Solutions Assignment

1 Marks Questions

Q1. Define mole fraction.

Q2. Explain the Henery's law about dissolution of a gas in a liquid.

Q3. What is meant by molality of the solution?

Q4. State the main disadvantage of molarity over molality as the unit of concentration.

Q5. Define ideal solution.

Q6. State Raoult's law for a solution of volatile liquids.

Q7. Define the term azeotrope.

Q8. Define the term osmotic pressure.

Q9. Define the following terms:
(a) Isotonic solutions
(b) Van't Hoff factor

Q10. Explain boiling point elevation constant for a solvent or ebullioscopic constant.

Q11. What is meant by reverse osmosis?

Q12. What is meant by colligative properties?

2 Marks Questions

Q1. A solution of glucose in water is labelled as 10% by weight and the density of the solution is 1.2g ml^{-1}. What would be the molarity of the solution? (Ans = 0.67M)

Q2. If the density of water of a lake is 1.25gml^{-1} and one kg of lake water contains 92g of Na^+ ions, Calculate the molarity of Na^+ ions in this lake water. (Na = 23 g $mole^{-1}$) (Ans = 4.579M)

Q3. State Henry's law and give its two applications.

Q4. The solubility of pure nitrogen gas at 25^0C and 1atm pressure is $6.8X10^{-6}molL^{-1}$. What is the concentration of nitrogen dissolved in water under atmospheric conditions? The partial pressure of nitrogen gas in the atmosphere is 0.78atm. (Ans = 5.304×10^{-4} mol L^{-1})

Q5. State Raoult's law for a solution containing volatile components. How does Raoult's law become a special case of Henry's law?

Q6. What is meant by positive and negative deviations from Raoult's law and how is the sign of ΔmixH related to positive and negative deviations from Raoult's law?

Q7. State how the vapour pressure of a solvent is affected when a non-volatile solute is dissolved in it?

Q8. What is meant by negative deviations from Raoult's law? Draw a diagram to illustrate the relationship between vapour pressure and mole fractions of components in a solution to represent negative deviation.

Q9. An aqueous solution of sodium chloride freezes below 273K. Explain the lowering in freezing point of water with the help of a suitable diagram.

Q10. 18 g glucose, $C_6H_{12}O_6$ (molar mass = 180g mol^{-1}) is dissolved in 1 kg of water in a sauce pan. At what temperature will this solution boil? (Ans = 373.202K)

Q11. A 1.00 molal aqueous solution of trichloroacetic acid (CCl_3COOH) is heated to its boiling point. The solution has the boiling point 100.18^0C. Determine the van't Hoff factor for trichloroacetic acid.
(Kb for water = 0.512 K Kg mol^{-1}). (Ans = i=0.35)

Q12. Define the term osmosis and osmotic pressure. Is the osmotic pressure of a solution a colligative property? Explain.

Q13. What is von't Hoff factor? What possible values can it have if the solute molecules undergo dissociation?

Q14. The molecular mass of polymers is determined by osmotic pressure method and not by measuring other colligative properties. Give two reasons.

Q15. Define the terms osmosis and osmotic pressure. What is the advantage of osmotic pressure as compared to other colligative properties for the determination of molar mass of solute in solution?

Q16. Find the boiling point of a solution containing 0.520g of glucose dissolved in 80.2 g of water.
(Given Kb for water = 0.52Km^{-1}) (Ans = 373.019K)

Q17. Find the freezing point of a solution containing 0.520g of glucose dissolved in 80.2 g of water.
(Given Kf for water is = 1.86Km^{-1}) (Ans = 272.933K)

Q18. The depression in freezing point of water observed for the same molar concentration of acetic acid, trichloroacetic acid and trifluoroacetic acid increases in the order as stated above. Explain.

3 Marks Questions

Q1. What concentration of nitrogen should be present in a glass of water at room temperature? Assume a temperature of 25^0C, a total pressure of 1atm and mole fraction of nitrogen in air of 0.78.
(K_H for nitrogen = 8.42 $X10^{-7}$ M/mm Hg). (Ans = 4.99 $X\ 10^{-4}$M)

Q2. Henry's law constant for CO_2 dissolving in water is 1.67 $X\ 10^8$ Pa at 298K. Calculate the quantity of CO_2 in 1 litre of soda water when packed under 2.5atm CO_2 pressure at 298K. (Ans = 3.707g)

Q3. The partial pressure of ethane over a saturated solution containing 6.56 $X\ 10^{-3}$g of ethane is 1bar. If the solution were to contain 5.0 $X\ 10^{-2}$g of ethane, then what will be the partial pressure of the gas? (A= 7.62bar)
Q4. Determine the osmotic pressure of a solution prepared by dissolving 2.5 $X\ 10^{-2}$g of K_2SO_4 in 2L of water at 25^0C, assuming that it is completely dissociated. (R=0.0821L atm K^{-1} mol^{-1}, molar mass of K_2SO_4 = 174gmol^{-1}). (Ans = 1.76 $X\ 10^{-3}$ atm)

Q5. 1g of a non-electrolyte solute when dissolved in 50g of benzene lowered the freezing point of benzene by 0.40K. Find the molar mass of the solute. (K_f for benzene = 5.12 K kg mol^{-1}). (Ans = 256g $mole^{-1}$)

Q6. Calculate the amount of KCl which must be added to 1Kg of water so that the freezing point is depressed by 2K.(Kf for water = 1.86 K kg mol^{-1}). (Ans = 40.15g)

Q7. At 25^0C, the saturated vapour pressure of water is 3.165k Pa (23.75mm Hg). Find the saturated vapour pressure of a 5% aqueous solution of urea (carbamide) at the same temperature.
(Molar mass of urea = 60.05g mol^{-1}). (Ans = 3.115kPa)

Q8. 15g of an unknown molecular material is dissolved in 450g of water. The resulting solution freezes at -0.34^0C. What is the molar mass of the material? (K_f for water = 1.86 K kg mol^{-1}). (Ans = 182.35g $mole^{-1}$)

Q9. A solution of glycerol ($C_3H_8O_3$) in water was prepared by dissolving some glycerol in 500g of water. This solution has a boiling point of 100.42^0C, what mass of glycerol was dissolved to make this solution?
(K_b for water = 0.512 K kg mol^{-1}). (Ans = 37.73g)

Q10. Calculate the freezing point of an aqueous solution containing 10.50g of $MgBr_2$ in 200g of water (Molar mass of $MgBr_2$ = 184g, K_f for water 1.86 K kg mol^{-1}). (Ans = 271.408K)

Q11. Calculate the boiling point of a solution prepared by adding 15g of NaCl to 250g of water. (K_b for water = 0.512 K kg mol^{-1}, molar mass of NaCl = 58.44 g mol^{-1}). (Ans = 374.051K)

Q12. What would be the molar mass of a compound if 6.21g of it dissolved in 24g of chloroform from a solution that has a boiling point of 68.04^0C. The boiling point of pure chloroform is 61.7^0C and the boiling point elevation constant, Kb for chloroform is 3.63^0C/m. (Ans = 148.15 g $mole^{-1}$)

Q13. A solution prepared by dissolving 8.95g mg of a gene fragment in 35ml of water has an osmotic pressure of 0.335 torr at 25^0C. Assuming the gene fragment is non-electrolyte, determine its molar mass. (Ans = 1.4193 g $mole^{-1}$)

Q14. What mass of NaCl must be dissolved in 65g of water to lower the freezing point of water by 7.50^0C? The freezing point depression constant (Kf) for water is 1.86^0C/m. Assume van't Hoff factor for NaCl is 1.87.
(Molar mass of NaCl = 58.5 g mol^{-1}). (Ans = 8.199g)

Q15. An aqueous solution containing 12.48g of barium chloride in 1 kg of water boils at 373.0832K. Calculate the degree of dissociation of barium chloride.
(Given, K_b for H_2O = 0.52 Km^{-1}, molar mass of $BaCl_2$ = 208.34 g mol^{-1}). (Ans = alpha = 83.5%)

Q16. At 300K, 36g of glucose, $C_6H_{12}O_6$ present per litre in its solution has an osmotic pressure of 4.98bar. If the osmotic pressure of another glucose solution is 1.52 bar at the same temperature, calculate the concentration of the other solution. (Ans = 0.0610 mol L^{-1})

Q17. Calculate the boiling point of one molar aqueous solution. Density of KBr solution is 1.06 g ml^{-1}.
(Kb for water = 0.52 K kg mol^{-1}, atomic mass; K=39, Br=80). (Ans = 373.553K)

Q18. A solution prepared by dissolving 1.25g of oil of winter green (methyl salicylate) in 99g of benzene has a boiling point of 80.31^0C. Determine the molar mass of this compound.
(Boiling point of pure benzene = 80.10^0C and Kb for benzene = 2.53^0C kg mol^{-1}). (Ans = 152 g $mole^{-1}$)

Q19. What mass of ethylene glycol must be added to 5.50kg of water to lower the freezing point of water from 0^0C to -10^0C? (Kf for water is = 1.86 K kg mol^{-1}) (Ans = 1.833 kg)

Q20. Calculate the amount of NaCl which must be added to one kg of water so that the freezing point is depressed by 3K. (Given, Kf = 1.86 K kg mol^{-1}) (Ans = 47.18g)

Q21. 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 Kf = 1.86 Km^{-1} and Kb = 0.52 Km^{-1}). (Ans = 0.458K)

Q22. 0.1 mole of acetic acid was dissolved in 1kg of benzene. Depression in freezing point of benzene was determined to be 0.256K. What conclusion can you draw about the state of the solute in solution?
(Given, K_f for benzene = 0.52 Km^{-1}). (Ans = i =0.5)

Q23. Calculate the mass of ascorbic acid ($C_6H_8O_6$) to be dissolved in 75g of acetic acid to lower its melting point by 1.5^0C. (K_f for acetic acid is 3.9 K kg mol^{-1}). (Ans = 5.08g)

Q24. 100mg of a protein is dissolved in just enough water to make 10ml of solution. If this solution has an osmotic pressure of 13.3mm Hg at 25^0C, what is the molar mass of this protein?
(R = 0.0821 L atm $mol^{-1}K^{-1}$ and 760mm Hg = 1 atm). (Ans = 13980.45 g $mole^{-1}$)

Q25. Calculate the temperature at which a solution containing 54g of glucose in 250g of water will freeze.
(K_f for water = 1.86 K kg mol^{-1} and molar mass of glucose = 180g mol^{-1}). (Ans = 270.77K)

5 Marks Questions

Q1. (i) Define the terms osmosis and osmotic pressure. Is the osmotic pressure of a solution a colligative property? Explain.
(ii) Calculate the boiling point of a solution prepared by adding 15g of NaCl to 250g of water.
(Kb for water = 0.512 K kg mol-1, molar mass of NaCl = 58.44g). (Ans = 374.051K)

Q2. (i) The molecular masses of polymers are determined by osmotic pressure method and not by measuring other colligative properties. Give reasons.
(ii) At 300K, 36g of glucose present per litre in its solution has an osmotic pressure of 4.98bar. If the osmotic pressure of another glucose solution is 1.52 bar at the same temperature, calculate the concentration of the other solution. (Ans = 0.0610 mol L^{-1})

Q3. (i) List the four factors on which the colligative properties of a solution depend.

(ii) Calculate the boiling point of one molar aqueous solution (density = 1.06g ml^{-1}) of KBr.
(Given, Kb for H_2O = 0.52 K kg mol^{-1}, Atomic mass of K=39 and Br=80). (Ans = 373.553K)

Q4. (i) What is van't Hoff factor? What possible values can it have if the solute molecules undergo dissociation?
(ii) An aqueous solution containing 12.48g of barium chloride in 1kg of water boils at 373.0832K. Calculate the degree of dissociation of barium chloride.
(Given Kb for H_2O = 0.52 Km^{-1}, molar mass of $BaCl_2$ = 208.34 g mol^{-1}). (Ans =83.5%)