## Single Correct Answer Type

1. The ratio of the value of any colligative property for KCl solution to that of sugar solution is
   a) 1   b) 0.5   c) 2   d) 4

2. What would be the freezing point of aqueous solution containing 17 g of C_2H_5OH in 1000 g of water.
   $K_{f\,H_2O} = 1.86$ K m^{-1}
   a) $-0.69°C$ b) $-0.34°C$ c) $0.0°C$ d) $0.34°C$

3. The osmotic pressure of a solution (density is 1 g mL^{-1}) containing 3 g of glucose (molecular weight $=$ 180) in 60 g of water at 15°C is
   a) 0.34 atm   b) 0.65 atm   c) 6.25 atm   d) 5.57 atm

4. The molal freezing point constant of water is 1.86 K m^{-1}, If 342 g of cane sugar ($C_{12}H_{22}O_{11}$) is dissolved in 1000 g of water, the solution will freeze at
   a) $-1.86°C$ b) $1.86°$ c) $-3.92°C$ d) $2.42°C$

5. On mixing 10 mL of acetone with 40 mL of chloroform, the total volume of the solution is
   a) $< 50\ mL$ b) $> 50\ mL$ c) $= 50$ mL   d) Cannot be predicted

6. The most likely of the following mixtures to be an ideal solution is
   a) $NaCl - H_2O$ b) $C_2H_5OH - C_6H_6$ c) $C_6H_{16}(l) - H_2O$ d) $C_6H_5OH - H_2O$

7. $FeCl_3$ on reaction with $K_4[Fe(CN)_6]$ in aqueous solution gives blue colour. These are separated by a semi-permeable membrane AB as shown. Due to osmosis, there is
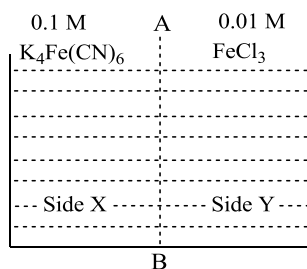
   a) Blue colour formation in side X
   b) Blue colour formation in side Y
   c) Blue colour formation in both of sides X and Y
   d) No blue colour formation

8. A mixture of volatile components A and B has total vapour pressure (in torr)
   $P = 254 - 119\chi_A$
   Where χ_A is the mole fraction of A in mixture. Hence, $P_A °$ and $P_B °$ are (in torr)
   a) $254, 119$ b) $119, 254$ c) $135, 254$ d) $154, 119$

9. An azeotropic solution of two liquids has boiling point lower than either of them when it
   a) Shows negative deviation from Raoult's law
   b) Shows no deviation from Raoult's law
   c) Shows positive deviation from Raoult's law
   d) Is saturated

10. Which has the maximum osmotic pressure at temperature T?
    a) 100 mL of 1 m urea solution
    b) 300 mL of 1 M glucose solution
    c) Mixture of 100 mL of 1 M urea solution and 300 mL of 1 M glucose solution
    d) All are isotonic

11. A 5% solution of cane sugar (molecular weight $= 342$) is isotonic with 1% solution of substance X. The molecular weight of X is
    a) 171.2   b) 68.4   c) 34.2   d) 136.2

12. A teacher one day pointed out to his students the peculiar fact that water is a unique liquid which freezes

exactly at 0°C and boils exactly at 100°C. He asked the students to find the correct statement based on this fact

a) Water dissolves anything, however sparingly the dissolution may be

b) Water is a polar molecule

c) Boiling and freezing temperatures of water were used to define a temperature scale

d) Liquid water is denser than ice

13. The vapour pressure (VP) of a dilute solution of non-volatile solute is P and the VP of a pure solvent is $P°$. The lowering of the VP is

a) +ve   b) −ve   c) $P/P°$ d) $P°/P$

14. The osmotic pressure of a solution increases if

a) Temperature is lowered

b) Volume is increased

c) Number of solute molecules is increased

d) None of the above

15. On mixing 10 mL of carbon tetrachloride with 10 mL of benzene, the total volume of the solution is

a) > 20 mL   b) < 20 mL c) = 20 mL   d) Cannot be predicted

16. Azeotropic mixtures are

a) Constant boiling point mixture without changing the composition

b) Those which boil at different temperatures

c) Mixtures of two solids

d) None of the above

17. A solution containing 4 g of a non-volatile organic solute, per 100 mL was found to have an osmotic pressure equal to 500 cm of mercury at 27°C. The molecular weight of solute is

a) 14.97   b) 149.7   c) 1697   d) 1.497

18. 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 2 K is observed. The van't Hoff factor (i) is

a) 0.5   b) 1   c) 2   d) 3

19. When a solution is separated from a solvent by a semi-permeable membrane, then the phenomenon taking place is called as

a) Osmosis   b) Diffusion   c) Solubility   d) None

20. A mixture of benzene and toluene forms

a) An ideal solution   b) Non-ideal solution   c) Suspension   d) Emulsion

21. Boiling point elevation is

a) Additive property   b) Constitutive property

c) Colligative property   d) Partly additive and partly constitutive

22. The Van't Hoff factor of NaCl assuming 100% dissociation

a) 1/2   b) 2   c) 1   d) 3

23. Which solution will have the highest boiling point?

a) 1% glucose in water   b) 1% sucrose in water   c) 1% NaCl in water   d) 1 % CaCl$_2$ in water

24. The osmotic pressure of equimolar solutions of BaCl$_2$, NaCl, and glucose follow the order

a) BaCl$_2$ > $NaCl$ > $Glucose$

b) Glucose > $NaCl$ > $BaCl_2$

c) NaCl > $BaCl_2$ > $Glucose$

d) NaCl > $Glucose$ > $BaCl_2$

25. The depression in freezing point is maximum if the solvent used is

a) Camphor   b) Naphthalene   c) Benzene   d) Water

26. If a 6.84% (weight/volume) solution of cane sugar (molecular weight = 342) is isotonic with 1.52% (weight/volume) solution of thiocarbamide, then the molecular weight of thiocarbamide is

a) 152   b) 760   c) 60   d) 180

27. 12.2 g of benzoic acid ($Mw = 122$) in 100 g benzene has depression in freezing point 2.6°: $K_f = 5.2° =$

kg mol^{-1}. If there is 100% polymerzation, the number of molecules of benzoic acid in associated state is

a) 1   b) 2   c) 3   d) 4

28. Assuming each salt to be 90 % dissociated which of the following will have the highest osmotic pressure?

a) Decinormal $Al_2(SO_4)_3$

b) Decinormal $BaCl_2$

c) Decinormal Na_2SO_4

d) A solution obtained by mixing equal volumes of (b) and (c) and filtering

29. Which statement is incorrect about osmotic pressure (π), volume (V) and temperature (T)?

a) $\pi \propto \frac{1}{V}$, if T is constant   b) $\pi \propto T$, if V is constant

c) $\pi \propto V$, if T is constant   d) πV is constant, if T is constant

30. The freezing point of 1% aqueous solution of calcium nitrate will be

a) 0°C   b) Above 0°C   c) 1°C   d) Below 0°C

31. The molal elevation constant of water $= 0.52$ K m^{-1}. The boiling point of 1.0 molal aqueous KCl solution (assuming complete dissociation of KCl) should be

a) 100.52°C   b) 101.04°C   c) 99.48°C   d) 98.96°C

32. The freezing point of 1 m NaCl solution assuming NaCl to be 100% dissociated in water is ($K_f = 1.86$ K m^{-1})

a) -1.86°C   b) -3.72°C   c) $+1.86$°C   d) $+3.72$°C

33. The freezing point of a 0.05 molal solution of non-electrolyte in water is ($K_f = 1.86$ K m^{-1})

a) -1.86°C   b) -0.93°C   c) -0.093°C   d) 0.093°C

34. An aqueous solution freezes at -0.186°C ($K_f = 1.86°$; $K_b = 0.512°$). What is the elevation in boiling point?

a) 0.186   b) 0.512   c) $\dfrac{0.512}{1.86}$ d) 0.0512

35. For a dilute solution, Raoult's law states that

a) The lowering of vapour pressure is equal to the mole fraction of the solute

b) The relative lowering of vapour pressure is equal to the mole fraction of the solute

c) The relative lowering of vapour pressure is proportional to the amount of solute in the solution

d) The vapour pressure of the solution is equal to the mole fraction of the solvent

36. Based on the given diagram, which of the following statements regarding the solutions of two miscible volatile liquids are correct?

    1. Plots AD and BC show that Raoult''s law is obeyed for the solution in which   B is a solvent and A is the solute and as well as for that in which. A is solvent and B is solute

    1. Plot CD shows that Dalton''s law of partial pressures is observed by the binary solutions of components A and B

    1. EF + EG = EH; and AC and BD corresponds to the vapour pressures of the pure solvents A and B, respectively

Select the correct answer using the codes given below: Codes:

a) 1 and 2   b) 2 and 3   c) 1 and 3   d) 1, 2, and 3

37. An aqueous solution of methanol in water has vapour pressure

a) Equal to that of water   b) Equal to that of methanol

c) More than that of water   d) Less than that of water

38. Solution distilled without change in composition at a temperature is called
    a) Amorphous
    b) Azeotropic mixture
    c) Ideal solution
    d) Super saturated solution
39. The osmotic pressure of a 5% (weight/volume) solution of cane sugar at 150°C is
    a) 4 atm
    b) 3.4 atm
    c) 5.078 atm
    d) 2.45 atm
40. The lowering of vapour pressure due to a solute in a 1 m aqueous solution at 100°C is
    a) 13.44 torr
    b) 14.12 torr
    c) 312 torr
    d) 352 torr
41. If a thin slice of sugar beet is placed in concentrated solution of NaCl, then
    a) Sugar beet will lose water from its cells
    b) Sugar beet will absorb water from solution
    c) Sugar beet will neither absorb nor lose water
    d) Sugar beet will dissolve in solution
42. Two solutions of KNO_3 and CH_3COOH are prepared separately. The molarity of both is 0.1 M and osmotic pressure P_1 and P_2 respectively
    The correct relationship between the osmotic pressures is
    a) $P_2 > P_1$
    b) $P_1 = P_2$
    c) $P_1 > P_2$
    d) $\dfrac{P_1}{P_1 + P_2} = \dfrac{P_2}{P_1 + P_2}$
43. The osmotic pressure of a dilute solution is directly proportional to the
    a) Diffusion rate of the solute
    b) Ionic concentration
    c) Boiling point
    d) Flow of solvent from a concentrated solution
44. Each pair forms ideal solution except
    a) C_2H_5Br and C_2H_5I
    b) C_6H_5Cl and C_6H_5Br
    c) C_6H_6 and $C_6H_5 \cdot CH_3$
    d) C_2H_6I and C_2H_5OH
45. The Henry's law constant for the solubility of N_2 gas in water at 298 K is $1.0 \times 105\ atm$. The mole fraction of N_2 In air is 0.8 The number of moles of N_2 from air dissolved in 10 moles of water of 298 K and 5 atm pressure is
    a) 4×10^{-4}
    b) 4.0×10^{-5}
    c) 5.0×10^{-4}
    d) 4.0×10^{-6}
46. The use of common salts, e.g NaCl or $CaCl_2$ anhydrous is made to clear snow on the rods. This causes:
    a) A lowering in the freezing point of water
    b) A lowering in the melting point of ice
    c) Ice melts at the temperature of atmosphere present at that time
    d) All of the above
47. The relative decrease in the vapour pressure of an aqueous solution containing 2 mol $[Cu(NH_3)_3Cl]Cl$ in 3 mol H_2O is 0.50. On reaction with $AgNO_3$, this solution will form
    a) 1 mol AgCl
    b) 0.25 mol AgCl
    c) 2 mol AgCl
    d) 0.40 mol AgCl
48. Which of the following 0.1 M aqueous solutions will have the lowest freezing point?
    a) Potassium sulphate
    b) Sodium chloride
    c) Urea
    d) Glucose
49. An azeotropic mixture of HCl and water has
    a) 84% of HCl
    b) 22.2% HCl
    c) 63% of HCl
    d) 20.2% HCl
50. 25 mL of an aqueous solution of KCl was found to require 20 mL of 1 M $AgNO_3$ solution when titrated using a K_2CrO_4 as indicator. The depression in freezing point of KCl solution with 100% ionization will be: ($K_f = 2.0°\ mol^{-1}$ kg and molarity = molality)
    a) 5.0°
    b) 3.2°
    c) 1.6°
    d) 0.8°
51. Which condition is not satisfied by an ideal solution?
    a) $\Delta_{mix}H = 0$
    b) $\Delta_{mix}V = 0$
    c) $\Delta_{mix}S = 0$
    d) Obeyance of Raoult's law
52. When 0.004 M Na_2SO_4 is an isotonic acid with 0.01 M glucose, the degree of dissociation of Na_2SO_4 is
    a) 75%
    b) 50%
    c) 25%
    d) 85%
53. The correct relationship between the boiling points of very dilute solutions of $AlCl_3(t_1)$ and $CaCl_2(t_2)$, having the same molar concentration, is

a) $t_1 = t_2$ b) $t_1 > t_2$ c) $t_2 > t_1$ d) $t_2 \geq t_1$

54. The osmotic pressure of a sugar solution at 24°C is 2.5 atm. The concentration of the solution in mole per liter is
    a) 10.25   b) 1.025   c) 1025   d) 0.1025

55. The boiling point of an azeotropic mixture of water and ethyl alcohol is less than that of the theoretical value of water and alcohol mixture. Hence the mixture shows
    a) The solution is highly saturated   b) Positive deviation from Raoult's law
    c) Negative deviation from Raoult's law   d) Nothing can be said

56. The freezing point among the following equimolal aqueous solutions will be highest for
    a) $C_6H_5NH_3Cl$ (aniline hydrochloride)   b) $Ca(NO_3)_2$
    c) $La(NO_3)_3$ d) $C_6H_{12}O_6$ (glucose)

57. Which aqueous solution has minimum freezing point?
    a) 0.0 1M NaCl   b) 0.005 M C_2H_5OH c) 0.005 M MgI_2 d) 0.005 M $MgSO_4$

58. The osmotic pressure of blood is 7.40 atm at 27°C. The number of mol of glucose to be used per liter for an intravenous injection that is to have the same osmotic pressure as blood is
    a) 0.3   b) 0.2   c) 0.1   d) 0.4

59. Which is not a colligative property?
    a) Lowering of vapour pressure   b) Freezing point
    c) Osmotic pressure   d) Elevation in boiling point

60. Semi-permeable membrane is chemically
    a) Copper ferrocyanide   b) Copper ferricyanide
    c) Copper sulphate   d) Potassium ferrocyanide

61. A pressure cooker reduces cooking time because
    a) Heat is more evenly distributed
    b) Boiling point of water inside the cooker is increased
    c) The high pressure tenderizes the food
    d) All of the above

62. Isotonic solutions are those which have
    a) Same osmotic pressure   b) Same molarity
    c) Same density   d) Same normality

63. The depression in freezing point of 0.01 m aqueous CH_3COOH solution is 0.02046°. 1 m urea solution freezes at -1.86°C. Assuming molality equal to molarity. pH of CH_3COOH solution is
    a) 2
    b) 3
    c) 3.2
    d) 4.2

64. Osmosis is the spontaneous flow through a semi-permeable membrane of
    a) A less concentrated solution into more concentrated solution
    b) The solvent from a solution of lower concentration to one of higher concentration
    c) Solute particles from a solution of higher concentration to one of lower concentration
    d) None

65. A molal solution is one that contains 1 mol of a solute in
    a) 1000 g of solvent   b) 1 L of solvent   c) 1 L of solution   d) 22.4 L of solution

66. The osmotic pressure of a non-aqueous solution is measured by
    a) Berkeley and Hartley method   b) Pfeffer's method
    c) Morse and Frazer method   d) Townend's method

67. The solutions in which the blood cells retain their normal shape, with regard to the blood, are
    a) Isotonic   b) Hypertonic   c) Hypotonic   d) None

68. An example of colligative property is
    a) Freezing point   b) Boiling point   c) Vapour pressure   d) Osmotic pressure

69. The osmotic pressure of a dilute solution is given by

    a) $P = P_0 \times N_1$　　　　b) $\pi V = nRT$　　　　c) $\Delta P = P_0 N_2$　　　　d) $\dfrac{\Delta P}{P^\circ} = \dfrac{P^\circ - P_S}{P^\circ}$

70. The osmotic pressure of a solution containing 0.1 mol of solute per liter at 273 K is

    a) $\dfrac{0.1}{1} \times 0.08205 \times 273$ atm　　　　　　b) $0.1 \times 2 \times 0.08205 \times 273$ atm

    c) $\dfrac{1}{0.1} \times 0.08205 \times 273$ atm　　　　　　d) $\dfrac{0.1}{1} \times \dfrac{273}{0.08205}$ atm

71. The freezing point of a solution prepared from 1.25 g of non-electrolyte and 20 g of water is 271.9K. If the molar depression constant is 1.86 K mol^{-1}, then molar mass of the solute will be

    a) 105.7　　　　b) 106.7　　　　c) 115.3　　　　d) 93.9

72. The mole fraction of component A in vapour phase is χ_1 and mole fraction of component A in liquid mixture is χ_2 (P_A° = vapour pressure of pure A; P_B° = vapour pressure of pure B). Then total vapour pressure of the liquid mixture is

    a) $\dfrac{P_A^\circ \chi_2}{\chi_1}$　　　　b) $\dfrac{P_A^\circ \chi_1}{\chi_2}$　　　　c) $\dfrac{P_A^\circ \chi_1}{\chi_2}$　　　　d) $\dfrac{P_B^\circ \chi_2}{\chi_1}$

73. Dissolving 120 g of urea (mol. Wt. 60) in 1000 g of water gave a solution of density 1.15 g/mL. The molarity of the solution is

    a) 1.78M　　　　b) 2.00M　　　　c) 2.05M　　　　d) 2.22M

74. Which of the following solutions has the minimum freezing point

    a) 1 molal NaCl solution　　　　　　b) 1 molal KCl solution
    c) 1 molal CaCl$_2$ solution　　　　　　d) 1 molal urea solution

75. If P° and P_s are vapour pressures of solvent and its solution, respectively, χ_1 and χ_2 are mole fractions of solvent and solute, respectively, then

    a) $P_s = P^\circ / \chi_2$　　　　b) $P^0 - P_s = P^\circ \chi_2$　　　　c) $P_s = P^\circ \chi_2$　　　　d) $\dfrac{P^\circ - P_s}{P_s} = \dfrac{\chi_1}{\chi_1 + \chi_2}$

76. When mercuric iodide is added to the aqueous solution of potassium iodide,

    a) Freezing point is raised　　　　　　b) Freezing point is lowered
    c) Freezing point does not change　　　　　　d) Boiling point does not change

77. The vapour pressure of a solvent decreased by 10 mm of Hg when a non-volatile solute was added to the solvent. The mole fraction of solute in solution is 0.2, what would be the mole fraction of solvent if the decrease in vapour pressure is 20 mm of Hg

    a) 0.8　　　　b) 0.6　　　　c) 0.4　　　　d) 0.2

78. Which of the following solutions has the maximum freezing point?

    a) 1 molar of NaCl solution　　　　　　b) 1 molar of KCl solution
    c) 1 molar of CaCl$_2$ solution　　　　　　d) 1 molar of urea solution

79. If Raoult's law is obeyed, the vapour pressure of the solvent in a solution is directly proportional to

    a) The mole fraction of the solvent　　　　　　b) The mole fraction of the solute
    c) The mole fraction of the solvent and solute　　　　　　d) The volume of the solution

80. The vapour pressure of pure benzene C$_6$H$_6$ at 50°C is 268 torr. How many moles of non-volatile solute per mole of benzene is required to prepare a solution of benzene having a vapour pressure of 167 torr at 50°C?

    a) 0.377　　　　b) 0.605　　　　c) 0.623　　　　d) 0.395

81. The value of K_f for water is 1.86°, calculated from glucose solution. The value of K_f for water calculated for NaCl solution will be

    a) = 1.86　　　　b) < 1.86　　　　c) > 1.86　　　　d) Zero

82. Which of the following solutions (1 molal) will have the maximum freezing point, assuming equal ionization in each case?

    a) [Fe(H$_2$O)$_6$]Cl$_3$　　　　　　b) [Fe(H$_2$O)$_5$Cl]Cl$_2 \cdot$ H$_2$O
    c) [Fe(H$_2$O)$_4$Cl$_2$]Cl $\cdot$ 2H$_2$O　　　　　　d) [Fe(H$_2$O)$_3$Cl$_3$] $\cdot$ 3H$_2$O

83. The mole fraction of toluene in the vapour phase which is in equilibrium with a solution of benzene (P_B° = 120 torr) and toluene (P_T° = 80 torr) having 2.0 mol of each is

    a) 0.50　　　　b) 0.25　　　　c) 0.60　　　　d) 0.40

84. When common salt is dissolved in water
    a) The melting point of the solution increases
    b) The boiling point of solution decreases
    c) Both melting point and boiling point decrease
    d) The boiling point of the solution increases
85. What will be the molecular weight of NaCl determined experimentally following elevation in the boiling point or depression in freezing point method?
    a) < 58.5 b) > 58.5 c) $= 58.5$ d) None
86. 0.004 M Na_2SO_4 is isotonic with 0.01 M glucose.Degree of dissociation of Na_2SO_4 is
    a) 75%   b) 50%   c) 25%   d) 85%
87. The molecular weight of benzoic acid in benzene as determined by depression in the freezing point method corresponds to
    a) Ionization of benzoic acid   b) Dimerization of benzoic acid
    c) Trimerization of benzoic acid   d) Solvation of benzoic acid
88. $PtCl_4 . 6H_2O$ can exist as a hydrated complex; 1 m aqueous solution has the depression in freezing point of 3.72°. Assume 100% ionization and $K_f(H_2O) = 1.86° \ mol^{-1} \ kg$, then the complex is
    a) $[Pt(H_2O)_6]Cl_4$ b) $[Pt(H_2O)_4Cl_2]Cl_2 \cdot 2H_2O$
    c) $[Pt(H_2O)_3Cl_3]Cl \cdot 3H_2O$ d) $[Pt(H_2O)_2Cl_4] \cdot 4H_2O$
89. The molal depression constant for water in 1.86°C. The freezing point of a 0.05-molal solution of a non electrolyte in water is
    a) $-1.86°C$ b) $-0.93°C$ c) $-0.093°C$ d) 0.93°C
90. Which of the following will have the highest boiling point at 1 atm pressure?
    a) 0.1 M NaCl   b) 0.1 M sucrose   c) 0.1 M $BaCl_2$ d) 0.1 M glucose
91. Blood has been found to be isotonic with
    a) Normal saline solution
    b) Saturated NaCl solution
    c) Saturated KCl solution
    d) Saturated solution of a 1 : 1 mixture of NaCl and KCl
92. Dry air was passed successively through a solution of 5 g of a solute in 180 g of water and then through pure water. The loss in the weight of solution was 2.50 g and that of pure solvent 0.04 g. The molecular weight of the solute is
    a) 31.25   b) 3.125   c) 312.5   d) None
93. The factor $\Delta T_f / K_f$ represents
    a) Molarity   b) Formality   c) Normality   d) Molality
94. The elevation in boiling point of a solution of13.44 g of $CuCl_2$in 1 kg of water using the following information will be (molecular weight of $CuCl_2 = 134.4$ and $k_b = 0.52 \ Km^{-1}$)
    a) 0.16   b) 0.05   c) 0.1   d) 0.2
95. A perfectly semi-permeable membrane when use to separate a solution from its solvent permits through it the passage of
    a) Solute only   b) Solvent only   c) Both (a) and (b)   d) None
96. Which of the following substances will lose its whose solubility with increase in temperature?
    a) NaOH   b) Na_2CO_3 c) Na_2SO_4 d) All
97. The relative lowering of vapour pressure is equal to the mole fraction of the non- volatile solute. This statement was given by
    a) Raoult   b) Henry   c) Joule   d) Dalton
98. The total vapour pressure of a mixture of 1 mol A ($P_A° = 150$ torr) and 2 mol B ($P_B° = 240$ torr) is 200 mm. In this case
    a) There is positive deviation from Raoult's law
    b) There is negative deviation from Raoult's law
   c) There is no deviation from Raoult's law

d) Molecular masses of A and B are also required

99. The Van't Hoff factor of very dilute solution of $Ca(NO_3)_2$ is
    a) 1   b) 2   c) 3   d) 4

100. Lowering in vapour pressure is highest for
    a) 0.2 m urea   b) 0.1 m glucose   c) 0.1 m $MgSO_4$ d) 0.1 m $BaCl_2$

101. Which salt shows maximum osmotic pressure in its 1 m solution
    a) $AgNO_3$ b) Na_2SO_4 c) $(NH_4)_3PO_4$ d) $MgCl_2$

102. The osmotic pressure of 40% (weight/volume) urea solution is 1.64 atm and that of 3.42% (weight/volume) cane sugar is 2.46 atm. When equal volumes of the above two solutions are mixed, the osmotic pressure of the resulting solution is
    a) 1.64 atm   b) 2.46 atm   c) 4.10 atm   d) 2.05 atm

103. Which solution will show maximum elevation in boiling point?
    a) 0.1 M KCl   b) 0.1 M $BaCl_2$ c) 0.1 M$FeCl_3$ d) 0.1M $Fe_2(SO_4)_3$

104. An ideal solution was obtained by mixing methanol and ethanol. If the partial vapour pressure of methanol and ethanol are 2.619 kPa and 4.556 kPa, respectively, the composition of vapour (in terms of mole fraction) will be
    a) 0.635 MeOH, 0.365 EtOH
    b) 0.365 MeOH, 0.635 EtOH
    c) 0.574 MeOH, 0.326 EtOH
    d) 0.173 MeOH, 0.827 EtOH

105. The colligative properties of a solution depend on
    a) The number of solute particles present in it
    b) The chemical nature of the solute particles present in it
    c) The nature of the solvent used
    d) None

106. At 40°C, the vapour pressures of pure liquids, benzene and toluene are 160 mm Hg and 60 mm Hg, respectively. At the same temperature, the vapour pressure of an equimolar solution of the two liquids, assuming the ideal solution, should be
    a) 140 mm Hg   b) 110 mm Hg   c) 220 mm Hg   d) 100 mm Hg

107. pH of a 0.1 M monobasic acid is found to be 2. Hence, its osmotic pressure at a given temperature T K is
    a) $0.1RT$ b) $0.11RT$ c) $1.1RT$ d) $0.01RT$

108. Equimolal solutions A and B show depression in freezing point in the ratio 2:1. A remains in the normal state in solution. B will be
    a) Normal in solution
    b) Dissociated in solution
    c) Associated in solution
    d) Hydrolysed in solution

109. A solution containing 8.6 g urea in 1 L was found to be isotonic with a 5% (weight/volume) solution of organic non-volatile solute. The molecular weight of latter is
    a) 348.9   b) 34.89   c) 3489   d) 861.2

Multiple Correct Answers Type

110. If P_0 and P_s are the V.P. of solvent and solution respectively and N_1 and N_2 are the mole of solute and solvent then :
    a) $\dfrac{(P_0 - P_s)}{P_0} = \dfrac{N_1}{(N_1 + N_2)}$
    b) $\dfrac{(P_0 - P_s)}{P_s} = \dfrac{N_1}{N_2}$
    c) $\dfrac{(P_0 - P_s)}{P_0} = \dfrac{N_1}{N_2}$
    d) None of these

111. Which of the following is/are not affected by temperature?
    a) Molarity   b) Molality   c) Normality   d) Mole fraction

112. A difference between diffusion and osmosis is
    a) A semi-permeable membrane is required for osmosis while diffusion requires no semi-permeable membrane
    b) In osmosis movement of molecules is only in one direction whereas in diffusion movement is on both sides
    c) In osmosis only the solvent moves while in diffusion both solute and solvent move
    d) None of the above
113. Consider the two solutions:
    I: 0.5 M NaCl aqueous solution at 25°C; NaCl is complete ionized
    II: 2.0 M C_6H_5COOH in benzene at 25°C, C_6H_5COOH dimerizes to the full extent
    Which of the following statement(s) is (are) correct?
    a) Both the solutions display equal osmotic pressure
    b) Both have equal vapour pressure
    c) Solution II is hypertonic
    d) Solution II has greater depression in freezing point than solution I
114. The dissolution of which of the following compounds is exothermic
    a) Na_2SO_4 b) NaOH   c) $CaCl_2$ d) LiBr
115. 2 L of 1 molar solution of a complex salt $CrCl_3.6H_2O$ ($Mw = 266.5$) shows an osmotic pressure of 98.52 atm. The solution is now treated with 1 L of 6 M $AgNO_3$, which of the following are correct?
    a) Weight of AgCl precipitated is 861 g
    b) The clear solution will show an osmotic pressure of 98.52 atm
    c) The clear solution will shown an osmotic pressure of 65.68 atm
    d) 2 mol of $[Cr(H_2O)_6](NO_3)_3$ will be present in solution
116. For a non-volatile solute
    a) The vapour pressure of a solute is zero
    b) Vapour pressure of solution = Vapour pressure of pure solvent
    c) Vapour pressure of solution = Vapour pressure of solvent in solution
    d) All of the above
117. Two miscible liquids A and B having vapour pressure in pure state $P_A°$ and $P_B°$ are mixed in mole fraction χ_A and χ_B to get a mixture having total vapour pressure of mixture P_M. Which of the following relations are correct?
    a) $\chi_A = \dfrac{P_M - P_B°}{P_A° - P_B°}$ b) $\dfrac{\chi_{A(l)}}{\chi'_{A(v)}} = \dfrac{P_M}{P_A°}$ c) $\dfrac{\chi_{A(l)}}{\chi'_{A(v)}} = \dfrac{P_M}{P_B°}$ d) All of these
118. Which of the following form is an ideal solution?
    a) Ethyl bromide + Ethyl iodide   b) Ethyl alcohol + Water
    c) Chloroform + Benzene   d) Benzene + Toluene
119. The vapour pressure of a dilute solution of a solute is influenced by :
    a) Temperature of solution
    b) Mole fraction of solute
    c) Melting point of solute
    d) Degree of dissociation of solute
120. The following is a graph plotted between the vapour pressure of two volatile liquids against their respective mole fractions
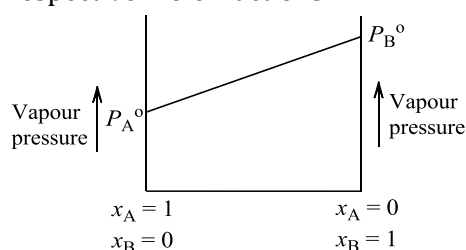
Which of the following statement is/are correct?

a) When $\chi_A = 1$ and $\chi_B = 0$, then $P = P_A^\circ$
b) When $\chi_B = 1$ and $\chi_A = 0$, then $P = P_B^\circ$

c) When $\chi_A = 1$ and $\chi_B = 0$, then $P < P_B^\circ$
d) When $\chi_B = 1$ and $\chi_A = 0$, then $P > P_A^\circ$

121. A maxima or minima is obtained in the temperature. The composition curve of a mixture of two liquids does not indicate

a) That the liquids are immiscible with one another

b) That the liquids are partially miscible at the maximum or minimum

c) An azeotropic mixture

d) A eutectic formation

122. Effect of adding a non-volatile solute to a solvent is:

a) To lower the vapour pressure
b) To increase its freezing point

c) To increase its boiling point
d) To decrease its osmotic pressure

123. Which pair(s) of liquids on mixing is/are expected to show no net volume change and no heat effect?

a) Acetone and ethanol
b) Chlorobenzene and bromobenzene

c) Chloroform and benzene
d) n-Butyl chloride and n-butyl bromide

124.
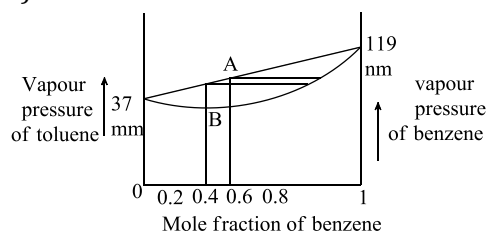
Choose the correct option:

a) A represents vapour composition and B liquid composition

b) A as well as B represent liquid composition

c) Both A and B represent vapour composition

d) A represents liquid composition and B vapour composition

125. The processes of getting fresh water from sea water is/are known as :

a) Osmosis   b) Filtration   c) Desaltation   d) Reverse osmosis

126. Which statement (s) is/are correct about osmotic pressure (P), volume (V) and temperature (T)?

a) $P \propto 1/V$ if T is constant

b) $P \propto T$ if V is constant

c) $P \propto V$ if T is constant

d) PV is constant if T is constant

127. The solution (s) which will boil at the highest temperature is/are

a) 0.1 M urea   b) 0.1 M HNO_3 c) 0.1 M $Ca(NO_3)_2$ d) 0.1 M $BaCl_2$

128. Which of the following statements is/are false for a solution of chloroform and acetone?

a) The solution formed is an ideal solution

b) The solution formed is a non-ideal solution with positive deviation from Raoult's law

c) The solution formed is a non-ideal solution with negative deviation from Raoult's law

d) The solution behaves ideally or non-ideally depending upon its composition

129. Which of the following statements is/are true about an azeotropic mixture?

a) An azeotropic mixture boils at constant temperature

b) The composition of an azetropic mixture changes on distillation

c) An azeotropic solution of two liquids has a boiling point lower than that of either of them when it shows positive deviation from the Raoult's law

d) An azetropic solution of two liquids has a boiling point higher than that of either of them if it shows positive deviation from Raoult's law

130. A mixture of two immiscible liquids A and B, having vapour pressure in pure state obeys the following relationship if χ_A and χ_B are mole fractions of A and B in vapour phase over the solution

a) $P'_A = P_M \chi'_A$

b) $\dfrac{P'_A}{P'_B} = \dfrac{W_A \times Mw_B}{Mw_A \times W_B}$

c) If $P'_A > P'_B$ then $\chi'_A < \chi'_B$

d) If $P'_A > P'_B$ then $n_A > n_B$

131. For a given value of degree of dissociation, which of the following have correct Van't Hoff factor?

a) $NaCl, i = 2 + \alpha$

b) $Ca(NO_3)_2, i = 1 + 2\alpha$

c) $K_4[Fe_3(CN)_6], i = 1 + 4\alpha$

d) $(NH_3)_3PO_4, i = 3 + \alpha$

132. Osmotic pressure of a solution is

a) Directly proportional to the molar concentration of the solution

b) Inversely proportional to the molecular weight of the solute

c) Inversely proportional to the temperature

d) Directly proportional to the volume of the solution

133. Osmotic pressure in dilute solution is

a) Inversely proportional to the moles of non-volatile solution

b) Directly proportional to temperature

c) Directly proportional to the molarity of solution

d) Independent of temperature and moles of solute dissolved

134. Which of the following statements is/are correct?

a) The freezing point of water is depressed by the addition of glucose

b) The degree of dissociation of a weak electrolyte decrease as its concentration decreases

c) Energy is released when a substance dissolves in water provided that the hydration energy of the substance is more than its lattice energy

d) If two liquids that form an ideal solution are mixed, the change in entropy is positive

135. Among 1% solution of urea, glucose and sucrose :

a) The vapour pressure and freezing point are the lowest for urea

b) The vapour pressure and boiling point are the lowest for urea

c) The depression in freezing point is the highest for urea

d) The elevation in boiling point is the highest for urea

136. Which of the following represent(s) correctly the changes in thermodynamic properties during the formation of 1 mole of an ideal binary solution?
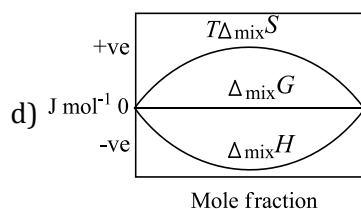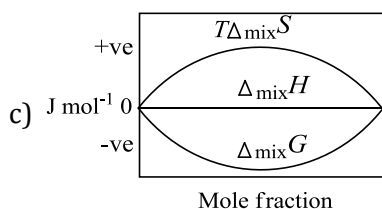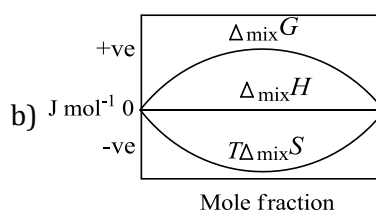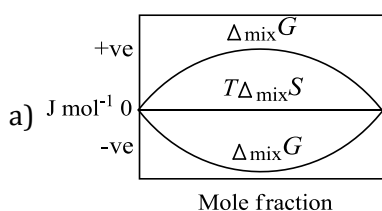
137. Which the following statements is/are correct?

a) Minimum boiling azeotropic mixture boils at temperature lower than either of the two pure components

b) Maximum boiling azeotropic mixture boils at temperature higher than either of the two pure components

c) Minimum boiling azeotropic mixture shows positive deviation

d) Maximum boiling azeotropic mixture shows negative deviation

138. The colligative properties of a solution is/are :

a) $\propto$ molality

b) $\propto$ 1/molecular weight

c) Proportional to each other

d) None of the above

139. Molecular weight of urea is 60. A solution of urea containing 6 g of urea in one litre is a
    a) 1 N
    b) 0.1 M
    c) 0.1 N
    d) 1 M

140. If P_0 and P_s are the V.P. of solvent and its solution respectively and N_1 and N_2 are the mole fraction of solvent and solute respectively then :
    a) $P_s = P_0 N_2$
    b) $P_0 - P_s = P_0 N_2$
    c) $P_s = P_0 N_1$
    d) $(P_0 - P_s)/P_s = N_1/(N_1 + N_2)$

141. Ideal solution is formed when its components :
    a) Have zero heat of mixing
    b) Have zero volume change
    c) Obey Raoult's law
    d) Can be converted into gases

142. In the depression in freezing point experiment, it is found that
    a) The vapour pressure of the solution is less than that of pure solvent
    b) The vapour pressure of the solution is more than that of pure solvent
    c) Only solute molecules solidify at freezing point
    d) Only solvent molecules solidify at freezing point

143. The osmotic pressure (s) of a decimolar solution of glucose at 30°C is/are :
    a) 24.88 atm
    b) 2.488 atm
    c) 0.248 atm
    d) 189.09 cm

144. By adding water to the solution of ionic compound its :
    a) Concentration remains same
    b) Concentration increases
    c) Ionization may increase
    d) Concentration decreases

145. On mixing 1 mole of C_6H_6 ($P^0 = 42$ mm) and 2 mole of C_7H_8 ($P^0 = 36$ mm), one can conclude :
    a) Total vapour pressure of mixture = 38 mm
    b) Mole fraction of vapours of C_6H_6 above liquid mixture $= \frac{7}{19}$.
    c) Positive deviation from Raoult's law
    d) Ideal solution of two

146. Consider the following solutions

    I. 1 M sucrose

    II. 1 M KCl

    III. 1 M benzoic acid in benzene

    IV. 1 M $(NH_3)_3PO_4$

    Which of the following is/are true?
    a) All solutions are isotonic
    b) III is hypotonic of I, II, and IV
    c) I, II, and III are hypertonic of IV
    d) IV is hypertonic of I, II, and III

147. What happens when glycerine is added to a litre of water?
    a) The freezing point of the water is lowered
    b) The boiling point of the water in increased
    c) The viscosity of the water is increased
    d) The temperature of the water is increased

148. 1 mol benzene ($P^°_{benzene} = 42$ mm) and 2 mol toluene ($P^°_{toluene} = 36$ mm) will have
    a) Total vapour pressure of 38 mm
    b) Mole fraction of vapour of benzene above liquid mixture is 7/19
    c) Positive deviation from Raoult's law
    d) Negative deviation from Raoult's law

149. Consider the following graph pertaining to distillation. The distillate to residue ratio is
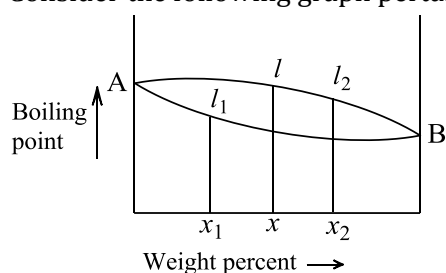
a) $\dfrac{l}{1_2 + l_2}$
b) $\dfrac{lx_1}{lx_2}$
c) $\dfrac{ll_1}{ll_2}$
d) $\dfrac{ll_2}{ll_1}$

150. Which are colligative properties?
   a) Boiling point
   b) Osmotic pressure
   c) Elevation in freezing point
   d) Depression in freezing point

151. Which relations are not correct for an aqueous dilute solution of K_3PO_4 if its degree of dissociation is α?
   a) $\dfrac{\Delta P}{P°} = \dfrac{\text{Molality} \times 18 \times (1 + 3\alpha)}{1000}$
   b) $\dfrac{\Delta P}{P°} = \dfrac{\pi_{obs} \times 18 \times (1 + 3\alpha)}{RT \times 1000}$
   c) $\dfrac{\Delta P}{P°} = \dfrac{\Delta T_{f\,obs} \times 18}{K_f \times 1000}$
   d) Mw of $K_3PO_4 = Mw_{obs} \times (1 + 3\alpha)$

152. Among 0.1 M solutions of NH_2CONH_2, Na_2PO_4 and $Al_2(SO_4)_3$:
   a) The vapour pressure and freezing point are the lowest for urea
   b) The vapour pressure and freezing point are the highest for urea
   c) The elevation in boiling point is the highest for $Al_2(SO_4)_3$
   d) The depression in freezing point is the highest for $Al_2(SO_4)_3$

153. Which of the following statements is/are correct?
   a) Patrol is a homogeneous mixture of alkanes
   b) Heterogeneous mixtures have variable compositions in different parts of the sample
   c) Homogeneous mixtures are uniform throughout the sample
   d) Alloys are heterogeneous mixtures of metals

154. Which of the following combinations are correct for a binary solution, in which the solute as well as solvent are liquid?
   a) C_6H_6 and $C_6H_5CH_3$; $\Delta_{sol}H > 0$; $\Delta_{sol}V = 0$
   b)
   $$\begin{array}{c} O \\ \| \\ CH_3 - C - CH_3 \end{array} \text{ and } CHCl_3;\ \Delta_{sol}H < 0; \Delta_{sol}V < 0$$
   c) H_2O and HCl; $\Delta_{sol}H > 0; \Delta_{sol}V < 0$
   d) H_2O and CH_2OH; $\Delta_{sol}H > 0$; $\Delta_{sol}V < 0$

155. When acetone and chloroform are mixed, hydrogen bonding takes place between them. Such a liquid pair will cause
   a) Positive deviation from Raoult's law
   b) Negative deviation form Raoult's law
   c) No deviation form Raoult's law
   d) Cannot be predicted

156. At constant temperature, the osmotic pressure(s) of solution (s) is/are :
   a) Directly proportional to the concentration
   b) Inversely proportional to the molecular weight of solute
   c) Directly proportional to the square of the concentration
   d) Directly proportional to the square root of the concentration

157. To 10 mL of 1 M $BaCl_2$ solution of 5 mL of 0.5 M K_2SO_4 is added. $BaSO_4$ is precipitated out. What will happen?
   a) Freezing point will increase
   b) Boiling point will increase
   c) Freezing point will lower down
   d) Boiling point will lower down

158. Which inorganic precipitate(s) act(s) as semipermeable membrane?
   a) Calcium phosphate
   b) Barium oxalate
   c) Nickel phosphate
   d) Copper ferrocyanide
159. Which of the following is/are true?
   a) For the same solution, elevation in boiling point = depression in freezing point
   b) The Van't Hoff factor for a dilute solution of $BaCl_2$ is 3
   c) The elevation in boiling point is due to increase in vapour pressure
   d) The depression in freezing point is due to decrease in vapour pressure
160. Which of the following forms ideal solution?
   a) C_6H_5Cl— C_6H_5Br
   b) C_6H_6— $C_6H_5CH_3$
   c) Hexane-heptane
   d) None of these
161. At what temperature(s) a 5% solution (wt./vol.) of glucose will develop an osmotic pressure of 7 atm?
   a) 33.94 K   b) 306.94 K   c) 273 K   d) 33.94°C
162. Which of the following solutions will boil at the highest temperature?
   a) 0.1 M urea
   b) 0.1 M sodium nitrate
   c) 0.1 M calcium nitrate
   d) 0.1 M barium chloride
163. The osmotic pressure of a solution depends on
   a) Nature of solute   b) Nature of solvent
   c) Temperature   d) Molar concentration of solute
164. For an ideal binary liquid system :
   a) The change in enthalpy (ΔH) is zero
   b) Raoult's law is obeyed
   c) Change in volume (ΔV) is zero
   d) None of the above
165. The ideal solutions are formed when on mixing :
   a) $\Delta H_{mix} = 0$ b) $\Delta V_{mix} = 0$ c) $\Delta G_{mix} > 0$ d) $\Delta S_{mix} > 0$
166. 1.2575 g sample of $[Cr(NH_3)_6]SO_4Cl$ ($Mw = 251.5$) is dissolved to prepare 250 mL solution showing an osmotic pressure of 1.478 atm of Hg at 27°C. Which of the following statements is/are correct about this solution?
   a) Each molecule furnishes three ions in solution
   b) The Van't Hoff factor is $= 3$
   c) The equilibrium molarity of $[Cr(NH_3)_6]SO_4Cl = 0$
   d) The equilibrium molarity of $[Cr(NH_3)_6]^{3+} = 0.02$ M

Assertion - Reasoning Type

This section contain(s) 0 questions numbered 167 to 166. Each question contains STATEMENT 1(Assertion) and STATEMENT 2(Reason). Each question has the 4 choices (a), (b), (c) and (d) out of which **ONLY ONE** is correct.

   a) Statement 1 is True, Statement 2 is True; Statement 2 **is** correct explanation for Statement 1

   b) Statement 1 is True, Statement 2 is True; Statement 2 **is not** correct explanation for Statement 1

   c) Statement 1 is True, Statement 2 is False

d) Statement 1 is False, Statement 2 is True

167

    Statement 1:   The mass of acetic acid molecule in benzene is more than the actual value of the solute.

    Statement 2:   Molecules of acetic acid dimerise in benzene due to hydrogen bonding.

168

    Statement 1:   Henry's law and Raoult's law are not independent, i.e., one can be derived from the other

    Statement 2:   The partial pressure is directly proportional to the mole fraction of the concerned species for ideal solutions

169

    Statement 1:   The osmotic pressure of 0.1 M urea solution is less than 0.1 M NaCl solution

    Statement 2:   Osmotic pressure is not a colligative property

170

    Statement 1:   van't Hoff factor for electrolytes is always more than unity.

    Statement 2:   The number of particles increases in solution due to electrolytic dissociation.

171

    Statement 1:   Non-ideal solutions form a azeotropic mixture

    Statement 2:   The boiling point of an azeotropic mixture is only higher than boiling points of both components

172

    Statement 1:   Ebulliscopy or cryoscopy cannot be used for the determination of mol. wt. of polymers.

    Statement 2:   High molecular weight solute leads to very low value of ΔT_b or ΔT_f.

173

    Statement 1:   Near the freezing point of an aqueous solution of a non-volatile solute only ice separates out.

    Statement 2:   The remaining solution shows equilibrium between solid solvent-liquid solvent.

174

    Statement 1:   Vapour pressure of 0.5 M sugar solution is more than 0.5 M KCl solution

    Statement 2:   The lowering of vapour pressure is directly proportional to the number of species present in the solution

175

    Statement 1:   On adding NaCl to water its vapour pressure increase

    Statement 2:   Addition of non-volatile solute decreases the vapour pressure

176

Statement 1: Osmotic pressure of non-aqueous solutions can be determined by Berkeley-Hartley method.

Statement 2: The semipermeable membrane used in Berkeley-Harley method is $Cu_2[Fe(CN)_6]$.

177

Statement 1: Camphor is used as a solvent in the determination of the molecular mass of naphthalene and anthracene

Statement 2: Camphor has high molal elevation constant

178

Statement 1: Addition of HgI_2 to aqueous solution of KI shows an increase in vapour pressure.

Statement 2: The number of particles present in solution decreases due to formation of complex K_2HgI_4.

179

Statement 1: The boiling point of 0.1 M urea solution is less than that of 0.1 M KCl solution.

Statement 2: Elevation of boiling point is directly proportional to the number of species present in the solution.

180

Statement 1: $\Delta_{mix} H$ and $\Delta_{mix}V$ are zero for an ideal solution

Statement 2: The interactions between the particles of the components of a solution are almost identical as between the particles in liquids

181

Statement 1: The dissolution of gases in water is always an endothermic process

Statement 2: The dissolution of gases in water proceed with a negative value of ΔS

182

Statement 1: Osmosis is a bilateral process.

Statement 2: In osmosis net flow from dilute to concentrated solution is noticed.

183

Statement 1: For isotonic solutions $C_1 = C_2$

Statement 2: For isotonic solutions $\pi_1 = \pi_2$

184

Statement 1: Boiling point of water is 100°C although water boils below 100°C on mountains.

Statement 2: Boiling point of a liquid is the temperature at which V.P. of liquid becomes equal to 1 atm.

185

Statement 1: Addition of a non-volatile causes a depression in vapour pressure.

Statement 2: Vapour pressure of a solution directly proportional to mole fraction of solvent.

186

Statement 1: 0.1 M solution of glucose has same increment in freezing point than has 0.1 M solution of urea

Statement 2: K_f for both has different value

187

Statement 1: Sodium chloride used to clear snow on the roads

Statement 2: Sodium chloride depresses the freezing point of water

188

Statement 1: The difference in the boiling points of equimolar solution of HCl and HF decreases as their molarity is decreased

Statement 2: The extent of dissociation decreases steadily with increasing dilution

189

Statement 1: The elevation in boiling point for two isotonic solutions may not be same

Statement 2: The boiling point depends upon the concentration of the solute

190

Statement 1: If red blood cells were removed from the body and placed in pure water pressure inside the cells increase.

Statement 2: The concentration of salt content in the cells increase.

191

Statement 1: The increasing pressure on water decreases its freezing point

Statement 2: The density of water is maximum at 273 K

192

Statement 1: Raoult's law for solute-solvent systems can be written as $\frac{P^0 - P_s}{P_s} = \frac{n}{N}$

Statement 2: For dilute solutions Raoult's law many be written as $\frac{P^0 - P_s}{P_s} = \frac{n}{N}$

193

Statement 1: Azeotropic mixture are formed only by nonideal solution and they may have boiling points either greater than both the components or less than both the components.

Statement 2: The composition of the vapour phase is same as that of the liquid phase of an azeotropic mixture.

194

Statement 1: 0.1 M solution of NaCl has greater osmotic pressure than 0.1 M solution of glucose at same temperature

Statement 2: In solution, NaCl dissociates to produce more number of particles

195

Statement 1: Cooking time in pressure cooker is reduced

Statement 2: The boiling point inside the pressure cooker is raised

196

Statement 1: The elevation in boiling point of a solution of non-electrolyte is proportional to its molality

Statement 2: The molal elevation constant is the ratio of the elevation in boiling point to its molality

197

Statement 1: The sum of mole fractions of all the component of a solution is unity

Statement 2: The mole fraction is a temperature-dependent quantity

198

Statement 1: A mixture of cyclohexane and ethanol – ve deviation from Raoult's law.

Statement 2: Cyclohexane reduces the intermolecular attraction between ethanol molecules.

199

Statement 1: If a liquid solute more volatile than the solvent is added to the solvent the vapour pressure of the solution may increase ie $P_s > P^0$.

Statement 2: In presence of a more volatile liquid solute only the solute will form the vapour and solvent will not.

200

Statement 1: Larger the value of cryoscopic constant of the solvent, lesser will be the freezing point of the solution

Statement 2: Depression in the freezing point depends on the nature of the solvent

201

Statement 1: Great care is taken in intra-venous injections to have comparable concentration of solutions to be injected to patient.

Statement 2: By not controlling the concentration the red blood cells may shrink or swell.

202

Statement 1: The water pouch of instant cold pack for treating athletic injuries breaks when squeezed and NH_4NO_3 dissolves lowering point of temperature.

Statement 2: Addition of non volatile solute into solvent result in depression of freezing point solvent.

203

Statement 1: A cook cries more in cutting onion rather than cutting an onion taken out from refrigerator.

Statement 2: The cold onion has lower vapour pressure of its volatile content.

204

Statement 1: Water boiling at 100°C at 1 atmospheric pressure in a beaker is not at equilibrium

Statement 2: If refers to an open system

205

Statement 1:   Addition of solvent to a solute always lowers the V.P.

Statement 2:   The increase in relative surface area give rise to an increase in V.P.

206

Statement 1:   Iodine is more soluble in CCl_4 than in water

Statement 2:   Non-polar solutes are more soluble in non-polar solvents

207

Statement 1:   One molar aqueous solution has always higher concentration than one molal

Statement 2:   The molality of a solution depends upon the density of the solution whereas molarity does not

208

Statement 1:   An ideal solution is one which obey Raoult's law.

Statement 2: $KCl(aq)$ is an ideal solution.

209

Statement 1:   The molecular weight of acetic acid determined by depression in freezing point method in benzene and water was found to be different.

Statement 2:   Water is polar and benzene is non polar.

210

Statement 1:   At low concentration, benzene and toluene forms ideal solution.

Statement 2:   Components with structural similarity forms ideal solution.

211

Statement 1:   Osmosis is one sided movement of solvent particles.

Statement 2:   In osmosis, the net movement of solvent particles from dil. to conc. solution and from conc.to dil. solution takes place through semipermeable membrane, showing finally the direction of dil. to conc.

212

Statement 1: ΔH_{mix} and ΔV_{mix} in an ideal solution are zero

Statement 2: $A - B$ interactions in ideal solutions are same as between $A - B$ and $B - B$

213

Statement 1:   The molecular mass of polymers cannot be calculated using the boiling point or freezing point method

Statement 2:   The boiling point method for determining the molecular masses is used for compounds stable at high temperature

214

Statement 1:   Ice melts earlier if NaCl is poured on it.

Statement 2: The freezing point of water is lowered on addition of NaCl.

Matrix-Match Type

This section contain(s) 0 question(s). Each question contains Statements given in 2 columns which have to be matched. Statements (A, B, C, D) in **columns I** have to be matched with Statements (p, q, r, s) in **columns II**.

215. p_A = partial pressure of component A in liquid mixture, $P_A°$ = vapour pressure of A, χ_A = mole fraction of A in liquid mixture

<table>
<tr><td align="center">Column-I</td><td align="center">Column- II</td></tr>
<tr><td>(A) $C_2H_5OH + H_2O$</td><td>(p) Azeotropic mixture</td></tr>
<tr><td>(B) $C_2H_2Br + C_2H_5I$</td><td>(q) Obeys Raoult's law</td></tr>
<tr><td>(C) $p_A = \chi_A P_A°$</td><td>(r) Non-ideal solution with positive deviation</td></tr>
<tr><td>(D) $H_2O + H_2SO_4$</td><td>(s) Non-ideal solution with negative deviation</td></tr>
<tr><td></td><td>(t) Ideal solution</td></tr>
</table>

CODES :

	A	B	C	D
a)	Q,t	p,r	p,s	p,q
b)	p,r	q,t	q,t	p,s
c)	p,q	p,s	p,r	q,t
d)	p,	p,r	q,s	p,r

216.

<table>
<tr><td align="center">Column-I</td><td align="center">Column- II</td></tr>
<tr><td>(A) $P° - P_s$</td><td>(p) $\dfrac{\text{Observed colligative property}}{\text{Normal colligative property}}$</td></tr>
<tr><td>(B) $P° \times \chi_A = P_A$</td><td>(q) Lowering in vapour pressure</td></tr>
<tr><td>(C) Mixture that boils like pure solvent</td><td>(r) Azeotropic mixture</td></tr>
<tr><td>(D) Van't Hoff factor</td><td>(s) Raoult's law</td></tr>
</table>

CODES :

	A	B	C	D
a)	q	s	r	p
b)	s	r	p	q
c)	p	q	s	r

d)   r   p   q   s

217. Mw_N = Norma molecular mass of solute

     Mw_2 = Observed molecular of solute from colligative property measurement

Column-I		Column- II
(A) $Mw_2 < Mw_N$		(p) 0.1 M CH_3COOH in benzene
(B) $Mw_2 \approx Mw_N/3$		(q) 0.1 M urea in water
(C) $Mw_2 > Mw_N$		(r) 0.05 M barium chloride in water
(D) $Mw_2 = Mw_N$		(s) 0.1 CH_3COOH in water

CODES :

	A	B	C	D
a)	R,s	r	p	q
b)	r	p	q	s
c)	p	r,s	r	p
d)	q	p	s	r

218.

Column-I		Column- II
(A) Additive property		(1) Molarity
(B) Constitutive property		(2) Dipole moment
(C) Additive and constitutive property		(3) Optical activity
(D) Colligative property		(4) Molecular weight

CODES :

	A	B	C	D
a)	2	3	1	4
b)	4	3	2	1
c)	1	4	2	3
d)	4	3	1	2

219.

Column-I		Column- II
(A) Raoult's law		(p) Effect of pressure on the solubility of gas in liquid
(B) Henry's law		(q) $\frac{P^\circ - P_S}{P^\circ} = \chi_B$
(C) Ethyl alcohol + Water		(r) Ideal solution

(D) Benzene + Toluene

(s) Azeotropic mixture

CODES:

	A	B	C	D
a)	p	q	r	s
b)	r	s	p	q
c)	q	p	s	r
d)	s	r	q	p

220. Match the following:

	Column-I		Column- II
(A)	Urea, glucose, fructose	(p)	1:0. 8:1
(B)	$NaCl, MgCl_2, K_2SO_4$	(q)	1:2:3
(C)	$Al_2(SO_4)_3, Na_3PO_4, K_4[Fe(CN)_6]$	(r)	1:1:1
(D)	$Glucose, NaCl, CaCl_2$	(s)	2:3:3

CODES:

	A	B	C	D
a)	r	s	p	q
b)	s	r	q	p
c)	p	q	s	r
d)	q	p	r	s

221.

	Column-I		Column- II
(A)	Method for the determination of osmotic pressure	(p)	Ebullioscopic determination
(B)	Method for the determination of relative lowering in vapour pressure	(q)	Cyroscopic constant
(C)	K_b	(r)	Berkeley and Hartley
(D)	K_f	(s)	Ostwald and Walker's method

CODES:

	A	B	C	D
a)	s	q	p	r
b)	r	s	p	q

c)	p	r	q	s
d)	q	p	s	r

222.

Column-I		Column- II
(A) ppm		**(p)** Van't Hoff factor
(B) ΔT_b		**(q)** Molal depression
(C) K_f		**(r)** Elevation in boiling point
(D) i		**(s)** $\dfrac{\text{Mass of solute}}{\text{Mass of solution}} \times 10^6$

CODES :

	A	B	C	D
a)	p	s	r	q
b)	s	r	q	p
c)	q	p	s	r
d)	r	q	p	s

223.
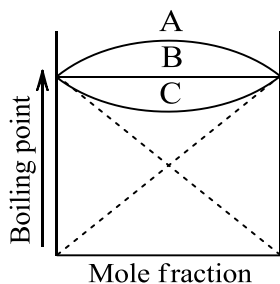
Column-I		Column- II
(A) A		**(p)** (+) deviation
(B) B		**(q)** Ideal
(C) C		**(r)** (−) deviation

CODES :

	A	B	C	D
a)	q	r	p	
b)	r	p	q	
c)	p	q	r	
d)	q	r	p	

224.

	Column-I					Column- II
(A)	Molarity				(p)	Number of gram moles of solute per kg of solvent
(B)	Normality				(q)	Number of gram moles of a solute per liter of solution
(C)	Molality				(r)	Number of gram equivalent of solute per liter of solution
(D)	NaCl				(s)	$i = 2$

CODES :

	A	B	C	D
a)	p	s	r	q
b)	r	q	s	p
c)	s	p	q	r
d)	q	r	p	s

225.

	Column-I						Column- II
(A)	0.1 N NaCl					(1)	OP = 0.125 ST
(B)	0.2 N Na$_2$SO$_4$					(2)	OP = 0.133 ST
(C)	0.1 N Ca(NO$_3$)$_2$					(3)	OP = 0.15 ST
(D)	0.1 N Al(NO$_3$)$_3$					(4)	OP = 0.30 ST
(E)	0.1 N Th(NO$_3$)$_4$					(5)	OP = 0.20 ST

CODES :

	A	B	C	D	E
a)	5	4	3	2	1
b)	3	1	4	2	1
c)	1	2	3	4	1
d)	2	4	1	5	1

226.

	Column-I		Column- II
(A)	Hypertonic	(p)	Solutions having same osmotic pressure
(B)	Isotonic	(q)	One solution has higher osmotic pressure than the second solution
(C)	Van't Hoff	(r)	Theory of dilute solution

(D) Beckmann   (s) Differential thermometer

CODES :

	A	B	C	D
a)	p	q	r	s
b)	r	s	q	p
c)	q	r	s	q
d)	s	p	q	r

<div align="center">Linked Comprehension Type</div>

This section contain(s) 24 paragraph(s) and based upon each paragraph, multiple choice questions have to be answered. Each question has atleast 4 choices (a), (b), (c) and (d) out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 227 to -227

The vapour pressure of the solution is comparatively smaller than that of the pure solvent (Raoult's law). Consequently, the temperature at which the vapour pressure of solution becomes equal to the external pressure, will be greater than that of pure solvent, rising its boiling point. Since, the decrease in vapour pressure is directly proportional to the amount fraction of the solute in the solution, it is therefore expected that the corresponding increase in the boiling points also depends on the amount fraction of the solute in the solution

227. When a non-volatile solute is dissolved in a solvent, the relative lowering of vapour pressure is equal to

a) Concentration of the solute in gram 100 mL
b) Mole fraction of solute
c) Mole fraction of solvent
d) Concentration of the solute in gram per litre

Paragraph for Question Nos. 228 to - 228

The variation of vapour pressure of the solvent and that of the solution with temperature are given by the respective solvent-vapour and solution-vapour curves of the phase diagram
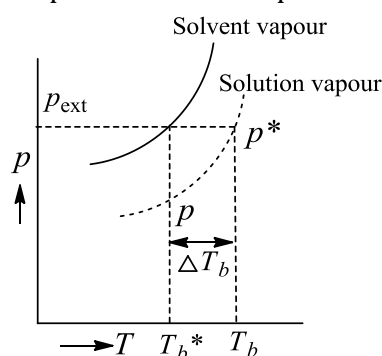
For a given value of the external pressure, the pure solvent will boil at temperature T_b^* and at temperature T_b let p_{ext} be equal to p^*, the vapour pressure of pure solvent

Applying the Clausius-Clapeyron equation to the solution vapour equilibrium for the two values of p, T_b^* and p^*, T_b we have

$$\text{In}\, \frac{p^*}{p} = \frac{\Delta_{vap}H_{1m}}{R}\left(\frac{1}{T_b^*} - \frac{1}{T_b}\right)$$

$$= \frac{\Delta_{vap}H_{1m}}{R}\frac{\Delta T_b}{T_b^*T_b}$$

228. The phase diagram for the pure solvent and solution are recorded below. The quantity indicated by L in the figure is
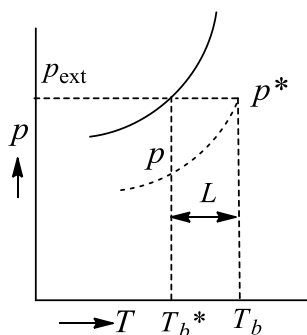
a) Δp b) $k_b \cdot m$ c) $k_f m$ d) m

Paragraph for Question Nos. 229 to - 229

An aqueous solution freezes at 272.4 K while pure water freezes at 273 K. Given, $K_f = 1.86$ K kg mol^{-1}, $K_b = 0.512$ K kg mol^{-1} and vapour pressure of water at 298 K = 23.756 mm of Hg. Determine the following

229. Molality of the solution is
     a) 0.322   b) 0.222   c) 0.413   d) 0.5

Paragraph for Question Nos. 230 to - 230

A solution of sucrose (molar mass =342) is prepared by dissolving 68.4 g in 1000 g of water. Calculate

230. The vapour pressure of solution at 293 K
     a) 0.0229   b) 0.4   c) 0.6   d) 0.9

Paragraph for Question Nos. 231 to - 231

The osmotic pressure π depends on the molar concentration of the solution ($\pi = CRT$). If two solutions are of equal solute concentration and, hence, have the same osmotic pressure, they are said to be isotonic. If two solutions are of unequal osmotic pressures, the more concentrated solution is said to be hypertonic and the more diluted solution is described as hypertonic.
Osmosis is the major mechanism for transporting water upward in the plants. Answer the following questions:

231. A plant cell shrinks when it is kept in:
     a) Hypotonic solution   b) Hypertonic solution   c) Isotonic solution   d) Pure water

Paragraph for Question Nos. 232 to - 232

The solutions which boil at constant temperature like a pure liquid and possess same composition in liquid as well as vapour state are called azeotropes. The components of azeotropes cannot be separated by fractional distillation. Only non-ideal solutions form azeotropes. Solutions with negative deviation form maximum boiling azeotrope and the solutions with positive deviation form minimum boiling azeotrope. The

boiling point of an azeotrope is never equal to the boiling points of any of the components of the azeotrope
Answer the following questions:

232. The azeotropic solutions of two miscible liquids
    a) Can be separated by simple distillation
    b) May show positive or negative deviation from Raoult's law
    c) Are supersaturated
    d) Behave like single pure component and boil at a fixed temperature

Paragraph for Question Nos. 233 to - 233

A 1.24 M aqueous solution of KI has density of 1.15 g cm^{-3}. Answer the following questions about this solution:

233. The percentage composition of solute in the solution is
    a) 17.89   b) 27.89   c) 37.89   d) 47.89

Paragraph for Question Nos. 234 to - 234

The electrolyte solutions show abnormal colligative properties. To account for this effect we define a quantity called the Van't Hoff factor given by

$$i = \frac{\text{Actual number of particles in solution after dissociation}}{\text{Number of formula units initially dissolved in solution}}$$

$i = 1$ (for non-electrolytes)
$i > 1$ (for electrolytes, undergoing dissociation)
$i < 1$ (for solutes, undergoing association)
Answer the following questions:

234. Benzoic acid undergoes dimerization in benzene solution. The Van't Hoff factor i is related to the degree of association α of the acid as
    a) $i = 2 - \alpha$ b) $i = 1 + (\alpha/3)$ c) $i = 1 - (\alpha/2)$ d) $i = 1 + (\alpha/2)$

Paragraph for Question Nos. 235 to - 235
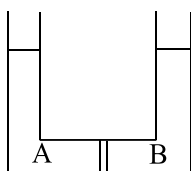
Compartments A and B have the following combinations of solution:

A	B
0.1 M KCl	0.2 M KCl
0.1% (m/V)NaCl	10% (m/V)NaCl
18 g L^{-1} glucose	34.2 g L^{-1} sucrose
20% (m/V) glucose	10% (m/V) glucose

Answer the following questions:

235. Indicate the number of solutions which is/are isotonic
    a) 1 only   b) 3 only   c) 4 only   d) 2 only

Paragraph for Question Nos. 236 to - 237

The boiling point elevation and freezing point depression of solutions have a number of practical applications. Ethylene glycol ($CH_2OH - CH_2OH$) is used in automobile radiators as an antifreeze because it lowers the freezing point of the coolant. The same substance also helps to prevent the radiator coolant from boiling away by elevating the boiling point. Ethylene glycol has low vapour pressure. We can also use glycerol as an antifreeze. In order for the boiling point elevation to occur, the solute must be non-volatile, but no such restriction applies to freezing point depression. For example, methanol (CH_3OH), a fairly volatile liquid that boils only at 65°C, is sometimes used as an antifreeze in automobile radiators

236. Which of the following is a better reagent for depression in freezing point but not for elevation in boiling point?

    a) CH_3OH

    b) $\begin{array}{l} CH_2OH \\ | \\ CH_2OH \end{array}$

    c) $\begin{array}{l} CH_2OH \\ | \\ CHOH \\ | \\ CH_2OH \end{array}$

    d) $C_6H_{12}O_6$

Paragraph for Question Nos. 237 to - 238

A solution M is prepared by mixing ethanol and water, the mole fraction of ethanol in the mixture is 0.9
Given : Freezing point depression constant of water
$\left(K_f^{water}\right) = 1.86 \text{ K kg mol}^{-1}$
Freezing point depression constant of ethanol
$\left(K_f^{ethanol}\right) = 2.0 \text{ K kg mol}^{-1}$
Boiling point elevation constant of water
$\left(K_b^{water}\right) = 0.52 \text{ K kg mol}^{-1}$
Boiling point elevation constant of ethanol
$\left(K_b^{ethanol}\right) = 1.2 \text{ K kg mol}^{-1}$
Standard freezing point of water = 273 K
Standard freezing point of ethanol = 155.7 K
Standard boiling point of water = 373 K
Standard boiling point of ethanol = 351.5 K
Vapour pressure of pure water = 32.8 mm Hg
Vapour pressure of pure ethanol = 40 mm Hg
Molecular weight of water = 18 g mol^{-1}
Molecular weight of ethanol = 46 g mol^{-1}
In answering the following questions consider the solutions to be ideal dilute solutions and solutes to be non-volatile and non-dissociative

237. The freezing point of the solution M is
    a) 268.7 K   b) 268.5 K   c) 150.9 K   d) 268.7 K

Paragraph for Question Nos. 238 to - 239

Properties such as boiling point, freezing point, and vapour pressure of a pure solvent change when solute

molecules are added to get homogenous solution. These are called colligative properties
Answer the following questions:

238. I.   0.001 m NaCl
     II. 0.001 m urea
     III. 0.001 m $MgCl_2$
     IV. 0.001 m CH_3COOH
     Increasing order of boiling points
     a) (ii)<(iv)<(i)<(iii)   b) (iv)<(i)<(ii)<(iii)   c) (iii)<(ii)<(i)<(iv)   d) (i)<(ii)<(iii)<(iv)

Paragraph for Question Nos. 239 to - 240

A certain vessel X has water and nitrogen gas at a total pressure of 2 atm and 300 K. All the contents of vessel are transferred to another vessel Y having half the capacity of the vessel X. The pressure of N_2 in this vessel was 3.8 atm at 300 K. The vessel Y is heated to 320 K and the total pressure observed was 4.32 atm. Assume that the volume occupied by the gasses in vessel is equal to the volume of the vessel. Calculate the following:

239. Pressure of $H_2O(g)$ in X at 320 K
     a) 0.1   b) 0.2   c) 1.0   d) 2.0

Paragraph for Question Nos. 240 to - 241

A system of greater disorder of molecules is more probable. The disorder of molecules is reflected by the entropy of the system. A liquid vapourises to form a more disordered gas. When a solute is present, there is additional contribution to the entropy of the liquid due to increased randomness. As the entropy of solution is higher than that of pure liquid, there is weaker tendency to form the gas. Thus, a solute (non volaile) lowers the vapour pressure of a liquid, and hence a higher boiling point of the solution
Similarly, the greater randomness of the solution opposes the tendency to freeze. In consequence, a lower temperature must be reached for achieving the equilibrium between the solid (frozen solvent) and the solution. The elevation in boiling point (ΔT_b) and depression in freezing point (ΔT_f) of a solution are the colligative properties which depend only on the concentration of particles of the solute and not their identity. For dilute solutions, ΔT_b and ΔT_f are proportional to the molarity of the solute in the solution

240. Dissolution of a non-volatile solute into a liquid leads to
     a) A decrease of entropy
     b) An increase in tendency of the liquid to freeze
     c) An increases in tendency to pass into the vapour phase
     d) A decrease in tendency of the liquid to freeze

Paragraph for Question Nos. 241 to - 242

Figure 2.36 (a) represents the distillation of mixture of liquid A and liquid B which gives both of pure liquid A and B. While Fig. 2.36(b) represents the azeotopic mixture of HNO_3 and H_2O which distillation gives and azeotropic mixture and either of pure liquid. We can not separate both the pure liquid, i.e., H_2O and HNO_3

(a)

(b)
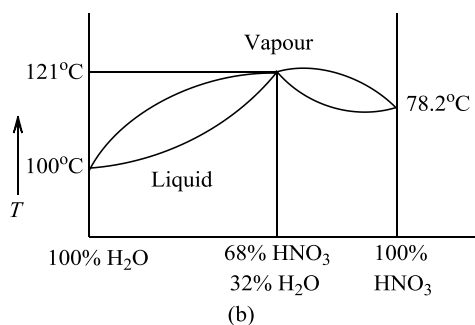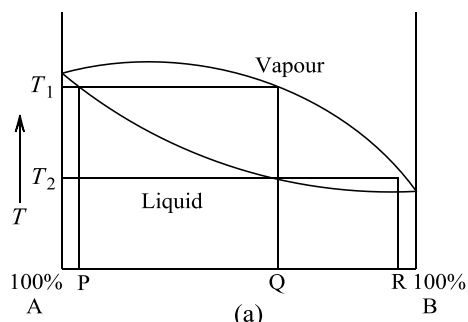
241. What is the result of distilling a mixture of 50% HNO_3 and 50% H_2O?
    a) Pure water and azeotropic mixture can be separated
    b) Pure H_2O and pure HNO_3 can be separated
    c) Pure HNO_3 and azeotropic mixture can be separated
    d) None of the above

Paragraph for Question Nos. 242 to - 242

Addition of non-volatile solute to a solvent always increases the colligative properties such as osmotic pressure, $\Delta P, \Delta T_b$ and ΔT_f. All these colligative properties are directly proportional to molality if solutions are dilute. The decrease in colligative properties on addition of non-volatile solute is due to increase in number of particles.

242. For different aqueous solutions of 0.1 N urea, 0.1 N NaCl, 0.1 N Na_2SO_4 and 0.1 N Na_3PO_4 solution at $27°C$ the correct statements are :
    1. The order of osmotic pressure is $NaCl > Na_2SO_4 > Na_3PO_4 > urea$
    2. $\pi = \frac{\Delta T_b}{K_b} \times ST$ for urea solution
    3. Addition of salt on ice increases its melting point
    4. Addition of salt on ice brings in melting of ice earlier
    a) 2, 3, 4   b) 1, 2, 4   c) 1, 2, 3   d) 3, 4

Paragraph for Question Nos. 243 to - 243

Addition of a non-volatile solute to a solvent lowers its vapour pressure. Therefore, the vapour pressure of a solution (*i.e.*, V.P. of solvent in a solution) is lower than that of pure solvent, at the same temperature. A higher temperature is needed to raise the vapour pressure upto one atmosphere pressure, when boiling point is attained. However increase in b.p. is small. For example 0.1 molal aqueous sucrose solution boils at $100.05°C$.
Sea water, an aqueous solution, which is rich in Na^+ and Cl^- ions, freezes about $1°C$ lower than frozen water. At the freezing point of a pure solvent, the rates at which two molecules stick together to form the solid and leave it to return to liquid state are equal when solute is present. Fewer solvent molecules are in contact with surface

of solid. However, the rate at which the solvent molecules leave the surface of solid remains unchanged. That is why temperature is lowered to restore the equilibrium. The freezing point depression in a dilute solution is proportional to molality of the solute.

243. An aqueous solution of 0.1 molal concentration of sucrose should have freezing point of $(K_f = 1.86)$:

    a) $+0.186°C$ b) $1.86°C$ c) $-1.86°C$ d) $-0.186°C$

Integer Answer Type

244. The osmotic pressure of a solution in atm obtained on mixing each 50 mL of 1.2% urea solution and 2.4% glucose solution at 300 K : (R = 0.08 litre atm K^{-1} mol^{-1}).

245. A mixture of two immiscible liquids nitrobenzene and water boiling at 99°C has a partial pressure of water 733 mm and of nitrobenzene 27 mm. The ratio of weights of water and nitrobenzene in mixture is ....

246. How many g of glucose must be present in 0.5 litre of a solution for its osmotic pressure be same as that of 8 g glucose in 1 litre?

247. $'n'$ moles of a non electrolyte are added to $'N'$ moles of solvent. The addition causes a lowering in vapour pressure of solvent by 20%. The ratio of moles of solvent and its solute is .....

248. An aqueous solution of a substance mol. wt. 240 has osmotic pressure 0.2 atm at 300 K. The density of solution in g/dm^3 is : $(R = 0.08$ litre atm K^{-1} $mol^{-1})$.

249. 12.2 g of benzoic acid $(Mw = 122)$ in 100 g water has elevation in boiling point of $0.27. K_b = 0.54$ K kg mol^{-1}. If there is 100% polymerization, the number of molecules of benzoic acid in associated state is

    a) 2   b) 1   c) 3   d) 4

250. The Van't Hoff factor for a solute which does not dissociate or associate in solution is

    a) 0   b) 2   c) 3   d) 1

251. The ratio of the value of any colligative property for BaCl$_2$ solution of urea solution under similar condition is

    a) 2   b) 3   c) 1   d) 4

252. The osmotic pressure of a solute is 600 mm at 300 K. The solution is diluted and the temperature is raised to 400 K and the solution shows an osmotic pressure of 200 mm. the solution was diluted to ......times.

253. Compound PdCl$_4$. 6H$_2$O is a hydrated complex; 1 m aqueous solution of it has freezing point 269.28 K. Assuming 100% ionization of complex, calculate number of ions furnished by complex in the solution

    a) 1   b) 2   c) 4   d) 0

254. A solution of liquids A and B having vapour pressure in pure state P_A^0 and P_B^0. The solution contains 30% mole of A which is in equilibrium with 60% mole of A in vapour phase. If P_B^0 is 2 cm, the P_A^0 is .....cm.

255. A 0.4 molal aqueous solution of $M_X A$ has freezing point 3.72°C. The K_f of H$_2$O is 1.86 K molality^{-1}. The value of X is ....

256. A solution of 6.2 g ethylene glycol in 55 g H$_2$O is cooled to $-3.72°C$. The ice separated from solution is : $(K_f$ H$_2$O $= 1.86$ K molality$^{-1})$

257. If for a sucrose, elevation in boiling point is 1.0°C, then what will be the boiling point of NaCl solution for same molal concentration?

    a) 1.0°C   b) 2.0°C   c) 3.0°C   d) 4.0°C

258. The osmotic pressure of urea solution at 10°C is 200 mm, becomes 105.3 mm when it is diluted and temperature raised to 25°C. The extent of dilution is

    a) 8 times   b) 5 times   c) 4 times   d) 2 times

259. The osmotic pressure of a solution containing 40 g of solute (molecular mass 246) per liter at 27°C is $(R = 0.0822$ atm L mol$^{-1})$

    a) 3.0 atm   b) 4.0 atm   c) 2.0 atm   d) 1.0 atm

260. A complex is represented as $CoCl_3 \cdot XNH_3$. Its 0.1 molal solution in water shows $\Delta T_F = 0.558°C$. K_f of H_2O is 1.86 K molality^{-1}. Assuming 100% ionisation, calculate the no. of NH_3 molecules associated with Co.

261. The total number of colligative properties are
   a) 1   b) 2   c) 3   d) 4

262. 3 mole of liquid A (V.P. = 60 mm) and a mole of B (V.P. = 40 mm) results in a solution having V.P. of 50 mm. The value of a is ....

: ANSWER KEY :

1) c	2) a	3) c	4) a
5) a	6) a	7) d	8) c
9) c	10) d	11) b	12) c
13) a	14) c	15) c	16) a
17) b	18) a	19) a	20) a
21) c	22) b	23) c	24) a
25) a	26) b	27) b	28) a
29) a	30) d	31) b	32) b
33) c	34) d	35) b	36) d
37) c	38) b	39) c	40) a
41) a	42) c	43) b	44) d
45) a	46) d	47) a	48) a
49) d	50) b	51) c	52) a
53) b	54) d	55) b	56) d
57) a	58) a	59) b	60) a
61) b	62) a	63) b	64) b
65) a	66) d	67) a	68) d
69) b	70) a	71) a	72) a
73) c	74) c	75) b	76) a
77) c	78) d	79) a	80) a
81) a	82) d	83) d	84) d
85) a	86) a	87) b	88) c
89) c	90) c	91) a	92) a
93) d	94) a	95) b	96) d
97) a	98) b	99) c	100) d
101) c	102) d	103) d	104) b
105) a	106) b	107) a	108) c
109) a			

1) a, b	2) b,d	3) a,b,c	4) a,d
5) a,b,c,d	6) a,c,d	7) a,c	8) a,b
9) a,d	10) a, b, d	11) a,b	12) a,c,d
13) a,c	14) b,d	15) a,b,c	16) c, d
17) a, b, d	18) c,d	19) a, b, d	20) a, c
21) a,b,d	22) b,c	23) a,b	24) b,c
25) a,c,d	26) a, c, d	27) c	28) a,b,c,d
29) a, b, c	30) b,c	31) b, c	32) a, b, c
33) a,d	34) b, d	35) c, d	36) a, b, d
37) b,c,d	38) a, b, c	39) a,b	40) b
41) b, c, d	42) a,c,d	43) b, c, d	44) a, b, c, d
45) b,d	46) c	47) a, b	48) b,c
49) a, d	50) b,d	51) a, b, c	52) b, d
53) c, d	54) c,d	55) a, b, c	56) a, b
57) a,b,c,d			

1) a	2) b	3) c	4) c
5) c	6) c	7) c	8) a
9) d	10) b	11) a	12) c
13) a	14) a	15) d	16) c
17) b	18) c	19) c	20) c
21) a	22) c	23) e	24) c
25) c	26) d	27) b	28) a
29) b	30) b	31) c	32) b
33) c	34) a	35) c	36) b
37) c	38) a	39) b	40) a
41) b	42) a	43) a	44) c
45) b	46) a	47) a	48) c

1) b	2) a	3) a	4) b
5) c	6) a	7) b	8) b
9) c	10) d	11) a	12) a

1) b	2) b	3) a	4) a
5) c	6) b	7) a	8) c
9) b	10) a	11) c	12) a
13) a	14) d	15) a	16) b
17) d			

1) 4	2) 4	3) 4	4) 4
5) 2	6) a	7) a	8) b
9) 4	10) b	11) 7	12) 4
13) 5	14) d	15) d	16) b
17) 5	18) d	19) 3	

SOLUTIONS

: HINTS AND SOLUTIONS :

1 **(c)**
Van't Hoff factor
$= \frac{\text{Experimental CP}}{\text{Calculated CP}} = 1 - \alpha + x\alpha + y\alpha$; For KCl it is 2
and for sugar it is 1

2 **(a)**
$\Delta T_f = \frac{1000 \times 1.86 \times 17}{46 \times 1000} = 0.69°C$
$T_f = 0 - 0.69 = -0.69°C$

3 **(c)**
$\pi \times \frac{63}{1000} = \frac{3}{180} \times 0.0821 \times 288$
$\therefore \pi = 6.25$ atm
$\therefore V_{\text{solution}} = $ Weight of solution × Density

4 **(a)**
$\Delta T_f = \frac{1000 \times K_f \times W}{Mw}$
$= \frac{1000 \times 1.86 \times 342}{100 \times 342} = 1.86$
$\therefore T_f = 0 - 1.86 = -1.86°C$

5 **(a)**
The interparticle forces in between $CHCl_3$ and acetone increase due to H-bonding and thus $\Delta_{\text{mixing}}V$ becomes negative

7 **(d)**
Osmosis of water and not of ion takes place

8 **(c)**
$P_{\text{Total}} = P_A°\chi_A + P_B°\chi_B$
$= P_A°\chi_A + P_B°(1 - \chi_A)$
$= P_B° - (P_B° - P_A°)\chi_A$
Given eq. $= 254 - 119\chi_A$
Compare with the given equation,
$\therefore P_B° = 254, P_B° - P_A° = 119$
$\therefore P_A° = 254 - 119 = 135$

9 **(c)**
Azeotropic mixtures are also known as constant boiling mixtures. They are liquid mixtures which boil over without any change in the composition. Such mixtures cannot be separated into components by fractional distillation. They are of two types: maximum boiling azeotropes and minimum boiling azeotropes
Maximum boiling azeotropes are formed by solutions having negative deviations. Boiling point is maximum
For example,
1.   Water and HCl

2.   Water and nitric acid

3.   Chloride form and acetone

4.   Acetic acid and pyridine

Minimum boiling azeotropes are formed by solutions having positive deviations. Boiling point is minimum. For example,

1.   Acetic acid and toluene

2.   Pyridine and water

3.   Ethanol and benzene

4.   Water and ethanol

10 **(d)**
$\pi = MRT$
1. $\pi = RT$
2. $\pi = RT$
3. $\pi = RT$ (mix has concentration =1 M)

11 **(b)**
For non-electrolytic solution, if isotonic,
$C_1 = C_2$
$= \frac{5 \times 1000}{342 \times 100} = \frac{1 \times 1000}{Mw_2 \times 100}$
$\therefore Mw_2 = 68.4$

12 **(c)**
The scaling of zero degree centigrade is based on this fact

13 **(a)**
Lowering is always positive

14 **(c)**
$\pi \propto n$

15 **(c)**
No changes in interparticle forces as both are non-polar

16 **(a)**
The definition of azeotropic mixture

17 **(b)**
$\pi V_2 = \frac{W_2}{Mw_2}RT$
$\frac{500}{76} \times \frac{100}{1000} = \frac{4}{Mw_2} \times 0.0821 \times 300$
$\therefore Mw_2 = 149.6$

18 **(a)**

Actual molecular weight of naphthoic acid $(C_{11}H_8O_2)=172$

Molecular mass (calculated)

$$= \frac{1000 \times k_f \times w}{W \times \Delta T_f}$$

$$= \frac{1000 \times 1.72 \times 20}{50 \times 2} = 344$$

van't Hoff factor $(i) = \frac{\text{actual mol.wt.}}{\text{calculated mo.wt.}} = \frac{172}{344}$

$$= 0.5$$

19 **(a)**

The movement of solvent particles from dilute solution to concentrated one through a semi-permeable membrane is called osmosis

20 **(a)**

Mixing of benzene and toluene does not involve any kind of decrease or increase in interaction forces in between molecules

21 **(c)**

Colligative properties are properties of solution which depend on the number of particles present in solution and

$$\Delta T_b = \frac{1000 \times K_b{'} \times n}{W}$$

22 **(b)**

NaCl furnishes two ions on complete dissociation

23 **(c)**

More is ΔT_b, more is boiling point

24 **(a)**

More is ΔT_f, lesser is freezing point

25 **(a)**

K_f for camphor is maximum (about 40 K m^{-1})

26 **(b)**

For two non-electrolyte solutions, if isotonic, $C_1 = C_2$

$$\therefore \frac{6.84 \times 100}{342 \times 100} = \frac{1.52 \times 1000}{Mw_2 \times 100} \Rightarrow Mw_2 = 760$$

27 **(b)**

m (benzoic acid)

$$= \frac{1000 K_b W_1}{\Delta T_b W_2}$$

$$= 244 \text{ (twice of actual molecular weight)}$$

28 **(a)**

$Al_2(SO_4)_3$ furnishes maximum number of ions

29 **(a)**

$\pi \propto \frac{1}{V}$ and not $\pi \propto V$

30 **(d)**

Freezing point is lowered on addition of solution in it

31 **(b)**

$\Delta T_b = K_b \times m = 0.52 \times 1 \times 2 = 1.04$;

$\therefore T_b = 100 + 1.04 = 101.04°C$

32 **(b)**

$\Delta T_f = 1.86 \times 1 \times 2 = 3.72$;

$\therefore T_f = 0 - 3.72 = -3.72°C$;

NaCl dissociates to give experimental molality

$= 1 \times 2 = 2$

33 **(c)**

$\Delta T_f = 1.86 \times 0.05 = 0.093$;

$\therefore T_f = 0 - 0.093 = -0.093°C$

34 **(d)**

$\Delta T_b = K_b \times$ Molality

$\Delta T_f = K_f \times$ Molality

$$\therefore \frac{\Delta T_b}{\Delta T_f} = \frac{K_b}{K_f} \Rightarrow \Delta T_b = \frac{\Delta T_f \times K_b}{K_f} = \frac{0.186 \times 0.512}{1.86}$$

$$= 0.0512$$

35 **(b)**

The relative lowering of vapour pressure is equal to the mole fraction of the solute

37 **(c)**

Vapour pressure of methanol + Water mixture > VP of H_2O but less than that of methanol

38 **(b)**

A characteristic of azeotropic mixture

39 **(c)**

$$\pi V = nRT; \pi \times \frac{100}{1000} = \frac{5}{342} \times 0.0821 \times 423$$

$\therefore \pi = 5.078$ atm

40 **(a)**

$$\frac{\Delta P}{P°} = \frac{W_2 \times Mw_1}{Mw_2 \times W_1}$$

$$\Delta P = \frac{1 \times 18}{1000} \times 760 = 13.68$$

(at 100°C, VP =760 torr)

41 **(a)**

Osmosis occurs from dilute solution to concentrated solution, i.e., exosmosis

42 **(c)**

KNO_3 is 100% ionized while CH_3COOH is a weak electrolyte

43 **(b)**

$$\pi V = nRT \Rightarrow \pi = \frac{n}{V}RT \Rightarrow \pi = CRT$$

44 **(d)**

C_2H_5OH show H-bonding as well as polarity both

45 **(a)**

$P_{N_2} = K_H \times$ mole $-$ fraction (N_2)

mole-fraction

$(N_2) \frac{1}{10^5} \times 0.8 \times 5 = 4 \times 10^{-5}moll^{-1}$

In 10 mole solubility is 4×10^{-4}.

46 (d)
Addition of salt lowers the freezing point of water and thus snow melts

47 (a)
$$\frac{\Delta P}{P^\circ} = 0.50 = \frac{n_1 i}{n_1 i + n_2}$$
$$0.50 = \frac{2i}{2i + 3}$$
$$i = 1.5 = 1 + x$$
$$x = 0.5$$
Hence, 2 mol NaCl will exists as 1 mol $Cl^{\ominus}$ due to 50% ionization

48 (a)
Urea and glucose do not dissociate in solution. Sodium chloride gives two ions and potassium sulphate gives three ions per formula unit. Therefore, the effective number of particles is maximum in potassium sulphate, and it shows the maximum depression in freezing point

49 (d)
Azeotropic mixture of HCl conatins 20.4% HCl

50 (b)
$$25 \times M_{(KCl)} = 20 \times 1\, M_{(AgNO_3)}$$
$$\therefore M_{(KCl)} = 0.8$$
$$\Delta T_f = M' K_f\, i$$
$$= 0.8 \times 2 \times 2$$

51 (c)
For an ideal solution
$\Delta_{mixing}H = 0;\ \Delta_{mixing}V = 0$ and it should obey Raoult's law

52 (a)
For $Na_2SO_4, \pi_1 = iMRT$
$= i \times 0.004 \times RT$
For glucose, $\pi_2 = CRT$
$= 0.01 RT$
$\pi_1 = \pi_2$ (isotonic)
or $0.004i = 0.01$
$i = 2.5$
$Na_2SO_4 \rightleftharpoons 2Na^{\oplus} + SO_4{}^{2-}$

1	0	0
$1 - \alpha$	2α	α
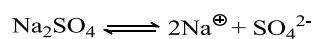
Total particles $= 1 - \alpha + 2\alpha + \alpha$
$= 1 + 2\alpha$
$$\therefore\ i = \frac{1 + 2\alpha}{1} = 2.5$$
$\alpha = 0.75$ or 75% dissociated

53 (b)
$AlCl_3$ furnishes more ions than $CaCl_2$ and thus

shows higher boiling point

54 (d)
$$\pi = CRT \Rightarrow 2.5 = C \times 0.0821 \times 297$$
$$\therefore C = 0.1025\ \text{mol L}^{-1}$$

55 (b)
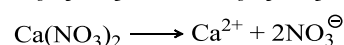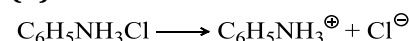Positive deviations from Raoult's law are noticed when
1. Experimental value of vapour pressure of mixture is more than calculated value
2. Experimental value of boiling point of mixture is less than the calculated value
3. $\Delta_{mixing}H = +ve$
4. $\Delta_{mixing}V = +ve$
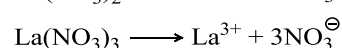
56 (d)
$C_6H_5NH_3Cl \longrightarrow C_6H_5NH_3{}^{\oplus} + Cl^{\ominus}$
$Ca(NO_3)_2 \longrightarrow Ca^{2+} + 2NO_3{}^{\ominus}$
$La(NO_3)_3 \longrightarrow La^{3+} + 3NO_3{}^{\ominus}$
Glucose does not dissociate. So it has the minimum number of particles, and therefore, it shows minimum depression in freezing point. So it has the maximum freezing point

57 (a)
Minimum freezing point means more number of ions
1. $0.01 \times 2 = 0.02$
2. $0.005 \times 1 = 0.005$
3. $0.005 \times 3 = 0.015$
4. $0.005 \times 2 = 0.01$

58 (a)
$$\pi = \frac{n}{V} RT$$
$$n = \frac{\pi V}{RT} = \frac{7.40 \times 1}{0.0821 \times 300} = 0.3$$

59 (b)
Elevation in boiling point, osmotic pressure, depression in vapour pressure, and depression in freezing point are colligative properties
Colligative properties are properties of solution which depend on the number of particles present in solution

60 (a)
It is $Cu_2Fe(CN)_6$ molecule in gelatinous state to work as semipermeable in nature

61 (b)

The temperature at which a liquid boils increases with increase in pressure

62 (a)
A solution of M/2 NaCl is isotonic with M glucose. The required condition is $\pi_1 = \pi_2$

63 (b)
$\Delta T_f = K_f \times m' \times i$

$\dfrac{\Delta T(\text{urea})}{\Delta T(CH_3COOH)} = \dfrac{m'(\text{urea})}{m'(CH_3COOH) \times i}$

$i = 1.1 \ (i = 1 \text{ for urea})$

$= (1 + x) \text{ for } CH_3COOH$

$x = 0.1$

$\therefore [H^\oplus] = Cx = 0.001$

$\therefore pH = 3$

64 (b)
It is the definition of osmosis

65 (a)
The number of moles of the solute present per kilogram of the solvent is known as its molality

$m = \dfrac{W_{solute}}{Mw_{solute}} \times \dfrac{1}{W_{solvent\ in\ kg}}$

$= \dfrac{W_{solute}}{Mw_{solute}} \times \dfrac{1}{W_{solvent\ in\ g}} \times 1000$

66 (d)
First three methods involve use of $Cu_2Fe(CN)_6$ as semi-permeable membrane which will be dissolved in non-aqueous solvent and thus only Townend's method having semi-permeable membrane of powered glass and clay can be used to determine the osmotic pressure of non-aqueous solutions

67 (a)
Osmosis will not take place

68 (d)
Colligative properties are properties of solution which depends on the number of particles present in solution. $\pi \propto n$

69 (b)
$\pi V = nRT \Rightarrow \pi = \dfrac{n}{V} RT \Rightarrow \pi = CRT$

70 (a)
$\pi V = nRT$;

$\therefore \pi \times 1 = 0.1 \times 0.082 \times 273$

71 (a)
$\Delta T_f = \dfrac{1000 K_f \times W_2}{Mw_2 \times W_1}, [\Delta T = 273 - 271.9 = 1.1]$

$1.1 = \dfrac{1000 \times 1.86 \times 1.25}{Mw_2 \times 20}$

$Mw_2 = 105.68$

72 (a)

$\chi_1 = \dfrac{P_A{}^\circ \chi_A}{P_{Total}} = \dfrac{P_A{}^\circ \chi_2}{P_{Total}}$

$\therefore P_{Total} = \dfrac{P_A{}^\circ \chi_2}{\chi_1}$

73 (c)
Molarity $= \dfrac{\text{Moles of solute}}{\text{Volume of solution(L)}}$

moles of urea $= \dfrac{120}{60} = 2$

weight of solution = weight of solution + weight of solute

$= 1000 + 120 = 1120 \text{ g}$

$\Rightarrow Volume = \dfrac{1120 g}{\frac{1.15 g}{mL}} \times \dfrac{1}{1000 mL/L}$

$= 0.974 \text{ K}$

$\Rightarrow \text{Molarity} = \dfrac{2.000}{0.974} = 2.05 \text{ M}$
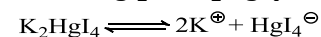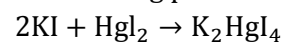
74 (c)
More is ΔT_f, lesser is freezing point

75 (b)
$\dfrac{P^\circ - P_S}{P^\circ}$ = Mole fraction of solute = χ_2

76 (a)
During complex formation, more number of particles join to form a larger particle which does not break. So the particle number is reduced and the freezing point is elevated

$2KI + HgI_2 \rightarrow K_2HgI_4$

$K_2HgI_4 \rightleftharpoons 2K^\oplus + HgI_4{}^\ominus$

77 (c)
$\therefore P^\circ - P_s = P^\circ \times \text{Mole fraction of solute}$

$10 = P^\circ \times 0.2$

$20 = P^\circ \times \chi_2$

$\therefore \chi_2 = 0.4 \Rightarrow \chi_1(\text{solvent}) = 1 - 0.4 = 0.6$

78 (d)
More is ΔT_f, lesser is freezing point

79 (a)
$P_S = P^\circ \chi_2$

80 (a)
$p = P_B{}^\circ \chi_B$ (B = Benzene acts as solvent)

$\chi_B = \dfrac{167}{268} = 0.623$

$\chi_{solute} = 1 - \chi_B = 0.377$

81 (a)
K_b is characteristic constant for given solvent

82 (d)
Larger the value of (i), Smaller the freezing point (d) is a case of non-electrolytes, $i = 1$

83 (d)
$\chi'_T(\text{vap}) = \dfrac{\chi_T P_T{}^\circ}{\chi_T P_T{}^\circ + \chi_B P_B{}^\circ}$

= 0.4

84 (d)

Addition of a solute increases the boiling point of solution

85 (a)

Normal molecular weight of electrolyte > Experimental molecular weight

86 (a)

When 0.004 M Na_2SO_4 solution is isotonic with 0.01 M solution of glucose, so their osmotic pressures are equal to each other.

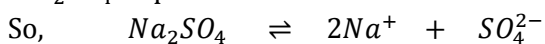Osmotic pressure of 0.01 M glucose $(\pi)_{glucose}$

=CST

∴   C= concentration of solution =0.01 M

S= solution constant =0.0821 L atm/K/mol

T= absolute temperature

∴ $\pi_{glucose} = 0.01 \times 0.0821\, T$ ---(i)

$\pi_{glucose} = \pi_{Na_2SO_4}$

Na_2SO_4 is present in ionic state in solution

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

At t=0   1   0   0

At equilibrium $1-\alpha$ 2α α

(where, α is the degree of dissociation of Na_2SO_4)

$(\pi_{cal})_{Na_2SO_4} = C \times S \times T= 0.004 \times 0.0821 \times$ T   ---(ii)

By van't Hoff factor

$\frac{(\pi_{obs})_{Na_2SO_4}}{(\pi_{cal})_{Na_2SO_4}} = \frac{\text{number of particles after dissociation}}{\text{number of particles before dissociation}}$

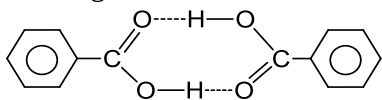$= \frac{1- \alpha+2\alpha+\alpha}{1}$

∵ $(\pi_{obs})_{Na_2SO_4} = \pi_{glucose}$

∴ $\frac{0.01 \times 0.0821\, T}{0.004 \times 0.0821 \times T} = \frac{1+2\alpha}{1}$

Or $\frac{10}{4} = \frac{1+2\alpha}{1}$ or   10=4+8α

$\alpha = \frac{10-4}{8} = 0.75$

%of α = 75%

87 (b)

Molecular weight of benzoic acid in benzene is determined by the depression in freezing point method, and comes out to be 244. The actual molecular mass is 122. Therefore, it corresponds to the dimers which are formed by hydrogen bonding

88 (c)

$\Delta T_f = \text{Molality} \times K_f \times i$

$i = 2$, hence complex is binary

Also, CN of Pt is 6 and complex is hydrated

89 (c)

$\Delta T_f = K_f \times \text{Molality} = 1.86 \times 0.05 = 0.093$

Thus, freezing point = $0 - 0.093 = -0.093$

90 (c)

$\Delta T_b = K_b \times \text{Molality} \times (1 - \alpha + x\alpha + y\alpha)$

ΔT_b is more $BaCl_2$ as it gives more number of ions, $(1 - \alpha + x\alpha + y\alpha)$ is more for $BaCl_2$ (it is 3)

91 (a)

Normal saline is 0.16 M NaCl solution

92 (a)

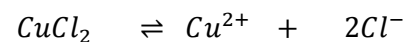$P° - P_S \propto$ loss in weight of water chamber and $P_S \propto$ loss in weight of solution chamber

$\frac{P° - P_S}{P_S} = \frac{n_2}{n_1} = \frac{W_2 \times Mw_1}{Mw_2 \times W_1}$

or $\frac{0.04}{2.50} = \frac{5 \times 18}{Mw_2 \times 180}$

∴ $Mw_2 = 31.25$

93 (d)

$\Delta T_f = K_f \times \text{Molarity}$

94 (a)

$CuCl_2$ is an electrolyte which ionise in solution as follows.

$CuCl_2 \rightleftharpoons Cu^{2+} + 2Cl^-$

At t=0   1 mole   0   0

After ionisation$(1 - \alpha)mole$ $\alpha mole$ $2\alpha mole$

Thus, number of particles after ionisation

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

∴ van,t Hoff factor (i)

$= \frac{\text{number of particloes after ionisation}}{\text{number of particles before ionisation}}$

or $(i) = \frac{1 + 2\alpha}{1}$ (On 100 % ionisation α = 1)

$= \frac{1 + 2 \times 1}{1} = 3$

The elevation in boiling point (when colligative property is abnormal)

$\Delta T^b = i \times k_b \times m$

$m \rightarrow$ molality of solution

Molality of $CuCl_2$ solution

$\frac{\frac{\text{weight of CuCl}_2 \text{in gram}}{\text{mol.weight of CuCl}_2}}{\text{weight of water (solvent)in kg}} = \frac{\frac{13.44}{134.4}}{1} = 0.1$ m

Thus, $\Delta T_b = 3 \times 0.52 \times 0.1 = 0.156 \approx 0.16°C$

95 (b)

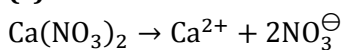Perfectly semi-permeable membrane allows the passage of solvent particles only

96 (d)

All get dissolved with the evolution of heat

97 (a)

This is Raoult's law

98 (b)

$P_{total} = P_A °\chi_A + P_B °\chi_B$

$= 210$ mm $> 200\, mm$

VP is decreased

99 (c)

$$Ca(NO_3)_2 \rightarrow Ca^{2+} + 2NO_3^{\ominus}$$

1	0	0
0	1	2

$$i = \frac{\text{Moles after dissociation}}{\text{Moles before dissociation}} = \frac{3}{1}$$

100 (d)

$$\frac{P° - P_S}{P°} = \text{Molality} \times (1 - \alpha + x\alpha + y\alpha)$$

The value of $P° - P_S$ is maximum for $BaCl_2$

101 (c)

Osmotic pressure $\propto$ moles:

$(NH_4)_3PO_4$ furnishes 4 ions in solution

102 (d)

$\pi = \frac{\pi_1 + \pi_2}{2}$, if equal volumes are mixed, volume of solution becomes double

103 (d)

$Fe_2(SO_4)_3$ furnishes more number of ions

104 (b)

$P_{EtOH} = P°_{EtOH} \times$ Mole fraction of EtOH in liquid phase

$= P_T \times$ Mole Fraction of EtOH in vapour Phase

Thus, mole fraction of EtOH in vapour phase

$$= \frac{P'}{P_T} = \frac{4.556}{4.556 + 2.619} = 0.635$$

105 (a)

Colligative properties are properties of solution which depend on the number of particles present in solution

106 (b)

$$P_m = 160 \times \frac{1}{2} + 60 \times \frac{1}{2} = 110 \text{ mm}$$

107 (a)

$$pH = 2$$
$$[H^{\oplus}] = 0.01 \ M = Cx = 0.1x$$
$$x = 0.1$$
$$i = 1 + x = 1.1$$
$$\pi = i\frac{n}{V}RT = iMRT = 1.1 \times 0.1RT = 0.11RT$$

108 (c)

$\frac{\Delta T_{f_A}}{\Delta T_{f_B}} = \frac{2}{1} = \frac{1}{1/2}$, i.e., B should associate to show higher ΔT

109 (a)

For two non-electrolyte solutions, if isotonic

$$C_1 = C_2$$

$$\therefore \frac{8.6}{60 \times 1} = \frac{5 \times 1000}{Mw_2 \times 100} \Rightarrow Mw_2 = 348.9$$

111 (b,d)

Molality and mole fraction are not affected by temperature because they involve masses of the solute and the solvent which do not change with temperature

113 (a,d)

NaCl: $0.5M(i = 2) \Rightarrow C_{eff} = 0.5 \times 2 = 1 \text{ M}$

$$C_6H_5COOH: 2.0 \text{ M} \left(i = \frac{1}{2}\right) \Rightarrow C_{eff} = 2 \times \frac{1}{2} = 1 \text{ M}$$

a. $\pi = C_{eff} RT \Rightarrow \pi$ is same as C_{eff} is same

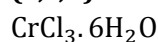**b.** Since both the solutions have different solvents, vapor pressure will be different

c. Solutions are isotonic

d. $\Delta T_f = iK_f \cdot m \Rightarrow \Delta T_f$ for solution II will be more as $(K_f)_{benzene} > (K_f)_{water}$

114 (a,b,c,d)

If heat of solution is negative, the dissolution process is exothermic and heat is released when the crystal dissolves. All the given compounds have negative heat of solution
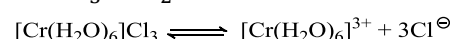
115 (a,c,d)

$CrCl_3 \cdot 6H_2O$

$$\pi = CRT(1 - \alpha + x\alpha + y\alpha)$$
$$98.52 = 1 \times 0.0821 \times 300 \times (x + y)(\alpha = 1)$$
$$\therefore (x + y) = 4$$

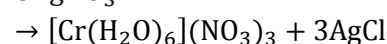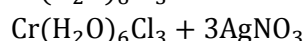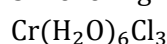$\therefore CrCl_3 \cdot 6H_2O$ can be written as:

$$[Cr(H_2O)_6]Cl_3 \rightleftharpoons [Cr(H_2O)_6]^{3+} + 3Cl^{\ominus}$$

1	0	0
$1 - \alpha$	α	α

3 mol of $AgNO_3$ will react with 1 mol of $Cr(H_2O)_6Cl_3$

$$Cr(H_2O)_6Cl_3 + 3AgNO_3$$
$$\rightarrow [Cr(H_2O)_6](NO_3)_3 + 3AgCl$$

moles $2 \times 1 = 2$ $1 \times 6 = 6$ 0

0

	0	0	2

6

$\therefore$ Moles of AgCl formed $= 6$

Weight of AgCl formed $= 6 \times 143.5 = 861$ g

$$[Cr(H_2O)_6](NO_3)_3 = \frac{2}{3}$$
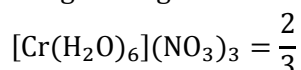
$$\pi = CRT \times (1 + 3\alpha) = \frac{2}{3} \times 0.0821 \times 300 \times 4$$
$$= 65.68 \text{ atm}$$

117 (a,b)

$P_M = P_A° \cdot \chi_A + P_B° \cdot \chi_B$; Also $P' = P_M \cdot \chi_{A(V)} = P_A° \cdot \chi_{A(l)}$

$$= P_A° \cdot \chi_A + P_B° \cdot (1 - \chi_A)$$

$$\therefore \chi_A = \frac{P_M - P_B{}^\circ}{P_A{}^\circ - P_B{}^\circ}$$

121 (a,c,d)

Greater is the intermolecular force on mixing, more negative will be the deviation
$$p < P_A{}^\circ\chi_A + P_B{}^\circ\chi_B$$

Experimental vapour pressure will be less than calculated vapour pressure

122 (a,c)

On addition of on-volatile substance, according to the colligative property, the vapor pressure of solution decreases and its boiling point increases

123 (b,d)

$\Delta_{mixing}V = 0$; $\Delta_{mixing}H = 0 \Rightarrow$ look for ideal solutions

127 (c,d)

Both $BaCl_2$ and $Ca(NO_3)_2$ will give 3 ions per molecule in solution and hence, show same colligative properties

130 (a,b,d)

For immiscible liquids
$$P_A' = P_M \cdot \chi_A'; \quad P_B' = P_M \cdot \chi_B'$$
$$\therefore \frac{P_A'}{P_B'} = \frac{\chi_A'}{\chi_B'} = \frac{n_A}{n_B} = \frac{W_A \times Mw_B}{Mw_A \times W_B}$$
If $P_A' > P_B'$, then $n_A > n_B$

132 (a,b)

$$\pi = CRT \Rightarrow \pi = \frac{n_2 RT}{V} = \frac{W_2 RT}{Mw_2 V}$$

133 (b,c)

We know that osmatic pressure $\pi = \frac{n}{V}RT$,

therefore osmatic pressure is directly proportional to the temperature and molarity

Molarity $= \dfrac{n}{V}$

134 (a,c,d)

a. There will be a depression in the freezing point by the addition of glucose in water

b. α increases as concentration decreases

c. $\Delta_{sol}H = \Delta_{latice}H + \Delta_{hyd}H$

          (−ve) (−ve)

d. Mixing of solution is always accompanied by an increase in entropy (randomness)

139 (b,c)

Molarity $= \dfrac{6}{60} = 0.1$. In case of urea, molarity and normality are the same

142 (a,d)

In the depression in freezing point experiment, it is found that the vapour pressure of a solution is less than that of pure solvent. Only solvent molecules solidify at freezing point. The temperature at which the vapour pressure of the liquid is equal to the vapour pressure of the solid is graphically the temperature at which the vapour pressure curve of the liquid intersects the vapour pressure curve of the solid. When a non-volatile solute is dissolved in a liquid, its freezing point is lowered
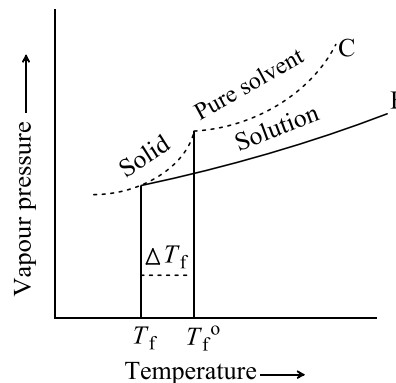
148 (a,b)

Benzene and toluene $\Rightarrow$ Ideal solution

$$P_{total} = P_A{}^\circ \chi_A + P_B{}^\circ \chi_B = 42 \times \frac{1}{3} + 36 \times \frac{2}{3}$$
$$= 38 \text{ mm Hg}$$

$$\chi_{Benzene}^V = \frac{P_{Benzene}}{P_{Total}} = \frac{42 \times \frac{1}{3}}{38} = \frac{7}{19}$$

151 (a,c,d)

$$\frac{\Delta P}{P^\circ} = \frac{n_2}{n_1} = \frac{n_2 \times Mw_1 \times 1000}{W_1 \times 1000} = \frac{\text{Molality} \times Mw_1}{1000}$$

For electrolyte $\frac{\Delta P}{P^\circ} = \frac{\text{Molality} \times M}{1000} \times (1 + 3\alpha)$

$(Mw_1 = 18$ for $H_2O)$

Also, $\pi_{obs} = C \times R \times T (1 + 3\alpha)$

$$\therefore \frac{\Delta P}{P^\circ} = \frac{\pi_{obs}}{RT} \times \frac{18}{1000}$$

$\Delta T_{f\,obs} = K_f \times \text{molaltiy} \times (1 + 3\alpha)$

$$\frac{\Delta P}{P^\circ} = \frac{\Delta T_{f\,obs} \times 18}{K_f \times 100}$$
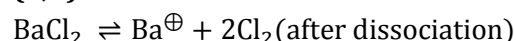
$$i = (1 + 3\alpha) = \frac{\text{Calculated molecular weight}}{\text{Observed molecular weight}}$$

Therefore, molecular weight of $K_3PO_4 = M_{obs} \times (1 + 3\alpha)$

157 (b,c)

Adding K_2SO_4 into $BaCl_2$, solution will result into precipitation of $BaSO_4$ which is non-volatile, and therefore boiling point of solution will be increased and its freezing point will decrease

159 (b,d)

$BaCl_2 \rightleftharpoons Ba^\oplus + 2Cl_2$ (after dissociation)
$i = 3$

163 (c,d)
Osmotic pressure is a colligative propery, therefore, it depends upon the number of constituents of solution. It also depends upon temperature as $\pi = CRT$

166 (a,b,c,d)
Molarity $= \dfrac{1.2575 \times 1000}{251.5 \times 250} = 0.02$ M, $\pi = CRT$
$\therefore \pi_{\text{obs}} = 0.02 \times 0.0821 \times 300 = 0.4926$ atm
$= 374.38$ mm
$\dfrac{\pi_{\text{obs}}}{\pi_{\text{cal}}} = i = \dfrac{1.478 \times 760}{374.38} = 3$
$\therefore n = 3$
Also

$$[\text{Cr(NH}_3)_6]\text{SO}_4.\text{Cl} \rightleftharpoons [\text{Cr(NH}_3)_6{}^{3+}] + \text{SO}_4{}^{2-} + \text{Cl}^{\ominus}$$
$\quad\quad 0.02 \quad\quad\quad\quad 0 \quad\quad 0 \quad\quad 0$

Eq conc $\;\;0 \quad\quad\quad\quad\quad 0.02 \quad 0.02 \quad 0.02$

167 (a)
This type of association of solute molecules normally happens in solvents of low dielectric constant.

168 (b)
Henry's law is for solute while Raoult's law is for solvent; both are dependent to each other

169 (c)
Osmotic pressure is a colligative property

170 (c)
Explanation is correct reason for statement.

171 (c)
The boiling point of azeotropic mixture may be higher or lower than the pure components

172 (c)
If mol. wt. is low, ΔT_b or ΔT_f being low cannot be read out accurately. A little error in measurement of ΔT_b will cause abnormal values of mol. wt.

173 (c)
Explanation is correct reason for statement.

174 (a)
Lowering of vapour pressure is a colligative property, hence it depends upon the number of solute particles

175 (d)
If a non-volatile solute is added to water its vapour pressure always decreases

176 (b)
$Cu_2[Fe(CN)_6]$ is soluble in non-aqueous solutions.

177 (a)
$K_{\text{f(camphor)}} = 37.7$ K kg mol^{-1}

178 (c)
Explanation is correct reason for statement.

179 (a)
KCl being an electrolyte provide more number of particles in solution, however urea being a non electrolyte remains as such in solution.

180 (a)
For ideal solution $\Delta_{\text{mix}}H$ and $\Delta_{\text{mix}}V$ are equal to zero

181 (d)
The dissolution of gases in water requires energy, hence it is endothermic in nature, but during dissolution entropy may increase or decrease

182 (c)
Explanation is correct reason for statement.

183 (b)
For isotonic solutions osmotic pressures are same. Concentrations are same only when solute neither dissociates nor associates.

184 (c)
Water boils at low temperature at mountains where atmospheric pressure is low, $i.e.,$ when P^0 = atmospheric pressure.

185 (c)
$P_s \propto \dfrac{N}{n+N}$ or $P_s = P^0 \dfrac{N}{n+N}$ or $\dfrac{P_s}{P^0} = \dfrac{N}{n+N}$
or $1 - \dfrac{P_s}{P^0} = 1 - \dfrac{N}{n+N}$ or $\dfrac{P^0 - P_s}{P^0} = \dfrac{n}{n+N}$

186 (c)
K_f is same for both solutions

187 (a)
According to colligative property addition of non-volatile solute to volatile solvent, the freezing point of solution decreases

188 (c)
Extent of dissociation increases steadily with increasing dilution

189 (e)
Both are incorrect

190 (c)
When a solution is separated from the pure solvent by mean of semipermeable membrane, the pure solvent passes through the membrane and goes to the solution and a hydrostatic

pressure is set up which is called as the osmotic pressure of the solution. So, when red blood cells were placed in pure water, the concentration of salt content would increase in the solution or decrease in cell so to assertion is true but reason is false.

191 **(c)**

Since $P \propto \frac{1}{T}$, therefore on increasing the pressure, the freezing temperature decreases

192 **(d)**

$\frac{P^0 - P_s}{P^0} = \frac{n}{n + N}$ or $\frac{P^0}{P^0 - P_s} = \frac{n + N}{n} = 1 + \frac{N}{n}$

or $\frac{P^0 - P^0 + P_s}{P^0 - P_s} = \frac{N}{n}$ or $\frac{P^0 - P_s}{P_s} = \frac{n}{N}$

[For dilute solution $n + N \approx N$ $\therefore$ $\frac{P^0 - P_s}{P^0} = \frac{n}{N}$]

193 **(b)**

Non-ideal solution with positive deviation *ie,* having more vapour pressure than expected, boil at lower temperature while those with negative deviation boil at higher temperature, than those of the components.

194 **(a)**

For NaCl, $i = 2$, while for glucose, $i = 1$. Hence, osmotic pressure of NaCl is higher than that of glucose solution

195 **(b)**

In cooker, the vapor pressure of solution increases therefore, its boiling temperature decreases since $P \propto \frac{1}{T}$

196 **(b)**

Equimolal solutions of all the substances in the same solvent will show equals elevation in boiling points

197 **(c)**

The sum of mole fraction is always unity and it is not temperature dependent

198 **(b)**

The given explanation is correct and a reduction in molecular attraction will increase vaporization nature and lead for higher vapour pressure than that calculated by Raoult's law. Thus, mixture will show positive deviation.

199 **(c)**

Both solute and solvent will from the vapour but vapour phase will become richer in more volatile component.

200 **(a)**

Depression in freezing point is a colligative property, hence its value depends upon the number of solute particles

201 **(c)**

Explanation is correct reason for statement.

202 **(b)**

The water pouch of instant cold pack for testing athletic injuries breaks when squeezed and NH_4NO_3 dissolves lowering the temperature because addition of nonvolatile solute into solvent results into depression of freezing point of solvent so both are true and correct explanation.

203 **(c)**

Vapour pressure decreases with decrease in temperature.

204 **(a)**

In an open system, equilibrium can never be achieved

205 **(b)**

Note that addition of solute to solvent (and not solvent to solute which will show reverse effect) shows a lowering in V.P. due to decrease in relative surface area.

206 **(a)**

Like dissolves like, i.e., non-polar solutes are soluble in non-polar solvent and polar solute are soluble in polar solvent

207 **(b)**

One molar aqueous solution has 1 mole in less than 1000 g of water. Hence, 1000 g of water will be associated with more than 1 mole while 1 molal has 1 mole in 1000 g of water

208 **(a)**

KCl is ionic salt and it dissociates in solution.

209 **(a)**

In benzene acetic dimerises but in water it does not this is because benzene is non polar where as water is polar. Hence, moleculard mass determined by depression in freezing point method comes out to be different.

210 **(c)**

Explanation is correct reason for statement.

211 **(b)**

Osmosis is net movement of solvent particles

from dil. to conc. and conc. to dil., *i. e.*, a bilateral process; The more movement is from dil. to conc. Thus net flow from dil. to conc. is noticed.

212 (a)

An ideal solution of the components A and B is defined as the solution in which the intermolecular interactions between A and B are the same magnitude as between the pure components or it is a solution there is no volume change or enthalpy change or mixing

213 (a)

Learn as a fact. The molecular mass of large molecules is determined using the osmotic pressure technique. The molecular mass of smaller molecules is determined using the freezing point lowering method

214 (c)

Explanation is correct reason for statement.

215 (b)

(**a** →**p, r**) $C_2H_5OH + H_2O$ = Azeotropic mixture
  (at a particular composition)

shows positive deviation

(**b** → **q, t**) $C_2H_5Br + C_2H_5I$ = ideal solution; obeys Raoult's law

(**c** → **q, t**) $p_A = P_A{}°\chi_A$ = Ideal solution (with non-volatile solute)

(**d** →**p, s**) $H_2O + H_2SO_4$ = Azeotropic mixture
  (at a particular composition)

shows negative deviation

216 (a)

(**a**→**q**) Lowering of vapour pressure $= P° = P_S$

= Pressure of pure solvent − Pressure of solution

(**b**→**s**)

(**c**→**r**)

(**d**→**p**)

217 (a)

(**a** → **r, s**) 0.1 MCH_3COOH in benzene

$\Rightarrow i < 1 (Mw_2 > Mw_N)$

(**b** → **r**) 0.1 M urea in water $\Rightarrow i = 1 (Mw_2 > Mw_N)$

(**c**→**p**) 0.05 M $BaCl_2$ in water

$\Rightarrow i = 3$ (assuming $\alpha = 1$) $\left(Mw_2 = \frac{Mw_N}{3}\right)$

(**d**→ **q**) 0.1 M CH_3COOH in water

$\Rightarrow i > 1 (Mw_0 < Mw_n)$

219 (c)

(**a**→**q**) Relatives lowering of vapour pressure $\left(\frac{P°-P_S}{P_S{}°}\right) = \chi_B$

(**b**→**p**) $P = K_H\chi_B$ (Henry's law)

(**c**→**s**) Azeotropic mixture deviates from ideal solution

(**d**→**r**) For ideal solution $\Delta_{mix}V = 0; \Delta_{mix}H = 0$

220 (a)

Osmotic pressure $(\pi) = iCRT; i$ =Van't Hoff factor

(**a**→**r**) i is same for glucose, urea, fructose i.e., $i = 1$

(**b**→**s**) NaCl; $i = 2$; $K_2SO_4; i = 3$; $MgCl_2: i = 3$

(**c**→**p**) $Al_2(SO_4)_3; i = 5$; $Na_3PO_4; i = 4$;

$K_4[Fe(CN)_6]; i = 5$

(**d**→**q**) Glucose; $i = 1$; NaCl; $i = 2$

$CaCl_2; i = 3$

221 (b)

(**a**→**r**) Osmotic pressure was determined experimentally by Berkeley and Hartley

(**b**→**s**) Ostwald and Walker's method is experimentally used for the determination

lowering in vapour pressure

(**c**→**p**)

(**d**→**q**)

222 (b)

(**a**→**s**) ppm (part per million)$=\frac{\text{Mass of solute} \times 10^6}{\text{Mass of solution}}$

(**b**→**r**) $\Delta T_b = T_S - T°$

(**c**→**q**) K_f = Molal depression constant

($\mathbf{d} \to \mathbf{p}$) i = van't Hoff factor

$$= \frac{\text{Observed collegative properties}}{\text{Calculated collegative properties}}$$

226 (a)

($\mathbf{a} \to \mathbf{s}$) Hypertonic solutions have higher osmotic pressure than some other solutions

($\mathbf{b} \to \mathbf{q}$) Isotonic solutions have same osmotic pressure than some other solutions

($\mathbf{c} \to \mathbf{r}$)

($\mathbf{d} \to \mathbf{s}$)

227 (b)

The relative lowering of vapour pressure is equal to the mole fraction of solute

228 (b)

L represents $\Delta T_b = k_b \cdot m$

229 (a)

Molarity of solution

$$\Delta T_f = K_f \times m \Rightarrow m = \frac{\Delta T_f}{K_f}$$

$\Delta T_f = 273 - 272.4 = 0.6$ K, $K_f = 0.86$ K kg mol^{-1}

$$\therefore m = \frac{0.6}{1.86} = 0.322$$

230 (a)

Vapour Pressure of solution can be calculated from the relation:

$$\frac{P_A{}^\circ - P_A}{P_A{}^\circ} = \chi_B = \frac{W_B/Mw_B}{W_A/Mw_A}$$

Here $W_A = 1000$ g, $W_A = 68.4$ g, $P_A{}^\circ = 0.023$ atm, $Mw_A = 18, Mw_B = 342$

Substituting the values, we get

$$\frac{0.023 - P_A}{0.023} = \frac{68.4/342}{1000/18}$$

or $\frac{0.023 - P_A}{0.023} = \frac{68.4 \times 18}{342 \times 100}$

or $\frac{0.023 - P_A}{0.023} = 0.0036$

or $0.023 - P_A = 0.0036 \times 0.023 = 0.000083$

$P_A = 0.023 - 0.00008 = 0.02292$ atm

Vapor pressure of solution = 0.02292 atm

231 (c)

Hypertonic solutions have higher osmotic

pressure and therefore they have higher concentration. When a plant cell is kept in hypertonic solution, water from plant cell moves to hypertonic solution and therefore the plant cell gets shrinked

234 (c)

2(Benzoic acid) $\rightleftharpoons$ Dimerized (Benzoic acid)

Initial mol   1   0

Mol at eq $1 - \alpha$ $\frac{\alpha}{2}$

Total moles $= 1 - \alpha + \frac{\alpha}{2} = 1 - \frac{\alpha}{2}$

$$\therefore i = \frac{\text{Total moles at equilibrium}}{\text{Initial moles}} = 1 - \frac{\alpha}{2}$$

235 (b)

Isotonic solution have same molarity

Molarity of 18 g glucose $= \frac{18}{276} / \frac{1000}{1000} = 0.065$

Molarity of 34.2 g sucrose $= \frac{34.2}{518} / \frac{1000}{1000} = 0.066$

The concentration of 18 g L^{-1} glucose is same to 34.2 g L^{-1} sucrose

236 (a)

$\Delta T_f = K_f \cdot m$ and $K_f \propto$ molecular weight. Therefore, larger the molecular weight lesser will be depression in freezing point

237 (c)

$\chi_{\text{Ethanol}} = 0.9$; $\chi_{\text{water}} = 0.1$
(Solvent $\equiv$ A)   (Solute $\equiv$ B)

$$\Delta T_f = K_f \cdot m = K_f \cdot \frac{\chi_B}{1 - \chi_B} \times \frac{1000}{Mw_A}$$

$$= 2 \times \frac{0.1}{0.9} \times \frac{1000}{46} = 4.83 \text{ K}$$

$T_f = T_f^\circ - \Delta T_f = 155.7 - 4.83 = 150.87$ K

238 (a)

Boiling point is higher if ΔT_b is higher which in turn depends on

$m_{\text{effective}}(= i m_{\text{effective}})$

$\therefore$ 0.001 m Urea< 0.001 m CH_3COOH < 0.001 m NaCl < 0.001 m $MgCl_2$

239 (a)

Pressure of N_2 in X =1.9 atm

Total pressure of vessel X = 2 atm

$\therefore$ Pressure of $H_2O(g)$ in X at 300 K = 2 − 1.9 = 0.1 atm

240 (d)

Addition of non-volatile solutes decrease the freezing point of solution

241 (a)

The composition of 50% H_2O and 50% HNO_3 will lies in between the azeotropic mixture and pure H_2O. Therefore, distillation of such composition will give pure H_2O and azeotropic

mixture

242 (b)

1. Molar concentrations are 0.1 M NaCl,
$\frac{0.1}{2} M$ Na$_2$SO$_4$ and $\frac{0.1}{3} M$ Na$_3$PO$_4$

$\therefore \pi \propto CX(1 - \alpha + X\alpha + Y\alpha) \propto C(X + Y)$ if $\alpha = 1$

$\therefore \pi_{\text{urea}} \propto 0.1 \times 1, \pi_{\text{NaCl}} \propto 0.1 \times 2;\ \pi_{\text{Na}_2\text{SO}_4}$

$$\propto \frac{0.1}{2} \times 3;\ \pi_{\text{Na}_3\text{PO}_4} \propto \frac{0.1}{3} \times 4$$

2. Also $\pi = CM \times S \times T$ and $\Delta T_b = $ Molality $\times K_b$

If Molarity = Molality (for dilute solution)

$$\pi = \frac{\Delta T_b}{K_b} \times S \times T$$

3. Addition of salt on ice lowers the freezing point.

4. Also addition of salt on ice lowers its melting point and thus, ice melts earlier

243 (d)

$$\Delta T_f = \frac{1000 \times K_f \times w}{m \times W} = K_f \times \text{molality}$$
$$= 1.86 \times 0.1 = 0.186;$$

Thus, f. p. $= 0 - 0.186°C = -0.186°C$

249 (a)

$\Delta T_b = iK_b m$

$$0.27 = i \times 0.54 \times \frac{12.2}{122} \times \frac{1000}{100}$$

or $i = 0.5$

Therefore, benzene associated as dimer, i.e., 2

250 (a)

$i = 1$, for non-electrolyte

251 (b)

For urea, $i = 1$, while for BaCl$_2$, $i = 3$, therefore, the ratios of any colligative property for BaCl$_2$ solution to urea solution is 3

253 (b)

$\Delta T = iK_f m$

$(273 - 269.28) = i \times 1.86 \times 1$

$3.72 = i \times 1.86$

$i = 2$

$\alpha = \frac{i - 1}{n - 1};\ (\alpha = 100\% = 1)$

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

257 (d)

$\Delta T_b = iK_b m$

For NaCl solution, $i = 2$

$\therefore$ for NaCl, $\Delta T_b = 2$

258 (d)

Let $\pi_1 = 200$ mm; $T_1 = 283$

$\pi_1 = 105.3; T_2 = 298$

Now, $\pi = \frac{n}{V} RT$

At $T_1, 200 = \frac{n}{V_1} R \times 283$ ...(i)

At $T_2, 50 = \frac{n}{V_2} \times R \times 298$ ...(ii)

Dividing (i) by (ii), we get

$\frac{200}{105.3} = \frac{V_2}{V_1} \times \frac{283}{298} \Rightarrow V_2 = 2V_1$

259 (b)

$$\pi = CRT = \frac{\left(\frac{W_2}{Mw_2}\right)RT}{V}$$

Given, $W_2 = 40$ g

$Mw_2 = 246$

$T = 27°C = 300$ K

$V = 1$ L

Substituting all the values, we get

$$\pi = \frac{40}{246} \times 0.082 \times 300 = 4 \text{ atm}$$

261 (d)

Total colligative properties are four