ST. MARY'S ENGLISH HIGH SCHOOL

CHEMISTRY

STD. – XII A1, A2 & B

1. *Name two ways of measuring the concentration of a solution which are not temperature dependent.*
2. *Name the law which governs the statement—"for a solution of a non-volatile solute, the mole fraction of the solute determines the vapour pressure of the solvent".*
3. *Write down the expression relating elevation of boiling point of a solvent when a solute is dissolved into it to form a dilute solution and the concentration of the solution defining the terms.*
4. *What is the equation relating osmotic pressure and number of moles of solute?*
5. *Why there is an increase in vapour pressure when HgI_2 is added to the aqueous solution of KI?*
6. *Why is osmotic pressure considered to be a colligative property?*
7. *Will the elevation in boiling point be same if 0.1 mole of sodium chloride (NaCl) or 0.1 mole of sugar is dissolved in one litre of water?*
8. *Why semipermeable membrane of $Cu_2[Fe(CN)_6]$ is not used for osmosis in non-aqueous solutions?*
9. *What happens to the vapour pressure of water when sodium chloride is added to it?*
10. *Why food gets cooked faster in a pressure cooker?*
11. *The dissolution of NH_4Cl in water is an endothermic process. What is the effect of temperature on its solubility?*
12. *Mixing of acetone with chloroform takes place with reduction in volume. What type of deviation from Raoult's Law is shown in this case?*
13. *Can we separate the components of an azeotropic mixture by distillation?*
14. *What will happen if pressure greater than osmotic pressure is applied on the solution side, separated from the solvent by a semipermeable membrane?*
15. *Equimolal solutions of sodium chloride and glucose are not isotonic. Explain why.*
16. *Why is it advised to add ethylene glycol to water in a car radiator while driving in a hill station?*
17. *Why is greater care taken in intraveneous injections to have comparable concentration of solutions to be injected to that of blood plasma?*
18. *The osmotic pressure of a 0.25 M urea solution is 2.67 atm. What will be the osmotic pressure of a 0.25 solution of potassium sulphate?*
19. *The elevation of boiling point produced by dilute equimolal solutions of three substances are in the order: A > Glucose > B. Suggest a reason for this observation.*

20. *Fill in the blanks with suitable words.*

(*i*) Elevation in boiling point and osmotic pressure are _____ properties.

(*ii*) According to Raoult's Law, the relative lowering in vapour pressure is equal to the mole fraction of _____.

(*iii*) Isotonic solutions have _____ osmotic pressure.

(*iv*) _____ in boiling point of a solvent is proportional to _____ of the solution *(1998)*

(*v*) The osmotic pressure of 0.1M NaCl and 0.1M urea solutions are _____ at the same temperature.

(*vi*) The solubility of gases in water _____ as the pressure increases.

(*vii*) The solution of benzene and toluene is a/an _____ solution.

(*viii*) Ideal solutions obey _____ Law.

(*ix*) 3 g of a solute of molar mass 30 is dissolved in 250 g of water. The molality of the solution is _____. *(IIT 1983)*

(*x*) Colligative properties of a dilute solution depend upon _____ of solute present in the solution.

(*xi*) _____ solutions of different non-volatile solutes in the same solvent (which neither dissociate nor associate in solutions) will have same boiling points or freezing points.

(*xii*) Plant cells shrink when placed in a _____ solution.

(*xiii*) Pure water can be obtained from sea water by _____.

(*xiv*) _____ is known as an anti freeze and is used to depress the _____ of water used in car radiators.

(*xv*) Semi-permeable membrane of _____ does not work in non-aqueous solutions because it dissolves in non-aqueous solvents.

(*xvi*) _____ and _____ are used to clear snow on roads as they depress the freezing point of water and reduce the temperature at which ice is expected to be formed.

(*xvii*) The shrinking of a cell due to flow of water out of the cell is called _____.

(*xviii*) The _____ is measured by Ostwald and Walker's method.

(*xix*) A 0.91% or 0.16 M NaCl solution is _____ with human RBCs.

(*xx*) _____ is the best colligative property to determine the molecular mass of polymers such as proteins.

(*xxi*) Given that ΔT_f is the depression in freezing point of the solvent in a solution of a non-volatile solute of molality '*m*', the quantity $\left(\frac{\Delta T_f}{m}\right)_{m\to o}$ is equal to _____ . *(IIT 1994)*

(*xxii*) A solution which does not obey Raoult's Law is called a/an _____ solution.

(*xxiii*) _____ Law indicates the relationship between solubility of a gas in a liquid and pressure.

(*xxiv*) _____ solutions can be separated by fractional distillation.

(*xxv*) _____ is a process in which the solvent molecules move towards pure solvent through semi-permeable membrane when pressure is applied on solution side from concentrated solution.

(*xxvi*) When HgI_2 is mixed with an aqueous solution of KI, then freezing point of the solution _____.

(*xxvii*) The _____ of the boiling point of a solvent by the addition of a solute is _____ proportional to the molality of the solution. *(2009)*

(*xxviii*) The _____ pressure of an aqueous solution of 0.1 M cane sugar is _____ than that of pure water. *(2010)*

21. *State, whether the following statements are True or False. If false, write the correct statement.*

(*i*) If two pure liquids are mixed to give an ideal solution, then ΔV_{mixing} and ΔH_{mixing} are zero.

(*ii*) The osmotic pressure is directly proportional to absolute temperature when concentration remains the same.

(*iii*) Molecular elevation constant and molal elevation constant of a solvent have the same value.

(*iv*) Freezing point of a solvent is directly proportional to molality of the solution. *(2001)*

(*v*) The value of van't Hoff factor is more than one in dissociation and less than one in association.

(*vi*) Molality of a solution changes with temperature whereas mole fraction does not change with temperature. *(1995)*

(*vii*) Addition of sodium chloride lowers the boiling point and freezing point of water. *(2003)*

(*viii*) Osmotic pressure and boiling point are colligative properties. *(2004)*

(*ix*) Fractional distillation cannot be applied to non-ideal solutions.

(*x*) Osmosis can be reversed by application of pressure on solution side.

(*xi*) Beckmann's thermometer can be used to measure any temperature between 0 °C to 100 °C.

(*xii*) Vapour pressure is a colligative property.

(*xiii*) Osmotic pressure is the best colligative property to determine the molecular mass of polymers such as proteins.

(*xiv*) The molarity of pure water is 55.5 M.

(*xv*) The temperature at which vapour pressure of a solvent is equal to external pressure is termed as its boiling point.

(*xvi*) Osmotic pressure is equivalent to mechanical pressure which must be applied on solution side to prevent osmosis.

(*xvii*) The molecular mass of an electrolyte determined by the application of a colligative property is always more than the normal molecular mass.

(*xviii*) $K_b = \Delta T_b$, when molality of the solution is one.

(*xix*) Berkeley and Hartley's method is used for the measurement of depression in freezing point.

(*xx*) Water boils below 100 °C on the addition of NaCl. *(2008)*

(*xxi*) Maximum boiling azeotropes show positive deviations from Raoult's Law.

(*xxii*) Completely miscible liquid pairs cannot be separated by fractional distillation.

(*xxiii*) A solution having ΔH_{mixing} = – ve will exhibit positive deviations from Raoult's Law.

(*xxiv*) In the process of osmosis, solvent molecules move from the dilute solution towards the solution of higher concentration.

22. *Match the following:*

(*i*)	Beckmann	(*a*)	Berkeley and Hartley's method *(2009)*
(*ii*)	Cottrell	(*b*)	Directly proportional to molality of solution
(*iii*)	Elevation in boiling point	(*c*)	Cryoscopic method *(2002)*
(*iv*)	Isotonic solutions	(*d*)	Ebullioscopic method *(2006, 2002)*
(*v*)	Osmotic pressure	(*e*)	Solutions have same osmotic pressure
(*vi*)	Ethanol and water	(*f*)	Raoult's Law *(2009)*
(*vii*)	Benzene and toluene	(*g*)	Minimum boiling azeotropes
(*viii*)	Reverse osmosis	(*h*)	Ideal solution
(*ix*)	van't Hoff factor	(*i*)	Desalination of sea water
(*x*)	Dilute solution	(*j*)	$\frac{\text{Observed colligative property}}{\text{Normal colligative property}}$

23. *Choose the correct answer for the following:*

(*i*) The relative lowering of vapour pressure of a solvent by the addition of a solute is
(*a*) proportional to the molality of the solution.
(*b*) proportional to the molarity of the solution.
(*c*) equal to the mole fraction of solute.
(*d*) equal to the mole fraction of solvent. *(2000)*

(*ii*) The molecular mass of proteins can be best determined by
(*a*) Victor Meyer method. (*b*) relative lowering of vapour pressure.
(*c*) osmotic pressure. (*d*) None of the above.

(*iii*) The molal elevation constant is the ratio of the elevation in boiling point to
(*a*) molarity. (*b*) molality.
(*c*) mole fraction of solute. (*d*) mole fraction of solvent.

(*iv*) Which of the following is not a colligative property?
(*a*) Osmotic pressure (*b*) Relative lowering of vapour pressure
(*c*) Depression in freezing point (*d*) Refractive index

(*v*) In cold countries, ethylene glycol is added to water in the radiators of cars during winters. It results in
(*a*) reducing viscosity. (*b*) reducing specific heat.
(*c*) reducing freezing point. (*d*) reducing boiling point.

(*vi*) The lowest freezing point of 0.1 M aqueous solution is of
(*a*) potassium sulphate. (*b*) sodium chloride.
(*c*) urea. (*d*) glucose. *(2006)*

(*vii*) Solutions which distil without change in composition or temperature are called
(*a*) amorphous. (*b*) azeotropic mixtures.
(*c*) super-saturated. (*d*) ideal.

(*viii*) An azeotropic mixture of two liquids boils at a lower temperature than either of them when
(*a*) it is saturated.
(*b*) it does not deviate from Raoult's Law.
(*c*) it shows negative deviation from Raoult's Law.
(*d*) it shows positive deviation from Raoult's Law.

(*ix*) Which of the following solution pairs can be separated by fractional distillation?
(*a*) Water-nitric acid (*b*) Water-hydrochloric acid
(*c*) Benzene-toluene (*d*) Ethanol-water

(*x*) The azeotropic mixture of water (b.p. = 100 °C) and HCl (b.p. = 85 °C) boils at 108.5 °C. When this mixture is distilled, it is possible to obtain
(*a*) pure HCl. (*b*) pure water.
(*c*) pure water as well as HCl. (*d*) neither HCl nor H_2O in pure states.

(*xi*) The molecular weight of benzoic acid in benezene as determined by depression in freezing point method corresponds to
(*a*) ionisation of benzoic acid. (*b*) dimerisation of benzoic acid.
(*c*) trimerisation of benzoic acid. (*d*) solvation of benzoic acid. *(IIT 1996)*

(*xii*) Azeotropes are
(*a*) liquid mixtures which distil unchanged in composition.
(*b*) liquids which can mix with each other in all proportions.
(*c*) solids which form solid solutions of definite composition.
(*d*) gases which can be separated. *(IIT 1996)*

(*xiii*) When the depression in freezing point is carried out, then equilibrium exists between *(IIT 2003)*
(*a*) liquid solvent and solid solvent. (*b*) liquid solute and solid solvent.
(*c*) liquid solute and solid solute. (*d*) liquid solvent and solid solute.

(*xiv*) Aqueous solutions of 0.004 M sodium sulphate and 0.01 M glucose are isotonic. The degree of dissociation of sodium sulphate is
(*a*) 25%. (*b*) 60%.
(*c*) 75%. (*d*) 85%. *(IIT 2004)*

(*xv*) 13.44 g of $CuCl_2$ is dissolved in 1 kg of water. Determine the elevation in boiling point of the solution. (K_b = 0.5 K kg mol^{-1} and molecular weight of $CuCl_2$ = 134.1.)
(*a*) 0.16 (*b*) 0.052
(*c*) 0.1 (*d*) 0.5 *(IIT 2005)*

(*xvi*) When 20 g of naphthoic acid ($C_{11}H_8O_2$) is dissolved in 50 g of benzene (K_f = 1.72 K kg mol^{-1}), a freezing point depression of 2K is observed. The van't Hoff factor, '*i*' is
(*a*) 0.5. (*b*) 1.
(*c*) 2. (*d*) 3. (*IIT 2007*)

(*xvii*) The molecular weight of sodium chloride determined by measuring the osmotic pressure of its aqueous solution is
(*a*) Double the theoretical value. (*b*) Same as the theoretical value.
(*c*) Half the theoretical value. (*d*) Three times the theoretical value. (*2009*)

(*xviii*) For a dissociated solute in solution, the value of van't Hoff factor is
(*a*) zero. (*b*) one.
(*c*) greater than one. (*d*) less than one. (*2010*)

Long Answer Questions

1. *What is the principle of determining the molecular weight of a non-volatile solute by osmotic pressure method?*
2. *The molecular weights of potassium chloride and glucose are determined by the depression of freezing point method. As compared to their theoretical molecular weights, what do you expect are the molecular weights determined by this experiment? Why?* (*2000*)
3. *Solution A is prepared by dissolving 2 moles of glucose in 1 litre of water and solution B is prepared by dissolving 1 mole of sodium chloride in 1 litre of water. Will the osmotic pressure of solution A be higher, lower or equal to that of B? Give reasons for your answer.* (*1998*)
4. (*i*) *Define osmotic pressure.*
   (*ii*) *How is osmotic pressure measured by Berkeley and Hartley's method? What are the advantages of this method?* (*2004*)
5. *Define osmotic pressure. Arrange the following in increasing order of osmotic pressure and give reasons in support of your answer:*
   (*i*) *34.2 g per litre of sucrose (molecular weight = 342).*
   (*ii*) *90.0 g per litre of glucose (molecular weight = 180).*
   (*iii*) *5.85 g per litre of sodium chloride (molecular weight = 58.5).* (*2004*)
6. *Two liquids A (b.p. = 85 °C) and B (b.p. = 110 °C) form a mixture which shows a minimum in its vapour pressure-composition plot.*
   (*i*) *Schematically represent the temperature-composition curve for the vapours in equilibrium with the liquids.*
   (*ii*) *Can the two liquids be completely separated by fractional distillation?* (*1998*)
7. *What type of completely miscible liquid pairs can be separated completely by fractional distillation? Give an example of such a pair. Draw the temperature–composition phase diagram indicating the phases present.* (*1999*)
8. *What are azeotropic mixtures? Give an example.*
9. *Explain the principle of fractional distillation.*
10. (*i*) *What is fractional distillation?*
    (*ii*) *State two requirements for using this technique.*
    (*iii*) *What types of liquids cannot be separated by using this method? Why?* (
11. *Water boils at 100 °C and ethyl alcohol at 78 °C. The vapour pressure-composition curve of this binary liquid system shows a maximum value. Sketch the boiling point-composition curve. Explain what happens when a solution containing 90% water and 10% alcohol is distilled. Can pure alcohol be obtained from this mixture by distillation?* (*2003*)

A. Fill in the Blanks :

1. The ..... in boiling point of a solvent is directly proportional to the ..... of the solution.
2. The ..... of the number of solvent moles to the total number of moles of solute and solvent is called .....
3. Relative lowering of vapour pressure is equal to the ..... of the solute in dilute solutions.
4. The colligative Properties of 0·1 M glucose solution will be ..... than that of 0·1 M sodium chloride solution.
5. For $CaCl_2$ solution, Van't Hoff factor (i) is ..... than one.
6. The freezing point of 0·1 M KCl solution is ..... than 0°C.
7. Van't Hoff factor for sucrose is ..... one while that for potassium ferrocyanide is ..... one.
8. The .....of the boiling point of a solvent by the addition of a solute is ..... proportional to the molality of the solution.

B. Correct the following statements :

(i) The molality of a solution depends on the temperature where as the mole fraction of a solution does not change with temperature. **(1995)**

(ii) Freezing point of a solution is directly proportional to its molality. **(2001)**

(iii) Addition of sodium chloride lowers the boiling point and freezing point of water. **(2003)**

(iv) Osmotic Pressure and boiling point are colligative Properties.

(v) The boiling point is directly proportional to the molality of the solution.

(vi) All solutions obey Raoult's law.

(vii) Water boils below 100°C by the addition of NaCl. **(2008)**

C. Choose the answer by selecting the correct alternative from the choices given :

1. The relative lowering of vapour pressure of a solvent by addition of a non volatile solute is : **(2000)**
   (a) Proportional to the molality of the solution
   (b) Proportional to the molarity of the solution
   (c) equal to the mole fraction of the solute
   (d) equal to the mole fraction of the solvent
2. Which is not a colligative property ?
   (a) osmotic pressure (b) lowering of vapour pressure
   (c) depression in freezing point (d) Molal elevation constant
3. The molal elevation constant is the ratio of the elevation in boiling point to :
   (a) molarity (b) molality
   (c) mole fraction of solute (d) mole fraction of solvent
4. The lowest freezing point of 0·1 M aqueous solution is of :
   (a) K_2SO_4 (b) NaCl
   (c) Urea (d) Glucose

5. The osmotic pressure of equimolar solutions of glucose, sodium chloride and barium chloride will be in the order :
(a) $BaCl_2$ > NaCl > glucose
(b) $BaCl_2$ > glucose > NaCl
(c) Glucose > $BaCl_2$ > NaCl
(d) NaCl > $BaCl_2$ > glucose

6. Van't Hoff factor for 0·1 M ideal solution is :
(a) 0·1
(b) 1
(c) 0·01
(d) none

7. Which of the following salts would have the same value of Van't Hoff factor as that of K_3 [Fe (CN)$_6$].
(a) Al_2 $(SO_4)_3$
(b) NaCl
(c) Na_2SO_4
(d) Al $(NO_3)_3$

8. The molal freezing point constant for water is 1·86. If 342 gm of cane sugar is dissolved in 1,000 gm of water, the solution will freeze at :
(a) 1·86°C
(b) – 1·86°C
(c) – 3·92°C
(d) 3·92°C

9. What is the Van't Hoff factor when benzene vapour pressure falls from165 mm to 162 mm on addition of 6g of CH_3COOH to 3 moles of benzene ?
(a) 0.56
(b) 0.325
(c) 2
(d) 0.07

10. If an aqueous solution of glucose is allowed to freeze, the crystals of which will be separated out first ?
(a) glucose
(b) water
(c) both of these
(d) none of these

11. The elevation in boiling point of a solution of 13.44 g of $CuCl_2$ in 1kg of water is (Given $k_b = 052$ K Kg mol^{-1}) molecular weight of $CuCl_2$ = 134.4)
(a) 0.05
(b) 0.1
(c) 0.16
(d) 0.21

12. A solution of urea (nol mass 56 g mol^{-1}) boils at 100.18°C at the atmospheric pressure. If K_f and K_b for water are 1.86 and 0.512 K Kg mol^{-1} respectively, the above solution will freeze at
(a) – 6.54°C
(b) –0.654°C
(c) 6.54°C
(d) 0.654°C

13. Which has the highest freezing point ?
(a) 1 m K_4[Fe(CN)$_6$] solution
(b) 1 m $C_6H_{12}O_6$ solution
(c) 1 m KCl solution
(d) 1 m $CaCl_2$ solution

14. At same temperature, which pair of the following solutions are isotonic solutions ?
(a) 0.2 m $BaCl_2$ and 0.2 m urea
(b) 0.1 m urea and 0.1 m NaCl
(c) 0.1 m NaCl and 0.1 m K_2SO_4
(d) 0.1 m Ba $(NO_3)_2$ and 0.1 m Na_2SO_4

15. The solution which has the lowest freezing point is
(a) 0.1 m potassium chloride
(b) 0.1 m potassium sulphate
(c) 0.1 m potassium nitrate
(d) 0.1 m aluminium sulphate

16. Phenol dimerises in benzene having Van't Hoff factor 0.54. What is the degree of association ?
(a) 0.46
(b) 0.54
(c) 0.27
(d) 0.92

17. When 20 g of naphthoic acid ($C_{11}H_8O_2$) is dissolved in 50 g of benzene (K_f = 172 K Kg mol^{-1}) a freezing point depression of 2 K is observed. The Van't Hoff factor is
(a) 0.5
(b) 1
(c) 2
(d) 3

18. The molecular weight of sodium chloride determined by measuring the osmotic pressure of its aqueous solution is :
(a) Double the theoretical value
(b) Same as theoretical value
(c) Half the theoretical value
(d) Three times the theoretical value. **(2009)**

D. Long Answer Questions

1. Name the law or principle obeyed in the following case :
   For the solution of a non volatile solute the mole fraction of the solute determines the vapour pressure of the solvent. **(1996)**
2. Solution A is prepared by dissolving 2 moles of glucose in 1 litre of water and solution B is prepared by dissolving 1 mole of sodium chloride in 1 litre at water. With the osmotic pressrue of the solution A be higher, lower or equal to that of B ? Give reasons for your answer. **(1998)**
3. The molecular weights of KCl and glucose are determined by the depression of freezing point method. As compared to their theoretical molecular weights, what do you expect are the molecular weights determined by this experiments ? Why ? **(2000)**
4. Define osmotic pressure. Arrange the following in increasing order of osmotic pressure and give reasons in support of your answer.
   (i) 34·2 gm per litre of sucrose (MW = 342)
   (ii) 90 gm per litre of glucose (MW = 180)
   (iii) 5·85 gm per litre of sodium chloride MW = 58·5
5. The molecular weights of sodium chloride and glucose are determined by the depression in freezing point method. Compared to their theoretical molecular weights, what will be their observed molecular weights when determined by the above method. Justify your answer. **(2007)**

E. Numerical Problems

1. The osmotic pressure of a dilute aqueous solution of a compound X containing 0·12 gm/litre is twice the osmotic pressure of dilute solution of another compound Y containing 0·18 gm/litre. What is the ratio of the molecular weight X to that of Y ? Both X and Y remain in the molecular form in solution.
2. The vapour Pressure of an aqueous solution of a non-volatile solute whose mole fraction is 0·01 is found to be 34·65 torr. What is the vapour pressure of pure water at the same temperature ? **(1997)**
3. 5 gm of a substance with molecular weight 200 is dissolved in 50 gm of a solvent with molecular weight 60 and vapour pressure 40 cm Hg at 27°C. Calculate the vapour Pressure of the solution at this temperature. **(1998)**
4. Calculate the weight of glucose which when dissolved in 100 gm of water Produces the same lowering of vapour pressure as 10 gm of fructose dissolved in 50 gm of water. Name the law used in deducing the answer. **(1999)**
5. A solution to be used in hand lotion is prepared by mixing 90 gm of water, 9·2 gm ethyl alcohol and 18·4 gm of glycerol ($C_3H_8O_3$). Calculate the mole fraction of glycerol present in it. **(1999)**
6. At 37°C, the osmotic pressure of blood is 7·65 atm. How much glucose (mol wt. 180) should be used per litre for the intravenous injection that is isotonic with blood ? **(1999, 2001)**
7. The cryoscopic constant of water is 1·806 K $mole^{-1}$ kg. an aqueous solution of cane sugar freezes at – 0·372°C. Calculate the molality of the solution. **(2000)**
8. 0·5 gm of a non-volatile solute is dissolved in 100 gm of ethyl acetate at 20°C. The vapour Pressure of the solution and the pure ethyl acetate are 72 torr and 72·89 torr respectively at 20°C. Calculate the molecular mass of the solute. **(2001)**

9. The freezing point of nitrobenzene is 278.8 K. A 0.25 molal solution of a substance (molecular weight 120) in nitrobenzene has a freezing point of 276.8 K. Calculate molal depression constant of nitrobenzene. **(2002)**

10. Calculate the osmotic pressure of a solution containing 3·42 gm of sucrose in 1 litre of water at 400 K.

11. An aqueous solution containing 0·2 gm of compound A in 21·7 gm of water freezes at 272·814 K. If the value of K_f for water is 1·86 K kg mole^{-1}. Calculate the molecular

12. Calculate the mole fraction of water in a NaOH solution which has 80 gm of NaOH and 54 gm of H_2O. (Relative atomic masses of Na : 23, O = 16, H = 1) **(2005)**

13. The depression in the freezing point of a sugar solution was found to be 0·402°C. Calculate the osmotic pressure of the sugar solution at 27°C. (K_f = 1·86 K kg mole^{-1})

14. A solution is prepared by dissolving 2 gm of sucrose and 2 gm of urea in 100 gm of water at 298 K. Calculate the vapour pressure of the solution if the V.P. of pure water at 298 K is 23·756 torr. (Mol. wt. of urea = 60 and sucrose = 342)

15. A decinormal solution of sodium chloride exerts an osmotic pressure of 4·82 atm at 27°C. Calculate the degree of dissociation of sodium chloride. **(2007)**

16. An aqueous solution of cane sugar containing 1.72 gm in 100 ml begins to freeze at −0.093°C. The depression in freezing point constant (K_f) of water is 1.86 K mole^{-1} kg.

17. If the molality of an aqueous solution of cane sugar is 0.4445, what is the mole fraction of cane sugar ? **(2008)**

18. Albumins are the most abundant proteins in blood. At 25°C, 3.5 g of albumin in 100 ml of water produces an osmotic pressure of 0.014 atms. What is the molecular weight of albumin ?

19. The boiling point of pure water is 373 K. Calculate the boiling point of an aqueous solution containing 18 gms of glucose (mw = 180) in 100 gms of water. Molal elevation constant of water is 0.52 K Kg mol^{-1}.

20. Equal weights of two substances X and Y are dissolved in equal volumes of water. The osmotic pressure of the solution containing Y is five times the osmotic. Pressure of the solution containing X. What is the molecular weight of X if that of Y is 60 ? **(2009)**

21. Which of the following solutions will have a lower vapour pressure and why ?
    (i) A 5% solution of cane sugar ($C_{12}H_{22}O_{11}$)
    (ii) A 5% solution of urea (NH_2CONH_2)

22. 2 gm of benzoic acid (C_6H_5COOH) dissolved in 25 gm of benzene shows a depression in freezing point equal to 1·62 K. K_f for benzene is 4·9 K Kg mole^{-1}. What is the percentage association of acid if it forms dimer in solution.

23. 0.5 g KCl was dissolved in the water and the solution originally at 0°C from at −0·24 C°. Calculate the percentage ionisation of the salt. K_f per 1000 g of water = 1.86.

24. Methanol and ethanol form nearly an ideal solution at 300 K. A solution is made by mixing 32 g methanol and 23 g ethanol at 300 K. Calculate the partial pressures of the constituents and the total pressure of the solution.
    At 300 K, $P^0_{CH_3OH}$ = 90 mm Hg, $P^0_{C_2H_5OH}$ = 51 mm Hg

25. The vapour pressures of benzene and toluene at 293 K are 75 mm and 22 mm Hg respectively 23.4 g of benzene and 64.4 g of toluene are mixed. If the two form an ideal solution. Calculate the mole fraction of benzene in the vapour phase assuming that the vapours are in equilibrium with the liquid mixture at this temperature.

26. The vapour pressure in the pure state at 300 K of two immiscible liquids A and B are 60 torr and 25 torr respectively. If 2 moles of A and 8 moles of B are mixed, what will be the total vapour pressure over the mixture at 300 K if the total volume of the mixture is 1000 ml. **(1993)**

Unsolved Questions

1. How many grams of ethylene glycol (molar mass = 62) should be added to 10 kg of water so that the resulting solution freezes at $-10°C$. ($K_f = 1 \cdot 86$)
   [**Ans.** 3 · 3 kg.]
2. Calculate the osmotic Pressure of a solution containing 10 g each of glucose ($C_6H_{12}O_6$) and sucrose ($C_{12}H_{22}O_{11}$) in 1,000 cm^3 of solution at 25°C.
   (R = 0 · 083 L bar K^{-1} $mole^{-1}$)
   [**Ans.** 2 · 1 bar]
3. The boiling point of water (100°C) becomes 100 · 52°C if 3 g of a non-volatile solute is dissolved in 20 ml of it. Calculate the molar mass of solute (K_b for water = 0 · 52 Km^{-1})
   [**Ans.** 150]
4. The vapour Pressure of pure water at 30°C is 31 · 80 mm Hg. How many gms of urea (molar mass = 60) should be dissolved in 100 g of water to lower the V.P. by 0 · 25 mm of Hg ?
   [**Ans.** 2 · 62 g.]
5. The freezing point of a solution containing 0 · 2 g of acetic acid in 20 g of benzene is lowered by 0 · 45°C. Calculate the degree of association of acetic acid in benzene (K_f for benzene is 5 · 12 K Kg $mole^{-1}$)
   [**Ans.** α = 94 · 5% or 0 · 945]
6. Calculate the boiling point of a solution containing 0 · 61 g of benzoic acid in 50 gm of CS_2 (l) assuming 84% dimerisation of the acid. The boiling point and K_b of CS_2 are 46 · 2°C and 2 · 3 K Kg $mole^{-1}$ respectively.
   [**Ans.** 46 · 3334°C]
7. If the osmotic pressure of a solution of 6 g of a substance in 1 litre of water at standard temperature is 2 · 24 atm. What is the molar mass of the substance ?
   [**Ans.** 60 gm/mole]
8. A solution of 2 · 95 g of sulphur in 100 g of cyclohexane had a freezing point of 4 · 18°C. The freezing point of pure cyclohexane is 6 · 5°C. What is the molecular formula of sulphur ? (K_f for cyclohexane = 20 · 2 Km^{-1}).
   [**Ans.** S_8]
9. The boiling point of ethanol is 78°C and its molar boiling point elevation constant per 1,000 g is 1 · 15 K. A solution of 1 · 12 g of a camphor in 32 g of ethanol has a boiling point of 78 · 28°C. Calculate the molecular mass of camphor.
   [**Ans.** 143 · 75 gm mol^{-1}]
10. Concentrated sulphuric acid has a density of 1 · 9 m/ml and 99% H_2SO_4 by weight. Calculate the molarity of sulphuric acid this acid.
    [**Ans.** 19 · 19 M]
11. An aqueous solution of NaCl is marked 10% (w/w) on the bottle. If the density of the solution is 0 · 071 g/cc. What is the molality and molarity ? Also what is mole fraction component in the solution.
    [**Ans.** 1 · 9 m, 1 · 83 M, 0 · 03]
12. A solution of sucrose has been prepared by dissolving 68 · 4 g of sucrose in 1 Kg of water. Calculate the following :
    (i) The vapour pressure of the solution at 298 K.
    (ii) Osmotic Pressure of the solution at 298 K.
    (iii) Freezing point of the solution.
    (Given : Vapour Pressure of water at 298 K = 0 · 024 atm, K_f for water 1 · 86 K Kg $mole^{-1}$)
    [**Ans.** (i) 0 · 0239 atm (ii) 4 · 89 atm (iii) 272 · 628 K]
13. A 1 · 7% solution of $AgNO_3$ is isotonic with 3 · 4% solution of glucose ($C_6H_{12}O_6$). Calculate the degree of dissociation of $AgNO_3$.
    [**Ans.** 90%]
14. The molal freezing point depression constant of benzene (C_6H_6) is 4 · 9 K $molal^{-1}$. Selenium exists as a polymer of Se_x type When 3 · 26 g of selenium is dissolved in 226 gm of benzene the observed freezing point is 0 · 112°C lower than for pure benzene. Deduce the molecular formula of selenium. (At mass of Se = 78 · 8 gm $mole^{-1}$)
    [**Ans.** Se_8]

15. Calculate the freezing point of an aqueous solution of a non-electrolyte having an osmotic pressure of 2 atm at 300K.

(K_f for water = 1·86 K Kg mol^{-1})

[**Ans.** – 0.151°C]

16. Molal elevation constant of chloroform is 3·88. When 0·3 g of camphor is added to 25·2 g of chloroform, the boiling point of solvent is raised by 0·299°C. Calculate the molecular weight of camphor.

[**Ans.** 154]

17. A solution containing 10·2 g of glycerol per litre is found to be isotonic with 2% solution of glucose. Calculate the molecular weight of glycerol. (Mol. wt. of glucose = 180)

[**Ans.** 91·8]

18. Two elements 'A' and 'B' form compounds having formulae AB_2 and AB_4 when dissolved in 20g of benzene,1g of , 1 g of AB_2 lowers the breezing point by 2·3°C whereas 1 g of AB_4 lowers the freezing point by 1·3°C. Calculate the atomic weights of A and B. (K_f for benzene = 5·1 K $molal^{-1}$)

[**Ans.** 25·57, 42·65]

19. Calculate the osmotic Pressure of Potassium ferrocyanide solution whose 0·1 M aqueous solution dissociates to 45% at 298 K.

[**Ans.** 6·85 atm]

20. The vapour Pressure of 5% aqueous solution of a non-volatile organic substance is 745 mm at 373 K. Calculate the molecular mass of the solute.

[**Ans.** 47·04]

21. Calculate K_b of water when 1 mole of the solute is dissolved in 1000 g of water. The latent heat of vaporisation of water is 539·9 calories per gram.

[**Ans.** 0·514]

22. Calculate the osmotic pressure of a solution obtained by mixing 100 cm^3 of 4·5% solution of urea (molecular mass = 60) and 100 cm^3 of 3·42% solution of cane sugar (molecular mass = 342) at 300 K.

[**Ans.** 10·455 atm]

23. Addition of 0.643 g of a compound to 50 ml of benzene (density = 0.879 g/ml) lowers the freezing point from 5.51°C to 5.03°C. If K_f for benzene is 5.12, calculate the molecular weight of the compound.

[**Ans.** 156.056]

24. 1.22 g benzoic acid is dissolved in (i) 100 g of acetone (K_b for acetone = 1.7) and (ii) 100 g of benzene (K_b for benzene = 2.6).The elevation in boiling points are 0.17°C and 0.13°C respectively.

(a) What are the molar masses of benzoic acid in both the solution ?

(b) What do you deduce out of it in terms of the structure of benzoic acid ?

[**Ans.** (a) 122,224 (b) It forms dimer in benzene]

25. Calculate the osmotic pressure and vapour pressure of 0.6% aqueous solution of urea (NH_2CONH_2) at 298 K. The vapour pressure of pure water at 298 K is 24 mm Hg. (Density of the solution is 1 g ml^{-1}).

[**Ans.** 2.44 atm, 23.96 mm Hg]

26. At 300 K, 36 g of glucose present per litre in its solution has an osmotic pressure of 4.98 bar. If osmotic pressure of solution is 1.52 bar at 300 K, what would be its concentration ?
[**Ans.** 10.98 gL^{-1}]

27. 0.01 m aqueous solution of $K_3[Fe(CN)_6]$ freezes at $-0.062°C$. What is the apparent percentage of dissociation ? (K_f for $= 1.86$ K Kg mol^{-1}).
[**Ans.** 77.7%]

28. An aqueous solution containing 1.248 g of barium chloride (molar mass = 208.34 g mol^{-1}) in 100 g of water boils at 100.0832°C. Calculate the degree of dissociation of $BaCl_2$. (K_b for water $= 0 \cdot 52$ K $molal^{-1}$).
[**Ans.** 83.5%]

29. Calculate the Van't Hoff factor of $CdSO_4$ (molar mass 208.4) if the dissociation of 5.21 g of $CdSO_4$ in half litre water gives a depression in freezing point of 0.168°C (K_f for water is 1.86 K $molal^{-1}$).
[**Ans.** 1.806]

30. To 500 cm^3 of water, 3×10^{-3} kg of acetic acid is added. If 23% of acetic acid is dissociated, what will be the depression in freezing point ? K_f for water $= 1.86$ K $molal^{-1}$, density of water $= 0.997$ g cm^{-3})
[**Ans.** 0.229°]

31. Solutions of A and B follow Raoult's law. At 300 K, when the total pressure above a given solution is 400 mm Hg, the mole fraction of A in the vapour is 0.45 and in liquid is 0.65. Calculate the vapour pressures of two liquids in the pure state at 300 K.
[**Ans.** 276.92 mm,628.57 mm]

32. The vapour pressure of pure liquid 'A' is 70 torr. It forms an ideal solution with B. The mole fraction of B is 0.2 and the total pressure of solution is 84 torr at 310 K. Calculate the vapour pressure of pure liquid 'B' at 310 K.
[**Ans.** 140 torr]

Q. 1. Define the term solution. How types of solutions are formed ? Write briefly about each type with an example.

Q. 2. Suppose a solid solution is formed between two substances, one whose particles are very large and the other whose particles are very small. What type of this solid solution is likely to be ?

Q. 3. Define the following terms
(*i*) mole fraction (*ii*) molality (*iii*) molarity (*iv*) mass percentage

Q. 4. Concentrated nitric acid used in the laboratory is 68% nitric acid by mass in aqueous solution. What should be the molarity of such a sample of the acid if the density of the solution is 1·504 g mL^{-1} ?

Q. 5. A solution of glucose in water is labelled as 10 per cent w/w. What would be the molality and mole fraction of each component in the solution ? If the density of the solution is 1·2 g mL^{-1}, then what shall be the molarity of the solution ?

Q. 6. How many mL of a 0·1 M HCl are required to react completely with 1 g mixture of Na_2CO_3 and $NaHCO_3$ containing equimolar amounts of the two ?

Q. 7. A solution obtained by mixing 300 g of 25% and 400 g of 4% solution by mass. Calculate the mass percentage of the resulting solution ?

Q. 8. An antifreeze 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 the solution is 1·072 g mL^{-1}, then what shall be the molarity of the solution ?

Q. 9. A sample of drinking water was found to be severely contaminated with chloroform, $CHCl_3$, supposed to be a carcinogen. The level of contamination was 15 ppm (by mass).
(i) Express this in percent by mass.
(ii) Determine the molality of chloroform in the water sample.