : m, it is independent of temperature change.

Q.20. Why osmotic pressure is considered as colligative property ?

Hint : It depends upon number of moles of solute present in solution.

Q.21. Liquid A and B on mixing produce a warm solution. Which type of deviation does this solution show ?

Hint : – ve deviations

Q.22. Give an example of a compound in which hydrogen bonding results in the formation of a dimer.

Hint : Carboxylic acids or other example

Q.23. What role does the molecular interaction play in solution containing chloroform and acetone ?

Hint : H-bonding formed, results in negative deviation from Raoult's law.

SHORT ANSWER TYPE QUESTIONS (2 Marks)

Q. 1. Molecular weight of a solute X is greater than that of solute Y. Their equal weights are dissolved separately in the equal quantity of same solvent. Which solution will show greater relative lowering of vapour pressure and why ?

Q. 2. Out of the following three solutions, which has the highest freezing point and why ?

(a) 0.1 M urea (b) 0.1M $BaCl_2$ (c) 0.1M Na_2SO_4

Q. 3. Which of the following solutions have highest boiling point and why ?

(a) 1M glucose (b) 1M KCl (c) 1M aluminium nitrate

Q. 4. Equal moles of liquid P and Q are mixed. What is the ratio of their moles in the vapour phase ? Given that $P_P^0 = 2 \times P_Q^0$.

Q. 5. On mixing liquid X and 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 ?

Q. 6. Explain the significance of Henry's constant (K_H). At the same temperature, hydrogen is more soluble in water than helium. Which of them will have higher value of K_H and why ?

Q. 7. How many grams of KCl should be added to 1 kg of water to lower its freezing point to – 8.0°C ? (K_f = 1.86 K kg/mol)

Ans. Since KCl dissociate in water completely, $i = 2$.

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

$$m = \frac{\Delta T_f}{i K_f}$$

$$m = \frac{8}{2 \times 1.86}$$

$$= 2.15 \text{ mol/kg}$$

Grams of KCl = 2.15 × 74. = 160.2 g/kg

Q.8. With the help of diagram, show the elevation in boiling point colligative properties ?

Q. 9. What do you mean by colligative properties ? Which colligative property is used to determine molar mass of polymer and why ?

Q.10. Define reverse osmosis. Write its one use.

Ans. Desalination of water.

Q.11. Why does an azeotropic mixture distills without any change in composition ?

Hint : It has same composition of components in liquid and vapour phase.

Q.12. Under what condition Van't Hoff factor is :

(a) equal to 1 ? (b) less than 1 ? (c) more than 1 ?

Q.13. If the density of some lake water is 1.25 gm/ml and contains 92 gm of Na^+ ions per kg of water, calculate the molality of Na^+ ion in the lake.

Ans. $n = \frac{92}{23} = 4$

$m = \frac{4}{1} = 4m$

Q.14. An aqueous solution of 2% non-volatile exerts a pressure of 1.004 Bar at the normal boiling point of the solvent. What is the molar mass of the solute ?

Hint : $\frac{P^0{}_A - P_A}{P^0{}_A} = \frac{w_B \times m_A}{m_B \times w_A}$

$$\frac{1.013 - 1.004}{1.013} = \frac{2 \times 18}{m_B \times 98}$$

$$m_B = 41.35 \text{ gm/mol}$$

Q.15. Why is it advised to add ethylene glycol to water in a car radiator in hill station ?

Hint : Anti-freeze.

Q.16. Calculate the molarity of pure water (d = 1 g mL^{-1}).

Ans. Desity of water = 1 g mL^{-1}

Mass of 1000 ml of water $= V \times d$

$= 1000 \text{ mL} \times 1 \text{ gm}^{-1}$

$= 1000$ g

Moles of water $= \frac{1000}{18} = 55.55$ mol

Now, mole of H_2O present in 1000 mL or 1 L of water.

So, molarity = 55.55M

Q.17. Define Henry's law. Give their two application.

Q.18. The dissolution of ammonium chloride in water is endothermic process. What is the effect of temperature on its solubility ?

Ans. Since dissolution of NH_4Cl in water is endothermic process, its solubility increases with rise in temperature (*i.e.,* Le-Chatelier process).

Q.19. Two liquids A and B boil at 145ºC and 190ºC respectively. Which of them has higher vapour pressure at 80ºC ?

Ans. Lower the boiling point more volatile is the respective compound. Therefore, liquid A will have higher vapour pressure at 80ºC.

Q.20. Why is liquid ammonia bottle first cooled in ice before opening it ?

Ans. At room temperature, the vapour pressure of liquid ammonia is very high. On cooling vapour pressure decreases, therefore the liquid ammonia will not splash out.

Q.21. Which colligative property is preferred for the molar mass determination of macromolecules ?

Ans. Osmotic pressure measurement is preferred for molar mass determination because :

(a) even in dilute solution the osmotic pressure values are appreciably high and can be measured accurately.

(b) osmotic pressure can be measured at room temperature.

Q.22. Define osmotic pressure determined from the measurement of osmotic pressure of a solution.

Ans. Osmotic pressure : The excess pressure applied to solution side to stop the process of osmosis is known as osmotic pressure.

$$\pi \propto C$$

$$\pi \propto T$$

$$\pi \propto CT$$

$$\pi = CRT$$

$$\pi = \frac{n_B}{V} RT$$

$$= \frac{n_B}{M_B V} RT$$

$$M_B = \frac{n_B RT}{\pi V}$$

SHORT ANSWER-II TYPE QUESTIONS (3 Marks)

Q. 1. Determine the amount of $CaCl_2$ dissolved in 2.5L at 27ºC such that its osmotic pressure is 0.75 atm at 27ºC. (i for $CaCl_2$ = 2.47)

Ans. For $CaCl_2$, $i = 2.47$

$$\pi = iCRT$$

$$= i\frac{n_B}{V} \times RT$$

$$0.75 = \frac{2.47 \times n_B \times 0.082 \times 300}{2.5}$$

$$n_B = \frac{0.75 \times 2.5}{2.47 \times 0.082 \times 300}$$

$$n_B = 0.0308 \text{ mol}$$

$$\text{Amount} = 0.0308 \text{ mol} \times 111 \text{g mol}^{-1}$$

$$= 3.418\text{g}$$

Q. 2. Determine the osmotic pressure of a solution prepared by dissolving 25 mg of K_2SO_4 in 2 litre of water at 25ºC assuming that it is completely dissociated.

Ans. If K_2SO_4 is completely dissociated,

$$K_2SO_4 \rightarrow 2K^+ + SO_4^{2-}$$

$$i = 3$$

$$\text{Mol mass of } K_2SO_4 = 2 \times 39 + 32 + 4 \times 16 = 174 \text{ g mol}^{-1}$$

$$\pi = iCRT$$

$$= i\frac{W_B \times RT}{M_B \times V}$$

$$= \frac{3 \times 25 \times 10^{-3} \times 0.082 \times 298}{174 \times 2.0}$$

$$= 5.27 \times 10^{-3} \text{ atm}$$

Q. 3. If the solubility product of CuS is 6×10^{-16}, calculate the maximum molarity of CuS in aqueous solution.

Ans. K_{sp} of CuS $= 6 \times 10^{-16}$

If S is the solubility, then

$$CuS \rightarrow Cu^{2+} + S^{2-}$$

$$[Cu^{2+}] = S,\ [S^{2-}] = S$$

$$K_{sp} = [Cu^{2+}][S^{2-}]$$

$$= S \times S = S^2$$

$$\text{Solubility } S = \sqrt{K_{sp}} = \sqrt{6 \times 10^{-6}}$$

$$= 2.45 \times 10^{-8}\ M$$

Highest molarity $= 2.45 \times 10^{-8}$ M

Q. 4. Suggest the most important type of intermolecular attractive interaction in the following pairs :

(a) n-hexane and n-octane **(b) I_2 and CCl_4**

(c) $NaClO_4$ and water

Ans. (a) Vander Waals interaction

(b) Vander Waals interaction

(c) Ion-dipole interaction

Q. 5. The vapour pressure of water is 12.3 Kpa at 300K. Calculate vapour pressure of 1 molal solution of a non-volatile solute in it.

Ans. Mole fraction of solute $= \dfrac{1}{1 + \dfrac{1000}{18}} = 0.0177$

$$\frac{P^0 - P_A}{P^0} = 0.0177$$

$$\frac{12.3 - P_A}{12.3} = 0.0177$$

$$P_A = 12.08 \text{ Kpa}$$

Q. 6. 6.90M solution of KOH in water contains 30% by mass of KOH. Calculate the density of the KOH solution. (Molar mass of KOH = 56 g mol^{-1})

Ans. Mass of KOH = 30 g

$$M = \frac{n_B}{V(\text{ml})} \times 1000$$

$$= \frac{W_B}{M_B \times V(\text{ml})} \times 1000 = \frac{30}{56 \times V} \times 1000$$

$$6.90 = \frac{30 \times 1000}{56 \times V}$$

$$V = \frac{30 \times 1000}{56 \times 6.90} = 81.43 \text{ mL}$$

$$D = \frac{M}{V}$$

$$= \frac{100}{81.43} = 1.28 \text{ g mL}^{-1}$$

Q. 7. An anti-freeze solution is prepared from 222.6 g of ethylene glycol $C_2H_4(OH)_2$ and 200 g of water. Calculate the molality of the solution. If the density of this solution be 1.072 g mL^{-1}, what will be the molarity of the solution ?

Ans. M_B of $C_2H_4(OH)_2$ = 62 g mol^{-1}

$$\text{Molality} = \frac{n_B}{W.} \times 1000 = \frac{W_B}{M \times W} \times 1000 = \frac{222.6 \times 1000}{62 \times 200}$$

$$= 17.95\text{m}$$

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

So,
$$\text{Volume} = \frac{\text{Mass}}{\text{Density}} = \frac{422.6}{1.072} = 394.22 \text{ ml}$$

$$M = \frac{n_B}{V} \times 1000$$

$$= \frac{222.6}{394.22 \times 62} \times 1000 = 9.11\text{M}$$

Q. 8. What would be the molar mass of compound if 6.21 g of it is dissolved in 24.0 g of $CHCl_3$ from a solution that has a boiling point of 68.04ºC. The boiling point of pure chloroform is 61.7ºC and the boiling point elevation constant K_b for chloroform is 3.63ºC/m.

Ans. Elevation in boiling point ΔT_b = 68.04 – 61.7 = 6.31ºC

Mass of substance W_B = 6.21 g

Mass of CHCl3 W_A = 24.0 g

K_B = 3.63 ºC/m

$$M_B = \frac{K_b \times W_B \times 1000}{\Delta T_b \times W_A} = \frac{3.63 \times 6.21 \times 1000}{6.34 \times 24}$$

$$= 148.15 \text{ g mol}^{-1}$$

Q. 9. 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 100.42ºC while pure water boils at 100ºC. What mass of glycerol was dissolved to make the solution ? (K_b = 0.512 K kg mol^{-1})

Ans. 37.73 g

Q.10. 18 g of glucose ($C_6H_{12}O_6$) (molar mass = 180 g mol^{-1}) is dissolved in 1 kg of water in a sauce pan. At what temperature will this solution boil ? (Kb for water = 0.52 K kg mol^{-1}, boiling point of pure water = 373.1 K)

Ans. 373.202 K

LONG ANSWER TYPE QUESTIONS (5 Marks)

Q. 1. (a) Define Raoult's law of binary solution containing non-volatile solute in it.

(b) On dissolving 3.24 g of sulphur in 40 g of benzene, boiling point of solution was higher than that of benzene by 0.81K (K_b = 2.53 K kg mol^{-1}). What is molecular formula of sulphur ? (Atomic mass s = 32 g mol^{-1})

Ans. (a) At a given temperature, the vapour pressure of a solution containing non-volatile solute is directly proportional to the mole fraction of the solvent.

(b)
$$M_B = \frac{K_b \times W_B \times 1000}{\Delta T_b \times W_A} = \frac{3.63 \times 6.21 \times 1000}{6.34 \times 24}$$

$$= 148.15 \text{ g mol}^{-1}$$

Let the molecular formula of sulphur = S_x

Atomic mass of sulphur = 32

Molecular mass = $32 \times x$

$32x = 253$

$x = 7.91 \approx 8$

Molecular formula of sulphur = S_8

Q. 2. (a) Outer shells of two eggs are removed. One of the egg is placed in pure water and the other is placed in saturated solution of NaCl. What will be observed and why ?

(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 ton at 25ºC. Assuming the gene fragment is a non-electrolyse, determine the molar mass.

Ans. (a) In pure water the egg swells and in saturated solution of NaCl it will shrinks.

(b) Mass of gene fragment $= 8.95$ mg

$= 8.95 \times 10^{-3}$ g

Volume of water $= 35.0$ ml $= 35 \times 10^{-3}$ L

$\pi = 0.335$ ton $= 0.335/760$ atm

Temp $= 25 + 273 = 298$ K

$$\pi = \frac{W_B RT}{M_B \times V}$$

$$\frac{0.335}{760} = \frac{8.95 \times 10^{-3} \times 0.0821 \times 298}{M_B \times 35 \times 10^{-3}}$$

$M_B = 141933$ g mol^{-3}

Q. 3. (a) Define van't Hoff factor.

(b) Calculate the freezing point depression expected for 0.0711M aqueous solution of Na_2SO_4. If this solution actually freezes at – 0.320ºC, what would be the value of van't Hoff factor ? (K_f = 1.86ºC mol^{-1})

Ans. (a) **Van't Hoff factor :** It is the ratio of the normal molar mass to the observed molar mass of the solute.

(b) $\Delta T_f = K_f \times M$

$\Delta T_f = 1.86 \times 0.0711 = 0.132$

Observed freezing point = 0 – (– 0.320) = 0.320ºC

$$i = \frac{\text{Observed freezing point}}{\text{Calculate freezing point}}$$

$$= \frac{0.320}{0.132} = 2.42$$

Q. 4. (a) What is the value of *i* when solute is associated and dissociated ?

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

Ans. (a) $i < 1$ when solute is associated and

$i > 1$ when solute is dissociated.

(b) $$m = \frac{n_g \times 1000}{W_A(g)}$$

$$= \frac{W_B \times 1000}{M_B \times W_A} = \frac{10.50 \times 1000}{184 \times 200} = 0.2853\text{M}$$

$MgBr_2$ ionizes as $MgBr_2 \rightarrow Mg^{2+} + 2Br^-$

$$i = 3$$

$$\Delta T_f = i \times K_f \times M$$

$$= 3 \times 1.86 \times 0.2855$$

$$= 1.59$$

Freezing point $= 0 - 1.59°C = - 1.59°C$

Q. 5. (a) What is the value of *i* for $Al_2(SO_4)_3$ when it is completely dissociated ?

(b) Calculate the boiling point of a solution prepared by adding 15.00 g of NaCl to 250 g of water. (K_b = 0.512 K kg mol^{-1} and molar mass of NaCl = 58.44 g mol^{-1})

Ans. (a) $Al_2(SO_4)_3 \rightarrow 2Al^{3+} + 3SO_4^{2-}$

$$i = 5$$

(b)

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

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

$$i = 2$$

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

$$= 1.05$$

Boiling point of solution = 100 + 1.05

= 101.05°C

VALUE BASED QUESTIONS (4 Marks)

Q. 1. Sauba divers when come towards the surface, pressure gradually decreases resulting in release of dissolved gases leading to formation of bubbles of N_2 gas in the blood which block the capillaries and thus bends are created. To avoid bends and toxic effect of high concentration of N_2 gas, the air is diluted with helium.

After the above passage, answer the following :

(a) Why is the harmful condition of bends overcome by the use of helium ?

(b) Which law is used to calculate the concentration of gases in solution ?

(c) Mention the value associated with providing divers air diluted with helum.

(d) Which gas has less value of K_H , O_2 or He, and why ?

Q. 2. Ram takes an open pan to cook vegetables at a hill station while Shyam cooked the same in a pressure cooker at the same place.

(a) Define normal boiling point of a liquid.

(b) Explain the reason who will cook vegetables faster.

(c) Mention the reason for delay in cooking.

(d) Which value is learnt by the student in the process of cooking food in pressure cooker ?

Q. 3. Sneha's grandmother lives in Manali. In winter, there is a lot of snow in front of the house. She asked Sneha to clear the snow. Sneha added NaCl to snow to clear it.

(a) Why Sneha does so ?

(b) Is the addition of $Ca(NO_3)_2$ a better choice than NaCl ? If yes, why ?

(c) What is the value in Sneha's thinking ?

(d) Define molal freezing point, depression constant, K_f.

Q. 4. Ira Singh, a student of class XII Chemistry stated that normal saline solution having 0.9% (mass/volume) NaCl is isotonic with the fluid inside the cell. Therefore, it is safe to inject normal saline solution intravenously.

(a) Define isotonic solutions. What would happen if the concentration of saline solution is (a) more, (b) less than 0.9% (mass/volume) NaCl ?

(b) What values are associated with the statement of Ira Singh ?