# SOLUTIONS

## MULTIPLE CHOICE QUESTIONS

1. **Osmotic pressure of a solution is 0.0821 atm at a temperature of 300 K. The concentration in moles/lit will be:**
   (a) 0.33
   (b) 0.666
   (c) 0.0033
   (d) 3

2. **The value of Henry's Law constant is:**
   (a) larger for gases with higher solubility
   (b) larger for gases with lower solubility
   (c) constant for all gases
   (d) not related to the solubility of gases

3. **The elevation in boiling point of 0.01 M $BaCl_2$ solution is about than that of 0.01 M solution of glucose.**
   (a) Same
   (b) two times
   (c) three times
   (d) four times

4. **Considering the formation, breaking and strength of Hydrogen bond, predict which of the following mixtures will show a positive deviation from Roult's law?**
   (a) Methanol and Acetone
   (b) Chloroform and Acetone
   (c) Nitric Acid and Water
   (d) Phenol and Aniline

5. **If a molecule AB undergoes dimerization in Benzene, its Van't Hoff factor is found to be 0.60. The degree of dissociation of AB is**
   (a) 20%
   (b) 60%
   (c) 80%
   (d) 50%

6. **Density of a 2.05 M solution of acetic acid in water is 1.02 g/mL. The molality of the solution is**
   (a) 3.28 mol $kg^{-1}$
   (b) 2.28 mol $kg^{-1}$

(c) 0.44 mol $kg^{-1}$
(d) 1.14 mol $kg^{-1}$

7. **At certain temperature, a 5.12% solution of cane sugar is isotonic with a 0.9% solution of an unknown solute. The molar mass of solute is**
   (a) 60
   (b) 46.67
   (c) 120
   (d) 90

8. **Which is not a colligative property?**
   (a) Osmotic pressure
   (b) Lowering of vapour pressure
   (c) Depression in freezing point
   (d) Molal elevation constant

9. **12g of Urea is dissolved in 1L of water and 68.4g sucrose is dissolved in 1L of water. Relative lowering of vapour pressure of Urea solution is:**
   (a) Greater than sucrose solution
   (b) Less than sucrose solution
   (c) Double that of sucrose solution
   (d) Equal to that of sucrose solution

10. **Ethylene glycol is used as an antifreeze in a cold climate. Mass of Ethylene glycol which should be added to 4kg water to prevent it from freezing at $-6^0$C will be ($K_f$ for water = 1.86Kkg/$mol^{-1}$, Molar mass of Ethylene glycol = 62g/mol)**
    (a) 204.30g
    (b) 800g
    (c) 304.60g
    (d) 400g

11. **The depression in freezing point for 1M Urea, 1M Glucose and 1M NaCl are in the ratio**
    (a) 1:1:2
    (b) 3:2:2
    (c) 1:2:3
    (d) None of these

12. **The solution that forms maximum boiling azeotropes is**
    (a) Carbon disulphide – Acetone
    (b) Benzene - Toluene
    (c) Acetone – Chloroform
    (d) n-Hexane – n-Hectane.

13. **The type of intermolecular interaction present in a solution of n- Hexane and n-Octane is:**
    (a) London dispersion forces
    (b) Dipole-dipole interaction
    (c) Hydrogen bonding
    (d) Ion-dipole interaction

**14. Which among the following is least soluble in water?**

(a) Phenol
(b) Toluene
(c) Ethylene glycol
(d) Pentanol

**15. Which of the following is dependent on temperature?**

(a) Molality
(b) Molarity
(c) Mole Fraction
(d) Mass percentage

## ANSWER KEY

| | | | | |
|---|---|---|---|---|
| 1. c | 2. b | 3. c | 4. a | 5. c |
| 6. b | 7. a | 8. d | 9. d | 10. b |
| 11. a | 12. c | 13. a | 14. b | 15. b |

## ASSERTION -REASON TYPE QUESTIONS

In the following questions, two statements (Assertion) A and Reason (R) are given.

Mark

(a) If A and R both are correct and R is the correct explanation of A
(b) If A and R both are correct but R is not the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

1. **Assertion**: When a blood cell is placed in hypertonic solution, it shrinks.
**Reason**: Blood is isotonic with 0.9% NaCl solution.

2. **Assertion**: The aquatic species feel more comfortable in winter than summer
**Reason**: Solubility of gases increases with increase of temperature.

3. **Assertion**: Azeotropic mixture are formed only by non-ideal solutions.
**Reason**: Boiling point of an azeotropic is either higher than both the components or lower than both the components.

**4.** **Assertion**: Soft drink and soda water bottles are sealed under high pressure.
**Reason:** The dissolution of gas in liquid is an endothermic process.

**5.** **Assertion**: On adding non-volatile solute to water its vapour pressure increases.
**Reason**: Relative lowering of vapour pressure is a colligative property

**6.** **Assertion**: Addition of ethylene glycol to water lowers the freezing point of water, therefore, used as antifreeze.
**Reason**: 1, 2-Ethanediol is soluble in water because it can form H-bond with water, therefore vapour pressure of solution is lowered.

**7.** **Assertion**: In an ideal solution, $\Delta H_{mix}$ is zero.
**Reason**: In an ideal solution, A – B interactions are lower than A-A and B-B interactions.

**8.** **Assertion**: Mixture of ethanol and cyclohexane forms a solution with negative deviation from Raoult's law.
**Reason**: When ethanol mixes in cyclohexane, it reduces the intermolecular force between ethanol molecules.

**9.** **Assertion**: Van't Hoff factor for Benzoic acid in Benzene is less than 1
**Reason**: Benzoic acid dimerizes in Benzene.

**10.** **Assertion**: Larger the value of cryoscopic constant of the solvent, lesser will be the freezing point of solution.
**Reason**: Depression in freezing point depends on the nature of the solvent.

**11.** **Assertion**: An aqueous solution of NaCl freezes below 273 K.
**Reason**: Vapour pressure of the solution is less than that of the pure solvent.

**12.** **Assertion**: The sum of mole fractions of all components of a solution is unity.
**Reason**: Mole fraction is independent of temperature.

**13.** **Assertion**: Osmosis involves movement of solvent molecules from its lower concentration to its higher concentration.
**Reason**: Solution having the same osmotic pressure are called isotonic solution.

**14.** **Assertion**: When blood cell is placed in a solution containing 1.5 % NaCl, it willshrink.

**Reason**: Blood is isotonic with 1.5% NaCl solution.

**15.** **Assertion**: Molarity of a solution in liquid state changes with temperature.
**Reason**: The volume of a solution changes with change in temperature.

## ANSWER KEY

| | | | | |
|---|---|---|---|---|
| 1. b | 2. c | 3. b | 4. c | 5. d |
| 6. a | 7. c | 8. d | 9. a | 10. c |
| 11. a | 12. b | 13. b | 14. c | 15. a |

## SHORT ANSWER QUESTIONS

1**. How does sprinkling of salt help in clearing the snow-covered roads in hilly areas? Explain the phenomenon involved in the process.**

Ans: The phenomenon involved in the melting of snow in snow covered roads is the in freezing point which caused by the addition of non-volatile impurities to a liquid. Addition

of salt (sodium chloride) lowers the freezing point temperature of water and thus, helps in the melting of snow.

**2. What is "semi permeable membrane"?**

Ans: The membranes which allow only the movement of the solvent molecules through them is called semi permeable membrane. The membranes appear to be continues sheet or flims. here only the molecules of the solvent can pass while those of the solute which are of bigger size, are not in a position to pass through.

**3. Give an example of a material used for making semipermeable membrane for out reverse osmosis.**

Ans: Polymer cellulose acetate is used for making semipermeable membrane for carrying out reverse osmosis.

4**.Distinction between molarity and molality.**
Ans: Molarity: It is the number of moles of solute dissolved in 1 litre of solution. It is temperature dependent.
Molality : It is the number of moles of solute dissolved in 1 kg of the solvent and independent of temperature.

**5.Define an ideal solution and write one of its characteristics**.
Ans: An ideal solution may be defined as the solution which obeys Raoult's law exactly over the entire range of temperature and pressure. For ideal solution Heat of mixing is zero
Volume change of mixing is zero.

**6. (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?**
Ans (i) Osmotic pressure
(ii) Minimum boiling azeotropes show positive deviation from Raoult's law.

**7.Explain why on addition of 1 mol of NaCl to 1 litre of water, the boiling point of water increases, while addition of 1 mol of methyl alcohol to one litre of water decreases its boiling point.**

Ans: Sodium chloride (NaCl) is a non-volatile solute. When added to water taken in a beaker, the solute occupies some surface area. As a result, the vapour pressure decreases and the point of solution increases. On the other hand, methyl alcohol is more volatile than addition of methyl alcohol to water increases the total vapour pressure of the boiling point of the solution decreases.

**8.What type of intermolecular attractive interaction exists in the pair of methanol and acetone?**

Ans: Solute-solvent dipolar interactions exist in the pair of methanol and acetone.
9. 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 $mol^{-1}$)
Answer:
As $\Delta T_b = iK_bm$

$(100.18 – 100)\ °C = i \times 0.512\ K\ kg\ mol^{-1} \times 1\ m$
$0.18\ K = i \times 0.512\ K\ kg\ mol^{-1} \times 1\ m$
$\therefore i = 0.3$

**10.At 300 K ,30g of glucose 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 other solution**

$\pi = W_2RT/M_2V = CRT$

4.98=30XRX300/180X1=50R

1.52=CXRX300=300CR

300CR/50R=1.52/4.98=0.051M

**11.Calculate the mass of NaCl (molarmass=58.5g/mol) to be dissolved in 37.2 g of water to lower the freezing point by 2 degree assuming that NaCl undergoes complete dissociation.**

I=2

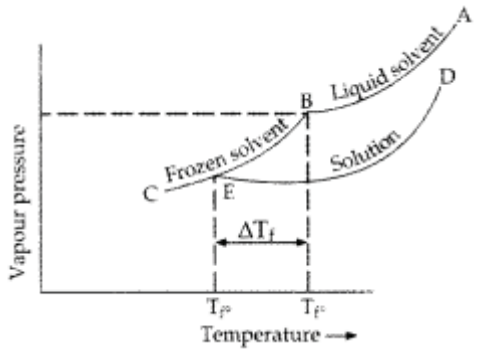
$W_2 = \Delta Tf \times M_2 \times W_1 / i \times Kf \times 1000$

W2=2x58.5x37.2/2x1.86x1000=1.17g

12. **What is the significance of Henry's Law constant $K_H$ ?**

Solution: Henry's Law constant ($K_H$) helps in comparing the relative solubilities of different gases in the same solvent (e.g. water). In general, lesser the value of $K_H$, more is the solubility of a gas

**13.An aqueous solution of sodium chloride freezes below 273 K. Explain the lowering in freezing points of water with the help of a suitable diagram.**
An aqueous solution of sodium chloride freezes below 273 K because vapour pressure g of the solution is g less than that of the pure solvent.



**14. 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.
Answer:
(i) Volume decreases by mixing X and Y. It shows negative deviations from Raoult's law. There will be rise in temperature. ($\Delta H_{mix} < 0$)
(ii) Blood cell will swell due to osmosis as water enters the cell.

**15. 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) (All India 2015)**
Answer:

$$\frac{P^0_{solvent} - P_{solvent}}{P^0_{solvent}} = \frac{W_{solute}}{M_{solute}} \times \frac{M_{solvent}}{W_{solvent}}$$

$$\frac{32.00 - 31.84}{32} = \frac{10}{M_{solute}} \times \frac{18}{200} = \frac{0.16}{32} = \frac{9}{10M_{solute}}$$

$$M_{solute} = \frac{32 \times 9}{1.6} = \mathbf{180\ g/mol}$$

## LONG ANSWER QUESTIONS

1.a) **Why is the mass determined by measuring a colligative property in case of some solutes is abnormal? Discuss it with the help of the Van't Hoff factor.**

Certain solutes do not behave normally in solution in the sense that they may either undergo dissociation or association. As a result, the number of solute particles in solution changes.

Since the colligative properties are linked with the number of particles, they show abnormal results. In the same way, the molecular masses of these solutes also show abnormal results.

The exact behavior of the solute in solution and the extent of association or dissociation can be expressed in terms of Van't Hoff factor (i).

i = Normal/ calculated molecular mass/ Observed molecular mass.

or i = Observed colligative properties/ Normal colligative properties.

- If i = 1 , solute behave normally in the solution
- If i > 1 , solute undergo dissociation in solution
- If i < 1 , solute undergo association in solution

b) **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 $mol^{-1}$). (Delhi 2014)**
Answer:
Given: $\Delta T_f = 0.48K, W_1 = 75g, M_2 = 256gmol^{-1}$ $W_2 = ?$

Usingformula,$W_2$ = M2×W1×ΔTf1000×Kf
= 256×75×0.481000×5.12 = 1.8 g

**2.a) Explain the following phenomena with the help of Henry's law.**

- **(i) Painful condition known as bends.**
- **(ii) Feeling of weakness and discomfort in breathing at high altitude.**
- **(b) Why soda water bottle kept at room temperature fizzes on opening?**

(i) When scuba divers go deep in the sea, solubility of atmospheric gases increases in blood. When the divers come up, there is release of dissolved gases and it leads to the formation of bubbles of nitrogen in our blood capillaries and hence there is painful sensation called bends. To avoid bends; the tanks of scuba divers are filled with He,$N_2$ and oxygen.

- (ii) At high altitude, partial pressure of oxygen is low, it leads to low concentration of oxygen in blood of people living there. Low concentration of oxygen develops anoxia, i.e., unable to think and act properly.
- (b) In order to increase the solubility of $CO_2$ gas in soft drinks and soda water, the bottles are normally sealed under high pressure. Increase in pressure increases the solubility of a gas in a solvent according to Henry's Law. If the bottle is opened by removing the stopper or seal, the pressure on the surface of the gas will suddenly decrease. This will cause a decrease in the solubility of the gas in the liquid. As a result, it will rush out of the bottle producing a hissing noise or with a fiz.

b )A solution prepared by dissolving 1.25 g of oil of winter green (methyl salicylate) in 99.0 g of benzene has a boiling point of 80.31°C. Determine the molar mass of this compound. (B.P. of pure benzene = 80.10°C and Kb for benzene = 2.53°C kg mol-1)

Answer:

Given : $W_2$ = 1.25 g, $W_1$ = 99 g

ΔTb = 80.31 – 80.10°C = 0.21°C

Kb = 2.53°C kg mol-1

According to the formula :

$M_2$ = 1000Kb $W_2$ /$W_1$ ΔTb

Substituting these values in the formula, we get

M2 = 1000×2.53×1.25 /99×0.21

= 152 g mol-1

**3. a) 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? ($K_b$ for water = 0.52 K kg $mol^{-1}$, boiling point of pure water = 373.15 K) (Delhi 2013)**
Answer:

We know that :
Elevation of boiling point $\Delta T_b$
WBMB×100×Kbwt. of solvent
Given: $W_B$ = 18 g
$M_B$ = Formula of glucose is $C_6H_{12}O_6$
= 6 × 12 + 12 + 6 × 16 = 180
Wt. of solvent = 1 kg or 1000 g,
$K_b$ = 0.52 K kg $mol^{-1}$
Hence, $\Delta T_b$ = 18g180×1000×0.521000g = 0.52 K ∴B.P of the solution = 373.15 + 0.052 =373.202 K
b) Define osmotic pressure of a solution.?How is the osmotic pressure related to the concentration of a solute in a solution?
Answer:
**Osmotic pressure :** It is the external pressure which is applied on the side solution which is sufficient to prevent the entry of the solvent through semi-permeable membrane.
According to the Boyle-van't Hoff Law, the osmotic pressure ($\pi$) of a dilute solution is directly proportional to its molar concentration provided temperature is constant.
$\pi \propto C$ (At constant temperature)
$\pi \propto CT$ (At constant concentration)
$\pi = CRT$ (R = Solution constant)

4.**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?**

Answer:(a) Since $MgCl_2$ is an ionic compound, so it undergoes complete dissociation.

| | $MgCl_2 \longrightarrow$ | $Mg^{2+}$ + | $2Cl^-$ |
|---|---|---|---|
| Initial moles | 1 | 0 | 0 |
| After dissociation | 0 | 1 | 2 |

∴ Total number of moles = 1 + 2 = 3

Thus, $i = \frac{3}{1} = 3$

Using formula,

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

$$\Delta T_f = 3 \times 1.86 \times \frac{1.9 \times 1000}{95 \times 50} \quad \left(\because m = \frac{w_b \times 1000}{M_b \times w_a}\right)$$

$$\therefore \Delta T_f = \frac{10602}{4750} = 2.232 \text{ K}$$

Also, $T_f = T°_f - \Delta T_f$ = 273.15 K – 2.233 K

∴ **$T_f$ = 270.92 K**

b(i) 2M glucose will have a higher boiling point than 1M glucose because elevation in boiling point is a colligative property which depends upon the number of particles in the solution

which is more in the case of 2M glucose solution.
(ii) When the external pressure applied becomes more than the osmotic pressure of the solution, then the solvent will flow from the solution into the pure solvent through the semi-permeable membrane. The process is called reverse osmosis.

**5. 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?**
**(iii)Define ideal solution?**
Answer:
(a) Given: $w_b$ = 2.56 g $w_a$ = 100 g = 0.1 kg
$\Delta T_f$ = 0.383 K $K_f$= 3.83 K kg $mol^{-1}$
Atomic mass of sulphur = 32 g $mol^{-1}$
$M_b$ = ?
Using formula,

$$M_b = \frac{K_f \times w_b}{\Delta T_f \times w_a} = \frac{3.83 \times 2.56}{0.383 \times 0.1}$$

$$\left[\because \Delta T_f = \frac{K_f \times w_b}{M_b \times w_a} \times 1000\right]$$

$\therefore M_b$ = 256 g $mol^{-1}$
Hence the no. of atoms present in one molecule of sulphur = 256/32 = 8
$\therefore$ the formula is $S_8$.
(b) (i) If RBCs are placed in contact with 1.2% NaCl solution, then the osmotic pressure of 1.2% NaCl becomes higher than that of RBCs due to which water present inside the cells moves into the NaCl solution which results in shrinkage of RBCs.
(ii) Reverse process will take place if RBCs are kept in contact with 0.4% NaCl solution which has less osmotic pressure ' due to which water moves into RBCs and th**ey will swell.**

**(iii)Ideal solution :** The solutions which obey Raoult's law over the entire range of concentration are known as ideal solutions.

## CASE BASED QUESTIONS

**1. Read the following paragraph and answer the questions:**

An ideal solution of two liquids is a solution in which each component obeys Raoult's law which states that the vapour pressure of any component in the solution depends on the mole fraction of that component in the solution and the vapour pressure of that component in the pure state. However, there are many solutions which do not obey Raoult's law. In other words, they show deviations from ideal behaviour which may be positive or negative. However, in either case, corresponding to a particular composition, they form a constant boiling mixtures called azeotropes.

(i) The mole fraction of Ethyl alcohol in its solution with Methyl alcohol is 0.80. The vapour pressure of pure Ethyl alcohol at this temperature is 40mm of Mercury. What is its vapour pressure in the solution if the solution is ideal?

(ii) Why do a solution of Phenol and Aniline exhibit negative deviation from ideal behaviour?

(iii) Write and example for maximum boiling azeotrope.

(iv) Why pure Ethyl alcohol cannot be obtained from rectified spirit even by fractional distillation?

(v) When two liquids A & B are mixed the volume of the resulting solution is found to be slightly greater than sum of the volumes of A & B. Identify the type of deviation exhibited by the solution.

**2. Read the following paragraph and answer the questions:**

Colligative properties of a solution depend upon the number of moles of the solute dissolved and do not depend upon the nature of the solute. However, they are applicable only to dilute solutions in which the solutes do not undergo any association or dissociation. For solutes undergoing such changes, Van't Hoff introduced a factor, called Van't Hoff factor (i). This has helped not only to explain the abnormal molecular masses of such solutes in the solution but has also helped to calculate the degree of association or dissociation.

(i) What is Van't Hoff factor (i) for a compound undergoing tertramerization in an organic solvent?

(ii) Arrange the following in the increasing order of freezing point
0.1M $Al_2(SO_4)_3$, 0.1M KCl, 0.1M Glucose, 0.1M $K_2SO_4$

(iii) The molar mass of Sodium Chloride determined by elevation of boiling point method is found to be abnormal. Why?

(iv) What is the elevation of boiling point of a solution of 13.44g of $CuCl_2$ in 1kg of water? ($K_b$ for water = 0.52Kkg/$mol^{-1}$, molar mass of $CuCl_2$ = 134.4g/mol)

(v) Equimolal solutions of NaCl and $BaCl_2$ are prepared in water. Freezing pint of NaCl is found to be $-2^0$C. What freezing point do you expect for $BaCl_2$ solution?

## ANSWER KEY

1. (i) $P_{C2H5OH} = x_{C2H5OH} \times P^0_{C2H5OH}$
= 0.80 x 40mm
= 32 mm of Mercury

(ii) The Hydrogen bond formed between Phenolic proton and lone pairs of electron of Aniline is stronger than the interactions existing in pure Phenol and in pure Aniline.

(iii) Mixture of water and Nitric acid.

(iv) Because a mixture of 95.4% alcohol and 4.6% of water forms an azeotrope.

(vi) Positive deviation.

2. (i) i= ¼ = 0.25

(ii) 0.1M $Al_2(SO_4)_3$, 0.1M K2SO4, 0.1M KCl, 0.1M Glucose

(iii) Elevation of boiling point is a colligative property. Since Sodium chloride dissociates in the solution we get abnormal molecular mass.

(iv) $\Delta T_b = iK_bm$
$= 3 \times 0.52 \times 0.1$
$= 1.56$ K

(v) i for NaCl = 2, i for $BaCl_2$ = 3
$\frac{\Delta T_f \text{ NaCl}}{\Delta T_f \text{ } BaCl_2} = \frac{2}{3}$
Hence $T_f$ for $BaCl_2 = -3^0C$

## CBSE BOARD QUESTIONS

1) **What type of intermolecular attractive interaction exists in the pair of methanol and acetone?**
Ans: - Solute-solvent dipolar interactions exist in the pair of methanol and acetone

2) **What mass of NaCl must be dissolved in 65g of water to lower the freezing point of water by 7.50°C? The freezing point depression constant ($K_f$) for water is 1.86°C/m.Assume van't Hoff factor for NaCl is 1.87(Molar mass of NaCl =58.5g)?**
Ans: - $\Delta T = ixK_fxw_Bx1000/m_BxW_A$
$\Delta T$=7.5, i=1.87, Kf=1.86$km^{-1}$, $w_A$=65g, $m_B$=58.5g/mol, $w_B$=?
Putting the values, we get,
$7.5=1.87x1.86xw_Bx1000/58.5x65$
$w_B$=8.2g

3) **Out of $BaCl_2$ and KCl, which one is more effective in causing coagulation of a negatively charged colloidal Sol? Give reason?**
Ans: - $BaCl_2$ is more effective in causing coagulation because it has double +ve charge than K+.

4) **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 $mol^{-1}$)**
Ans: - $\Delta T_b = iK_bm$
$(100.18 - 100)$ °C = i × 0.512 K kg $mol^{-1}$ × 1 m
0.18 K = i × 0.512 K kg $mol^{-1}$ × 1 m
∴ i = 0.3

5) **Explain why aquatic species are more comfortable in cold water rather than in warm water?**
Ans: - Aquatic species need dissolved oxygen for breathing. As solubility of gases decreases with increase of temperature, less oxygen is available in summer in the lake. Hence the aquatic species feel more comfortable in winter (low temperature) when the solubility of oxygen is higher.

6) **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? ($K_b$ for water = 0.52 K kg $mol^{-1}$, boiling point of pure water = 373.15 K)?**

Ans: - We know that:

Elevation of boiling point $\Delta T_b$,

$\Delta T_b = K_b x m$ (m-molality)

Hence, $\Delta T_b = 18 \times 1000 \times 0.52/180 = 0.52$ K

$\therefore$B.P of the solution = 373.15 + 0.052

= 373.202 K

7) **What is meant by 'reverse osmosis'?**

Ans: - If a pressure higher than the osmotic pressure is applied on the solution, the solvent will flow from the solution into the pure solvent through semipermeable membrane. This process is called reverse osmosis.

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

Ans: - The vapour pressure of a solvent decreases when a non-volatile solute is dissolved in it because some solvent molecules are replaced by the molecules of solute

9) **At 25°C, the vapour pressure of pure water is 23.76mm of Hg and that of an aqueous solution of urea is 22.98mm of Hg. Calculate the molality of the solution?**

Ans: - We know that,

$P^o$-P/Po=$X_B$=Mole fraction of solute

23.76-22.98/23.76=$X_B$

$X_B$=0.0328

molality of the solution 'm' =$X_B$x1000/ (1-0.0328) x18=1.88

10) **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)?**

Ans: -

$$\frac{P^0_{solvent} - P_{solvent}}{P^0_{solvent}} = \frac{W_{solute}}{M_{solute}} \times \frac{M_{solvent}}{W_{solvent}}$$

$$\frac{32.00 - 31.84}{32} = \frac{10}{M_{solute}} \times \frac{18}{200} = \frac{0.16}{32} = \frac{9}{10M_{solute}}$$

$$M_{solute} = \frac{32 \times 9}{1.6} = \mathbf{180\ g/mol}$$

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

Ans:- **Osmosis :** The net spontaneous flow of the solvent molecules from the solvent to the solution or from a less concentrated solution to a more concentrated solution through a semipermeable membrane is called osmosis.

**Osmotic pressure :** The minimum excess 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.

The osmotic pressure method has the advantage that it uses molarities instead of molalities and it can be measured at room temperature.

**12)(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?**

Ans: - Henry's law: "The solubility of a gas in a liquid at a particular temperature is directly proportional to the pressure of the gas in equilibrium with the liquid at that temperature."

Applications of Henry's law:

• In the production of carbonated beverages which are prepared under high pressure.

• Deep sea divers depend upon compressed air for their oxygen supply.

(ii) Raoult's law: 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.

$P = P°x$

Non-ideal solution shows positive and negative deviations from Raoult's law.

**13) Define the following terms:**

**(i) Ideal solution (ii) Azeotrope?**

Ans: - Ideal solution**:** An ideal solution is that which obeys Raoult's law and in which the intermolecular interactions between the different components are of same magnitude as that is found in pure components.

**(ii)** Azeotrope: It is a type of liquid mixture having a definite composition and boiling like a pure liquid, (distils without change in compositions)

**14) a) What type of deviation is shown by a mixture of ethanol and acetone? Give reason.**

**(b) A solution of glucose (molar mass = 180 g $mol^{-1}$) in water is labelled as 10% (by mass). What would be the molality and molarity of the solution?**

**(Density of solution = 1.2 g $mL^{-1}$)?**

Ans: - (a) Since acetone is nearly non-polar in nature and ethanol is polar in nature therefore, no interaction occurs between acetone and ethanol, the number of molecules increases, which shows positive deviation.

(b) 10% glucose means 10 g in 100 g solution or, 90 g of water = 0.090 kg of water

$$\therefore \text{ Molality} = \frac{10}{180 \times 0.090} = 0.617 \text{ m}$$

$$100 \text{ g of solution} = \frac{100}{1.2} \text{ mL}$$

$$= 83.33 \text{ mL} = 0.08333 \text{ L}$$

$$\therefore \text{ Molarity} = \frac{10}{180 \times 0.0833} = 0.067 \text{ M}$$