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SOLUTION XII (CHEMISTRY) CHAPTER - 2

1. The molal freezing point depression constant of benzene (C_6H_6) is 4.90K kg mol^{-1}. Selenium exists as a polymer of the type Se_x. When 3.26 g of selenium is dissolved in 226 g of benzene, the observed freezing point is 0.112 °C lower than for pure benzene. Deduce the molecular formula of selenium. (Atomic mass of Se = 78.8 g mol^{-1}) **Ans.** Se_8
2. Calculate the freezing point of a solution containing 0.520 g glucose ($C_6H_{12}O_6$) dissolved in 80.20 g of water. For water K_f = 1.86K kg mol^{-1}. **Ans.** 272.301K
3. (*a*) What are non-ideal solutions ?
   (*b*) State the type of non-ideality exhibited by a solution of cyclohexane and ethanol or a solution of acetone and chloroform. Give reason for your answer.
4. On dissolving 3.24 g of sulphur in 40 g of benzene, boiling point of solution was higher than that of benzene by 0.81 K. K_b value for benzene is 2.53 K kg mol^{-1}. What is molecular formula of sulphur ? (Atomic mass of sulphur = 32 g mol^{-1}) **Ans.** S_8
5. The vapour pressure of pure benzene at 25°C is 639.7 mm Hg and the vapour pressure of a solution of a non- volatile solute in benzene at the same temperature is 631.9 mm Hg. Calculate mole fraction of solute and molality of solution. **Ans.** 0.0122, 0.1583
6. Assuming complete ionisation, calculate the expected freezing point of solution prepared by dissolving 6.00 g of Glauber's salt, $Na_2SO_4.10H_2O$ in 0.1 Kg of H_2O (K_f for H_2O = 1.86 K kg mol^{-1})
   [At. mass of Na = 23, S = 32, O = 16, H = 1 a.m.u.] **Ans.** 271.96 K
7. An aqueous solution freezes at 272.4 K, while pure water at 273 K. Determine (*i*) the molality of the solution (*ii*) boiling point of solution (*iii*) lowering of vapour pressure of water at 298 K. (Given K_f = 1.86 K kg mol^{-1}, K_b = 0.512 K kg mol^{-1} and vapour pressure of pure water is 23.757 mm Hg)
   Ans. (*i*) 0.322 mol/kg (*ii*) 373.165 K (*iii*) 23.62 mm
8. At 298 K, the vapour pressure of pure water is 23.75 mm Hg.
   (*a*) At the same temperature calculate the vapour pressure over 10% aqueous solution of an organic compound whose molecular weight is 60 g mol^{-1}.
   (*b*) What will be the osmotic pressure of this solution of 298 K ? (R = 0.082 L atm K^{-1} mol^{-1})
   Ans. (*a*) 22.98 mm (*b*) 40.776 atm
9. One litre aqueous solution of sucrose (molar mass = 342 g mol^{-1}) weighing 1015 g is found to record an osmotic pressure = 4.82 atm at 293 K. What is the molality of the sucrose solution ? R = 0.082 I atm K^{-1} mol^{-1}. **Ans.** 0.21 m
10. A solution containing 12.5 g of a non-electrolyte substance in 175 g of water gave a boiling point elevation of 0.70 K. Calculate the molar mass of the substance. (K_b = 0.52 K kg mol^{-1}).
    Ans. 53 g mol^{-1}
11. A decimolar solution of K_4 [$Fe(CN)_6$] is 50% dissociated at 300 K. Calculate the osmotic pressure of solution (R = 0.0821 litre atm K^{-1} mol^{-1}). **Ans.** 7.389 atm
12. At 25°C, the vapour pressure of pure water is 23.76 mm of Hg and that of aqueous dilute solution of urea is 22.98 mm of Hg. Calculate the molality of the solution. **Ans.** *m* = 1.88 mol Kg^{-1}
13. Urea forms an ideal solution. Determine the vapour pressure of an aqueous solution containing 10 per cent by mass of urea at 40°. (Vapour pressure of pure water at 40°C = 55.3 mm Hg)
    Ans. 53.51 g mol^{-}
14. Calculate the freezing point of a 1 molar aqueous solution of KCl. (Density of solution = 1.04 g cm^{-3}, K_f = 1.86 K kg mol^{-1}, At. wt. of K = 39 and Cl = 35.5) **Ans.** 269.148 K
15. State Raoult's law. If ΔT is the elevation in boiling point of a solvent and m is no. of moles of solute per kilogram of solute, what is the relationship between ΔT and *m* ?
16. Calculate the amount of KCl which must be added to 1 kg of water so that the freezing point is depressed by 3 K. (K_f for water = 1.86 K kg mol^{-1}). **Ans.** 60.08 g
17. Benzene (C_6H_6) and Toluene (C_7H_8) form a nearly ideal solution. At 313 K, the vapour pressure of pure

benzene is 150 mm Hg and of pure toluene 50 mm Hg. Calculate the vapour pressure of a mixture of these containing equal masses at 313 K. **Ans.** 81.176 mm, 22.94 mm

18. A solution containing 18 g of non-volatile solute in 200 g of water freezes at 272.07 K. Calculate the molecular mass of solute. (K_f = 1.86 K/m) **Ans.** 180 g mol^{-1}

19. Conc. H_2SO_4 has a density of 1.9 g mL^{-1} and is 99% H_2SO_4 by weight. Calculate the molarity of H_2SO_4 (M. wt. of H_2SO_4 = 98 g mol^{-1}). **Ans.** 19.190 M

20. Heptane and Octane for ideal solution. At 373K, the vapour pressure of the two liquid components are 105.2K Pa and 46.8K Pa respectively. What will be vapour pressure, in bar, of a mixture of 25.0 g of heptane and 35.0 g of octane ? **Ans.** 7.3428×10^9 bar, 1.099×10^9 bar

21. A 5% solution by mass of cane sugar in water has freezing point of 271K. Calculate the freezing point of a 5% glucose in water if freezing point of pure water is 273.15K. **Ans.** 269.065K

22. Two elements A and B form compounds having formula AB_2 and AB_4 when dissolved in 20 g of C_6H_6. 1g of AB_2 lowers the freezing point by 2.3K where as 1.0 g of AB_4 lowers it by 1.3K. The molar depression constant for benzene is 5.1K kg mol^{-1}. Calculate atomic mass of A and B. **Ans.** 25.57 g/mol, 42.64 g/mol

23. How many ml of 0.1 M HCl are required to react completely with 1g mixture of Na_2CO_3 and Na HCO_3 containing equimolar amounts of two? **Ans** 157.8 ml

24. A solution of sucrose (M. Wt. 342) is prepared by dissolving 68.4 g of it per litre of solution. What is osmotic pressure at 300 K ? (R = 8.314 JK^{-1} mol^{-1}) **Ans.** 4.92 atm

25. What is the molar concentration of solute particles in human blood if the osmotic pressure is 7 atm at body temperature of 37°C ? **Ans.** 0.275 mol L^{-1}

26. An aqueous solution of 3.12 g of $BaCl_2$ in 250 g of water is found to boil at 100.0832°C. Calculate the degree of dissociation of $BaCl_2$. K_b (H_2O) = 0.52 K/m. **Ans.** 83%

27. What is osmotic pressure ? How will you determine the molecular mass of a substance by this method ? What are the conditions for getting accurate value of molecular mass of substance ?

28. What is Raoult's Law ? Discuss the factors responsible for the deviation from this law by taking suitable examples.

29. 18 g of glucose (molar mass 180 g mol^{-1}) is present in 500cm^3 of its aqueous solution. What is the molarity of the solution ? What additional data is required if the molality of the solution is also required to be calculated ? **Ans** 0.2 mol/L

30. An aqueous solution of sodium chloride is marked 10% (w/w) on the bottle. The density of solution is 1.071 g mL^{-1}. What is its molality and molarity ? Also, what is mole fraction of each component in the solution ? **Ans** 1.90 mol/kg, 1.83 mol/L, 0.03, 0.97

31. A solution of glucose in water is labelled as 10 per cent w/w, what would be the molality and mole fractions of each component in the solution? If density of solution is 1.2 g mL^{-1}, then what shall be molarity of the solution ? **Ans** 0.617 mol/kg, 0.01, 0.99, 0.66 mol/L

32. At 300K, 36 g of glucose present per litre in its solution has an osmotic pressure 4.98 bar. If the osmotic pressure of solution is 1.52 bar at the same temperature, what would be its concentration? **Ans** 0.061 $mol.L^{-1}$

33. Define the term solution. What kinds of solutions are possible ? Write briefly about each kind of solution with an example.

34. 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 solid solution is this likely to be ?

35. Define the following terms :

(*i*) Mole fraction (*ii*) Molality (*iii*) Molarity (*iv*) Mass percentage