16 Solutions

1. For preparing 0.1 N solution of a compound from its impure sample (percentage purity of which is known) weight of the substance required will be

(a) less than the theoretical weight.
(b) more than the theoretical weight.
(c) same as the theoretical weight.
(d) None of these.

2. A solution is prepared by dissolving 10 g NaOH in 1250 mL of a solvent of density 0.8 g/mL. The molality of the solution in mol kg^{-1} is

(a) 0.25 (b) 0.2 (c) 0.008 (d) 0.0064

3. Two solutions of a substance (non electrolyte) are mixed in the following manner. 480 mL of 1.5 M first solution + 520 mL of 1.2 M second solution. What is the molarity of the final mixture?

(a) 2.70 M (b) 1.344 M
(c) 1.50 M (d) 1.20 M

4. Formation of a solution from two components can be considered as

(i) Pure solvent $\rightarrow$ separated solvent molecules, ΔH_1
(ii) Pure solute $\rightarrow$ separated solute molecules, ΔH_2
(iii) Separated solvent and solute molecules $\rightarrow$ Solution, ΔH_3

Solution so formed will be ideal if

(a) $\Delta H_{soln} = \Delta H_3 - \Delta H_1 - \Delta H_2$
(b) $\Delta H_{soln} = \Delta H_1 + \Delta H_2 + \Delta H_3$
(c) $\Delta H_{soln} = \Delta H_1 + \Delta H_2 - \Delta H_3$
(d) $\Delta H_{soln} = \Delta H_1 - \Delta H_2 - \Delta H_3$

5. Which of the following liquid pairs shows a positive deviation from Raoult's law ?

(a) Water - Nitric acid
(b) Benzene - Methanol
(c) Water - Hydrochloric acid
(d) Acetone - Chloroform

6. Which will form maximum boiling point azeotrope?

(a) $HNO_3 + H_2O$ solution
(b) $C_2H_5OH + H_2O$ solution
(c) $C_6H_6 + C_6H_5CH_3$ solution
(d) None of these

7. A solution of acetone in ethanol

(a) shows a positive deviation from Raoult's law
(b) behaves like a non ideal solution
(c) obeys Raoult's law
(d) shows a negative deviation from Raoult's law

8. An aqueous solution is 1.00 molal in KI. Which change will cause the vapour pressure of the solution to increase? **Tricky**

(a) Addition of NaCl
(b) Addition of Na_2SO_4
(c) Addition of 1.00 molal KI
(d) Addition of water

9. A binary liquid solution is prepared by mixing *n*-heptane and ethanol. Which one of the following statements is correct regarding the behaviour of the solution?

(a) The solution is non-ideal, showing -ve deviation from Raoult's Law.
(b) The solution is non-ideal, showing +ve deviation from Raoult's Law.
(c) *n*-heptane shows +ve deviation while ethanol shows –ve deviation from Raoult's Law.
(d) The solution formed is an ideal solution.

10. P_A and P_B are the vapour pressure of pure liquid components, A and B, respectively of an ideal binary solution. If X_A represents the mole fraction of component A, the total pressure of the solution will be. **Tricky**

(a) $P_A + X_A(P_B - P_A)$ (b) $P_A + X_A(P_A - P_B)$
(c) $P_B + X_A(P_B - P_A)$ (d) $P_B + X_A(P_A - P_B)$

11. Vapour pressure of chloroform ($CHCl_3$) and dichloromethane (CH_2Cl_2) at 25ºC are 200 mm Hg and 41.5 mm Hg respectively. Vapour pressure of the solution obtained by mixing 25.5 g of $CHCl_3$ and 40 g of CH_2Cl_2 at the same temperature will be: (Molecular mass of $CHCl_3$ = 119.5 u and molecular mass of CH_2Cl_2 = 85 u).

(a) 90.92 mm Hg (b) 115.0 mm Hg
(c) 147.9 mm Hg (d) 285.5 mm Hg

12. The vapour pressure of a solution of the liquids A ($P°$ = 80 mm Hg and x_A = 0.4) and B ($P°$= 120 mm Hg and x_B = 0.6) is found to be 100 mm Hg. It shows that the solution exhibits

(a) positive deviation from ideal behaviour
(b) negative deviation from ideal behaviour
(c) ideal behaviour
(d) positive deviation for lower conc. and negative for higher conc.

13. Vapour pressure (in torr) of an ideal solution of two liquids *A* and *B* is given by : $P = 52X_A + 114$ where X_A is the mole fraction of *A* in the mixture. The vapour pressure (in torr) of equimolar mixture of the two liquids will be :

Tricky

(a) 166 (b) 83 (c) 140 (d) 280

14. The vapour pressure (at the standard boiling point of water) of an aqueous solution containing 28% by mass of a non-volatile normal solute (molecular mass = 28) will be

(a) 152 torr (b) 608 torr
(c) 760 torr (d) 547 torr

15. Lowering of vapour pressure of 1.00 *m* solution of a non-volatile solute in a hypothetical solvent of molar mass 40 g at its normal boiling point, is :

(a) 29.23 torr (b) 30.4 torr
(c) 35.00 torr (d) 40.00 torr

16. Equal masses of a solute are dissolved in equal amount of two solvents *A* and *B*, respective molecular masses being M_A and M_B. The relative lowering of vapour pressure of solution in solvent *A* is twice that of the solution in solvent *B*. If the solutions are dilute, M_A and M_B are related as

Toughnut

(a) $M_A \quad M_B$ (b) $2M_A \quad M_B$
(c) $M_A \quad 2M_B$ (d) $M_A \quad 4M_B$

17. At 20°C and 1.00 atm partial pressure of H_2, 18 mL of H_2 (STP) dissolves in 1 L of water. If 2 L of water is exposed to a gaseous mixture having a total pressure of 1425 torr (excluding the vapour pressure of water) and containing 80% H_2 by volume, the volume of H_2(STP) dissolved is

Toughnut

(a) 27 mL (b) 54 mL
(c) 33.75 mL (d) 67.50 mL

18. At a particular temperature, the vapour pressures of two liquids A and B are respectively 120 and 180 mm of mercury. If 2 moles of A and 3 moles of B are mixed to form an ideal solution, the vapour pressure of the solution at the same temperature will be (in mm of mercury)

(a) 156 (b) 145 (c) 150 (d) 108

19. Which one of the following gases has the lowest value of Henry's law constant?

(a) N_2 (b) He (c) H_2 (d) CO_2

20. Which one of the following binary mixtures forms an azeotrope with minimum boiling point type?

(a) acetone-ethanol
(b) H_2O-HNO_3
(c) benzene-toluene
(d) *n*-hexane-*n*-heptane

21. The vapour pressure of pure benzene and toluene at a particular temperature are 100 mm and 50 mm respectively. Then the mole fraction of benzene in vapour phase in contact with equimolar solution of benzene and toluene is

Tricky

(a) 0.67 (b) 0.75 (c) 0.33 (d) 0.50

22. 12 g of urea is dissolved in 1 litre of water and 68.4 g of sucrose is dissolved in 1 litre of water. The lowering of vapour pressure of first case is

(a) equal to second
(b) greater than second
(c) less than second
(d) double that of second

23. Which of the following statement is correct if the intermolecular forces in liquids A, B and C are in the order A < B < C?

(a) B evaporates more readily than A
(b) B evaporates less readily than C
(c) A and B evaporates at the same rate
(d) A evaporates more readily than C

24. At 80° C, the vapour pressure of pure liquid 'A' is 520 mm Hg and that of pure liquid 'B' is 1000 mm Hg. If a mixture solution of 'A' and 'B' boils at 80° C and 1 atm pressure, the amount of 'A' in the mixture is (1 atm = 760 mm Hg)

Toughnut

(a) 52 mol percent (b) 34 mol percent
(c) 48 mol percent (d) 50 mol percent

25. A solution at 20°C is composed of 1.5 mol of benzene and 3.5 mol of toluene. If the vapour pressure of pure benzene and pure toluene at this temperature are 74.7 torr and 22.3 torr, respectively, then the total vapour pressure of the solution and the benzene mole fraction in equilibrium with it will be, respectively :

Toughnut

(a) 35.8 torr and 0.280 (b) 38.0 torr and 0.589
(c) 30.5 torr and 0.389 (d) 30.5 torr and 0.480

26. Choose the correct statement with respect to the vapour pressure of a liquid among the following:
(a) Increases linearly with increasing temperature
(b) Increases non-linearly with increasing temperature
(c) Decreases linearly with increasing temperature
(d) Decreases non-linearly with increasing temperature

27. For an ideal solution of two components A and B, which of the following is true?
(a) $\Delta H_{mixing} < 0$ (zero)
(b) $\Delta H_{mixing} > 0$ (zero)
(c) A – B interaction is stronger than A – A and B – B interactions
(d) A– A, B – B and A – B interactions are identical.

28. Vapour pressure of pure benzene is 119 torr and that of toluene is 37.0 torr at the same temperature. Mole fraction of toluene in vapour phase which is in equilibrium with a solution of benzene and toluene having a mole fraction of toluene 0.50, will be :
(a) 0.137 (b) 0.237 (c) 0.435 (d) 0.205

29. How many grams of methyl alcohol should be added to 10 litre tank of water to prevent its freezing at 268 K ? (K_f for water is 1.86 K kg mol^{-1})
(a) 880.07 g (b) 899.04 g
(c) 886.02 g (d) 868.06 g

30. Henry's law constant K of CO_2 in water at 25°C is 3.0×10^{-2} mol L^{-1}atm^{-1}. The mass of CO_2 present in 100 L of soft drink bottled with a partial pressure of CO_2 of 4 atm at the same temperature is
(a) 5.28 g (b) 12.0 g (c) 428 g (d) 528 g

31. Vapour pressure of solution containing 2 mol of liquid A (P_A^o 80 torr) and 3 mol of liquid B (P_B^o 100 torr) is 87 torr. We can conclude that

Critical Thinking

(a) there is negative deviation from Raoult's law
(b) boiling point is higher than that expected for ideal solution
(c) molecular attractions between unlike molecules are stronger than those between like molecules
(d) All of these statements are correct

32. At 15°C and 1 atmosphere partial pressure of hydrogen, 20 mL of hydrogen measured at STP dissolves in 1 L of water. If water at 15°C is exposed to a gaseous mixture having a total pressure of 1500 mm of Hg (excluding the vapour pressure of water) and containing 80% hydrogen by volumne, then the volume of hydrogen measured at STP that will dissolve in 1 L of water is
(a) 20.0 mL (b) 31.6 mL
(c) 36.1 mL (d) 26.3 mL

33. The vapour pressure of two pure liquids A and B that form an ideal solution, are 400 and 800 mm of Hg respectively at a temperature t°C. The mole fraction of A in a solution of A and B whose boiling point is t°C will be
(a) 0.4 (b) 0.8 (c) 0.1 (d) 0.2

34. The total vapour pressure of a 4 mole % solution of NH_3 in water at 293 K is 50.0 torr. The vapour pressure of pure water is 17.0 torr at this temperature. Applying Henry's and Raoult's laws, the total vapour pressure for a 5 mole % solution is

Toughnut

(a) 58.25 torr (b) 33 torr
(c) 42.1 torr (d) 52.25 torr

35. Which one of the following aqueous solutions will exihibit highest boiling point ?
(a) 0.015 M urea (b) 0.01 M KNO_3
(c) 0.01 M Na_2SO_4 (d) 0.015 M glucose

36. The elevation in boiling point of a solution of 13.44 g of $CuCl_2$ in 1 kg of water using the following information will be (Molecular weight of $CuCl_2$= 134.4 g and K_b= 0.52 K kg mol^{-1})

(a) 0.16 (b) 0.05 (c) 0.1 (d) 0.2

37. The temperature at which 10% aqueous solution (*w*/*v*) of glucose will exhibit the osmotic pressure of 14 bar is –

(a) 307.3°C (b) 307.3 K
(c) 34 K (d) – 34°C

38. KBr is 80% ionized in solution. The freezing point of 0.4 molal solution of KBr is :

$K_f(H_2O)$ = 1.86 K kg/mole

(a) 274.339 K (b) – 1.339 K
(c) 257.3 K (d) – 1.339°C

39. A solution of urea (mol. 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

Toughnut

(a) 0.654 C (b) – 0.654 C
(c) 6.54 C (d) – 6.54 C

40. The solution containing 4.0 g of a polyvinyl chloride polymer in 1 litre of dioxane was found to have an osmotic pressure 6.0×10^{-4} atmosphere at 300K, the value of R used is 0.082 litre atmosphere $mole^{-1}K^{-1}$. The molecular mass of the polymer was found to be **Toughnut**

(a) 3.0×10^2 (b) 1.6×10^5
(c) 5.6×10^4 (d) 6.4×10^2

41. If the various terms in the given below expressions have usual meanings, the van't Hoff factor (*i*) cannot be calculated by which one of the following expressions

(a) $\pi V \quad \sqrt{i}nRT$
(b) $\Delta T_f \quad iK_f.m$
(c) $\Delta T_b \quad iK_b.m$
(d) $\dfrac{P^o_{solvent} - P_{solution}}{P^o_{solvent}} \quad i\left(\dfrac{n}{N \quad n}\right)$

42. A 0.001 molal solution of $[Pt(NH_3)_4Cl_4]$ in water had a freezing point depression of 0.0054°C. If K_f for water is 1.80, the correct formulation for the above molecule is

(a) $[Pt(NH_3)_4Cl_3]Cl$ (b) $[Pt(NH_3)_4Cl_2]Cl_2$
(c) $[Pt(NH_3)_4Cl]Cl_3$ (d) $[Pt(NH_3)_4Cl_4]$

43. Which of the following has the lowest freezing point?

(a) 0.1 m sucrose (b) 0.1 m urea
(c) 0.1 m ethanol (d) 0.1 m glucose

44. The van't Hoff factor *i* for a compound which undergoes dissociation in one solvent and association in other solvent is respectively :

(a) less than one and greater than one.
(b) less than one and less than one.
(c) greater than one and less than one.
(d) greater than one and greater than one.

45. If 0.1 M solution of glucose and 0.1 M solution of urea are placed on two sides of the semipermeable membrane to equal heights, then it will be correct to say that

(a) there will be no net movement across the membrane
(b) glucose will flow towards urea solution
(c) urea will flow towards glucose solution
(d) water will flow from urea solution to glucose

46. Determination of the molar mass of acetic acid in benzene using freezing point depression is affected by :

(a) Partial ionization (b) Dissociation
(c) Complex formation (d) Association

47. The observed osmotic pressure for a 0.10 M solution of $Fe(NH_4)_2(SO_4)_2$ at 25°C is 10.8 atm. The experimental (observed) value of van't Hoff factor will be :

(R = 0.082 L atm k^{-1} mol^{-1}) **Tricky**

(a) 4.42 (b) 4.00
(c) 3.42 (d) 5.42

48. 12 g of a nonvolatile solute dissolved in 108 g of water produces the relative lowering of vapour pressure of 0.1. The molecular mass of the solute is :

(a) 80 (b) 60 (c) 20 (d) 40

49. A molecule M associates in a given solvent according to the equation $M \rightleftharpoons (M)_n$. For a certain concentration of M, the van't Hoff factor was found to be 0.9 and the fraction of associated molecules was 0.2. The value of *n* is:

Tricky

(a) 3 (b) 5 (c) 2 (d) 4

50. A solution containing 0.85 g of $ZnCl_2$ in 125.0 g of water freezes at –0.23°C. The apparent degree of dissociation of the salt is (K_f for water = 1.86K kg mol^{-1}, atomic mass: Zn = 65.3 and Cl = 35.5)

Toughnut

(a) 1.36% (b) 73.5% (c) 7.35% (d) 2.47%

51. 0.5 molal aqueous solution of a weak acid (HX) is 20% ionised. If K_f for water is 1.86 K kg mol^{-1}, the lowering in freezing point of the solution is

(a) 0.56 K (b) 1.12 K

(c) – 0.56 K (d) – 1.12 K

52. 200 mL of an aqueous solution of a protein contains its 1.26 g. The osmotic pressure of this solution at 300 K is found to be 2.57×10^{-3} bar. The molar mass of protein will be

(R = 0.083 L bar mol^{-1} K^{-1})

(a) 51022 g mol^{-1} (b) 122044 g mol^{-1}

(c) 31011 g mol^{-1} (d) 61038 g mol^{-1}

53. Freezing point of an aqueous solution is (–0.186)°C. Elevation of boiling point of the same solution is K_b = 0.512°C, K_f = 1.86°C, find the increase in boiling point.

Toughnut

(a) 0.186 °C (b) 0.0512 °C

(c) 0.092 °C (d) 0.2372 °C

54. The relationship between osmotic pressure at 273 K when 10 g glucose (P_1), 10 g urea (P_2), and 10 g sucrose (P_3) are dissolved in 250 mL of water is

(a) $P_1 > P_2 > P_3$ (b) $P_3 > P_1 > P_2$

(c) $P_2 > P_1 > P_3$ (d) $P_2 > P_3 > P_1$

55. Which observation(s) reflect(s) colligative properties?

Critical Thinking

(i) A 0.5 m NaBr solution has a higher vapour pressure than a 0.5 m $BaCl_2$ solution at the same temperature

(ii) Pure water freezes at the higher temperature than pure methanol

(iii) A 0.1 m NaOH solution freezes at a lower temperature than pure water

Choose the correct answer from the codes given below

(a) (i), (ii) and (iii) (b) (i) and (ii)

(c) (ii) and (iii) (d) (i) and (iii)

56. The difference between the boiling point and freezing point of an aqueous solution containing sucrose (molecular wt = 342 g mole^{-1}) in 100 g of water is 105°C. If K_f and K_b of water are 1.86 and 0.51 K kg mol^{-1} respectively, the weight of sucrose in the solution is about

Tricky

(a) 34.2 g (b) 342 g (c) 7.2 g (d) 72 g

57. A solution containing 1.8 g of a compound (empirical formula CH_2O) in 40 g of water is observed to freeze at –0.465° C. The molecular formula of the compound is

(K_f of water = 1.86 kg K mol^{-1})

(a) $C_2H_4O_2$ (b) $C_3H_6O_3$

(c) $C_4H_8O_4$ (d) $C_6H_{12}O_6$

58. Freezing point of an aqueous solution is – 0.186°C. If the values of K_b and K_f of water are respectively 0.52 K kg mol^{-1} and 1.86 K kg mol^{-1}, then the elevation of boiling point of the solution in K is

(a) 0.52 (b) 1.04 (c) 1.34 (d) 0.052

59. If the elevation in boiling point of a solution of 10 g of solute (mol. wt. = 100) in 100 g of water is ΔT_b, the ebullioscopic constant of water is

(a) 10 (b) $10\,\Delta T_b$ (c) ΔT_b (d) $\dfrac{\Delta T_b}{10}$

60. Which one of the following statements is incorrect?

Critical Thinking

(a) The correct order of osmotic pressure for 0.01 M aqueous solution of each compound is $BaCl_2$ KCl CH_3COOH Sucrose

(b) The osmotic pressure (π) of a solution is given by the equation π = MRT, where M is the molarity of the solution

(c) Raoult's law states that the vapour pressure of a component over a solution is proportional to its mole fraction

(d) Two sucrose solutions of same molality prepared in different solvents will have the same freezing point depression

61. π_1, π_2, π_3 and π_4 atm are the osmotic pressures of 5% (mass/volume) solutions of urea, fructose, sucrose and KCl respectively at certain temperature. The correct order of their magnitudes is :

(a) $\pi_1 > \pi_4 > \pi_2 > \pi_3$ (b) $\pi_1 > \pi_4 > \pi_2 > \pi_3$

(c) $\pi_4 > \pi_1 > \pi_2 > \pi_3$ (d) $\pi_4 > \pi_1 > \pi_3 > \pi_2$

62. Which of the following has been arranged in the increasing order of freezing point?

(a) $0.025\text{M KNO}_3 < 0.1\text{M NH}_2\text{CSNH}_2 < 0.05\text{M BaCl}_2 < 0.1\text{M NaCl}$

(b) $0.1\text{M NaCl} < 0.05\text{M BaCl}_2 < 0.1\text{M NH}_2\text{CSNH}_2 < 0.025\text{M KNO}_3$

(c) $0.1\text{M NH}_2\text{CSNH}_2 < 0.1\text{ M NaCl} < 0.05\text{M BaCl}_2 < 0.025\text{M KNO}_3$

(d) $0.025\text{M KNO}_3 < 0.05\text{M BaCl}_2 < 0.1\text{M NaCl} < 0.1\text{M NH}_2\text{CSNH}_2$

63. 0.010M solution an acid *HA* freezes at –0.0205°C. If K_f for water is 1.860 K kg mol^{-1}, the ionization constant of the conjugate base of the acid will be (assume 0.010 M = 0.010 m) **Toughnut**

(a) 1.1×10^{-4} (b) 1.1×10^{-3}

(c) 9.0×10^{-11} (d) 9.0×10^{-12}

64. 1.0 M aqueous solution of $\text{CrCl}_3.6\text{H}_2\text{O}$ freezes at –5.58°C. Assuming complete ionization of the hydrated complex, which of the following isomers conforms to the observation (K_f for water = 1.86 K kg mol^{-1}) ?

(a) $[\text{Cr(H}_2\text{O)}_3\text{Cl}_3].3\text{H}_2\text{O}$

(b) $[\text{Cr(H}_2\text{O)}_4\text{Cl}_4]\text{Cl}.2\text{H}_2\text{O}$

(c) $[\text{Cr(H}_2\text{O)}_5\text{Cl}]\text{Cl}_2.\text{H}_2\text{O}$

(d) $[\text{Cr(H}_2\text{O)}_6]\text{Cl}_3$

65. Assuming degree of ionization to be unity in each case, which of the following equimolal solutions would freeze at the lowest temperature ?

(a) $[\text{Pt(NH}_3)_6]\text{Cl}_4$ (b) $[\text{Pt(NH}_3)_5\text{Cl}]\text{Cl}_3$

(c) $[\text{Pt(NH}_3)_4\text{Cl}_2]\text{Cl}_2$ (d) $[\text{Pt(NH}_3)_3\text{Cl}_3]\text{Cl}$

66. Which of the following aqueous solutions should have the highest osmotic pressure?

(a) 0.011 M AlCl_3 at 50 °C

(b) 0.03 M NaCl at 25 °C

(c) 0.012 M $(\text{NH}_4)_2\text{SO}_4$ at 25 °C

(d) 0.03 M NaCl at 50 °C

67. At 760 torr pressure and 20°C temperature, 1 L of water dissolves 0.04 gm of pure oxygen or 0.02 gm of pure nitrogen. Assuming that dry air is composed of 20% oxygen and 80% nitrogen (by volume), the masses (in g/L) of oxygen and nitrogen dissolved by 1 L of water at 20°C exposed to air at a total pressure of 760 torr are respectively: **Toughnut**

(a) 0.008, 0.016 (b) 0.016, 0.008

(c) 0.16, 0.08 (d) 0.04, 0.02

68. If sodium sulphate is considered to be completely dissociated into cations and anions in aqueous solution, the change in freezing point of water (ΔT_f), when 0.01 mol of sodium sulphate is dissolved in 1 kg of water, is (K_f = 1.86 K kg mol^{-1})

(a) 0.372 K (b) 0.0558 K

(c) 0.0744 K (d) 0.0186 K

69. The osmotic pressure (at 27° C) of an aqueous solution (200mL) containing 6 g of a protein is 2×10^{-3} atm. If R = 0.080 L atm $\text{mol}^{-1}\text{K}^{-1}$, the molecular weight of protein is

(a) 7.2×10^5 (b) 3.6×10^5

(c) 1.8×10^5 (d) 1.0×10^5

70. At temperature 327 °C and concentration C, osmotic pressure of a solution is P, the same solution at concentration C/2 and at temperature 427 °C shows osmotic pressure of 2 atm, value of P will be **Tricky**

(a) $\frac{12}{7}$ (b) $\frac{24}{7}$ (c) $\frac{6}{5}$ (d) $\frac{5}{6}$

71. In countries nearer to polar region, the roads are sprinkled with CaCl_2. This is

(a) to minimise the snow present on roads

(b) to minimise pollution

(c) to minimise the accumulation of dust on the road

(d) to minimise the wear and tear of the roads

72. If α is the degree of dissociation of Na_2SO_4, the vant Hoff's factor (*i*) used for calculating the molecular mass is

(a) $1 + \alpha$ (b) $1 - \alpha$ (c) $1 + 2\alpha$ (d) $1 - 2\alpha$

73. Which has the minimum freezing point ?

(a) One molal NaCl aq. solution

(b) One molal CaCl_2 aq. solution

(c) One molal KCl aq. solution

(d) One molal urea aq. solution

74. On mixing 3 g of non - volatile solute in 200 mL of water, its boiling point (100°) becomes 100.52°C. If K_b for water is 0.6 K/m then molecular wt. of solute is : **Toughnut**

(a) 10.5 g mol^{-1} (b) 12.6 g mol^{-1}

(c) 15.7 g mol^{-1} (d) 17.3 g mol^{-1}

75. Benzene freezes at 5.50ºC. If the freezing point of 2.48 g of phosphorous in 100 g benzene is 4.48ºC, the atomicity of phosphorus in benzene is (K_f (benzene) = 5.12 K kg mol^{-1}): **Toughnut**

(a) 1 (b) 3 (c) 4 (d) 8

76. A solute X has a solubility of 10.0 g in 100 g of water at 25°C. If a solution containing 4.0 g of solute in 50 g of water is subjected to evaporation at constant temperature of 25°C, the osmotic pressure of the solution

(a) remains unchanged throughout
(b) increases continuously
(c) increases to constant value
(d) decreases to constant value

77. At 17°C, the osmotic pressure of sugar solution is 580 torr. The solution is diluted and the temperature is raised to 57°C, when the osmotic pressure is found to be 165 torr. The extent of dilution is:

(a) 2 times (b) 3 times
(c) 4 times (d) 5 times

78. Which of the following terms has units of temperature? **Critical Thinking**

$\mathrm{I : K_f}$ $\mathrm{II : mK_f}$ $\mathrm{III : iK_f}$ $\mathrm{IV : \dfrac{mK_f}{i}}$

(a) I, II (b) I, III (c) II, III (d) II, IV

79. 0.5 m solution of a complex of iron and cyanide ions has the depression of f.pt. to be 3.72 K (K_f for water = 1.86 K molal^{-1}). The formula of the complex is:

(a) $K_4[Fe(CN)_6]$ (b) $K_2[Fe(CN)_4]$
(c) $K_3[Fe(CN)_6]$ (d) $Fe(CN)_4$

80. A living cell contains a solution which is isotonic with 0.2 M glucose solution. What osmotic pressure develops when the cell is placed in 0.05 M $BaCl_2$ solution at 300 K? **Toughnut**

(a) 1.23 atm (b) 3.69 atm
(c) 6.15 atm (d) None of these

Answer KEYs

1	(b)	**9**	(b)	**17**	(b)	**25**	(b)	**33**	(c)	**41**	(a)	**49**	(c)	**57**	(d)	**65**	(a)	**73**	(b)
2	(a)	**10**	(d)	**18**	(a)	**26**	(b)	**34**	(a)	**42**	(b)	**50**	(b)	**58**	(d)	**66**	(d)	**74**	(d)
3	(b)	**11**	(a)	**19**	(d)	**27**	(d)	**35**	(c)	**43**	(c)	**51**	(b)	**59**	(c)	**67**	(a)	**75**	(c)
4	(b)	**12**	(b)	**20**	(a)	**28**	(b)	**36**	(a)	**44**	(c)	**52**	(d)	**60**	(d)	**68**	(b)	**76**	(c)
5	(b)	**13**	(c)	**21**	(a)	**29**	(d)	**37**	(b)	**45**	(a)	**53**	(b)	**61**	(c)	**69**	(b)	**77**	(c)
6	(a)	**14**	(b)	**22**	(a)	**30**	(d)	**38**	(d)	**46**	(d)	**54**	(c)	**62**	(b)	**70**	(b)	**78**	(d)
7	(a)	**15**	(a)	**23**	(d)	**31**	(d)	**39**	(b)	**47**	(a)	**55**	(d)	**63**	(c)	**71**	(a)	**79**	(c)
8	(d)	**16**	(c)	**24**	(d)	**32**	(b)	**40**	(b)	**48**	(c)	**56**	(d)	**64**	(c)	**72**	(c)	**80**	(a)

Hints & Solutions

1. **(b)** More than theoretical weight since impurity will not contribute.

2. **(a)** Given w = 10 g, Mol. mass = 40 g

Weight of solvent = 1250 × 0.8 g = 10000 g = 1 kg

$$\therefore \text{molality} = \frac{10}{40 \times 1} \quad 0.25\,\text{m}$$

3. **(b)** From the molarity equation.

$$M_1V_1 + M_2V_2 = MV$$

$$M = \frac{M_1V_1 + M_2V_2}{V} \quad \text{where } V = V_1 + V_2$$

$$M = \frac{480 \times 1.5 + 520 \times 1.2}{480 \quad 520} \quad 1.344\ \text{M}$$

4. **(b)** For an ideal solution, $\Delta H_{mixing} = 0$

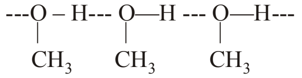
$\Delta H = \Delta H_1 + \Delta H_2 + \Delta H_3$

(According to Hess's law)

i.e., for ideal solutions there is no change in magnitude of the attractive forces in the two components present.

5. **(b)** Positive deviations are shown by such solutions in which solvent-solvent and solute-solute interactions are stronger than the solute-solvent interactions. In such solution, the interactions among molecules becomes weaker. Therefore their escaping tendency increases which results in the increase in their partial vapour pressures.

In pure methanol there exists intermolecular H–bonding.



$$\text{---}\underset{\displaystyle CH_3}{\underset{|}{O}}-H\text{---}\underset{\displaystyle CH_3}{\underset{|}{O}}-H\text{---}\underset{\displaystyle CH_3}{\underset{|}{O}}-H\text{---}$$

On adding benzene, its molecules come between methanol molecules there by breaking H-bonds which weaken intermolecular forces. This results in increase in vapour pressure.

6. **(a)** The solutions (liquid mixture) which boils at constant temperature and can distil as such without any change in composition are called azeotropes.

Solution of HNO_3 and H_2O will form maximum boiling point azeotrope. Maximum boiling azeotropes show negative deviation from Raoult's law.

	Composition (%)	Boiling Point
HNO_3	68.0	359 K
H_2O	32.0	373 K

Boiling point of the azeotrope of these two solutions is 393.5 K.

7. **(a)** A solution of acetone in ethanol shows positive deviation from Raoult's law. It is because ethanol molecules are strongly hydrogen bonded. When acetone is added, these molecules break the hydrogen bonds and ethanol becomes more volatile. Therefore its vapour pressure is increased.

8. **(d)** When the aqueous solution of one molal KI is diluted with water, concentration decreases, therefore the vapour pressure of the resulting solution increases.

9. **(b)** For this solution intermolecular interactions between heptane and ethanol are weaker than heptane -heptane and ethanol -ethanol interactions hence the solution of heptane and ethanol is non-ideal and shows positive deviation from Raoult's law.

10. **(d)** $P = P_A X_A + P_B X_B$

$= P_A X_A + P_B (1 - X_A)$

$\Rightarrow \; P_A X_A + P_B - P_B X_A$

$\Rightarrow \; P_B + X_A (P_A - P_B)$

11. **(a)** $n_{CHCl_3} = \dfrac{25.5}{119.5} \quad 0.213$

$n_{CH_2Cl_2} = \dfrac{40}{85} \quad 0.47$

$P_T = P_A^o X_A + P_B^o X_B$

$= 200 \times \dfrac{0.213}{0.683} + 41.5 \times \dfrac{0.47}{0.683}$

$= 62.37 + 28.55 = 90.92$

12. **(b)** $P_{total} = P_A^o \times X_A + P_B^o \times X_B$

$= 80.0 \times 0.4 + 120.0 \times 0.6 = 104$ mm Hg

The observed P_{total} is 100 mm Hg which is less than 104 mm Hg. Hence the solution shows negative deviation.

13. **(c)** Total V.P.,

$P = P_A^o X_A + P_B^o X_B = P_A^o X_A + P_B^o (1 - X_A)$

$= (P_A^o - P_B^o) X_A + P_B^o$

Thus, $P_B^\circ = 114$ torr ; $P_A^o - P_B^o \quad 52$

or $P_A^o = 166$ torr

Hence $P = 166 \times \dfrac{1}{2} + 114 \times \dfrac{1}{2} \quad 140$ torr

14. **(b)** Moles of solute $= \dfrac{28}{28} \quad 1$;

moles of water $= \dfrac{100 - 28}{18} \quad 4$

V.P. of solution

$= P_{H_2O}^o \times X_{H_2O} = 760 \times \dfrac{4}{5} \quad 608$ torr

15. **(a)** $P^o_{solvent} = 760$ torr (at the b. pt.);

$n_{solute} = 1$

$n_{solvent} = \dfrac{1000}{40} \quad 25$;

$\Delta P = 760 \times X_{solute} = \dfrac{760}{26}$ torr $= 29.23$ torr

16. **(c)** For dilute solution,

$\frac{\Delta P}{P} \Rightarrow \frac{n_{solute}}{n_{solvent}}$ For solution in A,

$$\frac{\Delta P_A}{P_A} \quad \frac{W/M}{W_A/M_A} \quad \frac{W}{M} \times \frac{M_A}{W_A} \qquad ....(i)$$

For solution in B, $\frac{\Delta P_B}{P_A^\circ} = \frac{W}{M} \times \frac{M_B}{W_B} \qquad ....(ii)$

From (i) and (ii),

$$\frac{\Delta P_A/P^\circ_A}{\Delta P_B/P^\circ_B} = 2 = \frac{M_A W_B}{M_B W_A} \quad \frac{M_A}{M_B} \; (W_A = W_B)$$

$M_A = 2M_B$

17. **(b)** $V_{dissolved} = KP_{H2}$

P_{H2} in the mixture $= X_{H2}P = \frac{80 \times 1425}{100} = 1140$

torr $= \frac{1140}{760} = 1.5$ atm

Hence, $V_{dissolved}$ in 2L of water $= 2 \times K \times P_{H2}$ $= 2 \times 18 \times 1.5 = 54$ mL

18. **(a)** Vapour pressure of solution $= P_A + P_B$

$$= P_A^o X_A + P_B^o X_B \quad \frac{120 \times 2}{5} \quad \frac{180 \times 3}{5}$$

156 mm Hg

19. **(d)** According to Henry's law the mass of a gas dissolved per unit volume of solvent is proportional to the pressure of the gas at constant temperature m = Kp i.e. as the solubility increases, value of Henry's law constant decreases. Since CO_2 is most soluble in water among the given set of gases. Therefore CO_2 has the lowest value of Henry's law constant.

20. **(a)** Minimum boiling azeotrope is formed by solution showing positive deviation. e.g. acetone – ethanol.

21. **(a)** Total vapour pressure = vapour pressure of pure benzene + vapour pressure of toluene

$= 100 + 50 = 150$ mm

We know,

$P^o_{C_6H_6} = P \times X_{C6H6}$

$100 = 150 \times X_{C6H6}$

$X_{C6H6} = \frac{100}{150} \quad 0.67$

22. **(a)** Moles of urea $= \frac{12}{60} \quad 0.2$

Moles of sucrose $= \frac{68.4}{342} \quad 0.2$

Both are non electrolyte hence lowering of V.P. will be same.

23. **(d)** Lesser the intermolecular forces, the more the volatile character.

24. **(d)** At 1 atmospheric pressure the boiling point of mixture is 80°C.

At boiling point the vapour pressure of mixture, $P_T = 1$ atmosphere $= 760$ mm Hg. Using the relation,

$P_T = P_A^\circ x_A + P_B^\circ x_B$, we get

$P_T \quad 520x_A \quad 1000(1 - x_A)$

$\{\because P_A^o \quad 520$ mm Hg,

$P_B \quad 1000$ mm Hg; $x_A \quad x_B \quad 1$

or $760 \quad 520x_A \quad 1000 - 1000x_A$ or $480x_A \quad 240$

or $x_A \quad \frac{240}{480} \quad \frac{1}{2}$ or 50 mol percent

25. **(b)** Total V.P. of solution $= P_A x_A \quad P_B x_B$

Given, $P_A \quad 74.7$ torr, $P_B \quad 22.3$ torr

$n_{benzene} = 1.5$ mol, $n_{toluene} = 3.5$ mol

$n_{solution} = 1.5 + 3.5 = 5$ mol

$x_A \quad \frac{n_{benzene}}{n_{solution}} \quad \frac{1.5}{5}$

Total V.P. of solution

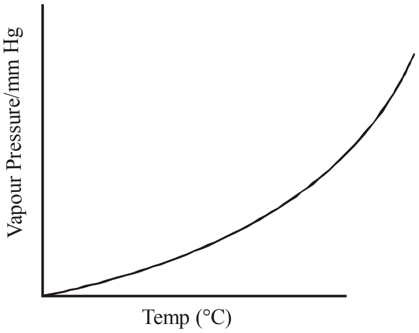
$$= \left(\frac{1.5}{5} \times 74.7 + \frac{3.5}{5} \times 22.3\right) \text{torr}$$

$= (22.4 + 15.6)$ torr $= 38$ torr

Mole fraction of benzene in vapour form =

$\frac{22.4}{38} = 0.589$

26. **(b)** If we plot a graph between the vapour pressure and the temperature. We would get a curve that rises faster as T increases, giving a curved line.



27. **(d)** Solutions in which solute - solute and solvent-solvent interactions are almost similar to solute solvent interactions are known as ideal solution.

28. **(b)** $P_A = P_A^o \times x_A$ = total pressure × y_A

$P_B = P_B^o \times x_B$ = total pressure × y_B

where x and y represents mole fraction in liquid and vapour phase respectively.

$$\frac{P_B^o x_B}{P_A^o x_A} = \frac{y_B}{y_A};\ \frac{P_B^o(1-x_A)}{P_A^o x_A} \quad \frac{1-y_A}{y_A}$$

on putting values $\frac{119(1-0.50)}{37\times 0.50} \quad \frac{1-y_A}{y_A}$

on solving $y_A = 0.237$

29. **(d)** $\Delta T_f = K_f m$

where m = molality

$$273-268 = 1.86\times\frac{w}{M\times v}$$

$$5 = 1.86\times\frac{w}{32\times 10}$$

$$w = \frac{5\times 32\times 10}{1.86}$$

$= 860.2 \approx 868.06$ g

30. **(d)** Moles of CO_2 dissolved

$= K \times P_{CO_2} \times V_{bottle} = 3\times 10^{-2}\times 4\times 100 \quad 12$;

Mass of $CO_2 = 12 \times 44 = 528$ g

31. **(d)** For ideal solution vapour pressure of solution

$= P_A^o X_A + P_B^o X_B$

$= 80\times\frac{2}{5}+100\times\frac{3}{5} \quad 92$ torr

Since observed vapour pressure of solution < ideal vapour pressure, the solution shows negative deviation.

32. **(b)** From the given data

$P_{H2} = 1500 \times 0.80$

$= 1200$ mm of Hg $= \frac{1200}{760}$ atmosphere $= 1.58$ atmosphere

If 's are volumes of gas dissolved by same volume of liquid, then from Henry's law

$$\frac{V_2}{V_1} = \frac{P_2}{P_1};\ \text{or}\ \frac{V_2}{20} = \frac{1.58}{1.0}$$

or $V_2 = 31.60$ mL

33. **(c)** V.P. of solution at t°C = 760 mm

[at b.p., V.P. of solution =atompheric pressure]

Thus $= P_A^o.x_A + P_B^o.x_B$

or $P = P_A^o.x_A + P_B^o.(1-x_A)$ $[\because x_A + x_B = 1]$

or $760 = 400X_A + 800(1-X_A)$ $[\because P = 760$ mm of Hg]

or $-800 + 760 = -400\ x_A$

or $-40 = -400\ x_A$

or $x_A = \frac{40}{400} = 0.1$

Thus mole fraction of in solution is 0.1

34. **(a)** The given data are

$P_{water} = 17.0$ torr;

P_{total} (4 mole % solution)

$= P_{NH_3} + P_{water} = 50.0$ torr

$X_{NH_3} = 0.04$ and $X_{water} = 0.96$

Now according to Raoult's law;

$P_{water} \quad X_{water}\ P_{water}$

$= 0.96 \times 17.0$ torr $= 16.32$ torr

Now Henry's law constant for ammonia is

$$K_H\ NH_3 \quad \frac{P_{NH_3}}{X_{NH_3}} \quad \frac{33.68\ \text{torr}}{0.04} \quad 842\ \text{torr}$$

Hence, for 5 mole % solution, we have

$P_{NH_3} \quad K_H\ NH_3\ X_{NH_3}$

$= (842$ torr$)\ (0.05) = 16.15$ torr

Thus, P_{total} (5 mole % solution)

$$P_{NH_3} \quad P_{water} \quad 42.1 \quad 16.15 \quad 58.25 \text{ torr}$$

35. **(c)** $\Delta T_b = K_b \times m$

Elevation in boiling point is a colligative property, which depends upon the no. of particles (concentration of solution). Thus greater the number of particles, greater is the elevation in boiling point and hence greater will be its boiling point.

$$Na_2SO_4 \rightleftharpoons 2Na^+ + SO_4^{2-}$$

Since Na_2SO_4 has maximum number of particles hence it has maximum boiling point.

36. **(a)** (i) $i = \dfrac{\text{No. of particles after ionisation}}{\text{No. of particles before ionisation}}$

(ii) $\Delta T_b = i \times K_b \times m$

$$\begin{array}{lcc} CuCl_2 \longrightarrow & Cu^{2+} + & 2Cl^- \\ 1 & 0 & 0 \\ (1-\alpha) & \alpha & 2 \end{array}$$

$i = \dfrac{1+2\alpha}{1}, \ = 1 + 2\alpha$

Assuming 100% ionization

So, $i = 1 + 2 = 3$

$\Delta T_b = 3 \times 0.52 \times 0.1 = 0.156 \approx 0.16$

$\left(m \quad \dfrac{13.44}{134.4} \quad 0.1\right)$

37. **(b)** $\pi \quad \dfrac{nRT}{V}$ or $T \quad \dfrac{\pi V}{nR}$

10% (w/v) aqueous solution of glucose means 10 g glucose is present in 100 mL of H_2O

$$= \frac{14 \times 100 \times 10^{-3} \times 180}{0.082 \times 10} = 307.3 \text{ K}$$

38. **(d)** $\Delta T_f \quad iK_f m$

$$\begin{array}{lcc} KBr \longrightarrow & K^+ \quad + & Br^- \\ 1 & 0 & 0 \\ (1-\alpha) & \alpha & \alpha \end{array}$$

$i = 1 + \alpha$

Here $\alpha = 0.8$ (80% ionization)

$= 1.8$

$\Delta T_f = (1.8)(1.86)(0.4) = 1.339$

$T_f = -1.339\,°C$

39. **(b)** As $\Delta T_f = K_f.m$

$\Delta T_b = K_b.m$

Hence, we have $m \quad \dfrac{\Delta T_f}{K_f} \quad \dfrac{\Delta T_b}{K_b}$

or $\Delta T_f = \Delta T_b \dfrac{K_f}{K_b}$

$\Rightarrow [\Delta T_b = 100.18 - 100 \quad 0.18 \ C]$

$= 0.18 \times \dfrac{1.86}{0.512} = 0.654°C$

As the freezing point of pure water is 0°C,

$\Delta T_f = 0 - T_f$

$0.654 = 0 - T_f$

$\therefore T_f = -0.654$

Thus the freezing point of solution will be – 0.654°C.

40. **(b)** $\pi V \quad \dfrac{w}{m} RT$

$\therefore \ 6 \times 10^{-4} \times 1 = \dfrac{4}{m} \times 0.0821 \times 300;$

$m = 1.64 \times 10^5$.

41. **(a)** Van't Hoff equation is

$\pi V = inRT$

For depression in freezing point.

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

For elevation in boiling point.

$\Delta T_b = i \times K_b \times m$

For lowering of vapour pressure,

$$\frac{P_{solvent} - P_{solution}}{P_{solvent}} \quad i\left(\frac{n}{N+n}\right)$$

42. **(b)** $\Delta T_f = i.K_f.m$; $0.0054 = i \times 1.8 \times 0.001$

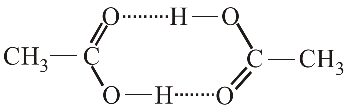
$i = 3$ so it is $[Pt(NH_3)_4Cl_2]Cl_2$.

43. **(c)** From the relation, $\Delta T_f = iK_f m$, it is evident that $\Delta T_f \quad i$. Since i is maximum for ethanol (others are non electrolytes), ΔT_f (depression in freezing point) will be maximum for C_2H_5OH and hence freezing point will be minimum for ethanol solution.

44. **(c)** If compound dissociates in solvent $i > 1$ and on association $i < 1$.

45. **(a)** As both the solutions are isotonic hence there is no net movement of the solvent through the semipermeable membrane between two solutions.

46. **(d)** Acetic acid contain carboxylic group – COOH which can form H-bonding so acetic acid dimerises.



47. **(a)** Given $\pi_{ob} = 10.8$ atm

$\pi_{nor} = CRT = 0.10 \times 0.0821 \times 298 = 2.446$

now experimental value of (i)

$$= \frac{\text{Observed osmotic pressure}}{\text{Normal osmotic pressure}}$$

$$= \frac{10.8}{2.446} \quad 4.42$$

48. **(c)** $\frac{P^o - P_s}{P^o} = \frac{n}{N} = \frac{w}{m} \times \frac{M}{W}$

$$0.1 = \frac{12}{m} \times \frac{18}{108}$$

$$m = \frac{12 \times 18}{0.1 \times 108} \quad 20$$

49. **(c)** van't Hoff factor (i) and the degree of association are related as below :

$$i = 1 - \alpha\left(1 - \frac{1}{n}\right)$$

$$0.9 = 1 - 0.2\left(1 - \frac{1}{n}\right)$$

On solving,

$$\left(1 - \frac{1}{n}\right) = \frac{1}{2}$$

$$\frac{1}{n} = 1 - \frac{1}{2} \quad \frac{1}{2}$$

$\therefore\ n = 2$

50. **(b)** Mol.wt. $\quad \frac{k_f \times w \times 1000}{\Delta T_f \times W}$

$$= \frac{1.86 \times 0.85 \times 1000}{0.23 \times 125} \approx 55 \text{ g}$$

Where
$w = 0.85$g
$W = 125$ g

$\Delta T_f = 0°C - (-23°C) = 23°C$

Now, $i \quad \frac{M_{\text{normal}}}{M_{\text{observed}}} \quad \frac{136.3}{55} \quad 2.47$

$$\underset{1-\alpha}{ZnCl_2} \rightleftharpoons \underset{\alpha}{Zn} \quad \underset{2\alpha}{2Cl^-}$$

Van't Hoff factor (i)

$$\frac{1 - \alpha + \alpha + 2\alpha}{1} \quad 2.47$$

$\therefore \quad \alpha = 0.735 = 73.5\%$

51. **(b)** As $\Delta T_f = K_f . m$

For,

$$\begin{array}{lccc} & HX & \rightleftharpoons H^+ & X^- \\ t\ 0 & 1 & 0 & 0 \\ t = eq & (1-0.20) & 0.20 & 0.20 \end{array}$$

Total no. of moles = 1 – 0.20 + 0.20 + 0.20
= 1 + 0.20 = 1.2

$\therefore\ \Delta T_f = 1.2 \times 1.86 \times 0.5 = 1.1160 \approx 1.12$ K

52. **(d)** Osmotic pressure (π) = CRT

$$(\pi) = \frac{wt \times 1000}{\text{Molecular mass} \times V} RT$$

$$= 2.57 \times 10^{-3} = \frac{1.26 \times 1000}{\text{Mol.mass} \times 200} \times 0.083 \times 300$$

Molecular mass = 61038 g

53. **(b)** $\Delta T_b = K_b \frac{W_B}{M_B \times W_A} \times 1000$;

$$\Delta T_f = K_f \frac{W_B}{M_B \times W_A} \times 1000 ;$$

$$\frac{\Delta T_b}{\Delta T_f} = \frac{K_b}{K_f} = \frac{\Delta T_b}{-0.186} \quad \frac{0.512}{1.86} \quad 0.0512 \text{ C.}$$

54. **(c)** Moles of glucose $\frac{10}{180}$ 0.05,

urea $\frac{10}{60}$ 0.16, Sucrose $\frac{10}{342}$ 0.029

Hence osmotic presure $P_2 > P_1 > P_3$ (π C)

55. **(d)** Colligative properties depends upon the no. of particles. Since methanol is non electrolyte hence cannot be considered.

56. **(d)** $(100+\Delta T_b)-(0-\Delta T_f)=105$

$\Delta T_b+\Delta T_f=5$

$m(K_b+K_f)=5$

$$m \quad \frac{5}{2.37} \quad \text{i.e.,} \ \frac{5}{2.37} \text{ moles in 1000 g water}$$

$$\text{(or)} \ \frac{5}{2.37\times10} \text{ moles in 100 g water}$$

$$\therefore \quad \text{Wt. of sucrose} = \frac{5}{2.37\times10}\times342 = 72\text{g}$$

57. **(d)** $\Delta T_f=K_f\times m$

$$M=\frac{1000\times K_f\times w_2 \ \text{solute}}{\Delta T_f\times w_1 \ \text{solvent}}$$

$$=\frac{1000\times1.86\times1.8}{0.465\times40}\Rightarrow M=180$$

Molecular formula = (empirical formula)$_n$

$$n=\frac{\text{Molecular mass}}{\text{Empirical formula mass}} \quad \frac{180}{30} \quad 6$$

Molecular formula = $(CH_2O)_6=C_6H_{12}O_6$.

58. **(d)** $\Delta T_f=i.K_f.m;\ \Delta T_b \quad i.K_b.m$

$$\frac{\Delta T_f}{\Delta T_b} \quad \frac{K_f}{K_b}$$

$$\Delta T_f=0-(-0.186\ C) \quad 0.186\ C$$

$$\frac{0.186}{\Delta T_b}=\frac{1.86}{0.52}\Rightarrow \ \Delta T_b \quad \frac{0.52\times0.186}{1.86} \quad 0.052$$

59. **(c)** $\Delta T_b \quad \dfrac{K_b\times w\times1000}{M\times W};$

$$\therefore K_b \quad \frac{\Delta T_b\times100\times100}{10\times1000} \quad \Delta T_b$$

60. **(d)** $\Delta T_f=K_f\times m\times i$. Since K_f has different values for different solvents, hence even if m is the same ΔT_f will be different

61. **(c)** Moles of urea = $\dfrac{5}{60}$;

moles of fructose = $\dfrac{5}{180}$;

$$C_{urea}=\frac{0.08\times1000}{100}\Rightarrow0.833$$

moles of sucrose = $\dfrac{5}{342}$;

$$C_{sucrose}=0.0146\times\frac{1000}{100}=0.146$$

moles of KCl(effective)

$$= \ 2\times\frac{5}{74.5} \quad \frac{5}{37.25};\ \frac{0.134\times1000}{100} \quad 1.34$$

$\pi \quad C$

this order is $\pi_4>\pi_1>\pi_2>\pi_3$

62. **(b)** Greater is the effective molarity (i × C), higher the ΔT_f value and lower the freezing point.

(i) 0.1 M NaCl = $i\times C=2\times0.1=0.2$

(ii) 0.05 M $BaCl_2=i\times C=3\times0.05=0.15$

(iii) 0.1 M $NH_2CSNH_2=i\times C=1\times0.1=0.1$

(iv) 0.025 M $KNO_3=i\times C=2\times0.025=0.50$

Thus, order is (i) < (ii) < (iii) < (iv)

63. **(c)** $\Delta T_f\text{(normal)}=K_fm=1.86\times0.01=0.0186$;

$$i=\frac{\Delta T_{f(obs)}}{\Delta T_{f(nor)}} \quad \frac{0.0205}{0.0186} \quad 1.10 \quad 1 \quad \alpha\ ;$$

$\alpha \quad 0.1$

$$K_a=\frac{C\alpha^2}{1-\alpha} \quad \frac{0.01\times0.1^2}{1-0.1} \quad \frac{1}{9}\times10^{-3}\ ;$$

$$K_b=\frac{K_w}{K_a}=1.0\times10^{-14}\times9\times10^3=9\times10^{-11}$$

64. **(c)** $i \quad \dfrac{5.58}{1.86} \quad 3$;

$$[Cr(H_2O)_5Cl]Cl_2.H_2O\longrightarrow$$

$$[Cr(H_2O)_5Cl]^{2+} \quad 2Cl^-$$

65. **(a)** $[Pt(NH_3)_6]Cl_4\rightarrow[Pt(NH_3)_6]^{4+} \quad 4Cl^-$;

$i=1+4=5$ (maximum)

66. **(d)** $\pi \quad iCT$; iCT is maximum for 0.03 M NaCl at 50 °C.

67. **(a)** Mass of oxygen $=\dfrac{20}{100}\times0.04 \quad 0.008\ g/L$

Mass of nitrogen

$$=\frac{80}{100}\times0.02 \quad 0.016\ g/L$$

68. **(b)** Sodium sulphate dissociates as

$Na_2SO_4(s) \longrightarrow 2Na \quad SO_4^{--}$

hence van't hoff factor $i = 3$

Now $\Delta T_f \quad i\,k_f.m$

$= 3 \times 1.86 \times 0.01 = 0.0558\,K$

69. **(b)** Using the relation,

$$M \quad \frac{w.R.T}{\pi V},$$

we get $M \quad \frac{6\times0.080\times300}{2\times10^{-3}\times0.2} = 3.6\times10^5$

70. **(b)** $\pi V = CRT$

$$\frac{\pi_1}{\pi_2} \quad \frac{C_1T_1}{C_2T_2}$$

$$\pi_1 = P, \pi_2 \quad 2\text{ atm. } C_1 \quad C, C_2 \quad \frac{C}{2}$$

$T_1 = 600\,K, T_2 = 700\,K$

$$\frac{P}{2} \quad \frac{2\times C\times600}{C\times700}$$

$$P \quad \frac{24}{7}.$$

71. **(a)** $CaCl_2$ acts as a non-volatile solute and results in depression in freezing point. Thus, snow is reduced and prevents blocking of roads in the polar region.

72. **(c)**

	Na_2SO_4	$\longrightarrow 2Na^+$	$+ SO_4^{2-}$
Mol. before dissociation	1	0	0
Mol. after dissociation	$1-\alpha$	2α	1α

$i = 1-\alpha+2\alpha+\alpha \quad 1 \quad 2\alpha$

73. **(b)** Among the given options, $CaCl_2$ solution will produce maximum (three) ions per molecule, so it will show minimum freezing point.

74. **(d)** $$\Delta T_b = K_b\frac{w}{M}\times\frac{1000}{W}$$

$$0.52 = 0.6\times\frac{3}{m}\times\frac{1000}{200} \quad W = 200\times1)$$

$$m = \frac{1.8\times5}{0.52} \quad 17.3\text{g mol}^{-1}$$

75. **(c)** Molecular mass of phosphorous

$$= \frac{1000\times K_f\times W_{solute}}{\Delta T_f\times W_{benzene}}$$

$$= \frac{1000\times5.12\times2.48}{1.02\times100} \quad 124.5 \quad (P)_x$$

or, $x \quad \frac{124.5}{31} \quad 4$

76. **(c)** The given solution is unsaturated (saturated one contains 5 g of solute in 50 g of water). On evaporation, concentration of solution increases to saturation and thereafter becomes constant due to excess solid separating out. Hence, osmotic pressure first increases and then becomes constant.

77. **(c)** $\pi_1 = \frac{nRT_1}{V_1},\ \pi_2 = \frac{nRT_2}{V_2}$

Hence, $\frac{\pi_1}{\pi_2} \quad \frac{580}{165} \quad \frac{V_2T_1}{V_1T_2} \quad \frac{V_2\times290}{V_1\times330}$

$\Rightarrow \frac{V_2}{V_1} \quad 4$

78. **(d)** $mK_f = \Delta T_f$ has the units of temperature. Van't Hoff factor, i, is dimensionless quantity.

79. **(c)** $\Delta T_f(\text{normal}) = K_f m = 1.86\times0.5 = 0.93^\circ$

Assuming 100% ionization, i = n = No. of ions per molecule

$= \frac{\text{Observed}\,\Delta T_f}{\text{Normal}\,\Delta T_f} \quad \frac{3.72}{0.93} \quad 4$

$K_3[Fe(CN)_6] \longrightarrow 3K^+ + [Fe(CN)_6]^{3-}$

no. of ions = 4

80. **(a)** For non electrolyte solute (glucose) i = 1

For $BaCl_2 \rightleftharpoons Ba^{2+} + 2Cl^-$

$i = 3$ (100 % ionized)

$i = (\text{number of ions after ionization} \times \alpha) + (1-\alpha)$

$= (3\times1) + (1-1) = 3$

$\pi = (iC_1 - i_2C_2)RT$

$\Rightarrow (1\times0.2 - 3\times0.05)\,0.0821\times300$

$\Rightarrow$ 1.23 atm