SOLUTIONS

FACT/DEFINITION TYPE QUESTIONS

1. "The importance of many pure substance in life depends on their composition."
Which of the following statement justify the above fact?
(a) 1 ppm of fluoride ions in water prevents tooth decay.
(b) 1.5 ppm of fluoride ions causes tooth decay.
(c) Concentration above 1.5 ppm can be poisonous.
(d) All of the above.

2. Which of the following fluoride is used as rat poison?
(a) CaF_2 (b) KF
(c) NaF (d) MgF_2

3. Most of the processes in our body occur in
(a) solid solution (b) liquid solution
(c) gaseous solution (d) colloidal solution

4. The term homogenous mixtures signifies that
(a) its composition is uniform throughout the mixture.
(b) its properties are uniform throughout the mixture.
(c) both composition and properties are uniform throughout the mixture.
(d) neither composition nor properties are uniform throughout the mixture.

5. Which of the following mixture is(are) called solution?
(i) water + ammonia (ii) water + acetone
(iii) acetone + alcohol (iv) hexane + water
(a) (i), (ii) and (iii) (b) (i), (iii) and (iv)
(c) (i) and (iv) (d) (ii) and (iii)

6. Which of the following is a quantitative description of the solution?
(a) Dilute (b) Concentrated
(c) Saturated (d) Molar

7. When a solute is present in trace quantities the following expression is used
(a) Gram per million (b) Milligram percent
(c) Microgram percent (d) Parts per million

8. Molarity of liquid HCl will be, if density of solution is 1.17 gm/cc
(a) 36.5 (b) 32.05
(c) 18.25 (d) 42.10

9. 1 M, 2.5 litre NaOH solution is mixed with another 0.5 M, 3 litre NaOH solution. Then find out the molarity of resultant solution
(a) 0.80 M (b) 1.0 M
(c) 0.73 M (d) 0.50 M

10. An X molal solution of a compound in benzene has mole fraction of solute equal to 0.2. The value of X is
(a) 14 (b) 3.2
(c) 1.4 (d) 2

11. The molarity of the solution containing 7.1 g of Na_2SO_4 in 100 ml of aqueous solution is
(a) 2 M (b) 0.5 M
(c) 1 M (d) 0.05 M

12. The vapour pressure of pure benzene at 25°C is 640 mm Hg and that of solution of solute A is 630 mm Hg. The molality of solution is
(a) 0.2 m (b) 0.4 m
(c) 0.5 m (d) 0.1 m

13. 4.0 g of NaOH is dissolved in 100 ml solution. The normality of the solution is
(a) 0.1 N (b) 0.5 N
(c) 4.0 N (d) 1.0 N

14. The molarity of pure water is
(a) 50 M (b) 18 M
(c) 55.6 M (d) 100 M

15. An aqueous solution of glucose is 10% in strength. The volume in which 1 g mole of it is dissolved, will be
(a) 9 litre (b) 1.8 litre
(c) 8 litre (d) 0.9 litre

16. 10 g of NaCl is dissolved in 10^6 g of the solution. Its concentration is
(a) 100 ppm (b) 0.1 ppm
(c) 1 ppm (d) 10 ppm

17. On adding a solute to a solvent having vapour pressure 0.80 atm, vapour pressure reduces to 0.60 atm. Mole fraction of solute is
(a) 0.25 (b) 0.75
(c) 0.50 (d) 0.33

18. 2.5 litres of NaCl solution contain 5 moles of the solute. What is the molarity?
(a) 5 molar (b) 2 molar
(c) 2.5 molar (d) 12.5 molar

19. The mole fraction of the solute in one molal aqueous solution i
(a) 0.009 (b) 0.018
(c) 0.027 (d) 0.036

20. 5 ml of N HCl, 20 ml of N/2 H_2SO_4 and 30 ml of N/3 HNO_3 are mixed together and volume made to one litre. The normality of the resulting solution is
(a) $\frac{N}{5}$ (b) $\frac{N}{10}$
(c) $\frac{N}{20}$ (d) $\frac{N}{40}$

21. 25ml of a solution of barium hydroxide on titration with a 0.1 molar solution of hydrochloric acid gave a titre value of 35 ml. The molarity of barium hydroxide solution was
(a) 0.07 (b) 0.14
(c) 0.28 (d) 0.35

22. Mole fraction of the solute in a 1.00 molal aqueous solution is
(a) 0.1770 (b) 0.0177
(c) 0.0344 (d) 1.7700

23. What is the normality of a 1 M solution of H_3PO_4 ?
(a) 0.5 N (b) 1.0 N
(c) 2.0 N (d) 3.0 N

24. The volume of 4 N HCl and 10 N HCl required to make 1 litre of 6 N HCl are
(a) 0.75 litre of 10 N HCl and 0.25 litre of 4 N HCl
(b) 0.50 litre of 4 N HCl and 0.50 litre of 10 N HCl
(c) 0.67 litre of 4 N HCl and 0.33 litre of 10 N HCl
(d) 0.80 litre of 4 N HCl and 0.20 litre of 10 N HCl

25. Molarity of H_2SO_4 is 18 M. Its density is 1.8 g/ml. Hence molality is
(a) 36 (b) 200
(c) 500 (d) 18

26. 200 ml of water is added to 500 ml of 0.2 M solution. What is the molarity of this diluted solution ?
(a) 0.5010 M (b) 0.2897 M
(c) 0.7093 M (d) 0.1428 M

27. How many grams of concentrated nitric acid solution should be used to prepare 250 mL of 2.0M HNO_3 ? The concentrated acid is 70% HNO_3
(a) 90.0 g conc. HNO_3 (b) 70.0 g conc. HNO_3
(c) 54.0 g conc. HNO_3 (d) 45.0 g conc. HNO_3

28. For preparing 0.1 N solution of a compound from its impure sample of which the percentage purity is known, the weight of the substance required will be
(a) Less than the theoretical weight
(b) More than the theoretical weight
(c) Same as the theoretical weight
(d) None of these

29. If $\frac{N}{10}$ 50 ml H_2SO_4, $\frac{N}{3}$ 30 ml HNO_3, $\frac{N}{2}$ 10 ml HCl is mixed and solution is made to 1L. Then normality of resultant solution is
(a) $\frac{N}{20}$ (b) $\frac{N}{40}$
(c) $\frac{N}{50}$ (d) N

30. A solution made by dissolving 40 g NaOH in 1000 g of water is
(a) 1 molar (b) 1 normal
(c) 1 molal (d) None of these

31. Which of the following concentration terms is/are independent of temperature?
(a) Molality only
(b) Molality and mole fraction
(c) Molarity and mole fraction
(d) Molality and normality

32. A solution is prepared by dissolving 10 g NaOH in 1250 mL of a solvent of density 0.8 mL/g. The molality of the solution in mol kg^{-1} is
(a) 0.25 (b) 0.2
(c) 0.008 (d) 0.0064

33. Which of the following units is useful in relating concentration of solution with its vapour pressure?
(a) mole fraction (b) parts per million
(c) mass percentage (d) molality

34. For mixture containing "four" components which of the following is correct in term of mole fraction?
(a) $x_1 + x_2 + x_3 + x_4 \neq 1$
(b) $\frac{n_3}{n_1 + n_2 + n_3} = x_3$
(c) $x_1 = \frac{n_1}{n_1 + n_2 + n_3 + n_4} = \frac{n_1}{\Sigma n}$
(d) $n_1 + n_2 + n_3 + n_4 = 1$

35. Which of the following concentration unit is independent of temperature ?
(a) Normality (b) Molarity
(c) Formality (d) Molality

36. Which of the following factor do not affect solubility of solid solute in liquid ?
(a) Temperature (b) Pressure
(c) Nature of solute (d) All of these

37. When a solid solute is added to the solvent, some solute dissolves and its concentration increases in solution. This process is known as _______. Some solute particles in solution collide with the solid solute particles and get separated out of solution. This process is known as _______.
(a) Crystallization, dissolution.
(b) Dissolution, saturation.
(c) Saturation, crystallization.
(d) Dissolution, crystallization.

38. At the state of dynamic equilibrium, for solute + solvent $\rightleftharpoons$ solution.
(a) Rate of dissolution = Rate of unsaturation.
(b) Rate of dissolution = Rate of unsaturation.
(c) Rate of dissolution = Rate of saturation
(d) Rate of crystallization = Rate of saturation.

39. Which of the following statements is incorrect?
(a) A solution in which no more solute can be dissolved at the same temperature and pressure is called a saturated solution.
(b) An unsaturated solution is one in which more solute can be dissolved at the same temperature.
(c) The solution which is in dynamic equilibrium with undissolved solute is the saturated solution.
(d) The minimum amount of solute dissolved in a given amount of solvent is its solubility.

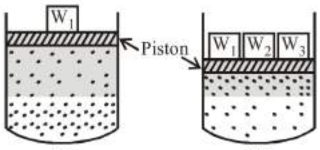
40. On dissolving sugar in water at room temperature solution feels cool to touch. Under which of the following cases dissolution of sugar will be most rapid ?
(a) Sugar crystals in cold water.
(b) Sugar crystals in hot water.
(c) Powdered sugar in cold water.
(d) Powdered sugar in hot water.

41. The solubility of a solid in a liquid is significantly affected by temperature changes.

Solute + Solvent $\rightleftharpoons$ Solution.

The system being in a dynamic equilibrium must follow Le-chatelier's principle. Considering the Le-chatelier's principle which of the following is correct?
(a) $\Delta H_{sol} > 0$; solubility ↑ ; temperature ↓
(b) $\Delta H_{sol} < 0$; solubility ↓ ; temperature ↑
(c) $\Delta H_{sol} > 0$; solubility ↓ ; temperature ↑
(d) $\Delta H_{sol} < 0$; solubility ↑ ; temperature ↑

42.



(a) (b)

On the basis of the figure given above which of the following is not true?
(a) In figure (a) assuming the state of dynamic equilibrium rate of gaseous particles entering and leaving the solution phase is same.
(b) In figure (b) on compressing the gas number of gaseous particles per unit volume over the solution increases.
(c) Rate at which gaseous particles are striking the solution to enter it, decreases.
(d) Rate at which gaseous particles are striking the solution to enter it, increases.

43. The statement "If 0.003 moles of a gas are dissolved in 900 g of water under a pressure of 1 atmosphere, 0.006 moles will be dissolved under a pressure of 2 atmospheres", illustrates
(a) Dalton's law of partial pressure
(b) Graham's law
(c) Raoult's law
(d) Henry's law

44. According to Henry's law, the amount of gas that will dissolve in blood plasma or any other liquid is determined by which of these factor?
(a) Solubility of the gas in the liquid.
(b) The total pressure of the gas mixture .
(c) pH of the liquid.
(d) The osmotic pressure of the gas mixture.

45. Henry's law constant of oxygen is 1.4×10^{-3} mol. lit^{-1}. atm^{-1} at 298 K. How much of oxygen is dissolved in 100 ml at 298 K when the partial pressure of oxygen is 0.5 atm?
(a) 1.4 g (b) 3.2 g
(c) 22.4 mg (d) 2.24 mg

46. At equillibrium the rate of dissolution of a solid solute in a volatile liquid solvent is ______.
(a) less than the rate of crystallisation.
(b) greater than the rate of crystallisation.
(c) equal to the rate of crystallisation.
(d) zero

47. A beaker contains a solution of substance 'A'. Precipitation of substance 'A' takes place when small amount of 'A' is added to the solution. The solution is ______.
(a) saturated (b) supersaturated
(c) unsaturated (d) concentrated

48. Maximum amount of a solid solute that can be dissolved in a specified amount of a given liquid solvent does **not** depend upon __________.
(a) Temperature (b) Nature of solute
(c) Pressure (d) Nature of solvent

49. Low concentration of oxygen in the blood and tissues of people living at high altitude is due to _________.
(a) low temperature
(b) low atmospheric pressure
(c) high atmospheric pressure
(d) both low temperature and high atmospheric pressure

50. Value of Henry's constant K_H _______.
(a) increases with increase in temperature.
(b) decreases with increase in temperature.
(c) remains constant.
(d) first increases then decreases.

51. The value of Henry's constant K_H is _______.
(a) greater for gases with higher solubility.
(b) greater for gases with lower solubility.
(c) constant for all gases.
(d) not related to the solubility of gases.

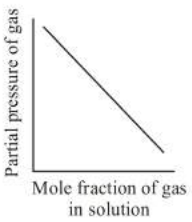
52. Which of the followingfactor(s) affect the solubility of a gaseous solute in the fixed volume of liquid solvent ?

(i) Nature of solute (ii) Temperature (iii) Pressure

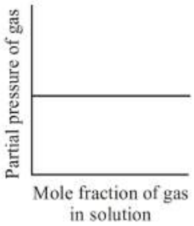
(a) (i) and (iii) at constant T
(b) (i) and (ii) at constant P
(c) (ii) and (iii) only
(d) (iii) only

53. Which of the following graph is a correct representation of Henry's law?

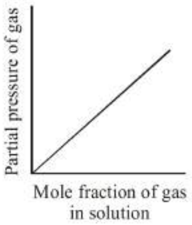
(a)



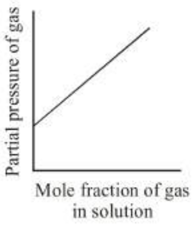
(b)



(c)



(d)



54. Which is an application of Henry's law?

(a) Spray paint (b) Bottled water
(c) Filling up atire (d) Soft drinks (soda)

55. Scuba divers may experience a condition called ______. To avoids this, the tanks used by scuba divers are filled with air diluted with _____ .

(a) Migrains, Hydrogen (b) Cramps, Nitrogen
(c) Nausea, Oxygen (d) Bends, Helium

56. People living at high attitudes often reported with a problem of feeling weak and inability to think clearly. The reason for this is.

(a) at high altitudes the partial pressure of oxygen is less than at the ground level.
(b) at high altitudes the partial pressure of oxygen is more than at the ground level.
(c) at high altitudes the partial pressure of oxygen is equal to at the ground level.
(d) None of these.

57. _____ a contemporary of Henry concluded independently that solubility of a gas in a liquid solution is a function of _____ of the gas.

(a) Mosley, temperature
(b) Dalton, temperature
(c) Dalton, partial pressure
(d) Mosley, partial pressure

58. Raoult's law becomes a special case of Henry's law when

(a) $K_H = p_1^\circ$ (b) $K_H > p_1^\circ$
(c) $K_H < p_1^\circ$ (d) $K_H \geq p_1^\circ$

59. Iodine and sulphur dissolve in

(a) water (b) benzene
(c) carbon disulphide (d) ethanol

60. The liquids at a given temperature vapourise and under equilibrium conditions the pressure exerted by the vapours of the liquid over the liquid phase is called

(a) osmotic pressure (b) atmospheric pressure
(c) hydrostatic pressure (d) vapour pressure

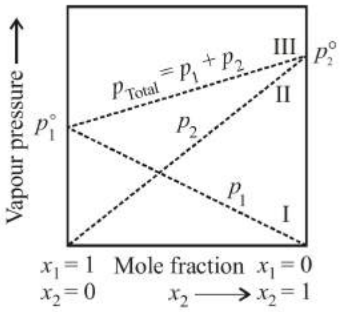
61. The vapour pressure of the solution at a given temperature is found to be .... than the vapour pressure of the pure solvent at the same temperature.

(a) higher (b) lower
(c) equal (d) can't calculate

62. The decrease in the vapour pressure of solvent depends on the

(a) quantity of non-volatile solute present in the solution
(b) nature of non-volatile solute present in the solution
(c) molar mass of non-volatile solute present in the solution
(d) physical state of non-volatile solute present in the solution

63. A plot of p_1 or p_2 vs the mole fractions x_1 and x_2 is given as.



In this figure, lines I and II pass through the point for which.

(a) $x_1 \neq 1; x_2 = 1$ (b) $x_1 = x_2 \neq 1$
(c) $x_1 = 1; x_2 \neq 1$ (d) $x_1 = x_2 = 1$

64. The vapour pressure of two liquids 'P' and 'Q' are 80 and 60 torr, respectively. The total vapour pressure of solution obtained by mixing 3 mole of P and 2 mole of Q would be

(a) 72 torr (b) 140 torr
(c) 68 torr (d) 20 torr

65. 18 g of glucose ($C_6H_{12}O_6$) is added to 178.2 g of water. The vapour pressure of water for this aqueous solution is

(a) 76.00 torr (b) 752.40 torr
(c) 759.00 torr (d) 7.60 torr

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

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

67. A mixture of ethyl alcohol and propyl alcohol has a vapour pressure of 290 mm Hg at 300 K. The vapour pressure of propyl alcohol is 200 mm Hg. If the mole fraction of ethyl alcohol is 0.6, its vapour pressure (in mm Hg) at the same temperature will be

(a) 360 (b) 350
(c) 300 (d) 700

68. Two liquids *X* and *Y* form an ideal solution. At 300 K, vapour pressure of the solution containing 1 mol of *X* and 3 mol of *Y* is 550 mm Hg. At the same temperature, if 1 mol of *Y* is further added to this solution, vapour pressure of the solution increases by 10 mm Hg. Vapour pressure (in mm Hg) of *X* and *Y* in their pure states will be, respectively

(a) 300 and 400 (b) 400 and 600
(c) 500 and 600 (d) 200 and 300

69. The vapour pressure of two liquids X and Y are 80 and 60 torr respectively. The total vapour pressure of the ideal solution obtained by mixing 3 moles of X and 2 moles of Y would be

(a) 68 Torr (b) 140 Torr
(c) 48 Torr (d) 72 Torr

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

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

71. A solution containing components A and B follows Raoult's law when

(a) A – B attraction force is greater than A – A and B – B
(b) A – B attraction force is less than A – A and B – B
(c) A – B attraction force remains same as A–A and B–B
(d) volume of solution is different from sum of volume of solute and solvent

72. Relation between partial pressure and mole fraction is stated by

(a) Graham's law (b) Raoult's law
(c) Le-Chatelier (d) Avogadro law

73. Which one of the following is not correct for an ideal solution?

(a) It must obey Raoult's law
(b) $\Delta H = 0$
(c) $\Delta H = \Delta V \neq 0$
(d) All are correct

74. An ideal solution is formed when its components

(a) have no volume change on mixing
(b) have no enthalpy change on mixing
(c) Both (a) and (b) are correct
(d) Neither (a) nor (b) is correct

75. All form ideal solution except

(a) C_6H_6 and $C_6H_5CH_3$ (b) C_2H_6 and C_2H_5I
(c) C_6H_5Cl and C_6H_5Br (d) C_2H_5I and C_2H_5OH.

76. Which one of the following is non-ideal solution

(a) Benzene + toluene
(b) *n*-hexane + *n*-heptane
(c) Ethyl bromide + ethyl iodide
(d) $CCl_4 + CHCl_3$

77. Mixtures of ethanol and acetone show positive deviation. The reason is

(a) In pure ethanol, molecules are hydrogen bonded.
(b) In pure acetone, molecules are hydrogen bonded
(c) In both molecules are hydrogen bonded
(d) None of these

78. A mixture of components *A* and *B* will show –ve deviation when

(a) $\Delta V_{mix} > 0$
(b) $\Delta H_{mix} < 0$
(c) *A*–*B* interaction is weaker than *A*–*A* and *B*–*B* interactions
(d) *A*–*B* interaction is stronger than *A*–*A* and *B*–*B* interactions.

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

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

80. A solution of acetone in ethanol

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

81. Negative deviation from Raoult's law is observed in which one of the following binary liquid mixtures?

(a) Ethanol and acetone
(b) Benzene and toluene
(c) Acetone and chloroform
(d) Chloroethane and bromoethane

82. Which one of the following binary liquid systems shows positive deviation from Raoult's law?

(a) Benzene-toluene
(b) Carbon disulphide-acetone
(c) Phenol-aniline
(d) Chloroform-acetone

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

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

84. Which one is not equal to zero for an ideal solution:

(a) ΔS_{mix}
(b) ΔV_{mix}
(c) $\Delta P = P_{observed} - P_{Raoult}$
(d) ΔH_{mix}

85. A mixture of two completely miscible non-ideal liquids which distill as such without change in its composition at a constant temperature as though it were a pure liquid. This mixture is known as

(a) binary liquid mixture (b) azeotropic mixture
(c) eutectic mixture (d) ideal mixture

86. The azeotropic mixture of water (b.p.100°C) and HCl (b.p.85°C) boils at 108.5°C. When this mixture is distilled it is possible to obtain

(a) pure HCl
(b) pure water
(c) pure water as well as pure HCl
(d) neither HCl nor H_2O in their pure states

87. The system that forms maximum boiling azeotrope is

(a) carbondisulphide – acetone
(b) benzene – toluene
(c) acetone – chloroform
(d) *n*-hexane – *n*-heptane

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

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

89. On the basis of information given below mark the correct option.

Information: On adding acetone to methanol some of the hydrogen bonds between methanol molecules break.

(a) At specific composition methanol-acetone mixture will form boiling azeotrope and will show positive deviation from Raoult's law.
(b) At specific composition methanol-acetone mixture forms boiling azeotrope and will show positive deviation from Raoult's law.
(c) At specific composition methanol-acetone mixture will form minimum boiling azeotrope and will show negative deviation from Raoult's law.
(d) At specific composition methanol-acetone mixture will form boiling azeotrope and will show negative deviation from Raoult's law.

90. According to Raoult's law, relative lowering of vapour pressure for a solution is equal to

(a) moles of solute (b) moles of solvent
(c) mole fraction of solute (d) mole fraction of solvent

91. The relative lowering of the vapour pressure is equal to the ratio between the number of

(a) solute molecules to the solvent molecules
(b) solute molecules to the total molecules in the solution
(c) solvent molecules to the total molecules in the solution
(d) solvent molecules to the total number of ions of the solute.

92. Vapour pressure of benzene at 30°C is 121.8 mm Hg. When 15 g of a non volatile solute is dissolved in 250 g of benzene its vapour pressure decreased to 120.2 mm Hg. The molecular weight of the solute (Mo. wt. of solvent = 78)

(a) 356.2 (b) 456.8
(c) 530.1 (d) 656.7

93. The value of P° for benzene is 640 mm of Hg. The vapour pressure of solution containing 2.5gm substance in 39gm. benzene is 600mm of Hg the molecular mass of *X* is

(a) 65.25 (b) 130
(c) 40 (d) 75

94. The vapour pressure at a given temperature of an ideal solution containing 0.2 mol of a non-volatile solute and 0.8 mol of solvent is 60 mm of Hg. The vapour pressure of the pure solvent at the same temperature is

(a) 150 mm of Hg (b) 60 mm of Hg
(c) 75 mm of Hg (d) 120 mm of Hg

95. 12 g of a nonvolatile solute dissolved in 108 g of water produces the relative lowering of vapour pressure of 0.1. The molecular mass of the solute is

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

96. The amount of solute (molar mass 60 $g.mol^{-1}$) that must be added to 180 g of water so that the vapour pressure of water is lowered by 10% is

(a) 30 g (b) 60 g
(c) 120 g (d) 12 g

97. The vapour pressure of water at 20°C is 17.5 mm Hg. If 18 g of glucose ($C_6H_{12}O_6$) is added to 178.2 g of water at 20°C, the vapour pressure of the resulting solution will be

(a) 17.325 mm Hg (b) 15.750 mm Hg
(c) 16.500 mm Hg (d) 17.500 mm Hg

98. Which one of the following is a colligative property ?

(a) Boiling point (b) Vapour pressure
(c) Osmotic pressure (d) Freezing point

99. Which one of the following aqueous solutions will exihibit highest boiling point ?

(a) 0.015 M urea (b) 0.01 M KNO_3
(c) 0.01 M Na_2SO_4 (d) 0.015 M glucose

100. The rise in the boiling point of a solution containing 1.8 g of glucose in 100 g of solvent is 0.1°C. The molal elevation constant of the liquid is

(a) 0.01 K/m (b) 0.1 K/m
(c) 1 K/m (d) 10 K/m

101. For an electrolyte, elevation of B.P. is directly proportional to

(a) molarity (b) molality
(c) mole fraction (d) All of these

102. Which of the following aqueous solution has minimum freezing point ?

(a) 0.01 m NaCl (b) 0.005 m C_2H_5OH
(c) 0.005 m MgI_2 (d) 0.005 m $MgSO_4$.

103. 1.00 g of a non-electrolyte solute (molar mass 250 g mol^{-1}) was dissolved in 51.2 g of benzene. If the freezing point depression constant, K_f of benzene is 5.12 K kg mol^{-1}, the freezing point of benzene will be lowered by

(a) 0.3 K (b) 0.5 K
(c) 0.4 K (d) 0.2

104. In a 0.2 molal aqueous solution of a weak acid HX the degree of ionization is 0.3. Taking k_f for water as 1.85, the freezing point of the solution will be nearest to

(a) −0.360°C (b) −0.260°C
(c) +0.481°C (d) −0.481°C

105. The molecular weight of benzoic acid in benzene as determined by depression in 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.

106. A 0.5 molal solution of ethylene glycol in water is used as coolant in a car. If the freezing point constant of water be 1.86°C per mole, the mixture shall freeze at

(a) 0.93°C
(b) –0.93°C
(c) 1.86°C
(d) –1.86°C

107. A solution of urea (mol. mass 56 g mol^{-1}) boils at 100.18°C at the atmospheric pressure. If K_f and K_b for water are 1.86 and 0.512 K kg mol^{-1} respectively, the above solution will freeze at

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

108. The freezing point of 1% solution of lead nitrate in water will be

(a) 2°C
(b) 1°C
(c) 0°C
(d) below 0°C

109. A solution of sucrose (molar mass = 342 g mol^{-1}) has been prepared by dissolving 68.5 g of sucrose in 1000 g of water. The freezing point of the solution obtained will be (K_f for water = 1.86 K kg mol^{-1}).

(a) – 0.372°C
(b) – 0.520°C
(d) + 0.372°C
(d) – 0.570°C

110. A solution containing 1.8 g of a compound (empirical formula CH_2O) in 40 g of water is observed to freeze at –0.465° C. The molecular formula of the compound is (K_f of water = 1.86 kg K mol^{-1})

(a) $C_2H_4O_2$
(b) $C_3H_6O_3$
(c) $C_4H_8O_4$
(d) $C_6H_{12}O_6$

111. Blood cells retain their normal shape in solution which are

(a) hypotonic to blood
(b) isotonic to blood
(c) hypertonic to blood
(d) equinormal to blood.

112. Isotonic solutions have same

(a) molar concentration
(b) molality
(c) normality
(d) None of these

113. As a result of osmosis, the volume of more concentrated solution

(a) gradually decreases
(b) gradually increases
(c) is not affected
(d) suddenly increases

114. Which of the following pairs of solution are isotonic at the same temperature ?

(a) 0.1 M $Ca(NO_3)_2$ and 0.1 M Na_2SO_4

(b) 0.1 M NaCl and 0.1 M Na_2SO_4

(c) 0.1 M urea and 0.1 M $MgCl_2$

(d) 0.2 M urea and 0.1 M NaCl

115. Osmotic pressure of 0.4% urea solution is 1.64 atm and that of 3.42% cane sugar is 2.46 atm. When the above two solutions are mixed, the osmotic pressure of the resulting solution is :

(a) 0.82 atm
(b) 2.46 atm
(c) 1.64 atm
(d) 4.10 atm

116. Osmotic pressure of a solution at a given temperature

(a) increases with concentration

(b) decreases with concentration

(c) remains same

(d) initially increases and then decreases

117. At 25°C, at 5 % aqueous solution of glucose (molecular weight = 180 g mol^{-1}) is isotonic with a 2% aqueous solution containing an unknown solute. What is the molecular weight of the unknown solute?

(a) 60
(b) 80
(c) 72
(d) 63

118. Which one of the following statements is false?

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

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

(c) The correct order of osmotic pressures of 0.01 M solution of each compound is $BaCl_2 > KCl > CH_3COOH >$ glucose

(d) In the equation osmotic pressure $\pi = MRT$, M is the molarity of the solution

119. Which of the following statements is **false**?

(a) Units of atmospheric pressure and osmotic pressure are the same.

(b) In reverse osmosis, solvent molecules move through a semipermeable membrane from a region of lower concentration of solute to a region of higher concentration.

(c) The value of molal depression constant depends on nature of solvent.

(d) Relative lowering of vapour pressure, is a dimensionless quantity.

120. During osmosis, flow of water through a semipermeable membrane is

(a) from both sides of semipermeable membrane with equal flow rates

(b) from both sides of semipermeable membrane with unequal flow rates

(c) from solution having lower concentration only

(d) from solution having higher concentration only

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

(a) there will be no net movement across the membrane

(b) glucose will flow towards urea solution

(c) urea will flow towards glucose solution

(d) water will flow from urea solution to glucose

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

(a) less than one and greater than one.

(b) less than one and less than one.

(c) greater than one and less than one.

(d) greater than one and greater than one.

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

(a) $\pi V = \sqrt{inRT}$

(b) $\Delta T_f = iK_f.m$

(c) $\Delta T_b = iK_b.m$

(d) $\dfrac{P^\circ_{\text{solvent}} - P_{\text{solution}}}{P^\circ_{\text{solvent}}} = i\left(\dfrac{n}{N+n}\right)$

124. Van't Hoff factor is given by the expression ________.

(a) $i = \dfrac{\text{Normal molar mass}}{\text{Abnormal molar mass}}$

(b) $i = \dfrac{\text{Abnormal molar mass}}{\text{Normal molar mass}}$

(c) $i = \dfrac{\text{Observed colligative property}}{\text{Calculated colligative property}}$

(d) Both (a) and (c)

125. We have three aqueous solutions of NaCl labelled as 'A', 'B' and 'C' with concentrations 0.1M, 0.01M and 0.001M, respectively. The value of van't Hoff factor for these solutions will be in the order ________.

(a) $i_A < i_B < i_C$ (b) $i_A > i_B > i_C$

(c) $i_A = i_B = i_C$ (d) $i_A < i_B > i_C$

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

(a) $1 + \alpha$ (b) $1 - \alpha$

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

127. The freezing point of equimolal aqueous solutions will be highest for

(a) $C_6H_5NH_3^+Cl^-$ (aniline hydrochloride)

(b) $Ca(NO_3)_2$

(c) $La(NO_3)_3$

(d) $C_6H_{12}O_6$ (glucose)

128. 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) $t_2 \geq t_1$

129. At 25°C, the highest osmotic pressure is exhibited by 0.1 M solution of

(a) $CaCl_2$ (b) KCl

(c) glucose (d) urea

130. Which one of the following salts will have the same value of van't Hoff factor (i) as that of $K_4[Fe(CN)_6]$.

(a) $Al_2(SO_4)_3$ (b) NaCl (c) $Al(NO_3)_3$ (d) Na_2SO_4.

131. Which of the following 0.10 m aqueous solutions will have the lowest freezing point ?

(a) $Al_2(SO_4)_3$ (b) $C_6H_{12}O_6$

(c) KCl (d) $C_{12}H_{22}O_{11}$

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

(a) 0.16 (b) 0.05

(c) 0.1 (d) 0.2

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

(a) 0.52 (b) 1.04

(c) 1.34 (d) 0.052

STATEMENT TYPE QUESTIONS

134. Study the given statements and choose the correct option.

(i) 3.62 mass percentage of sodium hypochlorite in water is used as commercial bleaching solution.

(ii) 35% volume percentage of ethylene glycol is used as an antifreeze (as coolent in car engines).

(iii) Concentration of dissolved oxygen in a litre of sea water is 5.8 ppm.

(a) Statements (i) and (ii) are correct

(b) Statements (i) and (iii) are correct

(c) Statements (ii) and (iii) are correct

(d) Statements (i),(ii) and (iii) are correct

135. Molarity and molality of a solution of NaOH is calculated. If now temperature of the solution is increased then which of the following statement(s) is/are correct ?

(i) Molarity of solution decreases

(ii) Molality of the solution increases

(a) Both statements are correct

(b) Statement (i) is correct only

(c) Statement (ii) is correct only

(d) Both statements are incorrect.

136. "If temperature increases solubility of gas decreases". For this situation which of the following statement(s) is/are correct ?

(i) Reaction is endothermic

(ii) Le-chatelier's principle can be applied

(a) Statement (i) and (ii) both are correct

(b) Statement (i) is correct only

(c) Statement (ii) is correct only

(d) Both statement(s) (i) and (ii) are incorrect

137. Read the following statements carefully and choose the correct option.

(i) Different gases have different K_H values at the same temperature.

(ii) Higher the value of K_H at a given temperature, lower is the solubility of the nature of gas in the liquid.

(iii) K_H is a function of the nature of the gas.

(iv) Solubility of gases increases with increase of temperature.

(a) (i), (ii) and (iv) are correct.

(b) (ii) and (iv) are correct.

(c) (i), (ii) and (iii) are correct.

(d) (i) and (iv) are correct.

138. Read the following statements and choose the correct option.

(i) Polar solutes dissolve in a polar solvent.
(ii) Polar solutes dissolve in a non-polar solvent.
(iii) Non-polar solutes dissolve in a non-polar solvent.
(iv) Non-polar solutes dissolve in a polar solvent.

(a) (i) and (ii) are correct.
(b) (i), (ii) and (iii) are correct.
(c) (i) and (iii) are correct.
(d) (ii) and (iv) are correct.

139. Read the following statements carefully and choose the correct option

(i) The vapour pressure of a liquid decreases with increase of temperature.
(ii) The liquid boils at the temperature at which its vapour pressure is equal to the atmospheric pressure.
(iii) Vapour pressure of the solvent decreases in the presence of non-volatile solute.
(iv) Vapour pressure of the pure solvent and solution is a function of temperature.

(a) (i), (ii) and (iv) are correct
(b) (i), (iii), and (iv) are correct
(c) (ii), (iii), and (iv) are correct
(d) (i), (ii) and (iii) are correct

140. On the basis of information given below mark the correct option.

(i) In bromoethane and chloroethane mixture intermolecular interactions of A-A and B-B type are nearly same as A-B type interactions.
(ii) In ethanol and acetone mixture A-A or B-B type intermolecular interactions are stronger than A-B type interactions.
(iii) In chloroform and acetone mixture A-A or B-B type intermolecular interactions are weaker than A-B type interactions.

(a) Solution (ii) and (iii) will follow Raoult's law.
(b) Solution (i) will follow Raoult's law.
(c) Solution (ii) will show negative deviation from Raoult's law.
(d) Solution (iii) will show positive deviation from Raoult's law.

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

(i) A 0.5 m NaBr solution has a higher vapour pressure than a 0.5 m $BaCl_2$ solution at the same temperature
(ii) Pure water freezes at the higher temperature than pure methanol
(iii) a 0.1 m NaOH solution freezes at a lower temperature than pure water

Choose the correct answer from the codes given below

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

142. Read the following statements carefully and choose the correct option

(i) Osmotic pressure is not a colligative property.
(ii) For dilute solutions, osmotic pressure is proportional to the molarity, C of the solution at a given temperature T.
(iii) During osmosis ,solvent molecules always flow from higher concentration to lower concentration of solution.
(iv) The osmotic pressure has been found to depend on the concentration of the solution

(a) (i), (ii) and (iv) are correct
(b) (ii) and (iv) are correct
(c) (iii), and (iv) are correct
(d) (i), (ii) and (iii) are correct

MATCHING TYPE QUESTIONS

143. Match the columns

	Column -I		Column-II
(A)	Mass percentage	(p)	Medicine and pharmacy
(B)	Mass by volume	(q)	Concentration of pollutants in water
(C)	ppm	(r)	Industrial chemical application
(D)	Volume percentage	(s)	Liquid solutions

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

144. Match the columns

	Column-I		Column-II
(A)	Na-Hg Amalgam	(p)	gas - solid
(B)	H_2 in Pd	(q)	gas - liquid
(C)	Camphor in nitrogen gas	(r)	liquid - solid
(D)	Oxygen dissolved in water	(s)	solid - gas

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

145. Match the Column I, II & III and choose the correct option.

	Column-I		Column-II		Column-III
(A)	Gaseous solutions	(p)	Solid-liquid	(h)	Copper dissolved in gold
(B)	Liquid solutions	(q)	Solid-solid	(i)	Chloroform mixed with nitrogen
(C)	Solid solutions	(r)	Liquid-gas	(j)	Common salt dissolved in water

(a) (A) – (r) – (h), (B) – (r) – (i), (C) – (p) – (j)
(b) (A) – (r) – (i), (B) – (p) – (j), (C) – (q) – (h)
(c) (A) – (r) – (j), (B) – (p) – (h), (C) – (q) – (i)
(d) (A) – (r) – (j), (B) – (q) – (i), (C) – (p) – (h)

146. Match the columns

	Column-I		**Column-II**
(A)	Saturated solution	(p)	Solution having same osmotic pressure at a given temperature as that of given solution.
(B)	Binary solution	(q)	A solution whose osmotic pressure is less than that of another.
(C)	Isotonic solution	(r)	Solution with two components
(D)	Hypotonic solution	(s)	A solution which contains maximum amount of solute that can be dissolved in a given amount of solvent at a given temperature.

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

147. Match the laws given in the Column-I with expression given in Column-II.

	Column-I		**Column-II**
(A)	Raoult's law	(p)	$\Delta T_f = K_f m$
(B)	Henry's law	(q)	$\pi = CRT$
(C)	Elevation of boiling point	(r)	$p = x_1 p_1^o + x_2 p_2^o$
(D)	Depression in freezing point	(s)	$\Delta T_b = K_b m$
(E)	Osmotic pressure	(t)	$p = K_H . x$

(a) A – (r), B – (t), C – (s), D – (p), E – (q)
(b) A – (t), B – (r), C – (q), D – (s), E – (p)
(c) A – (p), B – (t), C – (r), D – (q), E – (s)
(d) A – (s), B – (p), C – (q), D – (r), E – (t)

ASSERTION-REASON TYPE QUESTIONS

Directions : Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

148. Assertion : Molarity of a solution in liquid state changes with temperature.
Reason : The volume of a solution changes with change in temperature.

149. Assertion : If a liquid solute more volatile than the solvent is added to the solvent, the vapour pressure of the solution may increase i.e., $p_s > p^o$.
Reason : In the presence of a more volatile liquid solute, only the solute will form the vapours and solvent will not.

150. Assertion : If one component of a solution obeys Raoult's law over a certain range of composition, the other component will not obey Henry's law in that range.
Reason : Raoult's law is a special case of Henry's law.

151. Assertion : Azeotropic mixtures are formed only by non-ideal solutions and they may have boiling points either greater than both the components or less than both the components.
Reason : The composition of the vapour phase is same as that of the liquid phase of an azeotropic mixture.

152. Assertion : When methyl alcohol is added to water, boiling point of water increases.
Reason : When a volatile solute is added to a volatile solvent elevation in boiling point is observed.

153. Assertion : When NaCl is added to water a depression in freezing point is observed.
Reason : The lowering of vapour pressure of a solution causes depression in the freezing point.

154. Assertion : When a solution is separated from the pure solvent by a semi- permeable membrane, the solvent molecules pass through it from pure solvent side to the solution side
Reason : Diffusion of solvent occurs from a region of high concentration solution to a region of low concentration solution.

CRITICAL THINKING TYPE QUESTIONS

155. The normality of orthophosphoric acid having purity of 70 % by weight and specific gravity 1.54 is
(a) 11 N (b) 22 N
(c) 33 N (d) 44 N

156. Which of the following statements, regarding the mole fraction (x) of a component in solution, is incorrect?
(a) $0 \le x \le 1$
(b) $x \le 1$
(c) x is always non-negative
(d) None of these

157. Which one of the following gases has the lowest value of Henry's law constant?
(a) N_2 (b) He
(c) H_2 (d) CO_2

158. Equal masses of methane and oxygen are mixed in an empty container at 25°C. The fraction of the total pressure exerted by oxygen is
(a) 1/2 (b) 2/3
(c) $\frac{1}{3} \times \frac{273}{298}$ (d) 1/3

159. When a gas is bubbled through water at 298 K, a very dilute solution of the gas is obtained. Henry's law constant for the gas at 298 K is 100 kbar. If the gas exerts a partial pressure of 1 bar, the number of millimoles of the gas dissolved in one litre of water is
(a) 0.555 (b) 5.55
(c) 0.0555 (d) 55.5

160. K_H value for Ar(g), CO_2(g), HCHO (g) and CH_4(g) are 40.39, 1.67, 1.83×10^{-5} and 0.413 respectively.
Arrange these gases in the order of their increasing solubility.
(a) $HCHO < CH_4 < CO_2 < Ar$
(b) $HCHO < CO_2 < CH_4 < Ar$
(c) $Ar < CO_2 < CH_4 < HCHO$
(d) $Ar < CH_4 < CO_2 < HCHO$

161. What is the ratio of no. of moles of nitrogen to that of oxygen in a container of 5 litre at atmospheric pressure?
(a) 1 : 1.71 (b) 1 : 2
(c) 2 : 1 (d) 1 : 24

162. Consider a and b are two components of a liquid mixture, their corresponding vapour pressure (mmHg) are respectively 450 and 700 in pure states and total pressure given is 600. Then corresponding composition in liquid phase will be
(a) 0.4, 0.6 (b) 0.5, 0.5
(a) 0.6, 0.4 (d) 0.3, 0.7

163. Which will form maximum boiling point azeotrope
(a) $HNO_3 + H_2O$ solution (b) $C_2H_5OH + H_2O$ solution
(c) $C_6H_6 + C_6H_5CH_3$ solution (d) None of these

164. If two liquids A and B form minimum boiling azeotrope at some specific composition then _______.
(a) A – B interactions are stronger than those between A – A or B – B
(b) vapour pressure of solution increases because more number of molecules of liquids A and B can escape from the solution.
(c) vapour pressure of solution decreases because less number of molecules of only one of the liquids escape from the solution
(d) A – B interactions are weaker than those between A – A or B – B

165. Chloroform and acetone are added to each other, Raoult's law shows negative deviation.what does this suggests ?
(a) Exothermic reaction
(b) Endothermic reaction
(c) Zero change in enthalpy
(d) None of these

166. At 300 K the vapour pressure of an ideal solution containing 1 mole of liquid A and 2 moles of liquid B is 500 mm of Hg. The vapour pressure of the solution increases by 25 mm of Hg, if one more mole of B is added to the above ideal solution at 300 K. Then the vapour pressure of A in its pure state is
(a) 300 mm of Hg (b) 400 mm of Hg
(c) 500 mm of Hg (d) 600 mm of Hg

167. Someone has added a non electrolyte solid to the pure liquid but forgot that among which of the two beakers he has added that solid. This problem can be solved by checking
(a) relative lower in vapour pressure
(b) elevation in boiling point
(c) depression in Freezing point
(d) all above

168. The vapour pressure of a solvent decreases by 10 mm of Hg when a non-volatile solute was added to the solvent. The mole fraction of the solute in the solution is 0.2. What should be the mole fraction of the solvent if the decrease in the vapour pressure is to be 20 mm of Hg ?
(a) 0.8 (b) 0.6
(c) 0.4 (d) 0.2

169. Vapour pressure of benzene at 30°C is 121.8 mm. When 15g of a non-volatile solute is dissolved in 250 g of benzene, its vapour pressure is decreased to 120.2 mm. The molecular weight of the solute is
(a) 35.67 g (b) 356.7 g
(c) 432.8 g (d) 502.7 g

170. For a dilute solution containing 2.5 g of a non-volatile non-electrolyte solute in 100 g of water, the elevation in boiling point at 1 atm pressure is 2°C. Assuming concentration of solute is much lower than the concentration of solvent, the vapour pressure (mm of Hg) of the solution is (take $K_b = 0.76\ \text{K kg mol}^{-1}$)
(a) 724 (b) 740
(c) 736 (d) 718

171. The difference between the boiling point and freezing point of an aqueous solution containing sucrose (molecular wt = 342 g mole^{-1}) in 100 g of water is 105°C. If K_f and K_b of water are 1.86 and 0.51 K kg mol^{-1} respectively, the weight of sucrose in the solution is about
(a) 34.2 g (b) 342 g
(c) 7.2 g (d) 72 g

172. If the elevation in boiling point of a solution of non-volatile, non-electrolytic and non-associating solute in a solvent (K_b = x K kg mol^{-1}) is y K, then the depression in freezing point of solution of same concentration would be (K_f of the solvent = z K kg mol^{-1})
(a) $\frac{2xz}{y}$ (b) $\frac{yz}{x}$
(c) $\frac{xz}{y}$ (d) $\frac{yz}{2x}$

173. 1 g of a non-volatile, non-electrolyte solute of molar mass 250 g/mol was dissolved in 51.2 g of benzene. If the freezing point depression constant K_f of benzene is 5.12 kg K mol^{-1}. The freezing point of benzene is lowered by
(a) 0.3 K (b) 0.5 K
(c) 0.2 K (d) 0.4 K

174. The boiling point of 0.2 mol kg^{-1} solution of X in water is greater than equimolal solution of Y in water. Which one of the following statements is true in this case ?
(a) Molecular mass of X is greater than the molecular mass of Y.
(b) Molecular mass of X is less than the molecular mass of Y.
(c) Y is undergoing dissociation in water while X undergoes no change.
(d) X is undergoing dissociation in water.

175. What is the freezing point of a solution containing 8.1 g HBr in 100 g water assuming the acid to be 90% ionised ?
(K_f for water = 1.86 K kg mol^{-1}) :
(a) 0.85°K (b) −3.53°K
(c) 0°K (d) −0.35°K

176. An 1% solution of KCl (I), NaCl (II), $BaCl_2$ (III) and urea (IV) have their osmotic pressure at the same temperature in the ascending order (molar masses of NaCl, KCl, $BaCl_2$ and urea are respectively 58.5, 74.5, 208.4 and 60 g mole^{-1}). Assume 100% ionization of the electrolytes at this temperature
(a) I < III < II < IV (b) III < I < II < IV
(c) I < II < III < IV (d) III < IV < I < II

HINTS AND SOLUTIONS

FACT/DEFINITION TYPE QUESTIONS

1. **(d)**

2. **(c)** Sodium fluoride is used as rat poison.

3. **(b)** Almost all the processes in our body occur in liquid solution.

4. **(c)** In homogeneous mixtures composition and properties both are uniform throughout the mixture.

5. **(a)** Hexane is not water soluble, hence solution is not formed.

6. **(d)** Dilute, concentrated and saturated terms are qualitative methods of description of concentration of solution whereas molar or molarity is quantitative method.

7. **(d)**

8. **(b)** Density = 1.17 gm/cc (Given)

As $d = \frac{\text{Mass}}{\text{Volume}}$

volume = 1cc $\therefore$ mass = d = 1.17g

$$\text{Molarity} = \frac{\text{No. of moles}}{\text{Volume in litre}} = \frac{1.17 \times 1000}{36.5 \times 1}$$

$$= \frac{1170}{36.5} = 32.05\text{M}$$

9. **(c)** From molarity equation

$M_1V_1 + M_2V_2 = M_3(V_1 + V_2)$

$1 \times 2.5 + 0.5 \times 3 = M_3 \times 5.5$

$$M_3 = \frac{4}{5.5} = 0.73\text{M}$$

10. **(b)** Relation between molality and mole fraction is

$$m = \frac{1000 \times x_2}{x_1 M_1} = \frac{1000 \times .2}{0.8 \times 78} = 3.2$$

Thus, $X(m) = 3.2$

11. **(b)** $\text{M} = \frac{\text{Wt} \times 1000}{\text{M.Wt.} \times \text{V}}$; $\text{M} = \frac{7.1 \times 1000}{142 \times 100} = 0.5\text{M}$

12. **(a)** $\frac{\Delta p}{p^\circ} = \frac{n_2}{n_1 + n_2}$ or $\frac{n_2}{n_1 + n_2} = \frac{640 - 630}{640} = \frac{0.0156}{1}$

or 1 mole i.e., 78g benzene contains solute = 0.0156 mol

$$\therefore \text{Molality of solution} = \frac{0.0156 \times 10^3}{78} = 0.2\ m$$

13. **(d)** $\text{Normality} = \frac{\text{Moles of solute}}{\text{Volume of solution in litre}}$

Given mass of solute = 4.0 g

No. of moles of NaOH = 4/40

Volume of solution = 100 ml = 100/1000 L

$$\text{Normality} = \frac{4/40}{100/1000} \approx 1\text{ N}$$

14. **(c)** $\text{Molarity} = \frac{\text{Number of moles}}{\text{Volume of solution (L)}}$

$$\text{Moles of water} = \frac{\text{Mass}}{\text{Molar mass}} = \frac{1000}{18} = 55.6$$

$$\text{Molarity} = \frac{55.6}{1} = 55$$

15. **(b)** $\because$ 10 g glucose is dissolved in = 100 ml solution.

$\therefore$ 180 g (g mole) is dissolved in

$$= \frac{100}{10} \times 180 = 1800\text{ ml} = 1.8\text{ L}$$

16. **(d)** $\text{ppm} = \frac{\text{Mass of solute}}{\text{Mass of solution}} \times 10^6$

$$\therefore \text{ppm} = \frac{10}{10^6} \times 10^6 = 10\text{ ppm}$$

17. **(a)** $\frac{p^\circ - p}{p^\circ} = x_{\text{solute}}$

Given, $p^\circ = 0.8$ atm, $p = 0.6$ atm, $x_{\text{solute}} = ?$

$\frac{0.8 - 0.6}{0.8} = x_{\text{solute}}$ or $\frac{0.2}{0.8} = x_{\text{solute}}$,

or $x_{\text{solute}} = 0.25$

18. **(b)** $\text{Molarity} = \frac{\text{No. of moles of solute}}{\text{Volume in litres}} = \frac{5}{2.5} = 2\ M$

19. **(b)** One molal solution means one mole of solute is present in 1 kg (1000 g) solvent

i.e., mole of solute = 1

$$\text{Mole of solvent } (H_2O) = \frac{1000\text{g}}{18\text{g}} = \frac{1000}{18}$$

$$\text{Mole fraction of solute} = \frac{1}{\left(1 + \frac{1000}{18}\right)} = \frac{18}{1008} = 0.018.$$

20. **(d)** $NV = N_1V_1 + N_2V_2 + N_3V_3$

or, $1000\text{N} = 1 \times 5 + \frac{1}{2} \times 20 + \frac{1}{3} \times 30$ or $\text{N} = \frac{1}{40}$.

21. **(a)** For HCl

M = N = 0.1

$N_1V_1 = N_2V_2$; $25 \times N_1 = 0.1 \times 35$

$$N_1 = \frac{0.1 \times 35}{25};\ \therefore \text{M} = \frac{0.1 \times 35}{25 \times 2} = 0.07.$$

22. **(b)** 1 molal solution means 1 mole of solute dissolved in 1000 gm solvent.

$\therefore$ $n_{\text{solute}} = 1$ $\quad w_{\text{solvent}} = 1000$ gm

$$\therefore \quad n_{\text{solvent}} = \frac{1000}{18} = 55.56$$

$$x_{\text{solute}} = \frac{1}{1+55.56} = 0.0177$$

23. **(d)** H_3PO_4 is tribasic so N = 3M = 3 × 1N = 3N.

24. **(c)** $N_1V_1 + N_2V_2 = NV$

$4x + 10(1-x) = 6 \times 1; -6x = -4; x = 0.67$

Thus 0.67 litre of 4N HCl

$1 - x = 1 - 0.67 = 0.33$ litre of 10 N HCl

25. **(c)** $$\text{Molality (m)} = \frac{\text{Molarity}}{\text{Density} - \dfrac{\text{Molarity} \times \text{Molecular mass}}{1000}}$$

$$= \frac{18}{1.8 - \dfrac{18 \times 98}{1000}} = 5000$$

26. **(d)** No. of millimoles = 500 × 0.2 = 100

Thus, molarity of diluted solution

$$= \frac{100}{700}$$

(Molarity = No. of moles L^{-1} = No. of millimoles mL^{-1})

= 0.1428 M

27. **(d)** $$\text{Molarity (M)} = \frac{\text{wt} \times 1000}{\text{mol. wt.} \times \text{vol (ml)}}$$

$$2 = \frac{\text{wt.}}{63} \times \frac{1000}{250}$$

$$\text{wt.} = \frac{63}{2}\text{ gm}$$

$$\text{wt. of 70\% acid} = \frac{100}{70} \times 31.5 = 45\text{ gm}$$

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

29. **(c)** Applying the law of equivalence,

$$N_1V_1 + N_2V_2 + N_3V_3 = N_RV_R$$

$$\frac{N}{10} \times 50 + \frac{N}{3} \times 30 + \frac{N}{2} \times 10 = N_R \times 1000$$

$$5N + 10N + 5N = 1000 \times N_R$$

$$\Rightarrow N_R = \frac{N}{50}$$

30. **(c)** 40 g NaOH = 1 mole

$$\therefore \quad \text{molality} = \frac{\text{moles of the solute}}{\text{mass of the solvent in kg}} = \frac{1}{1} = 1\text{ molal}$$

31. **(b)** Both molality and mole fraction are not related to the volume of solution, thus they are both independent of temperature.

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

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

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

33. **(a)**

34. **(c)** In a given solution sum of all the mole fraction is unity i.e.,

(a) $x_1 + x_2 + x_3 + x_4 = 1$

(b) $\dfrac{n_3}{n_1 + n_2 + n_3 + n_4} = x_3$

35. **(d)** Volume is temperature dependent, hence expression involving volume term (normality, molarity and formality) varies with temperature

$$\text{Normality} = \frac{\text{geq of solute}}{\text{vol. of solution in L}}$$

$$\text{Molarity} = \frac{\text{moles of solute}}{\text{vol. of solution in L}}$$

$$\text{Formality} = \frac{\text{formula mass}}{\text{vol. of solution in L}}$$

$$\text{Molality} = \frac{\text{moles of solute}}{\text{mass of solvent in kg}}$$

Since molality does not include the volume term, it is independent of temperature.

36. **(b)** An increase in temperature of the solution increases the solubility of a solid solute.

The amount of solute that dissolve depends on what type of solute it is.

For solids and liquid solutes, changes in pressure have practically no effect on solubility.

37. **(d)**

38. **(b)** Number of solute particles going into solution will be equal to the solute particles separating out and a state of dynamic equilibrium is reached.

$$\text{solute + solvent} \rightleftharpoons \text{solution.}$$

i.e., rate of dissolution = rate of crystallization.

39. **(d)** The maximum amount of solute dissolved in a given amount of solvent is its solubility.

40. **(d)**

41. **(b)** According to Le-chateliers principle, for an exothermic reaction ($\Delta H < 0$) increase in temperature decreases the solubility.

42. **(c)** On increasing the pressure over the solution phase by compressing the gas to a smaller volume (in fig b) increase the number of gaseous particles per unit volume over the solution and also the rate at which the gaseous particles are striking the surface of solution to enter it. The solubility of the gas will increase until a new equilibrium is reached resulting in an increase in the pressure of a gas above the solution and thus its solubility increases.

43. **(d)**

44. **(a)** According to Henry's law at a constant temperature, the solubility of a gas in a liquid is directly proportional to the pressure of the gas.

45. **(d)** According to Henry's law,
$m = k \times p$
given $K_H = 1.4 \times 10^{-3}$
$p_{O_2} = 0.5$ or
$p_{O_2} = K_H \times x_{O_2}$
$$\therefore x_{O_2} = \frac{0.5}{1.4 \times 10^{-3}}$$
No. of moles; $n = \frac{m}{M}$
$$0.7 \times 10^{-4} = \frac{m}{32}$$
$m = 22.4 \times 10^{-4}\,g = 2.24\,mg$

46. **(c)**

47. **(b)** [**Hint :** If added substance dissolves, the solution is unsaturated. If it does not dissolve solution is saturated. If precipitation occurs solution is supersaturated.]

48. **(c)**

49. **(b)** Body temperature of human beings remains constant.

50. **(a)** **51.** **(b)** **52.** **(a)**

53. **(c)** The partial pressure of the gas in vapour phase (p) is proportional to the mole fraction of the gas (x).
$p = K_H.x$
Where K_H is Henry's constant.

54. **(d)** To increase the solubility of CO_2 in soft drinks and soda water, the bottle is sealed under high pressure.

55. **(d)** Scuba divers must cope with high concentrations of dissolved gases while breathing air at high pressure underwater. Increased pressure increases the solubility of atmospheric gases in blood. When the divers come towards surface, the pressure gradually decreases. This releases the dissolved gases and leads to the formation of bubbles of nitrogen in the blood. This blocks capillaries and creates a medical condition known as bends, which are painful and dangerous to life. To avoid bends, as well as, the toxic effects of high concentrations of nitrogen in the blood, the tanks used by scuba divers are filled with air diluted with helium (11.7% helium, 56.2% nitrogen and 32.1% oxygen).

56. **(a)** At high altitudes the partial pressure of oxygen is less than that at the ground level. This leads to low concentrations of oxygen in the blood and tissues of people living at high altitudes or climbers. Low blood oxygen causes climbers to become weak and unable to think clearly, symptoms of a condition known as anoxia.

57. **(c)**

58. **(a)** Raoult's law becomes special case of Henry's law when K_H become equal to p_1°.

59. **(c)** **60.** **(d)**

61. **(b)** In the solution, the surface has both solute and solvent molecules; thereby the fraction of the surface covered by the solvent molecules gets reduced. Consequently, the number of solvent molecules escaping from the surface is correspondingly reduced, thus, the vapour pressure is also reduced.

62. **(a)** For example, decrease in the vapour pressure of water by adding 1.0 mol of sucrose to one kg of water is nearly similar to that produced by adding 1.0 mol of urea to the same quantity of water at the same temperature.

63. **(d)**

64. **(a)** Given $V.P_P = 80$ torr
$V.P_Q = 60$ torr
$P_{total} = V \cdot P_P \times x_p + V \cdot P_q \times x_q$
$$= \left[80 \times \frac{3}{5} + 60 \times \frac{2}{5}\right] = 16 \times 3 + 12 \times 2$$
$P_{total} = 48 + 24 = 72$ torr

65. **(b)** Moles of glucose $= \frac{18}{180} = 0.1$

Moles of water $= \frac{178.2}{18} = 9.9$

Total moles $= 0.1 + 9.9 = 10$

$$p_{H_2O} = \text{Mole fraction} \times \text{Total pressure} = \frac{9.9}{10} \times 760$$
$= 752.4$ Torr

66. **(d)** $p = p_A x_A + p_B x_B$
$= p_A x_A + p_B(1 - x_A)$
$\Rightarrow p_A x_A + p_B - p_B x_A$
$\Rightarrow p_B + x_A(p_A - p_B)$

67. **(b)** $p_A^\circ = ?$, Given $p_B^\circ = 200$ mm of Hg, $x_A = 0.6$,
$x_B = 1 - 0.6 = 0.4$, $P = 290$ of Hg
$$P = P_A + P_B = P_A^\circ x_A + P_B^\circ x_B$$
$$\Rightarrow 290 = P_A^\circ \times 0.6 + 200 \times 0.4 \;\therefore\; p_A^\circ = 350 \text{ mm of Hg.}$$

68. **(b)** $p_{total} = p_A^\circ x_A + p_B^\circ x_B$
$$550 = p_A^\circ \times \frac{1}{4} + p_B^\circ \times \frac{3}{4}$$
$p_A^\circ + 3p_B^\circ = 550 \times 4$ ...(i)
In second case
$$p_{total} = p_A^\circ \times \frac{1}{5} + p_B^\circ \times \frac{4}{5}$$
$p_A^\circ + 4p_B^\circ = 560 \times 5$ ...(ii)
Subtract (i) from (ii)
$\therefore p_B^\circ = 560 \times 5 - 550 \times 4 = 600$
$\because p_A^\circ = 400$

69. **(d)** According to given information
$p_X = 80$ Torr
$p_Y = 60$ Torr
$n_X = 3$ moles
$n_Y = 2$ moles
$$\text{mole fraction of X}(x_X) = \frac{n_X}{n_X + n_Y} = \frac{3}{3+2} = \frac{3}{5}$$

mole fraction of Y$(x_Y) = \frac{n_Y}{n_X + n_Y} = \frac{2}{3+2} = \frac{2}{5}$

Total Pressure, $P = p_X x_X + p_Y x_Y$

$= \frac{3}{5} \times 80 + \frac{2}{5} \times 60 = 48 + 24 = 72$ Torr.

70. **(a)** Total vapour pressure = vapour pressure of pure benzene + vapour pressure of toluene
$= 100 + 50 = 150$ mm
We know,

$P^\circ_{C_6H_6} = P \times x_{C_6H_6}$

$100 = 150 \times x_{C_6H_6}$

$x_{C_6H_6} = \frac{100}{150} = 0.67$

71. **(c)** These two components A and B follows the condition of Raoult's law if the force of attraction between A and B is equal to the force of attraction between A and A or B and B.

72. **(b)** According to Raoult's law "The partial pressure of a volatile component of a solution is directly proportional to its mole fraction in solution at any temperature".

$p = P_x^\circ$

where, p = Partial pressure of component
P° = Vapour pressure of component in pure form
x = mole fraction of component in solution.

73. **(c)** For an ideal solution, $\Delta H = 0$, $\Delta V = 0$
Hence, option (c) is incorrect.

74. **(c)** For ideal solution,

$\Delta V_{mixing} = 0$ and $\Delta H_{mixing} = 0$.

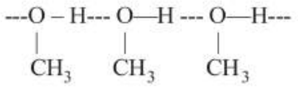
75. **(d)** C_2H_5I and C_2H_5OH form non-ideal solution.

76. **(d)**

77. **(a)** On adding acetone, its molecules get in between the host molecules and break some of the hydrogen bonds between them. Due to weakening of interactions, the solution shows positive deviation from Raoult's law.

78. **(d)** A solution containing A and B components shows negative deviation when A–A and B–B interactions are weaker than that of A–B interactions. For such solutions.
$\Delta H = -ve$ and $\Delta V = -ve$

79. **(b)** Positive deviations are shown by such solutions in which solvent-solvent and solute-solute interactions are stronger than the solute-solvent interactions. In such solution, the interactions among molecules becomes weaker. Therefore their escaping tendency increases which results in the increase in their partial vapour pressures.
In pure methanol there exists intermolecular H–bonding.



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

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

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

81. **(a)** Acetone and chloroform shows negative deviation from Raoult's law when these are mixed, the hydrogen bonding takes place between the two molecular species due to which escaping tendency of either liquid molecules becomes less and boiling point of solution increases.

82. **(b)**

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

84. **(a)** For an ideal solution $\Delta S_{mix} > 0$

85. **(b)**

86. **(d)** Azeotropic mixture is constant boiling mixture, it is not possible to separate the components of azeotropic mixture by boiling.

87. **(c)**

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

89. **(b)**

90. **(c)** Relative lowering of vapour pressure depends upon the mole fraction of solute.

i.e., $\frac{P^\circ - P}{P^\circ}$ = mole fraction of solute

91. **(b)** According to Raoult's law, the relative lowering in vapour pressure of a dilute solution is equal to the mole fraction of the solute present in the solution.

$\frac{p^\circ - p}{p}$ = Mole fraction of solute $= \frac{n}{n+N}$

92. **(a)** Given vapour pressure of pure solvent
$(P^\circ) = 121.8$ mm Hg; Weight of solute $(w) = 15$ g
Weight of solvent $(W) = 250$ g; Vapour pressure of solution $(P) = 120.2$ mm Hg and Molecular weight of solvent $(M) = 78$
From Raoult's law

$$= \frac{P^o - P}{P^o} = \frac{w}{m} \times \frac{M}{W}$$

$$\frac{121.8 - 120.2}{121.8} = \frac{15}{m} \times \frac{78}{250}$$

or $\quad m = \frac{15 \times 78}{250} \times \frac{121.8}{1.6} = 356.2$

93. **(d)** $\frac{P^\circ - P}{P^\circ} = \frac{n_2}{n_1 + n_2}$

$\frac{640-600}{640} = \frac{2.5/x}{39/78}$

$x = \frac{640 \times 78 \times 2.5}{39 \times 40} = 80$

94. **(c)** According to Raoult's law

$\frac{p^\circ - p}{p^\circ} = x_B$

$$\begin{bmatrix} x_B = \text{Mole fraction of solute} = \frac{.2}{.2+.8} = \frac{1}{5} \\ p = 60 \text{ mm of Hg} \end{bmatrix}$$

$\frac{p^\circ - p}{p^\circ} = \frac{1}{5}$ or $4p^\circ = (p) \times 5$

$\Rightarrow p^\circ = \frac{60 \times 5}{4} = 75 \text{mm of Hg}$

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

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

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

96. **(b)** $\left[\frac{P^\circ - P}{P^\circ}\right] \times 100 = \frac{w_2}{M_2} \times \frac{M_1}{w_1} \times 100 = 10$

$\frac{w_2}{60} \times \frac{18}{180} \times 100 = 10$ or $w_2 = 60$ g

Thus, 60 g of the solute must be added to 180 g of water so that the vapour pressure of water is lowered by 10%.

97. **(a)** The vapour pressure of a solution of glucose in water can be calculated using the relation

$\frac{p^\circ - p_s}{p_s} = \frac{\text{Moles of glucose in solution}}{\text{Moles of water in solution}}$

or $\frac{17.5 - p_s}{p_s} = \frac{18/180}{178.2/18}$ $\quad [\because p^\circ = 17.5]$

or $17.5 - p_s = \frac{0.1 \times p_s}{9.9}$ or $p_s = 17.325$ mm Hg.

Hence (a) is correct answer.

98. **(c)** Osmotic pressure is a colligative property.

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

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

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

Since Na_2SO_4 has maximum number of particles (c) hence has maximum boiling point.

100. **(c)** $K_b = \frac{0.1 \times 180 \times 100}{1.8 \times 1000} = 1 \text{ K/m}$

101. **(b)** $\Delta T_b = K_b \times i \times m$

Where ΔT_b = Elevation in boiling point

K_b = molal elevation constant

i = vant Hoff factor

$\therefore \Delta T_b \propto$ molality.

102. **(a)** $\Delta T_f = i \times K_f \times m$

Van't Hoff factor, $i = 2$ for NaCl, $m = 0.01$

hence $\Delta T_f = 0.02 K_f$ which is maximum in the present case.

Hence ΔT_f is maximum or freezing point is minimum.

103. **(c)**

$$\Delta T = K_f m = \frac{K_f \times W_2 \times 1000}{M_2 W_1} = 5.12 \times \frac{1}{250} \times \frac{1000}{51.2} = 0.4\text{K}$$

104. **(d)** $(\underset{1-0.3}{HX} \rightleftharpoons \underset{0.3}{\overset{+}{H}} + \underset{0.3}{X^-}, i = 1.3); \Delta T_f = K_f \times m \times i$

$\Delta T_f = 1.85 \times 0.2 \times 1.3 = 0.481^\circ C$

$\therefore T_f = T_f^\circ - \Delta T_f = 0 - 0.481^\circ C = -0.481^\circ C$

105. **(b)** Benzoic acid exists as dimer in benzene.

106. **(b)** $\Delta T_f = K_f \times m = 1.86 \times 0.5 = 0.93^\circ C;\ T_f = -0.93^\circ C$

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

$\Delta T_b = K_b . m$

Hence, we have $m = \frac{\Delta T_f}{K_f} = \frac{\Delta T_b}{K_b}$

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

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

$= 0.18 \times \frac{1.86}{0.512} = 0.654^\circ C$

As the Freezing Point of pure water is 0°C,

$\Delta T_f = 0 - T_f$

$0.654 = 0 - T_f$

$\therefore T_f = -0.654$

Thus the freezing point of solution will be $-0.654^\circ C$.

108. **(d)** Addition of solute to water decreases the freezing point of water (pure solvent).

$\therefore$ When 1% lead nitrate (solute) is added to water, the freezing point of water will be below 0°C.

109. **(a)** $\Delta T_f = K_f \frac{1000 W_2}{M_2 W_1} = \frac{1.86 \times 1000 \times 68.5}{342 \times 1000} = 0.372$

$T_f = T^\circ_f - \Delta T_f$

$T_f = -0.372^\circ C$

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

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

$= \frac{1000 \times 1.86 \times 1.8}{0.465 \times 40} \Rightarrow M = 180$

Molecular formula = (empirical formula)$_n$

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

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

111. (b) Blood cells neither swell nor shrink in isotonic solution. As isotonic solutions have equal concentration therefore there is no flow of solvent occurs and hence solvent neither enters nor flow out of the blood cells.

112. (a) Isotonic solutions have same molar concentration at given temperature provided the Van't Hoff factor (i) is same.

113. (b)

114. (a) The solution which provide same number of ions are isotonic.

$Ca(NO_3)_2 \longrightarrow Ca^{2+} + 2NO_3^-$

Total ions produced = 3

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

Total ions produced = 3

$\therefore$ 0.1 M $Ca(NO_3)_2$ and 0.1 M Na_2SO_4 are isotonic.

115. (d) Osmotic pressure is a colligative property. Hence resulting osmotic pressure of the solution is given by

$\pi_T = \pi_1 + \pi_2 + \pi_3$ ....

$\pi_T = 1.64 + 2.46 = 4.10$ atm.

116. (a) According to Boyle-van't Hoff law,

$\pi \propto C$ (at constant temp)

117. (c) Isotonic solutions have same osmotic pressure

$\pi_{\text{glucose}} = \pi_{\text{unknown solute}}$

$$\therefore \frac{m_1}{M_1} = \frac{m_2}{M_2} \text{ or } \frac{5}{180} = \frac{2}{M_2} \Rightarrow M_2 = 72$$

118. (b) $\Delta T_f = K_f \times m$

K_f is a characteristic of a particular solvent *i.e.*, it will be different for different solvents.

119. (b)

120. (c) During osmosis water flows through semipermeable membrane from lower concentration to higher concentration.

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

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

123. (a) Van't Hoff equation is

$\pi V = inRT$

For depression in freezing point.

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

For elevation in boiling point.

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

For lowering of vapour pressure,

$$\frac{P^{\circ}_{\text{solvent}} - P_{\text{solution}}}{P^{\circ}_{\text{solvent}}} = i\left(\frac{n}{N+n}\right).$$

124. (d) **125. (c)**

126. (c) $Na_2SO_4 \longrightarrow 2Na^+ + SO_4^{2-}$

Mol. before dissociation $1 \quad 0 \quad 0$

Mol. after dissociation $1-\alpha \quad 2\alpha \quad 1\alpha$

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

127. (d) The salt that ionises to least extent will have highest freezing point. [i.e., minimum ΔT_f]

128. (b) $AlCl_3$ furnishes more ions than $CaCl_2$ and thus possess higher boiling point i.e., $t_1 > t_2$.

129. (a) Concentration of particles in $CaCl_2$ solution will be maximum as $i = 3$ for $CaCl_2$ and $i = 2$ for KCl.

Glucose and Urea do not dissociate into ions, as they are nonelectrolytes.

130. (a) $K_4[Fe(CN)_6]$ and $Al_2(SO_4)_3$ both dissociates to give 5 ions or $i = 5$

$K_4[Fe(CN)_6] \rightleftharpoons 4K^+ + [Fe(CN)_6]^{4-}$

and $Al_2(SO_4)_3 \rightleftharpoons 2Al^{3+} + 3SO_4^{--}$

131. (a) Depression in freezing point $\propto$ No. of particles.

(when concentration of different solutions is equal)

$Al_2(SO_4)_3$ provides five ions on ionisation

$Al_2(SO_4)_3 \longrightarrow 2Al^{3+} + 3SO_4^{2-}$

while KCl provides two ions

$KCl \longrightarrow K^+ + Cl^-$

$C_6H_{12}O_6$ and $C_{12}H_{22}O_{11}$ are not ionised so they have single particle in solution.

Hence, $Al_2(SO_4)_3$ have maximum value of depression in freezing point or lowest freezing point.

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

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

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

$1 \quad 0 \quad 0$

$(1-\alpha) \quad \alpha \quad 2\alpha$

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

Assuming 100% ionization

So, $i = 1 + 2 = 3$

$$\Delta T_b = 3 \times 0.52 \times 0.1 = 0.156 \approx 0.16 \quad \left[m = \frac{13.44}{134.4} = 0.1\right]$$

133. (d) $\Delta T_f = i.k_f.m$; $\Delta T_b = i.k_b.m$

$$\frac{\Delta T_f}{\Delta T_b} = \frac{k_f}{k_b}$$

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

$$\frac{0.186}{\Delta T_b} = \frac{1.86}{0.52} \Rightarrow \Delta T_b = \frac{0.52 \times 0.186}{1.86} = 0.052$$

STATEMENT TYPE QUESTIONS

134. (d)

135. (b) Molarity include volume thus with increase intemperature increases' volume increases, hence molarity decreases while in case of molality mass of solvent is taken, which is not effected by temperature.

136. (c) As temperature increases solubility of gas decreases, so dissolution of gas can be considered as exothermic process.

137. (c) Solubility of gases increase with decrease of temperature.

138. (c) A solute dissolves in a solvent if intermolecular interactions are similar in the two or we may say like dissolves like.

139. (c) The vapour pressure of a liquid increases with increase of temperature.

140. (b)

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

142. (b) Osmotic pressure is a colligative property as it depends on the number of solute molecules and not on their identity. For dilute solutions, during osmosis solvent molecules always flow from lower concentration to higher concentration of solution.

MATCHING TYPE QUESTIONS

143. (d) **144. (c)** **145. (b)** **146. (a)** **147. (a)**

ASSERTION-REASON TYPE QUESTIONS

148. (a)

149. (c) Both the solute and solvent will form the vapours but vapour phase will become richer in the more volatile component.

150. (b) **151. (b)** **152. (d)** **153. (a)** **154. (b)**

CRITICAL THINKING TYPE QUESTIONS

155. (c) Equivalent weight of orthophosphoric acid

$$(H_3PO_4) = \frac{3+31+64}{3} = \frac{98}{3}$$

Now 100 gm solution contains 70 gm H_3PO_4

$\frac{100}{1000 \times 1.54}$ litre of solution contains $\frac{70}{98/3}$ gm equivalent of H_3PO_4

Normality of solution

$$= \frac{\frac{70 \times 3}{98}}{\frac{1}{10 \times 1.54}} = \frac{70 \times 3}{98} \times 10 \times 1.54 = 33 \text{ N}$$

156. (a) Mole fraction of any component A in solution

$$x = \frac{\text{No. of moles of A}}{\text{Total No. of moles of solution}}$$

As total no. of moles of solution > No. of moles of A

Thus x can never be equal to one or zero.

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

158. (d) Let the mass of methane and oxygen = m gm.

Mole fraction of O_2

$$= \frac{\text{Moles of } O_2}{\text{Moles of } O_2 + \text{Moles of } CH_4}$$

$$= \frac{m/32}{m/32 + m/16} = \frac{m/32}{3m/32} = \frac{1}{3}$$

Partial pressure of O_2 = Total pressure × mole fraction

of O_2, $P_{O_2} = P \times \frac{1}{3} = \frac{1}{3}P$

159. (a) $k_H = 100 \text{ kbar} = 10^5 \text{ bar}, p = 1 \text{ bar}$

$p = k_H \times x_A$

$$x_A = \frac{p}{k_H} = \frac{1}{100 \times 10^3} = 10^{-5}$$

$$\text{Moles of water} = \frac{1000}{18} = 55.5$$

Weight of water = 1000 g ($\because$ 1000 mL = 1000 g)

$$\text{Mole fraction} = 10^{-5} = \frac{x}{55.5 + x}$$

As 55.5 >>> x, thus neglecting x from denominator

$$10^{-5} = \frac{x}{55.5} \Rightarrow x = 55.5 \times 10^{-5} \text{ moles}$$

or 0.555 millimoles.

160. (c)

161. (a) % of N_2 in atmosphere = 78.9%

% of O_2 in atmosphere = 20.95%

Partial pressure of N_2 = 0.789 atm = 0.799 bar

Partial pressure of O_2 = 0.2095 atm = 0.212 bar

According to Henry's law,

$$P = (K_H)_{O_2} x \Rightarrow \frac{0.212}{(34.86 \times 1000)} = x_{O_2} = 6.08 \times 10^{-6}$$

$$P = (K_H)_{N_2} x \Rightarrow \frac{0.799}{(76.48 \times 1000)} = x_{N_2} = 1.0447 \times 10^{-5}$$

$$\Rightarrow \left(\frac{n_{O_2}}{n_{O_2} + n_{H_2O} + n_{N_2}}\right) : \left(\frac{n_{N_2}}{n_{O_2} + n_{H_2O} + n_{N_2}}\right)$$

$$\Rightarrow x_{O_2} : x_{N_2}$$

$$6.08 \times 10^{-6} : 1.04 \times 10^{-5}$$

$$= 1 : 1.71$$

162. (a) According to idea of Raoult's law "partial pressure of one of the component is proportional to mole fraction of that component in the solution."

$$P = P_1^\circ x_1 + P_2^\circ x_2$$

$$600 = 450\,x_1 + 700\,x_2$$

$$4.5\,x_1 + 7x_2 = 6$$

$\because$ $x_1 + x_2 = 1$

$\therefore$ $x_1 = 0.6\,x_2 = 0.4$

$\Rightarrow$ $x_1 = 0.4, x_2 = 0.6$

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

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

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

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

164. (a)

165. (a) Since formation of hydrogen bonding takes place, due to this bond energy is supposed to be released and hence change in enthalpy is negative,so reaction is exothermic.

166. (a) According to Raoult's law,

$$P_T = x_A p_A^\circ + x_B p_B^\circ$$

Given, $= P_{T_1}$ 500 mm Hg

$n_A = 1$ and $n_B = 2 \therefore x_A = 1/3$ and $x_B = 2/3$

$$\Rightarrow 500 = \frac{1}{3} p_A^\circ + \frac{2}{3} p_B^\circ$$

$$\Rightarrow 1500 = p_A^\circ + 2p_B^\circ \quad \text{...(i)}$$

Also given Qn that one more mole of B is added to the solution, the pressure of the ideal solution increases by 25 mm Hg.

$$\therefore P_{T_2} = 500 + 25 = 525 \text{ mm Hg}$$

Also, $n_B = 3 \therefore x_A = 1/4$ and $x_B = 3/4$

$$525 = \frac{1}{4} p_A^\circ = \frac{3}{4} p_B^\circ \quad \text{...(ii)}$$

$$2100 = P_A^\circ + 3P_B^\circ$$ Subtract (i) and (ii),

$$p_B^\circ = 600 \text{ mm Hg}$$

$$p_A^\circ + 2p_B^\circ = 1500 \Rightarrow p_A^\circ = 300 \text{ mm Hg.}$$

167. (d)

168. (b) According to Raoult's law

$$\frac{\Delta p}{p^\circ} = \frac{n}{n+N} \text{ (mole fraction of solute)}$$

$$\frac{10}{p^\circ} = 0.2 \therefore p^\circ = 50 \text{ mm of Hg}$$

For other solution of same solvent

$$\frac{20}{p^\circ} = \frac{n}{n+N} \text{ (Mole fraction of solute)}$$

$$\Rightarrow \frac{20}{50} = \text{Mole fraction of solute}$$

$\Rightarrow$ Mole fraction of solute $= 0.4$

As mole fraction of solute + mole fraction of solvent $= 1$

Hence, mole fraction of solvent $= 1 - 0.4 = 0.6$

169 (b) Relative lowering of vapour pressure is given by :

$$\frac{P^\circ - P_s}{P^\circ} = \frac{w/m}{w/m + W/M}$$

where, $P^\circ =$ vapour pressure of pure solvent

$P_s =$ vapour pressure of solution

$w =$ mass of solute

$m =$ molecular mass of solute

$W =$ mass of solvent

$M =$ molecular mass of solvent

For dilute solution

$$\Rightarrow \frac{121.8 - 120.2}{121.8} = \frac{15/m}{250/78} = \frac{15}{m} \times \frac{78}{250} = 1.3 \times 10^{-2}$$

$$\Rightarrow m = 356.265$$

170. (a) From Raoult law

$$\frac{p^\circ - p}{p^\circ}$$

$$= \frac{\text{No.of moles of solute}}{\text{No. of moles of solvent+ No. of moles of solute}}$$

When the concentration of solute is much lower than the concentration of solvent,

$$\frac{p^\circ - p}{p^\circ} = \frac{\text{No. of moles of solute}}{\text{No. of moles of solvent}}$$

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

$$m = \frac{\text{Number of moles of the solute}}{\text{Mass of solvent in grams}} \times 1000$$

$$\Delta T_b = K_b \times \frac{\text{Number of moles of the solute}}{\text{Mass of solvent in grams}} \times 1000$$

Number of moles of solute

$$= \frac{\Delta T_b \times \text{Mass of solvent in grams}}{K_b \times 1000}$$

$$= \frac{2 \times 100}{0.76 \times 1000} = 0.26,$$

Number of moles of solvent $= \frac{100}{18} = 5.56$

From equation (i) we get, $\frac{760 - p}{760} = \frac{0.26}{5.56}$

On solving, $p = 724.46 \approx 724$

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

$\Delta T_b + \Delta T_f = 5$

$m(k_b + k_f) = 5$

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

(or) $\frac{5}{2.37 \times 10}$ moles in 100 g water

$\therefore$ Wt. of sucrose $= \frac{5}{2.37 \times 10} \times 342 = 72\text{g}$

172. (b) Given $k_b = x\ \text{K kg mol}^{-1}$

$\Delta T_b = k_b \times m$

$\therefore\ y = x \times m$

$m = \frac{y}{x}$

We know

$\Delta T_f = k_{f \times m}$

On substituting value of m,

$\Delta T_t = \frac{yz}{x}$

173. (d) Mass of non-volatile solute = 1g

Molar mass of solute = 250g mol^{-1}

Mass of benzene = 51.2g, $K_f = 5.12\ \text{K kg mol}^{-1}$

$$\Delta T_f = \frac{K_f \times 1000 \times w_2}{M_2 \times w_1}$$

where, w_2 = mass of the solute

M_2 = molar mass of solute

w_1 = mass of the solvent

On substituting given values, $\Delta T_f = \frac{5.12 \times 1000 \times 1}{51.2 \times 250}$

$\therefore\ \Delta T_f = 0.4\text{K}$

174. (d) $\Delta T_b = iK_b m$

Given, $(\Delta T_b)_x > (\Delta T_b)_y$

$\therefore\ i_x K_b m > i_y K_b m$ (K_b is same for same solvent)

$i_x > i_y$

So, x is undergoing dissociation in water.

175. (b) Given mass of solute = 8.1 g

Mass of solvent = 100 g

For HBr

$$\begin{array}{lcc} HBr \longrightarrow & H^+ + & Br^- \\ 1 & 0 & 0 \\ (1-\alpha) & \alpha & \alpha \end{array}$$

$\alpha = 90\% = 0.9$

$i = 1 + \alpha = 1 + 0.9 = 1.9$

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

$= 1.86 \times \frac{\text{moles of solute}}{\text{mass of solvent in kg}} \times 1.9$

$= 1.86 \times \frac{8.1/81}{100/1000} \times 1.9$

$= 1.86 \times 1 \times 1.9 = 3.534\text{K}$

$T_f = T_f{}^\circ - \Delta T_f$

or $T_f = 0 - 3.534\ \text{K}$

$\therefore\ T_f = -3.534\ \text{K}$

176. (d) 1% solution contains 1 g of the solute in 100 g of solution.

Osmotic pressure, $\pi = CRT$

The value of R and T is same for all the solute however, all of them undergo 100% dissociation

$\therefore\ \pi \propto i \times C$

$i_{KCl} = 2, i_{NaCl} = 2, i_{BaCl_2} = 3$ and $i_{urea} = 1$.

$n_{KCl} = 1/74.5$

$C_{KCl} = \frac{1/74.5}{100} \times 1000 = 0.13$

or $\pi_{KCl} = 2 \times 0.13 = 0.26$

$n_{NaCl} = \frac{1}{58.5}$

$C_{NaCl} = \frac{1/58.5}{100} \times 1000 = 0.17$

$\therefore\ \pi_{NaCl} = 2 \times 0.17 = 0.34$

$n_{BaCl2} = \frac{1}{208.4}$

$C_{BaCl_2} = \frac{1/208.4}{100} \times 1000 = 0.048$

or $\pi_{BaCl_2} = 3 \times 0.048 = 0.14$

$n_{urea} = \frac{1}{60}$

$C_{urea} = \frac{1/60}{100} \times 1000 = 0.16$

$\therefore\ \pi_{urea} = 1 \times 0.16 = 0.16$

$\therefore\ \pi_{BaCl_2} < \pi_{urea} < \pi_{KCl} < \pi_{NaCl}$

or III < IV < I < II