I. Multiple Choice Questions (Type-I)

1. Which of the following units is useful in relating the concentration of a solution with its vapour pressure?
(i) mole fraction
(ii) parts per million
(iii) mass percentage
(iv) molality
Solution:
Option (i) is the answer.

2. 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?
(i) Sugar crystals in cold water.
(ii) Sugar crystals in hot water.
(iii) Powdered sugar in cold water.
(iv) Powdered sugar in hot water.
Solution:
Option (iv) is the answer.

3. At equilibrium the rate of dissolution of a solid solute in a volatile liquid solvent is _____.
(i) less than the rate of crystallisation
(ii) greater than the rate of crystallisation
(iii) equal to the rate of crystallisation
(iv) zero
Solution:
Option (iii) is the answer.

4. A beaker contains a solution of a substance 'A'. Precipitation of substance 'A' takes place when a small amount of 'A' is added to the solution. The solution is _____.
(i) saturated
(ii) supersaturated
(iii) unsaturated
(iv) concentrated
Solution:
Option (ii) is the answer.

5. The maximum amount of a solid solute that can be dissolved in a specified amount of a given liquid solvent does not depend upon _____.
(i) Temperature
(ii) Nature of solute
(iii) Pressure
(iv) Nature of solvent
Solution:

Option (iii) is the answer.

6. Low concentration of oxygen in the blood and tissues of people living at high altitude is due to _____.
(i) low temperature
(ii) low atmospheric pressure
(iii) high atmospheric pressure
(iv) both low temperature and high atmospheric pressure
Solution:
Option (ii) is the answer.

7. Considering the formation, breaking and strength of hydrogen bond, predict which of the following mixtures will show a positive deviation from Raoult's law?
(i) Methanol and acetone.
(ii) Chloroform and acetone.
(iii) Nitric acid and water.
(iv) Phenol and aniline.
Solution:
Option (i) is the answer.

8. Colligative properties depend on _____.
(i) the nature of the solute particles dissolved in solution.
(ii) the number of solute particles in solution.
(iii) the physical properties of the solute particles dissolved in solution.
(iv) the nature of solvent particles.
Solution:
Option (ii) is the answer.

9. Which of the following aqueous solutions should have the highest boiling point?
(i) 1.0 M NaOH
(ii) 1.0 M Na_2SO_4
(iii) 1.0 M NH_4NO_3
(iv) 1.0 M KNO_3
Solution:
Option (ii) is the answer.

10. The unit of ebulioscopic constant is _____.
(i) K kg mol–1 or K (molality)–1
(ii) mol kg K–1 or K–1(molality)
(iii) kg mol–1 K–1 or K–1(molality)–1
(iv) K mol kg–1 or K (molality)
Solution:
Option (i) is the answer.

11. In comparison to a 0.01 M solution of glucose, the depression in freezing point of a 0.01 M $MgCl_2$ solution is _____.
(i) the same
(ii) about twice
(iii) about three times
(iv) about six times
Solution:
Option (iii) is the answer.

12. An unripe mango placed in a concentrated salt solution to prepare pickle, shrivels because _____.
(i) it gains water due to osmosis.
(ii) it loses water due to reverse osmosis.
(iii) it gains water due to reverse osmosis.
(iv) it loses water due to osmosis.
Solution:
Option (iv) is the answer.

13. At a given temperature, osmotic pressure of a concentrated solution of a substance _____.
(i) is higher than that at a dilute solution.
(ii) is lower than that of a dilute solution.
(iii) is same as that of a dilute solution.
(iv) cannot be compared with an osmotic pressure of a dilute solution.
Solution:
Option (i) is the answer.

14. Which of the following statements is false?
(i) Two different solutions of sucrose of the same molality prepared in different solvents will have the same depression in freezing point.
(ii) The osmotic pressure of a solution is given by the equation $\Pi = CRT$ (where C is the molarity of the solution).
(iii) Decreasing order of osmotic pressure for 0.01 M aqueous solutions of barium chloride, potassium chloride, acetic acid and sucrose is $BaCl_2 > KCl > CH_3COOH >$ sucrose.
(iv) According to Raoult's law, the vapour pressure exerted by a volatile component of a solution is directly proportional to its mole fraction in the solution.
Solution:
Option (i) is the answer.

15. The values of Van't Hoff factors for KCl, NaCl and K_2SO_4 , respectively, are _____.
(i) 2, 2 and 2

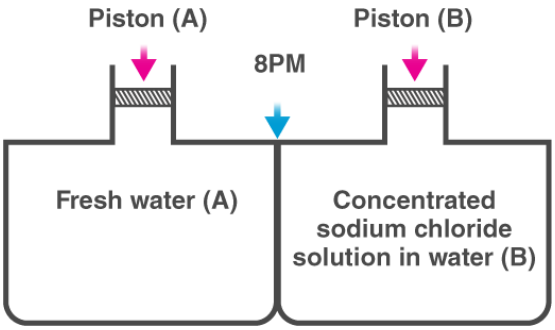
(ii) 2, 2 and 3
(iii) 1, 1 and 2
(iv) 1, 1 and 1
Solution:
Option (ii) is the answer.

16. Which of the following statements is false?
(i) Units of atmospheric pressure and osmotic pressure are the same.
(ii) In reverse osmosis, solvent molecules move through a semipermeable membrane from a region of lower concentration of solute to a region of higher concentration.
(iii) The value of molal depression constant depends on the nature of the solvent.
(iv) Relative lowering of vapour pressure is a dimensionless quantity.
Solution:
Option (ii) is the answer.

17. Value of Henry's constant KH
_____.
(i) increases with increase in temperature.
(ii) decreases with increase in temperature.
(iii) remains constant.
(iv) first increases then decrease.
Solution:
Option (i) is the answer.

18. The value of Henry's constant KH
is _ .
(i) greater for gases with higher solubility.
(ii) greater for gases with lower solubility.
(iii) constant for all gases.
(iv) not related to the solubility of gases.
Solution:
Option (ii) is the answer.

19. Consider Fig. 2.1 and mark the correct option.
(i) water will move from the side (A) to side (B) if a pressure lower than the osmotic pressure is applied on piston (B).
(ii) water will move from the side (B) to side (A) if a pressure greater than the osmotic pressure is applied on piston (B).
(iii) water will move from the side (B) to side (A) if a pressure equal to osmotic pressure is applied on piston (B).
(iv) water will move from the side (A) to side (B) if pressure equal to osmotic pressure is applied on the piston
(A).



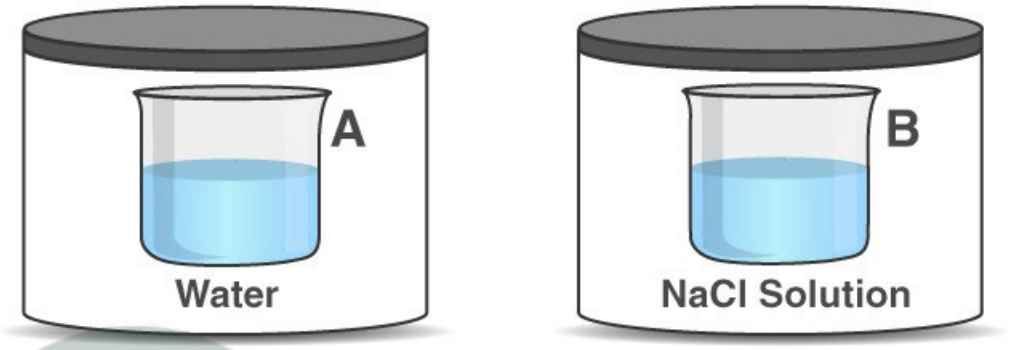
Solution:
Option (ii) is the answer.

20. 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_____.
(i) iA< iB< iC
(ii) iA> iB> iC
(iii) iA= iB= iC
(iv) iA<iB> iC
Solution:
Option (iii) is the answer.

21. On the basis of information given below mark the correct option.
Information:
(A) In bromoethane and chloroethane mixture intermolecular interactions of A–A and B–B type are nearly the same as A–B type interactions.
(B) In ethanol and acetone mixture A–A or B–B type intermolecular interactions are stronger than A–B type interactions.
(C) In chloroform and acetone mixture A–A or B–B type intermolecular interactions are weaker than A–B type interactions.
(i) Solution (B) and (C) will follow Raoult's law.
(ii) Solution (A) will follow Raoult's law.
(iii) Solution (B) will show a negative deviation from Raoult's law.
(iv) Solution (C) will show a positive deviation from Raoult's law
Solution:
Option (ii) is the answer.

22. Two beakers of capacity 500 mL were taken. One of these beakers, labeled as "A", was filled with 400 mL water whereas the beaker labelled "B" was filled with 400 mL of 2 M solution of NaCl. At the same temperature, both the beakers were placed in closed containers of the same material and same capacity as shown in Fig. 2.2.
At a given temperature, which of the following statement is correct about the

vapour pressure of pure water and that of NaCl solution.
(i) the vapour pressure in container (A) is more than that in a container (B).
(ii) the vapour pressure in container (A) is less than that in the container (B).
(iii) vapour pressure is equal in both containers.
(iv) the vapour pressure in container (B) is twice the vapour pressure in container (A).



Solution:
Option (i) is the answer.

23. If two liquids A and B form minimum boiling azeotrope at some specific composition then _____.
(i) A–B interactions are stronger than those between A–A or B–B.
(ii) vapour pressure of solution increases because more number of molecules of liquids A and B can escape from the solution.
(iii) vapour pressure of solution decreases because less number of molecules of only one of the liquids escape from the solution.
(iv) A–B interactions are weaker than those between A–A or B–B.
Solution:
Option (i) is the answer.

24. 4L of 0.02 M aqueous solution of NaCl was diluted by adding one litre of water. The molality of the resultant solution is _____.
(i) 0.004
(ii) 0.008
(iii) 0.012
(iv) 0.016
Solution:
Option (iv) is the answer.

25. 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.
(i) At specific composition, methanol-acetone mixture will form minimum boiling azeotrope and will show positive deviation from Raoult's law.
(ii) At specific composition, methanol-acetone mixture forms maximum boiling azeotrope and will show positive deviation from Raoult's law.
(iii) At specific composition, methanol-acetone mixture will form minimum boiling azeotrope and will show negative deviation from Raoult's law.
(iv) At specific composition, methanol-acetone mixture will form maximum boiling azeotrope and will show negative deviation from Raoult's law.
Solution:
Option (ii) is the answer.

26. KH value for Ar(g), CO2(g), HCHO (g) and CH4(g) are 40.39, 1.67, 1.83×10–5 and 0.413 respectively. Arrange these gases in the order of their increasing solubility.
(i) HCHO < CH4< CO2 < Ar
(ii) HCHO < CO2< CH4< Ar
(iii) Ar < CO2< CH4< HCHO
(iv) Ar < CH4 < CO2 < HCHO
Solution:
Option (iii) is the answer.

II. Multiple Choice Questions (Type-II)
Note: In the following questions two or more options may be correct.

27. Which of the following factor (s) affect the solubility of a gaseous solute in the a fixed volume of liquid solvent?
(a) nature of solute (b) temperature (c) pressure
(i) (a) and (c) at constant T
(ii) (a) and (b) at constant P
(iii) (b) and (c) only
(iv) (c) only
Solution:
Option (i) and (ii) are the answers.

28. Intermolecular forces between two benzene molecules are near to same strength as those between two toluene molecules. For a mixture of benzene and toluene, which of the following are not true?
(i) Δmix H = zero
(ii) Δmix V = zero
(iii) These will form a minimum boiling azeotrope.
(iv) These will not form the ideal solution.
Solution:
Option (iii) and (iv) are the answers.

29. Relative lowering of vapour pressure is a colligative property because _____.

(i) It depends on the concentration of a non-electrolyte solute in a solution and does not depend on the nature of the solute molecules.
(ii) It depends on a number of particles of electrolyte solute in a solution and does not depend on the nature of the solute particles.
(iii) It depends on the concentration of a non-electrolyte solute in solution as well as on the nature of the solute molecules.
(iv) It depends on the concentration of an electrolyte or nonelectrolyte solute in solution as well as on the nature of solute molecules.
Solution:
Option (i) and (ii) are the answers.

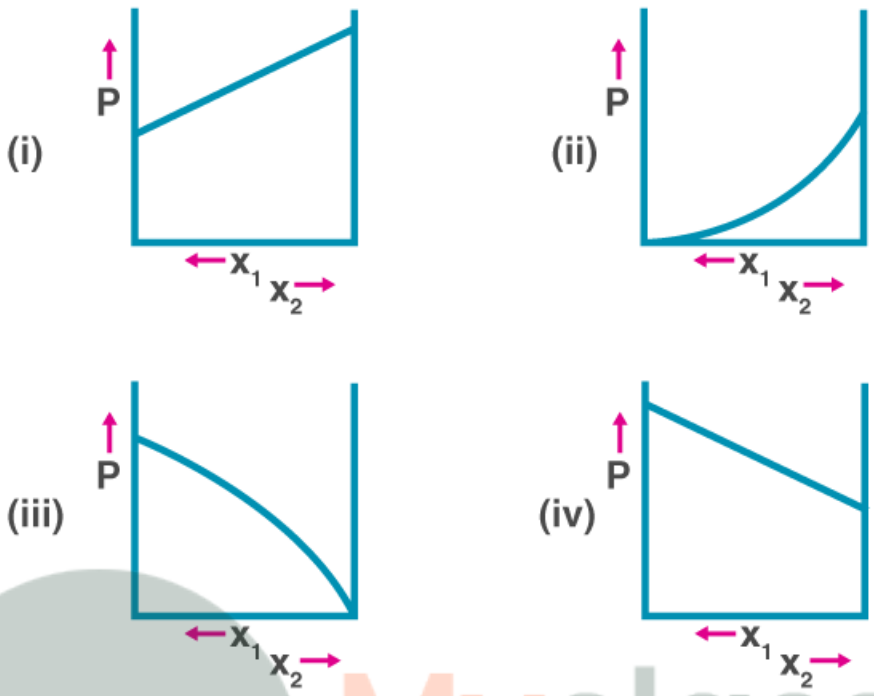
30. Van't Hoff factor i is given by the expression _____.
(i) i = Normal molar mass/Abnormal molar mass
(ii) i = Abnormal molar mass/ Normal molar mass
(iii) i= Observed colligative property/calculated colligative property
(iv) i = Calculated colligative property/ Observed colligative property
Solution:
Option (i) and (iii) are the answers.

31. Isotonic solutions must have the same _____.
(i) solute
(ii) density
(iii) elevation in boiling point
(iv) depression in freezing point
Solution:
Option (ii) and (iii) are the answers.

32. Which of the following binary mixtures will have the same composition in the liquid and vapour phase?
(i) Benzene - Toluene
(ii) Water-Nitric acid
(iii) Water-Ethanol
(iv) n-Hexane - n-Heptane
Solution:
Option (ii) and (iii) are the answers.

33. In isotonic solutions _____.
(i) solute and solvent both are same.
(ii) osmotic pressure is the same.
(iii) solute and solvent may or may not be same.
(iv) a solute is always the same solvent may be different.
Solution:
Option (ii) and (iii) are the answers.

34. For a binary ideal liquid solution, the variation in total vapour pressure versus the composition of the solution is given by which of the curves?



Solution:
Option (i) and (iv) are the answers.

35. Colligative properties are observed when _____.
(i) a non-volatile solid is dissolved in a volatile liquid.
(ii) a non-volatile liquid is dissolved in another volatile liquid.
(iii) a gas is dissolved in non-volatile liquid.
(iv) a volatile liquid is dissolved in another volatile liquid.
Solution:
Option (i) and (ii) are the answers.

III. Short Answer Type

36. Components of a binary mixture of two liquids A and B were being separated by distillation. After some time separation of components stopped and the composition of the vapour phase became the same as that of a liquid phase. Both the components started coming in the distillate. Explain why this happened.
Solution:
Both the components started coming in the distillate and the vapour and liquid phase will have the same composition. This shows an azeotropic mixture. Therefore it can't be separated by distillation.

37. Explain why on the addition of 1 mol of NaCl to 1 litre of water, the boiling point of water

increases, while the addition of 1 mol of methyl alcohol to one litre of water decreases its boiling point.
Solution:
On addition of 1 mol of NaCl to 1 litre of water, the boiling point of water increases, while the addition of 1 mol of methyl alcohol to one litre of water decreases its boiling point because if a non-volatile solute like NaCl is added this happens. Methyl alcohol is volatile than water so it decreases the boiling point.

38. Explain the solubility rule "like dissolves like" in terms of intermolecular forces that exist in solutions.
Solution:
"Like dissolves like" means that a solute dissolves in a solvent if their intermolecular interactions are similar. That is if polar solutes can dissolve in polar solvents and non-polar solutes can dissolve in non-polar solvents.

39. Concentration terms such as mass percentage, ppm, mole fraction and molality are independent of temperature, however, molarity is a function of temperature. Explain.
Solution:
A change in temperature causes a change in volume, therefore changes the molarity of a solution. Hence, terms such as mass percentage, ppm, mole fraction, and molality are independent of temperature as they are calculated based on mass and do not involve volume.

40. What is the significance of Henry's Law constant KH?
Solution:
Henry's law states that in a solution, "the partial pressure of the gas in the vapour phase (p) is proportional to the mole fraction of the gas (x) in the solution"
The equation is given as $p = KHx$, where KH is the Henry Law's constant. The constant is a function of the nature of the gas. If kH value is high at a given temperature, then lower will be the solubility of a gas in the liquid.

41. Why are aquatic species more comfortable in cold water in comparison to warm water?
Solution:
Aquatic species are more comfortable in cold water due to the increased solubility and availability of O_2.

42. (a) Explain the following phenomena with the help of Henry's law.
(i) A painful condition known as bends.
(ii) Feeling of weakness and discomfort in breathing at high altitude.
(b) Why soda water bottle kept at room temperature fizzes on opening?
Solution:
(i) Bends is a condition that occurs to sea drivers or scuba drivers. They have to breathe air under high pressure underwater. Nitrogen gas is not soluble at normal pressure. In underwaters, they dissolve in the blood. Once the divers come up to the surface, the gases escape the blood by forming bubbles of N_2 in blood. These bubbles can block capillaries and obstruct the flow of O_2, which forms the painful condition of bends.
(ii) At higher altitudes, atmospheric pressure is low and it reduces the solubility of oxygen in blood and

tissues of people travelling or living at high altitudes. The lack of oxygen causes weakness and unable to think properly, a condition known as anoxia.

(iii) When a soda water bottle is opened at room temperature and normal pressure conditions, the pressure inside the bottle reduces and solubility of CO_2 reduces, thus causing the gas bubbles to escape and soda water fizzing.

43. Why is the vapour pressure of an aqueous solution of glucose lower than that of water?
Solution:
Example of water and glucose can be taken for explaining this. In water, the surface of the liquid will be occupied by the water molecules. When we add glucose into it, some of the surfaces will be occupied by the glucose molecules. Therefore the number of a solvent molecule will escape from the surface and thus vapour pressure also get reduced.

44. How does sprinkling of salt help in clearing the snow-covered roads in hilly areas? Explain the phenomenon involved in the process.
Solution:
Salt is a de-icing agent and can be used to melt ice. If the freezing point is lowered the ice starts melting. So the addition of salt to snow reduces the freezing point from O°C to lower.

45. What is a "semi-permeable membrane"?
Solution:
A semipermeable membrane is a membrane that allows only the flow of solvent molecules but not solute molecules. Cellulose acetate and phospholipid bilayer in biological cells are the examples for semi-permeable membrane.

46. Give an example of a material used for making semipermeable membrane for carrying out reverse osmosis.
Solution:
Examples of materials used for the semipermeable membrane include cellulose acetate and polyamides.

IV. Matching Type
Note: In the following questions match the items given in Column I and Column II.

46. Match the items given in Column I and Column II.

Column I	Column II
(i) Saturated solution	(a) Solution having the same osmotic pressure at a given temperature as that of the given solution.
(ii) Binary solution	(b) A solution whose osmotic pressure is less than that of another.
(iii) Isotonic solution	(c) Solution with two components.
(iv)Hypotonic solution	(d) A solution which contains the maximum amount of solute that can be dissolved in a given amount of solvent at a given temperature.
(v) Solid solution	
(vi) Hypertonic solution	

	(e) A solution whose osmotic pressure is more than another. **(f) A solution in the solid phase**

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Solution:

(i) is d
(ii) is c
(iii) is a
(iv) is b
(v) is f
(vi) is e

48. Match the items given in Column I with the type of solutions given in Column II.

Column I	**Column II**
(i) Soda water	**(a) A solution of the gas in solid**
(ii) Sugar solution	**(b) A solution of the gas in gas**
(iii) German silver	**(c) A solution of solid in liquid**
(iv) Air	**(d) A solution of solid in solid**
(v) Hydrogen gas in palladium	**(e) A solution of the gas in liquid**
	(f) A solution of liquid in solid

Solution:

(i) is e
(ii) is c
(iii) is d
(iv) is b
(v) is a

49. Match the laws given in Column I with expressions given in Column II.

Column I	**Column II**
(i) Raoult's law	**(a) $\Delta Tf = Kfm$**
(ii) Henry's law	**(b) $\Pi = CRT$**
(iii) Elevation of boiling point	**(c) $p = x_1P_1^0 + X_2P_2^0$**
(iv) Depression in freezing point	**(d) $\Delta Tb = Kbm$**
(v) Osmotic pressure	**(e) $p = KH.x$**

Solution:

(i) is c
(ii) is e
(iii) is d
(iv) is a
(v) is b

50. Match the terms given in Column I with expressions given in Column II.

Column I	Column II
(i) Mass percentage	(a) Number of moles of the solute component/ The volume of solution in litres
(ii) Volume percentage	(b) Number of moles of a component/ Total number of moles of all the components
(iii) Mole fraction	(c) Volume of the solute component in solution 100/ A total volume of solution * 100
(iv) Molality	(d) Mass of the solute component in solution 100/ The total mass of the solution *100
(v) Molarity	(e) Number of moles of the solute Components/Mass of solvent in kilograms

Solution:

(i) is d
(ii) is c
(iii) is b
(iv) is e
(v) is a