CHAPTER – SOLUTION

Previous Years' CBSE Board Questions

2.2 Expressing Concentration of Solutions

VSA (1 mark)

1. Define the following term :
   Molarity *(1/5 AI 2014)*

2. Define the following term :
   Mole fraction *(1/2 Delhi 2012, AI 2012, 2009)*

3. What is meant by molality of a solution?
   (1/5 AI 2009)

4. State the main advantage of molality over molarity as the unit of concentration.
   (Delhi 2009C)

SA I (2 marks)

5. Calculate the molarity of 9.8% (w/W) solution of H_2SO_4 if the density of the solution is 1.02 g mL^{-1}.
   (Molar mass of H_2SO_4 = 98 g mol^{-1})
   (2/5 Foreign 2014)

6. Differentiate between molarity and molality of a solution. How can we change molality value of a solution into molarity value?
   (Delhi 2014C)

7. Define :
   (i) Mole fraction   (ii) Molality
   (2/5 AI 2014 C)

8. A solution of glucose ($C_6H_{12}O_6$) in water is labelled as 10% by weight. What would be the molality of the solution?
   (Molar mass of glucose = 180 g mol^{-1})
   (2/5 AI 2013)

9. Differentiate between molarity and molality in a solution. What is the effect of temperature change on molarity and molality in a solution?
   (2/5 Delhi 2011, 2009, 2/5 AI 2011)

10. Differentiate between molarity and molality of a solution. Explain how molarity value of a solution can be converted into its molality?
    (Foreign 2011)

11. Define the term, 'molarity of a solution'. State one disadvantage in using the molarity as the unit of concentration. *(2/3 AI 2010C)*

12. 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 this solution be 1.072 g mL^{-1} what will be the molality of the solution?
    (Delhi 2007)

SA II (3 marks)

13. 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})
    (3/5 AI 2014)

2.3 Solubility

VSA (1 mark)

14. Gas (A) is more soluble in water than gas (B) at the same temperature. Which one of the two gases will have the higher value of K_H (Henry's constant) and why? *(1/2 AI 2016)*

15. Explain the following :
    Henry's law about dissolution of a gas in a liquid. *(1/5 AI 2012)*

16. State the following :
    Henry's law about partial pressure of a gas in a mixture. *(1/5 Delhi, AI 2011)*

SA I (2 marks)

17. State Henry's law and mention two of its important applications. *(2/5, AI 2013C, 2012C)*

18. Explain why aquatic species are more comfortable in cold water rather than in warm water. *(Delhi 2012C)*

19. State Henry's law correlating the pressure of a gas and its solubility in a solvent and mention two applications for the law. *(Delhi 2008)*

SA II (3 marks)

20. The partial pressure of ethane over a saturated solution containing 6.56×10^{-2} g of ethane is 1 bar. If the solution contains 5.0×10^{-2} g of ethane, then what will be the partial pressure of the gas? *(Delhi 2013C, AI 2012C)*

21. If N_2 gas is bubbled through water at 293 K, how many millimoles of N_2 gas would dissolve in 1 litre of water? Assume that N_2 exerts a partial pressure of 0.987 bar. Given that Henry's law constant for N_2 at 293 K is 76.48 k bar. *(AI 2012C)*

22. What concentration of nitrogen should be present in a glass of water at room temperature? Assume a temperature of 25°C, a total pressure of 1 atmosphere and mole fraction of nitrogen in air of 0.78.
[K_H for nitrogen = 8.42×10^{-7} M/mm Hg]
(3/5 AI 2009)

2.4 Vapour Pressure of Liquid Solutions

VSA (1 mark)

23. Define Raoult's law. *(1/5 AI 2014C)*

24. State the following :
Raoult's law in its general form in reference to solutions. *(1/5 Delhi, 1/2 AI 2011)*

25. State 'Raoult's law' for a solution of volatile liquids. *(AI 2009C)*

SA I (2 marks)

26. State Raoult's law for the solution containing volatile components. What is the similarity between Raoult's law and Henry's law?
(Delhi 2014, AI 2013)

27. State Raoult's law for a solution containing volatile components. Name the solution which follows Raoult's law at all concentrations and temperatures. *(2/5 Foreign 2014)*

28. State Raoult's law. How is it formulated for solutions of non-volatile solutes? *(Delhi 2012C)*

SA II (3 marks)

29. The vapour pressure of pure liquids *A* and *B* are 450 and 700 mm Hg respectively, at 350 K. Find out the composition of the liquid mixture if total vapour pressure is 600 mm Hg. Also find the composition of the vapour phase. *(3/5 AI 2013C)*

2.5 Ideal and Non-ideal Solutions

VSA (1 mark)

30. In non-ideal solution, what type of deviation shows the formation of maximum boiling azeotropes? *(1/2 AI 2016)*

31. Some liquids on mixing form 'azeotropes'. What are 'azeotropes'? *(Delhi 2014)*

32. Define the following term :
Azeotrope *(1/5 Foreign 2014)*

33. Define the following term :
Ideal solution
(1/5 AI 2013, 2012, 1/2 Delhi 2012)

34. How is it that alcohol and water are miscible in all proportions ? *(AI 2007)*

SA I (2 marks)

35. What is meant by positive deviations from Raoult's law? Give an example. What is the sign of $\Delta_{mix}H$ for positive deviation? *(Delhi 2015)*

36. Define azeotropes. What type of azeotrope is formed by positive deviation from Raoult's law? Give an example. *(Delhi 2015)*

37. What is meant by negative deviation from Raoult's law? Give an exmaple. What is the sign of $\Delta_{mix}H$ for negative deviation?
(Foreign 2015)

38. Define azeotropes. What type of azeotrope is formed by negative deviation from Raoult's law? Give an example. *(Foreign 2015)*

39. What type of deviation is shown by a mixture of ethanol and acetone? Give reason.
(2/5 AI 2014)

40. What is meant by positive and negative deviations from Raoult's law and how is the sign of $\Delta_{mix}H$ related to positive and negative deviations from Raoult's law? *(AI 2013 C)*

41. Explain why a solution of chloroform and acetone shows negative deviation from Raoult's law. *(2/5 Delhi 2011C)*

42. Non-ideal solutions exhibit either positive or negative deviations from Raoult's law. What are these deviations and why are they caused? Explain with one example for each type.
(Delhi 2010)

43. What type of intermolecular attraction exists in each of the following pairs of compounds:
    (i) *n*-hexane and *n*-octane
    (ii) methanol and acetone *(Delhi 2010C)*

44. State Raoult's law for solutions of volatile liquids. Taking suitable examples explain the meaning of positive and negative deviations from Raoult's law. *(Delhi, AI 2008)*

45. What is meant by negative deviation 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. *(AI 2008C)*

2.6 Colligative Properties and Determination of Molar Mass

VSA (1 mark)

46. What are isotonic solutions? *(Delhi 2014)*

47. Define the following term:
    Molal elevation constant (K_b) *(1/5 AI 2014)*

48. How is the vapour pressure of a solvent affected when a non-volatile solute is dissolved in it? *(1/2 Delhi 2014C)*

49. Define the following term:
    Osmotic pressure *(1/5 AI 2013)*

50. Define the following term:
    Isotonic solutions *(1/2 Delhi 2012)*

51. Explain the following:
    Boiling point elevation constant for a solvent. *(AI 2012)*

52. What is meant by colligative properties? *(1/5 AI 2009)*

53. State the condition resulting in reverse osmosis. *(AI 2007)*

SA I (2 marks)

54. (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? *(2/5 Delhi 2016)*

55. 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?
    (2/5 Delhi 2016)

56. Why does a solution containing non-volatile solute have higher boiling point than the pure solvent? Why is elevation of boiling point a colligative property? *(AI 2015)*

57. 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)*

58. 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)*

59. An aqueous solution of sodium chloride freezes below 273 K. Explain the lowering in freezing point of water with the help of a suitable diagram. *(Delhi 2013C)*

60. Define the terms osmosis and osmotic pressure. Is the osmotic pressure of a solution a colligative property? Explain. *(2/5 Delhi 2011)*

61. List any four factors on which the colligative properties of a solution depend.
    (2/5 AI 2011C)

62. Define the terms, 'osmosis' and 'osmotic pressure'. What is the advantage of using osmotic pressure as compared to other colligative properties for the determination of molar masses of solutes in solutions? *(AI 2010)*

63. Outer hard shells of two eggs are removed. One of the egg is placed in pure water and the other is placed in saturated solution of sodium chloride. What will be observed and why?
    (AI 2010C)

64. Find the boiling point of a solution containing 0.520 g of glucose ($C_6H_{12}O_6$) dissolved in 80.2 g of water.
    [Given : K_b for water = 0.52 K/m] *(AI 2010C)*

65. Define the term 'osmotic pressure'. Describe how the molecular mass of a substance can be determined on the basis of osmotic pressure measurement. *(Delhi, AI 2008)*

SA II (3 marks)

66. Calculate the freezing point of the solution when 31 g of ethylene glycol ($C_2H_6O_2$) is dissolved in 500 g of water.
(K_f for water = 1.86 K kg mol^{-1}) *(AI 2015)*

67. A solution containing 15 g urea (molar mass = 60 g mol^{-1}) per litre of solution in water has the same osmotic pressure (isotonic) as a solution of glucose (molar mass = 180 g mol^{-1}) in water. Calculate the mass of glucose present in one litre of its solution. *(3/5 AI 2014)*

68. Calculate the boiling point elevation for a solution prepared by adding 10 g of $CaCl_2$ to 200 g of water. (K_b for water = 0.52 K kg mol^{-1}, molar mass of $CaCl_2$ = 111 g mol^{-1})
(2/3 Foreign 2014)

69. Define the following terms :
(i) Osmotic pressure
(ii) Colligative properties *(Foreign 2014)*

70. Some ethylene glycol, $HOCH_2CH_2OH$, is added to your car's cooling system along with 5 kg of water. If the freezing point of water-glycol solution is –15.0°C, what is the boiling point of the solution?
(K_b = 0.52 K kg mol^{-1} and K_f = 1.86 K kg mol^{-1} for water) *(Delhi 2014C)*

71. 1.00 g of a non-electrolyte solute dissolved in 50 g of benzene lowered the freezing point of benzene by 0.40 K. The freezing point depression constant of benzene is 5.12 K kg mol^{-1}. Find the molar mass of the solute. *(AI 2013, 2008)*

72. A 5% solution (by mass) of cane-sugar in water has freezing point of 271 K. Calculate the freezing point of 5% solution (by mass) of glucose in water if the freezing point of pure water is 273.15 K.
[Molecular masses : Glucose $C_6H_{12}O_6$: 180 amu; Cane-sugar $C_{12}H_{22}O_{11}$: 342 amu]
(3/5 AI 2013C)

73. 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 100.42°C while pure water boils at 100°C. What mass of glycerol was dissolved to make the solution?
(K_b for water = 0.512 K kg mol^{-1})
(Delhi 2012, 2010, AI 2012)

74. 15.0 g of an unknown molecular material was dissolved in 450 g of water. The resulting solution was found to freeze at –0.34°C. What is the molar mass of this material?
(K_f for water = 1.86 K kg mol^{-1})
(Delhi 2012, 3/5, AI 2012, 2010)

75. A solution containing 30 g of non-volatile solute exactly in 90 g of water has a vapour pressure of 2.8 kPa at 298 K. Further 18 g of water is added to this solution. The new vapour pressure becomes 2.9 kPa at 298 K. Calculate
(i) the molecular mass of solute and
(ii) vapour pressure of water at 298 K.
(Delhi 2012C)

76. Calculate the boiling point of a solution prepared by adding 15.00 g of NaCl to 250.00 g of water. (K_b for water = 0.512 K kg mol^{-1}), (Molar mass of NaCl = 58.44 g)
(3/5 Delhi 2011)

77. 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 torr at 25°C. Assuming the gene fragment is a non-electrolyte, determine its molar mass. *(3/5 Delhi, AI 2011)*

78. What would be the molar mass of a compound if 6.21 g of it dissolved in 24.0 g of chloroform to form a solution that has a boiling point of 68.04°C. The boiling point of pure chloroform is 61.7°C and the boiling point elevation constant, K_b for chloroform is 3.63°C/m.
(3/5 Delhi 2011)

79. What mass of NaCl must be dissolved in 65.0 g 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 = 58.5 g mol^{-1}). *(AI 2011)*

80. The molecular masses of polymers are determined by osmotic pressure method and not by measuring other colligative properties. Give two reasons. *(3/5 AI 2011C)*

81. Calculate the boiling point of one molar aqueous solution (density 1.06 g mL^{-1}) of KBr.
[Given : K_b for H_2O = 0.52 K kg mol^{-1}, atomic mass : K = 39, Br = 80] *(3/5 AI 2011C)*

82. 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.pt. of pure benzene = 80.10°C and K_b for benzene = 2.53°C kg mol^{-1}) *(Delhi 2010)*

83. What mass of ethylene glycol (molar mass = 62.0 g mol^{-1}) must be added to 5.50 kg of water to lower the freezing point of water from 0°C to – 10.0°C?
(K_f for water 1.86 K kg mol^{-1}) *(AI 2010)*

84. 100 mg of a protein is dissolved in just enough water to make 10.0 mL of solution. If this solution has an osmotic pressure of 13.3 mm Hg at 25°C, what is the molar mass of the protein? (R = 0.0821 L atm mol^{-1} K^{-1} and 760 mm Hg = 1 atm.) *(Delhi, 3/5, AI 2009)*

85. Calculate the amount of sodium chloride which must be added to one kilogram of water so that the freezing point of water is depressed by 3 K. [Given : K_f = 1.86 K kg mol^{-1}, atomic mass : Na = 23.0, Cl = 35.5] *(3/5, Delhi, AI 2009C)*

86. x g of a non-electrolytic compound (molar mass = 200) is dissolved in 1.0 L of 0.05 M NaCl aqueous solution. The osmotic pressure of this solution is found to be 4.92 atm at 27°C. Calculate the value of x. Assume complete dissociation of NaCl and ideal behaviour of the solution. (R = 0.082 L atm mol^{-1} K^{-1})
(AI 2009C)

87. Calculate the freezing point of a solution containing 18 g glucose, $C_6H_{12}O_6$ and 68.4 g sucrose, $C_{12}H_{22}O_{11}$ in 200 g of water. The freezing point of pure water is 273 K and K_f for water is 1.86 K m^{-1}. *(AI 2009C)*

88. Calculate the temperature at which a solution containing 54 g of glucose, ($C_6H_{12}O_6$), in 250 g of water will freeze.
(K_f for water = 1.86 K mol^{-1} kg) *(Delhi 2008)*

89. A solution containing 8 g of a substance in 100 g of diethyl ether boils at 36.86°C, whereas pure ether boils at 35.60°C. Determine the molecular mass of the solute. (For ether K_b = 2.02 K kg mol^{-1}) *(AI 2008)*

90. A 0.1539 molal aqueous solution of cane sugar (mol. mass = 342 g mol^{-1}) has a freezing point of 271 K while the freezing point of pure water is 273.15 K. What will be the freezing point of an aqueous solution containing 5 g of glucose (mol. mass = 180 g mol^{-1}) per 100 g of solution. *(AI 2007)*

2.7 Abnormal Molar Masses

VSA **(1 mark)**

91. Define the following term :
Van't Hoff factor *(1/5 Delhi 2012, AI 2009)*

SA I **(2 marks)**

92. What is van't Hoff factor? What types of values can it have if in forming the solution the solute molecules undergo
(i) Dissociation (ii) Association?
(2/5 AI 2014C)

93. Assuming complete dissociation, calculate the expected freezing point of a solution prepared by dissolving 6.00 g of Glauber's salt, $Na_2SO_4 \cdot 10H_2O$ in 0.100 kg of water.
(K_f for water = 1.86 K kg mol^{-1}, atomic masses : Na = 23, S = 32, O = 16, H = 1) *(2/5, AI 2014C)*

94. 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}) *(Delhi 2012)*

95. What is van't Hoff factor? What possible value can it have if the solute molecules undergo dissociation? *(2/5 Delhi 2011C)*

SA II **(3 marks)**

96. 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}) *(Delhi 2016)*

97. 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 the CS_2 = 3.83 K kg mol^{-1}, atomic mass of sulphur = 32 g mol^{-1}) *(3/5 Delhi 2016)*

98. Calculate the boiling point of solution when 4 g of $MgSO_4$ ($M = 120$ g mol^{-1}) was dissolved in 100 g of water, assuming $MgSO_4$ undergoes complete ionization.
(K_b for water = 0.52 K kg mol^{-1})   *(AI 2016)*

99. 3.9 g of benzoic acid dissolved in 49 g of benzene shows a depression in freezing point of 1.62 K. Calculate the van't Hoff factor and predict the nature of solute (associated or dissociated).
(Given : Molar mass of benzoic acid = 122 g mol^{-1}, K_f for benzene = 4.9 K kg mol^{-1})   *(Delhi 2015)*

100. Calculate the mass of NaCl (molar = 58.5 g mol^{-1}) to be dissolved in 37.2 g of water to lower the freezing point by 2°C, assuming that NaCl undergoes complete dissociation.
(K_f for water = 1.86 K kg mol^{-1}) *(Foreign 2015)*

101. Determine the osmotic pressure of a solution prepared by dissolving 2.5×10^{-2} g of K_2SO_4 in 2 L of water at 25°C, assuming that it is completely dissociated.
($R = 0.0821$ L atm K^{-1} mol^{-1}, molar mass of $K_2SO_4 = 174$ g mol^{-1})   *(Delhi 2013)*

102. Calculate the amount of KCl which must be added to 1 kg of water so that the freezing point is depressed by 2 K (the K_f for water = 1.86 K kg mol^{-1}).   *(Delhi 2012)*

103. Calculate the freezing point of an aqueous solution containing 10.50 g of $MgBr_2$ in 200 g of water. (Molar mass of $MgBr_2 = 184$ g mol^{-1}) (K_f for water = 1.86 K kg mol^{-1})
(3/5 Delhi 2011)

104. A 0.561 m solution of an unknown electrolyte depresses the freezing point of water by 2.93°C. What is van't Hoff factor for this electrolyte? The freezing point depression constant (K_f) for water is 1.86°C kg mol^{-1}.   *(Foreign 2011)*

105. Phenol associates in benzene to a certain extent to form a dimer. A solution containing 20 g of phenol in 1.0 kg of benzene has its freezing point lowered by 0.69 K. Calculate the fraction of phenol that has dimerised
[Given K_f for benzene = 5.1 K m^{-1}]
(3/5 Delhi 2011C)

106. An aqueous solution containing 12.48 g of barium chloride in 1.0 kg of water boils at 373.0832 K. Calculate the degree of dissociation of barium chloride.
[Given K_b for H_2O = 0.52 K m^{-1}; Molar mass of $BaCl_2$ = 208.34 g mol^{-1}]
(3/5, Delhi 2011C)

107. A decimolar solution of potassium ferrocyanide $K_4[Fe(CN)_6]$ is 50% dissociated at 300 K. Calculate the value of van't Hoff factor for potassium ferrocyanide.   *(Delhi 2010C)*

108. The boiling point elevation of 0.30 g acetic acid in 100 g benzene is 0.0633 K. Calculate the molar mass of acetic acid from this data. What conclusion can you draw about the molecular state of the solute in the solution?
[Given K_b for benzene = 2.53 K kg mol^{-1}]
(AI 2008C)

109. The freezing point of a solution containing 0.2 g of acetic acid in 20.0 g of benzene is lowered by 0.45°C. Calculate.
(i) the molar mass of acetic acid from this data
(ii) van't Hoff factor
[For benzene, K_f = 5.12 K kg mol^{-1}]
What conclusion can you draw from the value of van't Hoff factor obtained?
(AI 2008C)

LA **(5 marks)**

110. (i) The depression in freezing point of water observed for the same molar concentration of acetic acid, trichloroacetic acid and trifluroacetic acid increases in the order as stated above. Explain.
(ii) Calculate the depression in freezing point of water when 20.0 g of $CH_3CH_2CHClCOOH$ is added to 500 g of water.
[Given : $K_a = 1.4 \times 10^{-3}$, $K_f = 1.86$ K kg mol^{-1}]
(Delhi 2008C)